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Alina KVIETKAUSKIENĖ

**AN INTELLIGENT INVESTMENT STRATEGY
FOR RETURN SUSTAINABILITY
IN GLOBAL EQUITY MARKETS**

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VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

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Abstract

The increasing amount of available information on the activities of stock markets and issuers, a rapid expansion of stock markets (increasing market capitalization, growing number of listed companies) and the intensive growth of globalization processes, does not always help investors to make effective investment decisions. Therefore, the issue of stock markets and stock selection for the formation of investment portfolios is particularly important to investors. Although, the issuer's financial data and the databases of financial markets are very detailed and able to characterise many of the features of the subject being analysed, these data are not fully provided for the purpose of sustainable investments. This problem is being solved in the dissertation – searching ways, how to apply and combine the most commonly used individual methods for equity market selection, stocks selection and investment portfolio formation, thus using statistical data, which are already available, for assessing the markets of different development levels and for the selection of particular stocks to achieve the investment return sustainability.

The aim of the dissertation is to develop a methodology for the implementation of intelligent investment strategy in equity markets, which provides opportunities for achieving investment return sustainability in financial markets for various investors.

The dissertation consists of an introduction, three chapters, general conclusions, literature reference list (283 publications), list of scientific publications by the author on the topic of the dissertation (23 publications), summary in Lithuanian and 8 annexes. The volume of the dissertation is 157 pages, excluding annexes. Text contains 20 numbered formulas, 36 figures and 26 tables.

The factors of globalization, which have an influence on financial markets behaviour, were analysed, the possibilities of classical investment methods application for the stock markets and particular stock selection as well as the links between various economic indicators and stock market returns were examined, the concepts of investment return sustainability and intelligent investment strategy were expanded in the first chapter. The methodology of stock markets evaluation, stock selection and intelligent investment strategy for investor is proposed in the second chapter. Experimental and numerical results of the intelligent investment strategy implementation are presented in the final chapter.

23 articles on the topic of the dissertation has been published: six of them in the journals, abstracted and indexed in scientific international databases, three in other peer-reviewed scientific journals, eleven in conferences proceedings and three in the conferences proceedings referred by the *Clarivate Analytics Web of Science*. The results of the dissertation were presented at ten scientific conferences.

Reziუმэ

Dэl didэjanчиэ prieinamos informacijos, susijusios su akcijэ rinkэ ir emitentэ veikla, kiekiэ, sparчиai besipleчиanчиэ akcijэ rinkэ (didэjanti rinkэ kapitalizacija, augantis listinguojamэ bendroviэ skaičius) ir intensyvэjanчиэ globalizacijos procesэ, investuotojams tampa vis sunkiau priimti efektyvius investicinius sprendimus. Dэl шios priežasties konkreчios akcijэ rinkos ir jos akcijэ parinkimo investiciniam portfeliui formuoti klausimas yra ypaч svarbus investuotojams. Nors emitentэ finansiniэ duomenэ ir finansэ rinkэ statistiniэ duomenэ bazэs yra labai išsamios ir gali apibэdinti daugybэ nagrinэjamo subjekto veiklos požymiэ, шie duomenys yra ne iki galo panaudojami tvariэ investicijэ tikslui. Шi problema ir yra sprendžiama disertacijoje – ieškoma бэdu, kaip tikslingai pritaikyti ir sujungti daэniausiai pavieniui taikomus akcijэ rinkэ atrankos, konkreчiэ akcijэ parinkimo ir investicinio portfelio formavimo metodus, taip panaudojant turimus statistinius duomenis įvairaus išsivystymo lygio rinkoms vertinti ir akcijэ atrankai, siekiant investicinэs grэžos tvarumo.

Disertacinio darbo tikslas – parengti įžvalgios investavimo akcijэ rinkose strategijos įgyvendinimo metodikэ, sudaranчиэ galimybes investuotojams siekti investicijэ grэžos tvarumo.

Darбэ sudaro įvadas, trys pagrindiniai skyriai, bendrosios išvados, literatэros sарaшas (283 šaltiniai), autorэs publikacijэ disertacijos tema sарaшas (23 publikacijos), santrauka lietuviэ kalba ir 8 priedai. Disertacijos apimtis (be priedэ) – 157 puslapiai, tekste panaudota 20 sunumeruotэ formuliэ, 36 paveiksiai ir 26 lentelэs.

Pirmajame skyriuje analizuojamas globalizacijos veiksniэ poveikis finansэ rinkoms, nagrinэjamos klasikiniэ investavimo metodэ taikymo galimybэs akcijэ rinkэ ir akcijэ atrankai, išplэstos investicinэs grэžos tvarumo bei įžvalgios investavimo strategijos koncepcijos, nagrinэjamos įvairiэ ekonominiэ rodikliэ ir akcijэ rinkэ grэžos sарajos. Antrajame skyriuje pateikta akcijэ rinkэ vertinimo ir akcijэ parinkimo algoritmo kэrimo tyrimo metodika, taip pat pasiэlyta įžvalgios investavimo strategijos schema. Treчiajame skyriuje pateikti eksperimentiniai ir skaitiniai įžvalgios investavimo strategijos įgyvendinimo ir testavimo rezultatai.

Disertacijos tema paskelbtos 23 mokslinэs publikacijos, iš kuriэ 6 – žurnaluose, referuojamuose mokslinэse duomenэ bazэse, 3 – kituose recenzuojamuose moksliniuose žurnaluose, 11 – konferencijэ medžiagose, 3 – konferencijэ medžiagose, referuojamose *Clarivate Analytics Web of Science* duomenэ bazэje. Disertacijos rezultatai buvo pristatyti 10 moksliniэ konferencijэ

Notations

Symbols

α – alpha ratio;

β – systemic risk measure beta;

β_i – the slope of characteristic line at the same time, which shows the relative volatility of the portfolio;

β_m – beta of the market and shows the slope of the stock market;

χ^2 – chi criteria;

χ_{crit}^2 – chi criteria with degree of freedom;

b_i – i-th variable displacement constant;

Cov – covariance coefficient;

C_v – coefficient of variation;

$E_{k,l}$ – the average of shares profitability;

m – number of indicators;

$\max_j r_{ij}$ – the largest i-th indicator's value from all alternatives;

$\min_j r_{ij}$ – the lowest i-th indicator's value from all alternatives;

n – number of data points;

P_i – probability value corresponding to the calculated return;

R – expected average return;

r – number of experts;

r_F – risk free rate;
 R_i – expected return;
 r_i – the average annual return of the portfolio or investment;
 \approx
 r_{ij} – the normalised value of i-th indicator for j-m object;
 $R_{k,l}$ – the profitability of shares;
 r_m – return of the appropriate market index;
 S – sum of each indicator valuation results of deviation squares;
 σ – standard deviation;
 σ_i – the average standard deviation of average annual return;
 s_i – the sum of all experts evaluation of i-th indicator;
 S_j – the sum of all weighted normalised values;
 S_{max} – the maximum possible S value;
 W – concordance coefficient;
 w_i – the weight of i-th indicator;
 x_{ij} – the estimate of expert x according to factor j .

Abbreviations

APT – adequate portfolio theory;
 ASREA – actual to sufficient ratio (owner equity to total assets);
 ASRL – Actual to sufficient ratio (liquidity);
 CA – current assets;
 CCMV – cardinality constrained mean-variance;
 CEIC – A Euromoney Institutional Investor Company;
 CL – current liabilities;
 CPI – consumer price index;
 EMH – Efficient market hypothesis;
 ETF – exchange-traded funds;
 GDP – gross; domestic product
 I – inventories;
 ICI – the Investment Company Institute;
 IIS – intelligent investment strategy;
 LA – long-term assets;
 LL – long-term liabilities;
 LLA – low liquid assets that should be financed at the expense of owner equity;
 LR – liquidity ratio;
 MADM – Multiple Attribute Decision Making;
 MCDM – Multiple Criterion Decision Making;
 MODM – Multiple Objective Decision Making;
 MPNWC – minimally permissible net working capital;
 OECD – Organisation for Economic Cooperation and Development;
 OE – owner equity;
 OETAR – owner equity to total assets ratio;
 P – provisions;
 PMI – purchasing managers index;
 SAW – Additive weighting method;

SI – sustainable investing;
SLL – sufficient liquidity ratio;
SLOETAR – sufficient level of owner equity to total assets ratio;
SRI – socially responsible investing;
SROI – sustainable return on investment;
SSTL – sufficient short-term liabilities;
SVOE – sufficient value of owner equity;
P – provisions;
PVL – permissible value of liabilities;
TA – total assets;
TAP – technical analysis based portfolio;
UK – the United Kingdom;
USA – the United States of America;
USD – the United States of America dollar;
WCED – World Commission on Environment and Development;
ZEW – ZEW Indicator of Economic Sentiment.

Concepts

Close to real market conditions – means that investment decisions were performed in DNB trade demo version.

Equity market – “a market that gives companies a way to raise needed capital and gives investors an opportunity for gain by allowing those companies’ stock shares to be traded” (Business dictionary, 2018). The terms equity market and stock market are synonymous.

Feasibility study – possibilities research.

Financial soundness – concept, which is used for description of company financial stability, based not only on the financial independence of the company and on the level of liquidity, but also on the adequacy of the coefficient level to achieve the financial balance of long-term corporate financing. The terms financial soundness and financial stability are used as synonymous in the thesis.

Intelligent investment strategy – investment strategy that is able to adapt to different market conditions using the complex of integrated methods for investment decision making and seeking the investment return sustainability.

Impact indicators – are the indicators that have the greatest influence on stock market return in the long run.

Sustainability – is the ability to maintain or support an activity or process over the long term.

Investment return sustainability – stable investment return in long period of time, taking into account the opportunities of each market and changing environmental conditions. If we would like to quantify the understanding of the sustainability of investment return, then in this case, the sustainability of investment return would be such investment return over a chosen period that is higher than the benchmark generated return during the same period.

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Introduction

Problem Formulation

The increasing amount of available information on the activities of stock markets and issuers, a rapid expansion of stock markets (increasing market capitalization, growing number of listed companies) and the intensive growth of globalization processes, does not always help investors to make effective investment decisions. Therefore, the issue of stock markets and stock selection for the formation of investment portfolios is particularly important to those investors, who unambiguously agree, that one of the major factors for successful investment is a proper selection of stocks and stock markets. For this purpose, the selection criteria are widely analysed in scientific literature, looking for the most successful factors, having the most significant effect on stock markets return, so as to identify the best combination of methods, helping to achieve the investment return sustainability.

The scientific problem, which is being analysed and solved in the dissertation, is formulated as follows: there is no unique stock market evaluation methodology, suitable for all stock markets with various levels of development, enabling to select such equity markets and stocks, in which investors would be able to achieve the investment return sustainability in long run. Although, the issuer's financial data and the databases of financial markets are very detailed and able to

characterise many of the features of the subject being analysed, these data are not fully provided for the purpose of sustainable investments. The mentioned problem could be solved by deliberately applying and combining the most commonly used individual methods for stock market selection, stocks selection and investment portfolio formation, thus using statistical data, which are already available, for assessing the markets of different development levels and for the selection of particular stocks to achieve the investment return sustainability.

Relevance of the Thesis

Rapidly changing economic environment also causes changes in financial market behaviour. Data analysis and business intelligence solutions are highly relevant to the development of integrated management, economics and mathematical methods. Application of individual methods in economics does not ensure effective solution of complex economic problems, however the possibility of individual methods integration into a common system or process creates the basis for a holistic research. Financial market participants must quickly adapt to rapidly changing economic conditions and be able to analyse large volumes of data and make efficient investment decisions. Long run investment decisions must be effective, with particular emphasis on assumptions not about short-term returns but on the investment return sustainability.

This is especially relevant, when sales volumes are growing fast in the world stock markets. At the end of 2017, the total world stock market capitalisation was about 69 trillion dollars, which means that the stock market plays an important role in global economic development. Naturally, the highest sales volumes are in the most developed equity markets, such as the United States, the United Kingdom, Germany, Switzerland, and Hong Kong, therefore, it is expected to get the highest return on these markets, avoiding the full potential of other markets and losing relatively higher return. In this regard, the limitations of individual methods are revealed taking into consideration the fact that the scientific research are carried out only on individual stock markets analysis and testing, since the depth of the research also requires technical capacity in order to expand the field of research and not to lose opportunities of higher return in other less-analysed markets, such as Austria, Bulgaria, or Estonia, where the annual investment return can reach about 20% or more.

Created intelligent investment strategy can become a reliable tool for an investor in making effective investment decisions on any global stock market by properly integrating the most commonly used individual stock market selection, stock selection and investment portfolio formation techniques.

Object of the Research

The object of the research is the investment return in equity markets.

Aim of the Thesis

The aim of the thesis is to develop a methodology for the implementation of intelligent investment strategy in financial markets, which provides opportunities for investors to achieve investment return sustainability.

Tasks of the Thesis

In order to achieve the aim of the thesis, the following tasks are formulated:

1. To analyse the factors of globalization, which have influence on financial markets behaviour.
2. To carry out a critical analysis of search theories and methods for effective investment possibilities.
3. To develop the concepts of return sustainability and intelligent investment strategy.
4. To provide a scheme of an intelligent investment strategy, combining mostly individually used methods for stock market selection, selection of stocks and investment portfolio formation techniques.
5. To establish a methodology for stock markets evaluation, choosing the impact indicators on investment return and to carry out an assessment of selected stock markets.
6. To model an algorithm for stock selection based on the assessment of the financial soundness of companies listed in the stock markets.
7. To empirically verify the intelligent investment strategy using back-testing method and in accordance with real market conditions.

Research Methodology

In order to achieve the aim set out in the dissertation, recent scientific works on investment topic were analysed and summarised. The methods of comparative analysis, logical and systematic analysis were used to analyse conceptual provisions related to models of investment portfolio theory and financial market valuation methods. Expert evaluation and multi-criteria evaluation (SAW) methods have been used to assess stock markets as well. In addition, the methodology of

financial soundness evaluation of a company was used to create a stock selection algorithm. Stochastic optimization (an adequate portfolio model) and back-testing methods were used to reveal the use of possibilities of an intelligent investment strategy. In order to process the obtained results, methods of concretisation, generalisation and graphical analysis were used.

Scientific Novelty of the Thesis

1. The conceptions of investment return sustainability and intelligent investment strategy were developed, defining investment return sustainability as a stable investment return in the long run, taking into account the opportunities of each market and changing environmental conditions, and an intelligent investment strategy – as an ability to adapt to different market conditions, applying composition of integrated investment decision-making methods for achieving investment return sustainability.
2. The selection of stock markets by integrating multi-criteria evaluation method (SAW) has revealed new opportunities for assessing the attractiveness of investments in different levels of stock markets.
3. On the basis of a critical research analysis, a stock market assessment methodology has been developed, selecting adequate impact indicators that can be used to ensure investment return sustainability.
4. Proposed stock selection algorithm, which creates opportunity to expand investment decision making significantly and adapt to the current market conditions, it also helps to select stocks of companies, which are suitable for investment portfolio formation, and enables achieving investment return sustainability in long run.
5. Based on the carried out scientific research, an intelligent investment strategy has been developed, combining the methods of the most commonly used individual equity market selection, stock selection and investment portfolio formation methods.

Practical Value of the Research Findings

1. Developed stock market evaluation methodology, selecting adequate impact indicators for stock return, and integrated stock selection algorithm allowing to analyse large arrays of equity markets data and making important conclusions.

2. Intelligent investment strategy can be easily adapted to any market participant in terms of profitability and risk that is acceptable to them, taking into account the opportunities offered by the market.
3. Proposed intelligent investment strategy is sufficiently complete, therefore, it can be adapted for study purposes and improving existing investment strategies. It can also be used in conjunction with classical investment portfolio formation methods for making efficient investment decisions and seeking investment return sustainability in long run.
4. The research results can be used for analysing and quantifying the investment opportunities and stability of stock markets.
5. Effectiveness of introduced intelligent investment strategy was tested under close to real market conditions and it was proved that the use of this strategy allows reaching higher investment return compared to index return during the same period of time.

Defended Statements

1. Using a set of indicators, which have the most significant impact on stock market return, for the analysis and evaluation of global stock markets, it is possible to determine reliability of investment return and ensure sustainability in stock markets in long run.
2. In order to achieve investment return sustainability, it is necessary to analyse eligibility of the issuers for investment, taking into account their indicators of financial stability including stock return and risk, thus creating a stock selection algorithm.
3. The investment return sustainability can be achieved by using the logic of intelligent investment strategy, which is based on the combination and appliance of the most commonly used stock market selection, stock selection and investment portfolio formation methods.

Approval of the Research Findings

23 articles on the topic of the dissertation has been published: six of them in the journals, abstracted and indexed in scientific international databases, three in other peer-reviewed scientific journals, eleven in conferences proceedings and three in the conferences proceedings referred by the *Clarivate Analytics Web of Science*. The results of the dissertation were published at ten scientific conferences:

- 2017. The 5 th International Scientific Conference *Contemporary Issues in Business, Management and Education'2017*. Vilnius, Lithuania.

- 2017. The 20th Conference for Lithuanian Junior Researchers *Business in XXI century*. Vilnius, Lithuania.
- 2016. National Scientific Conference *Socialinė įtrauktis ir švietimo įstaigų veikla: sumaniosios edukacijos link (Social Inclusion and the Activity of Educational Institutions: towards the Smart Education)*. Vilnius, Lithuania.
- 2016. The 9th International Scientific Conference *Business and Management'2016*. Vilnius Lithuania.
- 2016. The 19th Conference for Lithuanian Junior Researchers *Business in XXI century*. Vilnius, Lithuania.
- 2015. National Scientific Conference *Verslumo ugdymo ir konkurencingumo didinimo problemos (The Problems of Entrepreneurship Development and Increase of Competitiveness)*. Vilnius, Lithuania.
- 2015. The 4th International Scientific Conference *Contemporary Issues in Business, Management and Education'2015*. Vilnius, Lithuania.
- 2015. National Scientific-Practical Conference, *Lietuvos ekonomikos augimo ir stabilumo strateginės kryptys (Strategic Trends of Economic Growth and Stability in Lithuania)*. Vilnius, Lithuania.
- 2014. The 8th International Scientific Conference *Business and Management'2014*. Vilnius, Lithuania.
- 2014. The 17 th Conference for Lithuanian Junior Researchers *Business in XXI century*. Vilnius, Lithuania.

Structure of the Dissertation

The dissertation consists of an introduction, three chapters, general conclusions, reference list (283 publications), list of publications by the author on the topic of the dissertation (23 publications), summary in Lithuanian and 8 annexes. The volume of the dissertation is 157 pages, excluding annexes. Text contains 20 numbered formulas, 36 figures and 26 tables.

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Feasibility Study of Investment in Global Financial Markets

The first chapter reviews the role of financial markets in the context of globalization, their mutual relations, globalization influence on financial markets and their suggested opportunities for the investors, provides the different approaches and methods of stock market analysis and investment portfolio formation. The research has been broadened by observation of behavioural finance as well as scientific theories like Markowitz and adequate portfolio. In addition, the concepts of investment return sustainability and intelligent investment strategy have been expanded and the impact of various macroeconomic indicators on stock markets returns has been investigated. What is more, the set of impact criteria for stock markets evaluation has been proposed. This chapter also formulates the main object and tasks of the present thesis. The research results are presented in the publications by the author: Rutkauskas & Kvietkauskienė (2013a), Kvietkauskienė (2014), Rutkauskas et al. (2014b), Rutkauskas et al. (2015a), Danilevičienė & Kvietkauskienė (2015), Kvietkauskienė & Plakys (2017) and conference proceedings by Rutkauskas & Kvietkauskienė (2013b), Rutkauskas et al. (2014a), Rutkauskas & Kvietkauskienė (2014), Kvietkauskienė & Martinkutė-Kaulienė (2014b), Rutkauskas et al. (2015b), Kvietkauskienė & Danilevičienė (2016), Kvietkauskienė & Martinkutė-Kaulienė (2016), Miltakytė & Kvietkauskienė (2016) and Kvietkauskienė & Martinkutė-Kaulienė (2017).

1.1. Role of Financial Markets in the Context of Globalization

Financial system plays the key role in the economy of a country by stimulating economic growth, influencing economic performance of the participants, affecting economic welfare; financial system makes transfer of funds more efficient. One part of transaction may possess superior information than the other part, so it can lead to the information asymmetry problem and inefficient allocation of financial resources. By overcoming the information asymmetry problem the financial system facilitates balance between surplus and deficit units.

The financial system consists of three elements:

- financial markets;
- financial institutions;
- financial regulators.

Financial markets play the most important part in the whole financial system and the economy. One of the most important conditions for sustainability in order to accelerate economic growth and ensure financial stability is the existence of financial market dynamics. The key function of financial markets is to open the way for financially active investors to participate actively in the management of finance while making financial decisions, however; Pujari (2015a) distinguished four main functions of the financial markets, affecting the country's economy (Pujari, 2015a):

1. To mobilise the savings and their allocation for more productive use.
2. To facilitate price setting.
3. To escalate the financial asset liquidity.
4. To reduce the cost of purchase and sale transactions.

Investment opportunities in global financial markets is analysed in the thesis, so it is appropriate to distinguish the most important capital markets functions, which may indicate the way for investors, how they should allocate their available financial resources in order to take an advantage of the opportunities offered by these functions (Pujari, 2015b):

- the function of economic barometer;
- the fixing of securities prices;
- the security of transactions;
- the acceleration of economic growth;
- the dissemination of capital cult;
- the creation of speculation opportunity;
- liquidity;
- improved allocation of capital;
- the promotion of savings and investment habits.

It is fully understandable that the full-scale use of the opportunities, which is created by these functions, requires special efforts and specific resources. The fact that both of those functions are consequences of the implementation and actions directed to increase in performance of these functions, introduces a common measure based on traditional methods. It develops the necessity to form these functions according to the cost effectiveness for realisation of functions possibilities. Hence, one of the most important chains of the capital market development strategy is the optimal allocation between capital market functions in order to ensure the efficiency of integral functional capital market that can be formed.

Functioning of other economic sectors depends on finance management success, therefore, the high importance of financial markets is observed in every financial system of the state. Financial markets play a special role in creating conditions for financial resources to move where their efficiency utilization would be the greatest. Economic entities acquire both material and financial resources in the countries of market economies. Financial markets provide a very wide range of investment opportunities: investment funds, currencies, equities, bonds and commodities, etc. The pricing of these financial instruments is an important challenge for these markets. Undoubtedly, financial markets not only select the correct cost of activities, but also provide a priority of given development opportunities. Therefore, the financial markets help to increase the production and its efficiency. Financial markets also influence the welfare of consumers because it allows them to acquire their needs in time (Rutkauskas & Kvietkauskienė, 2013).

It is very important to note the process of financial markets integration due to the globalization influence. The main reasons of this process are production and trade internationalisation, the cross-country financial liberalisation. Martinaitytė (2008) explains correlation between open economy and financial liberalisation, but the influence of financial globalization is smaller, because of a number of insider risks such as imbalance between savings and investment decisions, uncertainty in monetary policy and short-term consolidated decisions.

It is generally understood that we live in a globalized world. The concept of globalization was formed in the second half of XX century and was examined by many foreign authors (Larsson, 2001; Held et al. 2002; Scholte, 2005; Al-Rodhan & Stoudmann, 2006; Dreher *et al.*, 2008; Marginean, 2015; Bourguignon, 2017). Most modern theorists support the view that globalization is associated with the fundamental space, distance, time, and the existence of social change, which is as large as the changes of human activities and relationships (Dreher *et al.*, 2008; Urbšienė, 2011; Marginean, 2015). The arguments, which can be found in many scientific works, identify globalization as a phenomenon leading to substantial changes in the world and creating a new business environment, where business or economic entities re-take the leading business solutions (Dicken, 2003; Held *et al.*, 2002; Bhagwati, 2007).

A big number of studies of financial globalization appeared after Fisher report in the annual meeting of International Monetary Fund in 1997. Many authors (Kearney, 2007; Lockwood & Redoano, 2005; Raab *et al.*, 2008; Martens & Raza, 2008) used different indicators and ratios in order to measure financial globalization.

The globalization of financial markets is the integral part of economic dimension of globalization and can take many forms in different areas of financial system:

- the openness of market and mobility of capital growth;
- the processes of national financial systems integration into the global financial system;
- the liberalization of international transactions, carried out using a variety of financial instruments;
- increasing intertwining level across countries financial markets.

The dominant view of globalization formed the impression that financial markets have provided unlimited possibilities for humanity. In order to evaluate and compare the degree of financial markets globalization, it is very important to measure the level of globalization correctly. Whereas a globalization of financial markets is the economic globalization component, it would be right to say that the same factors operate the processes of financial markets globalization that led to the globalization process in general: economic, technological, social and political forces (Amit & Zot, 2004; Stonenhouse *et al.*, 2004; Mikdashi, 2003; Gatignon & Kimberly, 2004; Kropas, 2007; Isard, 2005) (see Fig. 1.1).

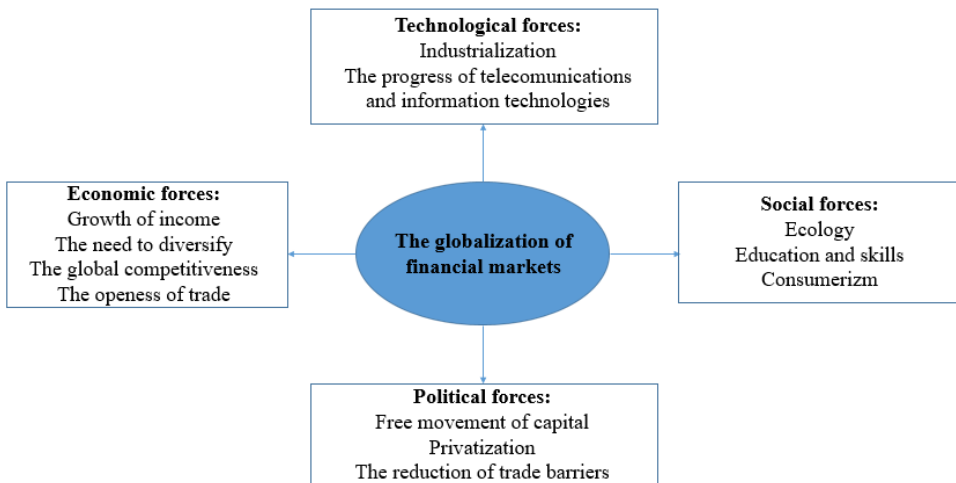


Fig. 1.1. The forces of financial market globalization (created by author, using Stonenhouse *et al.*, 2004; Gatignon & Kimberly, 2004)

Furthermore, Beck (2001) put forward the idea that globalization is not only a choice of business, countries or organizations. If globalization is compatible with all institutions in each country, then its influence will be unpredictable and unstable, so it is necessary to examine its nature, in other words, to analyse not only economic effects of globalization but also political and cultural. Many scientists (Stonhouse *et al.*, 2004; Dreher *et al.*, 2008; Bourguignon, 2017) emphasize that globalization is an irreversible process, which is often presented as a huge international market, the information revolution, universal promotion of human rights, the global industrial culture, polycentric international policy influencing individual's daily lives. This is the key moments of the positive effects of globalization.

However, on the other side are visible and negative effects of globalization on the lives of people all over the world such as global pollution, international cultural conflicts and natural disasters.

Although the proponents of globalization argue that positive aspects counter-balance the negative, the criticism of globalization impact on financial market is stronger. The representative of mainstream current Bhagwati (1998) argues that the risk of financial market globalization is greater than its benefits. According to scientists, growing level of globalization increases its negative impact and global nature threats. Separate countries have not been able to solve global problems or formulate global decisions. For this purpose, a series of international institution (such as International Monetary Fund, World Bank, the Bassel Committee, etc.) has been established in the financial sector. However, globalization processes develop faster and the non-compliance is increasingly deepening of globalizing financial markets and international institutions development level (Gatignon & Kimberly, 2004; Soros, 2002). Therefore, the authorities of these institutions have to reduce the threats of globalization. These "supranational" institutions (World Bank, International Monetary Fund and others) are also criticized for partiality, by claiming that they represent the rich countries and major international companies rather than for local companies or the developing countries, which are the most vulnerable ones (Stiglitz & Charlton, 2006; Elliott *et al.*, 2002).

The negative impact of globalization consists of fact that countries are losing political independence, they become more vulnerable, instability and other threats are increasing. Globalization does not reduce, but increases income inequality between countries and inside the countries. Mundell (1997) distinguishes one negative influence of globalization – the loss of monetary policy autonomy. From the three monetary policy objectives (capital mobility, independent monetary policy and exchange rate stability) at the same time can be achieved only two, sacrificing the third objective. However, Brakman *et al.* (2010) the refusal of monetary policy autonomy consider as not disadvantage, but advantage, because the opportunity to use monetary policy for short-term goals is eliminated, which leads to higher

inflation in the long run, the GDP growth slows down and social welfare becomes worse. However, the consequences of crisis become more severe (higher GDP decline, a longer recovery period, higher number of banks bankruptcies), if monetary policy instruments cannot be applied during the crisis (Bordo *et al.*, 2001).

According to Held *et al.* (2002), the chunky capital of financial markets is dominant in the interests of all over the world. Whereas the passing force of globalization is globalization of financial markets, it is important to know the adequate form of capital movement in the financial markets. Capital movements accompanied by innovative capital solutions and emerging individual interests. Therefore, it is particularly important to understand the anatomy of the decision-making in global capital market.

World economies are increasingly integrated into the global economy. Such process is conditioned by the stimulus strength of globalization. It is possible to distinguish the following reasons and assumptions of globalization: the global use of Earth resources, the economic efficiency of development, cross-cultural integration, communication improvement, fundamental scientific discoveries and technological opportunities, adequate opportunities of education and qualification, the convergence of existence quality, globalization challenges for the sustainability of the Earth (Fig. 1.2). These are the main factors that create a potential for economic activity and its population for allocation of resources in a global scale (Rukauskas *et al.*, 2014). It should be pointed out that only a combination of global forces leads global economic factors to join international (intellectual) entrepreneurship and globalization.

It is very important to overview the key question: how the process of globalization and its structure are determined by the physical changes, faced by Earth and its environment as well as opportunities of fundamental science and technology discoveries and how this leads subjectively emergent interests. As regards the problem of globalization of financial markets, the process of globalization takes place prominently and comprehensively, and one can talk about interoperability of development opportunities here. However, this situation creates an opportunity to examine financial markets under the globalization conditions and new findings might be revealed.

Globalization is an exclusive feature of modern financial markets because around the world the trends of general investment environment and a rapid development of integration between national markets is created. Currently, investors are not confined to opportunities of their own country markets, using the extensive opportunities of information technologies and the development of financial institutions; investors also effectively operate with the resources in international markets.

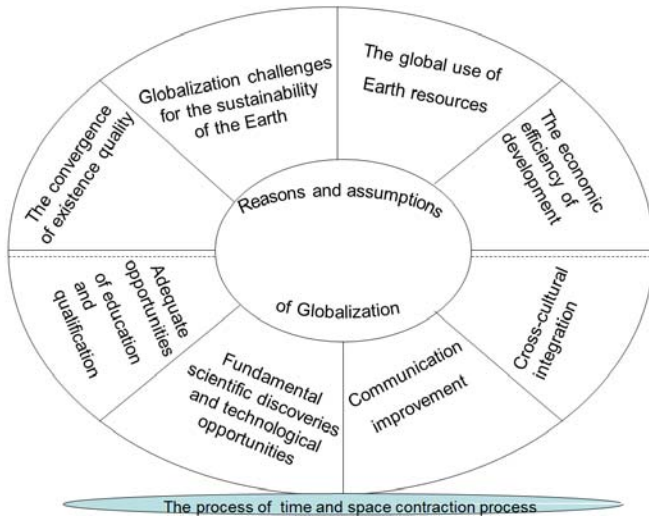


Fig. 1.2. The reasons and assumptions of globalization (Rutkauskas & Kvietkauskienė, 2013a)

Based on Rutkauskas and Kvietkauskienė (2013a), several reasons and assumptions of financial markets globalization can be excluded: communication improvement, cross-cultural integration, fundamental scientific discoveries and technological opportunities and the economic efficiency of development (Fig. 1.3).

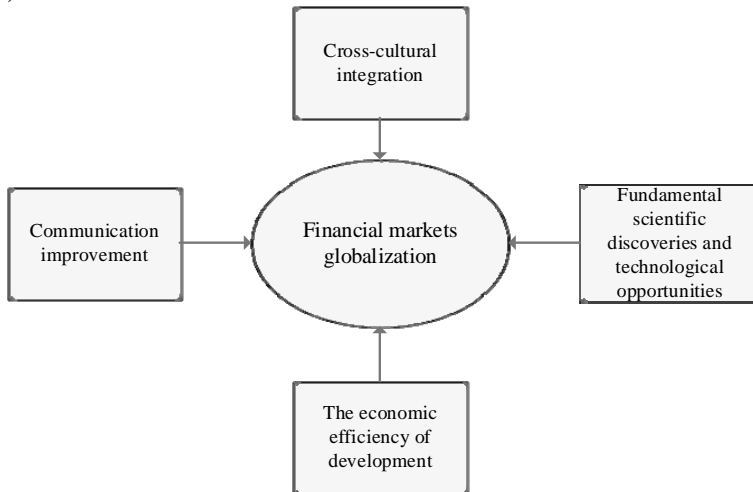


Fig. 1.3. The reasons and assumptions of financial markets globalization (created by author based on Rutkauskas & Kvietkauskienė, 2013a)

Searching for interactions of globalization with the development peculiarities of global regional and national financial systems, the process of globalization can be structured on the basis of Held et al. (2002), submitted thoughts about three main schools of hyperglobalists, sceptics and transformationalists. These schools cannot be equated with traditional affinities but the definition of globalization in their work is defined on the basis of each school approach to:

- concept;
- driving forces;
- socio-economic implications;
- influence for state power and governance;
- historical perspectives.

Of course, the influence of globalization is more important to the financial markets of developed countries. Increasing impact of financial globalization can promote imbalance of the financial markets and lead to financial crises. Different interest groups dominate in the world, which influence financial markets behaviour, regulate the ongoing globalization process, whereas the disagreements between different interest groups have negative consequences for the global economy, leads to the global conflicts, the financial markets crisis. Since the prevailing interest groups in the world touch one of the main highways – the global financial market, it is important to correctly identify their arguments. It is identified that there are prevailed interest forms in the world: hyperglobalists, sceptics and transformationalists.

Hyperglobalists and sceptics submit their arguments that existence of functioning global capital markets has led the equalization of return on financial assets around the world. Various empirical studies allow setting that in the group of the largest national economies exist global (real) interest rate with a small and static risk premia for different countries (Held *et al.*, 2002). As a result, it can be concluded that long-term interest rates emerge in the developing global capital market, despite the fact that interest rates do not level out. The formation of real global interest rates indicates the global credit demand and supply. This means a relatively high level of world financial centers interfaces and growing financial integration (Walter, 1993).

According to Rutkauskas et al. (2009), it is possible to better understand the impact of the globalization process on the circumstances behind the profit margin generated by each financial activity, similar to the level of profitability in the currency exchange and capital markets where the interplay between supply and demand and profitability is dominant, in the case of supply-demand balance. The emergence of profitability values can be observed in the context of volatility, i.e. creating an indicator of the probability distribution indicator. It is thus possible to monitor how objectively the assumption of financial assets rate of return is formed

the possibilities probability distribution for the specific market. These opportunities in every market and every moment are different, but they obey given standard, i. e. enough to accurately and reliably approximate by one of the probability distributions (Rutkauskas *et al.*, 2009).

Consequently, investment decisions have to be formed according to the extent of globalization, its opportunities and threats under these economic conditions. More investors can get more investment opportunities and study new markets at a greater distance than before. Due to the reasons and assumptions of financial markets globalization, which is being analysed in this chapter, these opportunities present a wider range of investment options and new ways to get higher investment return for investors. There is a need to expand the horizons, to study investment opportunities in global financial markets (in this case analysis of global stock markets analysis is selected) more thoroughly.

1.2. Development of the Concept of Intelligent Investment Strategy

As it was mentioned previously, stock market is very complex and changing system, and its behaviour is influenced by many factors such as economic environment, industrial development, political situation and market news. In order to ensure investment return in stock market, every investor has been looking for suitable tools and methods to analyse stock market (Chen & Chen, 2016). The aim of the thesis is to propose an investment strategy, which will consists of integrated methods that will help investors make effective investment decisions. Investment strategy is introduced with a term of intelligent, so it is important to define the concept of intelligence in the current dissertation.

A concept of “*intelligence*” has different meanings in scientific literature and various encyclopedias, but there is still no standard definition of it. Usually it can be defined in different ways including capacity for logic, understanding, abstract thought, self-awareness, communication, learning, emotional knowledge, memory, planning, creativity and problem solving. The main understandings of a concept “*intelligence*” will be analysed in detail: psychologists’ interpretations, collective interpretations from encyclopedia and different dictionaries, the use of the concept by researchers. The main definitions of intelligence concept are presented in Table 1.1.

Poh (2000) in his paper presents intelligent decision support system for investment decision making combining normative decision theory and decision analysis with traditional investment analysis and evaluation methods. Chen & Chen (2016) have used the similar understanding of intelligence concept in their research paper. The concept of intelligence has been used for model description,

which integrated different methods in investment process. According to their usage of intelligence concept, it can be understood that intelligence is the integration of several methods to the whole that can offer an intelligent approach, which could evaluate or recognise certain tendencies or signals in stock markets.

Table 1.1. The definitions of “*intelligence*” concept (created by author)

The source of concept	The understanding
Sternberg, 2000	“A biological mechanism by which the effects of a complexity of stimulus are brought together and given a somewhat unified effect in behaviour”
Szirko, 2004	“Intelligence is the ability to learn, exercise judgment, and be imaginative”
Oxford English Dictionary, 2006	“The ability to use memory, knowledge, experience, understanding, reasoning, imagination and judgement in order to solve problems and adapt to new situations”
World Book Encyclopedia, 2006	“...the ability to adapt to the environment”
Goertzel, 2006	“Achieving complex goals in complex environments”
Cambridge Advanced Learner’s Dictionary, 2006	“The ability to learn, understand and make judgments or have opinions that are based on reason”
The American Heritage Dictionary, 5 th edition, 2011	“The capacity to acquire and apply knowledge”
Encyclopedia Britannica, 2017	“...ability to adapt effectively to the environment, either by making a change in oneself or by changing the environment or finding a new one . . . intelligence is not a single mental process, but rather a combination of many mental processes directed toward effective adaptation to the environment”

Summarising different interpretations of intelligence concept, the intelligence is attributed as the possibility to integrate different methods to the whole system for effective investment decisions making. The logic of intelligent investment strategy interpretation by the author is presented in Figure 1.4. In addition, several synonyms have been proposed as far-sighted or visionary, which can also be used for intelligence description.

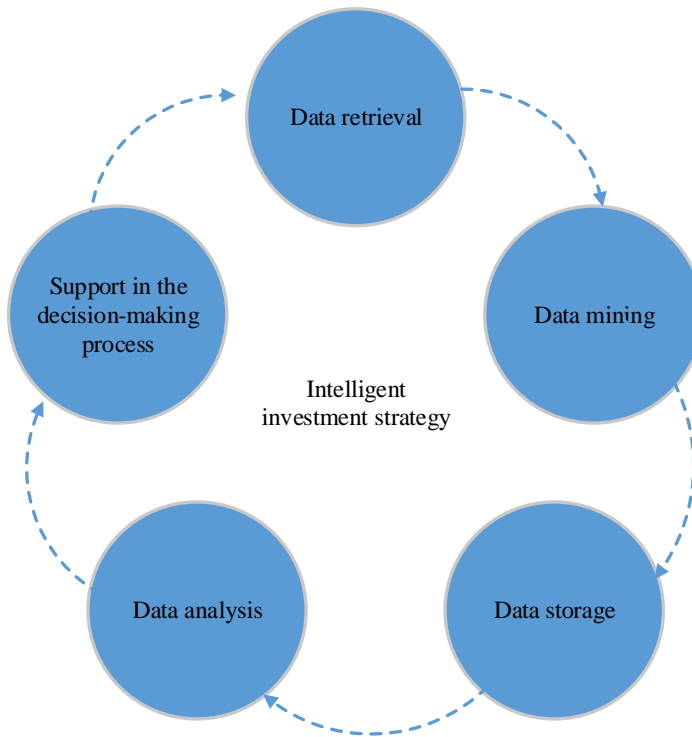


Fig. 1.4. The definition of intelligent investment strategy in the dissertation (created by author)

Intelligent investment strategy developed in the dissertation could be defined as the ability to adapt to different market conditions using the complex of integrated methods for investment decision making and seeking the investment return sustainability. Regarding the previously mentioned aspects, the problems to assure investment return sustainability in global equity markets is analysed.

1.3. Insights of Investment Return Sustainability

Currently, sustainability is one of the most popular academic fields of research. The general definition of “*sustainability*”, described in Business dictionary (2018), could be defined as “ability to maintain or support an activity or process over the long term”. The grounds of this relatively new sustainability science can be found in the concept of sustainable development, proposed by the World Commission on Environment and Development (1987) (hereinafter – WCED, also

known as the Brundtland Commission). Sustainable development is defined as “development that meets the present needs without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987). WCED for this argument has gained global support, arguing that the development should ensure the economic and environmental co-existence.

Today, “*sustainability*” is recognised worldwide as a major problem faced by the twenty-first century’s society. According to Clark and Dickson (2003), the challenge of sustainable development is the reconciliation of society development goals with the Earth’s environmental limits over the long term. It is very difficult to define sustainability and measure it quantitatively, because there are many confrontations with an immediate problem, in that sustainability has become used in very different contexts that have almost become meaningless. For example, Rutkauskas and Stasytytė (2012), Clark and Dickson (2003), Blackburn (2007) and Sinclair (2011) define sustainability as orientation of activity towards today’s needs satisfaction, leaving the possibility for future generations to satisfy their needs as well, and it summarises the main concept of science capable of finding the solution for the mentioned problem. Whereas, Campbell (2009) describes sustainability as concept, which is about the same things that engineering is about - achieving outcomes in responsible ways. It is about achieving a specified objective in a way that can produce investment return. Rutkauskas (2015) developed similar approach to sustainability, where sustainability is defined as the state of systems and processes that can help them become safe and efficient and which could be achieved through engineering. It is very important to analyse whether current capital investments will give the required return in the future (Rutkauskas, 2012).

Nowadays, sustainable investing can be a great win for investors and companies. The majority of market participants know about sustainable development in financial markets. Many of investment banks propose to manage funds in line with financial sustainability; all big companies publish environmental, social and community indicators. Therefore, it seems that sustainable investing plays an important role.

The understanding of sustainable investing (hereinafter – SI) was developed during the last several decades. Consequently, it is a field with essential number of terms and concepts that are used differently in many markets (Sustainable Investing... 2012). The majority of empirical research shows that sustainable investing approach can lead to a better financial return balanced with the risk (Colin, 2008; Kiss *et al.*, 2012). However, only a small percentage of investors incorporate environmental and social factors into their investment and decision-

making process. Therefore, it can be said that sustainable investing has the potential to become a major approach among investors, especially those who are willing to take a long-term perspective (Renne-Malone, 2010).

Talking about sustainable business, sustainability must be defined as acting with long term goals and consequences, so sustainable business must be managed in a way that its processes or overall state can be maintained indefinitely (Taylor & Donald, 2007).

Big companies are making their decisions based on their environmental, social and economic impacts, because they recognize that every act that is detrimental to society in some way may come back as a negative repercussion on the business itself. This kind of forward thinking might not have worked in the earlier days of free enterprise but it is becoming more common today among even large corporations, as managers and investors realise that environmental and social impacts are of great importance to the buying public and purchasing habits are being driven accordingly. A company that aims for corporate sustainability is also probably competitive, has good management, and long term potential for value, three criteria looked for by biotech investors. On the other hand, a company with a track record for making decisions based on local and global sustainability might appear to take losses in the short term for higher costs or smaller profit margins, but can profit overall from higher employee satisfaction and productivity, and a better reputation as well as long term following due to public perceptions of the company. Over the decades, the major goal of any business was financial profit, but in a view of the ongoing process of global sustainability, the goal of financial profit must be balanced with social and environmental goals. In this way, social and environmental systems can lead to solutions that have long-term financial viability and generate not only financial profit but already wealth. So, according to this view, financial profit can be achieved without damage to society or the environment (Taylor & Donald, 2007).

Investors' behaviour has fundamentally changed in recent years. Despite this, the financial return is still the main goal for investors, countries and companies. The amount of invested capital in sustainable funds has been rapidly increasing over the last few years. The market for socially responsible investments (hereinafter – SRI) has amounted in recent years. Renneboog et al. (2008) may serve a comprehensive review of the developments and methods in SRI. While Guerard (1997) examines the performance differences of portfolios with various screening criteria, Bello (2005) compares the performance of sustainable and common funds. Galema et al. (2008) considers the impact on SRI on stock return and concludes that SRI has a significant impact on the stock returns.

A number of studies (Cooley *et al.*, 2001, 2003; Jarrett & Stringfellow, 2000; Bengen, 2001; Ameriks *et al.*, 2001; Miglietti, 2007; Weiss, 2001, Evensky, 2000; Vora & McGinnis, 2000; Terry, 2003; Tezel, 2004; Spitzer & Singh, 2006;

Milevsky, 2007; Trainor, 2005) are addressed for examination of sustainability in investment portfolio, yet most of them are seeking not to determine the optimal composition of the portfolio, but the most possible amount that can be removed from portfolio over a given period of time. Examination of portfolio requires using the methods of simulation modelling and verification of historical market data.

There are not many definitions of sustainable investment return on investment in scientific literature. In addition, there is a distinguished a concept of sustainable return on investment, according to which, sustainable return on investment (hereinafter – SROI) is described as a methodology that identifies the initiatives, which will best accomplish goals of investor. SROI determines the full value of investment by assigning monetary values to all of the costs and benefits – economic, social and environmental (Sustainable return..., 2012). The process provides decision support in contemplation of help to communicate the full value of the project, by placing a monetary value on the sustainable initiatives including the direct, indirect/non-cash costs and benefits and the externalities, like greenhouse gas emissions and public health and safety. These benefits are generally overlooked in a traditional economic assessment and therefore not revealed to stakeholders (Sustainable return..., 2012). Ability to understand and demonstrate the links between the greater care for human and social capital and environmental responsibility is recognised as a challenge while assessing sustainable return on investment (The business..., 2012).

However, there is an obstacle that in many scientific articles (Williams & Parker, 2010; Maughan, 2012; Nicholls *et al.* 2012; Eisenhower, 2011) SROI concept was used for the determining the value of outcomes from charitable donations, for solving the waste of energy problems, built environment, migration and etc. Therefore, different formation of sustainability concept appears when investment decisions in financial markets were examined and in search of sustainable investment return in long-term. Investors generally seek to maximise their profits, but nowadays the reliability of investment is very important for every investor as a component of overall investment process According to Rutkauskas (2015), the sustainable investment return could be defined as satisfaction of certain investor's needs with the necessary level of guarantee. An approach that any subject of financial market cannot achieve more than possibilities offered by the market is used in the thesis.

The concept of investment return sustainability has been proposed, when the investment process is evaluated, taking into account that sustainability is the ability to maintain or support an activity or process over the long term. Defining investment return sustainability as a stable investment return in long period of time, it is crucial to consider all market opportunities and changing environmental conditions. If we would like to quantify the understanding of the investment return sustainability, then in this case, the sustainability of investment return would be

such investment return over a chosen period that is higher than the benchmark generated return during the same period.

1.4. Breakdown of Methods for Financial Market Evaluation and Investment Strategies

As it was discussed in the Subchapter 1.1, the main purpose of each financial market is to focus on economic and social progress oriented activities. In this way, the main goal for investors is to get higher profit with lower risk. There are main economic theories that analyse market behaviour and help to choose the best financial market for further investments. Nevertheless, the possibility of predicting the future price of financial assets from historical data is one of the most important challenges both for individual investors and for companies linked to the financial environment (Cervello-Royo *et al.*, 2015). There is a variety of methods and strategies used for making investment decisions in financial markets. Hence, the main problem for investors is to choose the right method that can be easily adapted to different financial markets.

1.4.1. Comparison of Methods for Financial Market Evaluation

The Efficient market hypothesis (hereinafter – EMH), proposed by Fama (1965), is one of the methods used for market evaluation. The main idea of this method is that a stock market is active, which means, there are well informed and prepared investors, who evaluate stocks based on all available information. According to this hypothesis, the prices in efficient market reflect the impact of the information relating to events that occurred in the past, and information related to the events that may happen in the near future. Thus, the prices in effective market reflect the impact of the information relating to events that occurred in the past, and information related to the events that may happen in the near future. Due to the competition between the advanced players of efficient market, it is assumed that the actual price of the security is a bit consistent with the fair value at any time. If the market is efficient, any available information or analysis does not earn more than any selected index earns. However, there is a variety of evidence to find more “anomalies” in the international stock markets, which are usually caused by doubts about the efficient market hypothesis (Mittal & Jain, 2009). Over the years, many scientists and academicians studied the stock market behaviour, involving developed and emerging economy in order to have a clear understanding of the market efficiency and thus raised a number of interesting questions, which are still being solved in considerable debates. The performance of various studies throughout the world (Milian, 2015; Akbas *et al.*, 2016; Brown & Yang, 2017) found that

stock returns were not completely random, and various anomalies, such as a weekend effect, a day-of-the-week effect and others exist in the markets. On the other hand, some studies (Steeley, 2001) show that these “anomalies” tend to disappear over time, and therefore it can be concluded that the market is efficient (Mittal & Jain, 2009).

Generalising the empirical research and theoretical fundamentals, Eugene F. Fama (1970) identified three forms of market efficiency: weak, semi-strong and strong forms. Others scientists (Kim & Singal, 2002; Atallah *et al.*, 2004; Cajueiro *et al.*, 2009; Bae *et al.*, 2012; Hooy & Lim, 2013) analysed the impact of deregulations on financial market efficiency. The majority of financial analysts and researchers adopt a weak form, reject a strong form and believe that in most cases the market has semi-strong form. Of course, there are exceptional cases when the market is inefficient. Entry into the financial market is immediately exposed to uncertainties to be taken into account when making investment decisions, but the EMH concept does not cover the uncertainty of this core value decision and does not reflect the market value. Against this background, the following conclusion that complete or perfect information for all market participants is unavailable, hence the absolutely efficient market cannot exist, has been made.

According to EMH, the efficient nature of the market makes it impossible to predict prices by means of historical series, which implies that it is not possible to develop an investment strategy that can beat the market under the classical criteria of risk and return (Cervello-Royo *et al.*, 2015). However, there is abundant evidence in the scientific literature against this hypothesis, as it is going to be demonstrated subsequently in the thesis; most of methods are based on the usage of technical analysis.

Shiller (1989) argued that in a rational stock market, investors would base stock prices on the expected receipt of future dividends, discounted to a present value. He examined the performance of the USA stock market since 1920s, and considered a few kinds of expectations of future dividends and discount rates that could justify the wide range of variation experienced in the stock market. Shiller concluded that the volatility of the stock market was greater than could plausibly be explained by any rational view of the future. He has written many works about irrational market behaviour and was honored with the Nobel Prize for contribution to the financial market volatility and asset price dynamics in 2013.

Other method, which is one of the most widely used methods for financial analysis that is based on the hypothesis that past price tends to repeat itself in the future is technical analysis (Gorgulho *et al.*, 2011). Bagheri *et al.* (2014) noted that technical and fundamental analyses are used more often to analyse financial market in order to make investment decisions. Technical analysis is a wide term that includes the usage of a range of trading strategies in global financial markets (Masry, 2017). This method was firstly used by the Japanese rice dealers, who

were selling futures contracts (called future), 300 years ago. Afterwards, the Japanese used price prediction method was called "Japanese candles" (Шевченко, 2001). Kirkpatrick and Dahlquist (2013) define technical analysis as the analysis of historical market data, principally volume data and price changes. All this collected information is used to make investment decisions or trading. For technical analysis, short-term and psychological factors are the most important. This analysis can be applied for the financial instruments that are traded in the market and which have the changing market price, but in most cases it is applicable for stocks, currencies, commodities, futures and options markets.

There is excluded group of technical factors (Żbikowski, 2015; Hu *et al.*, 2015; Patel *et al.*, 2015) that determine the price of stocks. These factors are related to market conditions, taking into account changes in prices, demand and supply factors and trade turnover. The obtained data is presented in graphs. Studying charts, the technical analysis seeks to measure the time of securities buying and selling in order to anticipate market volatility: the need to buy before the market take-off (called upswing) and sell – before the market drops (called the downswing). These graphs are widely used in the compilation of the stock market averages and indexes, as well as identifying individual stock and commodity prices (Cibulskienė, Grigaliūnienė, 2006; Zapranis & Tsinaslanidis, 2012; Bagheri *et al.*, 2014).

Technical analysis can be represented and interpreted by the following scheme (Fig. 1.5), where the most important and best-known technical analysis theories are demonstrated.

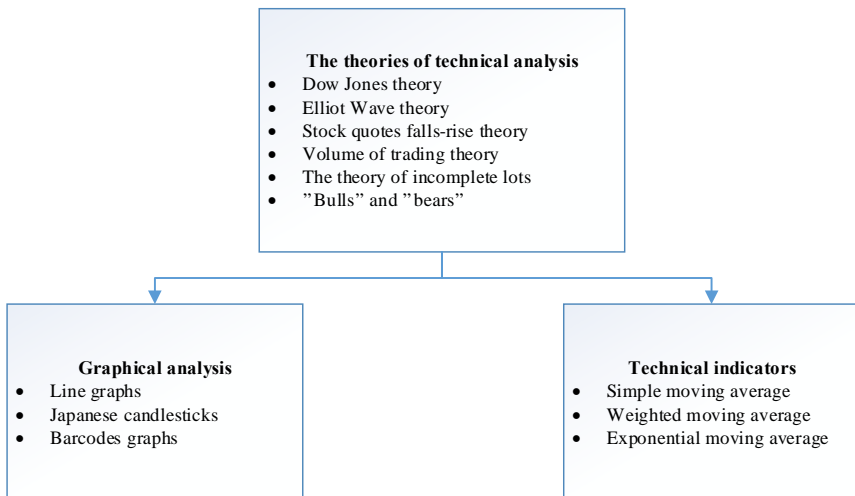


Fig. 1.5. The methods of technical analysis (created by author, using Cibulskienė & Grigaliūnienė, 2006; Zapranis & Tsinaslanidis, 2012; Bagheri *et al.*, 2014)

The positive aspect of this analysis is the fact that it allows predicting short-term stock market price fluctuations. The description of stock prices change graphically gives valuable information on market prices and future trends. Whereas the technical analysis is performed in accordance with statistical analysis, assuming that the stock prices in past determine the future prices, and only the internal market information. Many other factors that influence market behaviour may be taken into account in order to achieve the highest accuracy. According to Narayan et al. (2013) technical analysis lacks a theoretical motivation, it provides information about the evolution of market prices and the possible dynamics, but, in authors opinion, it is not enough to develop an effective investment strategy.

Fundamental analysis is another type of analysis, also used by investors, that pays attention to macro indicators or the balance sheet of the listed companies (Daniel *et al.*, 2017). Fundamental analysis involves audit reports, financial statements, management capabilities and stock's rate of return, beta coefficient and other return and risk parameters (Bayramoglu & Hamzacebi, 2016; Albadvi *et al.*, 2007).

Fundamental analysis is the basis of the general economic situation and evaluation of the country's development factors. The results provide the opportunity to evaluate the companies or investment attractiveness. Fundamental analysis is used to determine the course of variable stocks prices. This analysis covers three stages:

1. Analysis of national economy.
2. Industry analysis.
3. Company analysis.

Analysing the economic situation, it is possible to determine whether the situation in the market is appropriate for investment. Negative macroeconomic effects influence expected profits and the assumed degree of risk regardless of a diversified portfolio. The industry analysis takes into account the relative weight of the single branch of the economy, the life-cycle stage. The third stage of fundamental analysis evaluates separate companies and their securities. This analysis includes calculation of liquidity, solvency, efficiency, profitability, and other indicators of the company. The annual and quarterly companies' reports, other publications, contained in print and on websites, the information collected by shareholders and public reports of companies executives and the information of special studies conducted by market participants are used for this analysis.

Therefore, it can be observed one weakness of analysis: the accuracy of analysis depends on the transparency of used information. Furthermore, using this method, it can only be assessed attractiveness of investments. It is not clear under what criteria the most suitable investment market had to be chosen. This analysis allows determining whether situation in the market is suitable for the investment, but does not allow recognising which markets will be the most attractive in terms

of investment. According to Silva et al. (2015), some investors believe that they can overcome the market using fundamental or technical analysis.

For each market participant it is important to understand the significance of EMH in two cases - when the market is efficient and inefficient. Before described technical analysis is completely opposite to EMH. Technical analysis suggests that the prices of financial instruments vary according to trends that persist over time. Meanwhile, the efficient market hypothesis suggests that the price and volume of data are already reflected in prices. Investors who accept EMH try to form portfolios that could diversify the risk or assimilate the market. However, investors who use technical analysis try to bet the market regularly via revealing inefficiencies in market structure (Masry, 2017).

A fundamental analysis shows that investors who receive the same data may have different conclusions, and if one of the findings is better than another one, then they can get higher profits. It would appear that both of these theories have nothing common but the fact that some investors do not believe in EMH, help the market to be efficient. After all, fundamental analysis is performed on a daily basis and is reflected in prices.

The variety of investment models could be used for different investment strategies formation, but all these methods had their own limitations and in most cases are not universal and applicable for every financial market evaluation. Many scientists (Liao & Chou, 2013, Booth *et al.*, 2014, Gottschlich & Hinz, 2014, Hu *et al.*, 2015 and etc.) propose different combinations of investment models and strategies in order to introduce trading rules that should help to select stocks or other assets by different indicators, however, the size of the sample used in these works is limited, it is difficult to build a database wide enough to rule out possible random results. In order to overcome this limitation, the large volume of data will be tested in this thesis, which widens the size of the sample in a very significant way.

1.4.2. Analysis of Investment Strategies

Investment strategies could be divided into two main categories: passive and active investment strategies. The summarised graphical representation of the variety of investment strategies has been proposed (Fig. 1.6) and the major support and criticisms of passive and active investment strategies has been shortly described in this section.

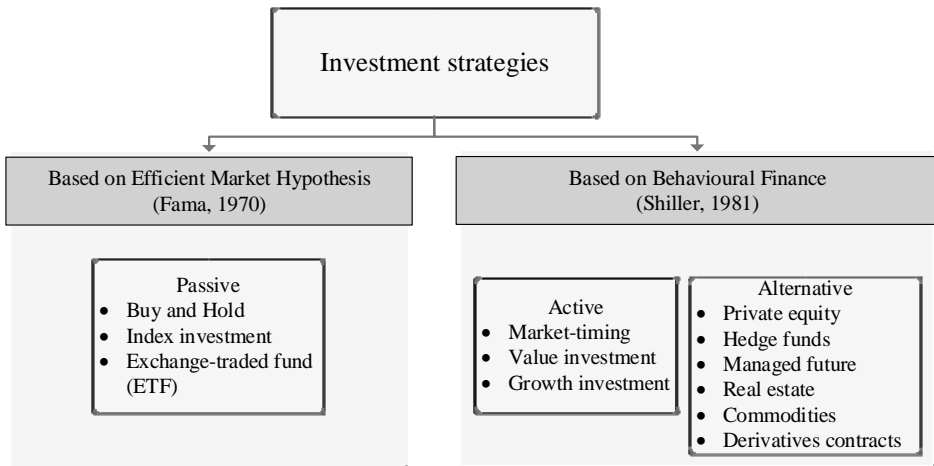


Fig. 1.6. Classification of investment strategies (created by author according to Reilly & Brown, 2006; McAllen, 2010; Mauricas, 2017)

The main goal of passive investment strategies is to maximise investment return over a long period of time. These strategies are long lasting; therefore investors do not expect to get quick financial gain or wealth. Passive investment strategies support EMH. Reilly and Brown (2006) highlights these key investment prospects based on a passive strategy: stock markets are generally fairly effective; for many active investors it is difficult to overcome portfolio fees and make any profit. Two types of passive management strategies are distinguished in the scientific literature:

- Buy & Hold strategy is an investment strategy which main principle is the maintenance of purchased investments during the entire investment period. Investors usually appreciate this strategy negatively, because it does not provide an opportunity to earn more than the market. McAllen (2010) argues that this strategy never worked and will not work well.
- Index investment strategy is an investment strategy which purpose is to reproduce as accurately as possible a special market index (for example, S&P500, EURO STOXX index or others). However, this strategy has its own limitations, due to money movements, companies' bankruptcies and mergers, stocks should be bought and sold and, as a result, index movement cannot be fully replicated and the difference between portfolio and index result revealed over the time.

The purpose of active investment strategies usage is to get better portfolio results than passive portfolio results, including transaction costs (Kancerevyčius, 2009). Active investment is characterised by higher risk and higher taxes, but also

with the opportunity to get higher profit. Reilly & Brown (2006) highlighted active strategies that are based on fundamental and technical analyses. In addition, it should be noted, that active investment strategies find support in behavioural finance theories and could be divided into two types: security selection and market timing (Mauricas, 2017).

Value investment is one of the most popular active investment strategies. Graham (1934) was the first who described this strategy. The principle of value investing is very simple – to buy stocks that cost less than their fair value on a stock exchange. The success story of Warren Buffett only once again demonstrates the effectiveness of a value-investment strategy. However, academic world largely dismissed the success of Warren Buffet as pure luck with Nobel prize winner W. Sharpe calling it a “three sigma event” (Mauricas, 2017).

Contrary to value investing, growth investing strategy does not attempt to estimate an intrinsic value of the company. Investors choose growth stocks and are looking for companies that are characterised by rapid expansion, with prices rising and it is expected that this trend will continue due to reinvestment of profits. More attention is paid to the future perspectives assessment. Thomas Rowe Price was acknowledged the first growth investor by establishing Rowe Price Associates Investment Company, specialising in growth investing (Mauricas, 2017). Fisher (1960) also was growth investor, who argued that qualitative factors, such as good company management and industry developments are the ones investors should be looking at in determining prospective investments. Selection of growth companies is not so easy. The most sophisticated part of application of this strategy is the selection of growth stocks.

Comparing these two investment strategies, it could be noted that value strategy is more risky in the long run, than growth strategy. Furthermore, the value investment strategy does not appreciate human resources, because human resources support growth strategy (Cronqvist *et al.*, 2015).

According to market timing strategy, the investors buy or sell securities based on the state of the financial markets (market phases); buy stocks when market rises, sell stocks when market declines (Wiedemer *et al.*, 2012). In order to use this strategy, sufficient precise prediction is required, which is why this strategy is attributed to technical analysis, and the application of this strategy requires constant market tracking and monitoring, which in turn requires a lot more time resources.

The analysis of investment strategies use revealed that each strategy has certain limitations, which complicates the adoption of investment decisions. There is no universal strategy for investing in stocks that would be appropriate in all cases. When applying one or another investment strategy, it is often necessary to use a more detailed analysis of companies or stocks based on fundamental or technical

indicators, investors have to find ways and methods, which help to select appropriate indicators for evaluation of stock markets or stocks. And this is an inexhaustible problem of how to select the most suitable stocks for investment portfolio formation, which stocks or companies will guarantee higher return with lower risk, how to select right market, which investment strategy the best fits investor needs, how to integrate different methods in order to take effective investment decisions and many other answers are still to be looked for.

Hence, the intelligent investment strategy, which should be the set of different methods and used for financial markets evaluation and the selection of financial instruments, will be proposed. For that reason, the tools for risk evaluation and indicators for stock markets selection will be selected in the next sections.

1.5. Risk Evaluation Techniques

In highly volatile financial markets risk and uncertainty are universal features of economic activity. In capitalist economies, uncertainty is paramount. Sometimes it arises from competition because the profitability of investment depends on the unknown activities of other market subjects (Beckert & Berghoff, 2013).

Taking into account the abundance of risk concept use, it is necessary to strive for the constructiveness of this concept. Therefore, it is important to examine the risk definition used in various scientific work. Stasytytė (2011) has extensively analysed the risk content based on carried out researches in social sciences, with a strong emphasis on risk perceptions in investment science and has stopped at the definition: “Risk is the uncertainty associated with the loss-making event”.

Hopkin (2010) defined risk as effect of uncertainty on objectives. As it is known, uncertainty is the most commonly encountered in financial markets. However, Knight (1921) argues that there is a difference between the concept of risk and uncertainty, where risk is described by randomness that can be measured faithfully. It is very important to note that this difference is important in markets (especially in financial markets). Ellsberg (1961) suggests a more precise definition of uncertainty, in which an event is uncertain or ambiguous if it has unknown probability. For example, the probability of profitability in financial markets is unknown, so we encounter with uncertainty in financial markets. As well as, uncertainty and risk are distinct characteristics of random environments, and they can also affect the individual behaviour of subjects' very differently. Such behaviour is inconsistent with the expected utility model, and this observation has inspired a significant amount of recent research in economics. The main factors of market volatility are unknown factors and these factors shall be referred as market uncertainty.

However, the author is trying to deny the idea that risk is just a bearer of disasters and risk management is a desire to avoid this. It is important to activate the idea that risk taking means searching for success. In any case, it is needed to understand that risk is a substance of existence and the real phenomena illustrates its genetic power.

The evaluation of investment risk is a very complicated task. It is hard to choose a quantitative risk assessment measure. Markowitz (1952) was the first, who suggested calculation of investment risk; his proposed variation of the average of probability distribution (dispersion) took over many scientists.

The standard deviation is calculated by the following formula (Markowitz, 1952):

$$\sigma = \sqrt{\sum_{i=1}^n (R_i - R)^2 \times P_i}, \quad (1.1)$$

where n – number of data points, R_i – expected return, R – expected average return, P_i – probability value corresponding to the calculated return.

However, the standard deviation as a risk measure is criticised by many Lithuanian and foreign scientists (Rutkauskas, 2015; Brown *et al.*, 1987). They noted that the standard deviation is an absolute measure of risk and is inadequate risk measure in the case when it compares several investments with different profitability. In this case, a relative measure of risk is used – the coefficient of variation that determines how much risk lies with each of the expected profitability of the unit (Brown *et al.*, 1987):

$$C_v = \frac{\sigma}{R}, \quad (1.2)$$

The values of variation coefficient can range from 0 to 1, i. e. $0 < C_v < 1$, therefore, the coefficient of variation has undesirable properties when variables can have mean values near zero. Higher coefficient means larger degree of risk.

The extension of standard deviation is used the most in the scientific literature as value at risk approach (VAR). This method was developed by several researchers (Szego, 2002; Wang, 2000; Gilli & Kellezi, 2000), who argued that the model accurately reflects what the maximum loss is over a period of time with the choice of a particular level of confidence. In other words, VAR is defined as the maximum possible change of the portfolio value with a certain probability within a given period of time.

However, economists also criticize this method and propose to take into account several suitable risk metrics for measuring uncertainty. CVaR and interdependence measure, which is widely considered by many scientists (Topaloglu *et al.*, 2002; Yao *et al.*, 2013) can be distinguished from several alternative methods.

Sharpe model is used to determine and evaluate the investment management. The main objective of this model is to create an effective portfolio of many well-known indices, in order to gain profits. For this purpose, American economist W. F. Sharpe created reward-to-variability ratio, so-called Sharpe ratio. This indicator is used to evaluate, how efficiently return on assets compensates the risk assumed by investor (Gavrilova, 2011). The indicator is calculated as the average annual return minus the risk-free return on investment and the obtained result is divided by standard deviation (risk) (Sharpe, 1966):

$$S_i = \frac{r_i - r_f}{\sigma_i}, \quad (1.3)$$

where r_i – the average annual return of the portfolio or investment, r_f – risk free rate, σ_i – the average standard deviation of average annual return.

This indicator shows, how many units of investment return generate one assumed unit of risk and allows determining whether successful investment decisions lead the investment return, or the assumption of additional risk (Gavrilova, 2011).

In addition, Treynor model is used for risk evaluation, which was created in 1965. This ratio includes the return and risk, but there have been identified two risk components:

- risks that occur due to general market fluctuations;
- risks that arise from fluctuations in specific securities portfolio.

Characteristic line was developed in order to identify the risk. It allowed defining the relationship between the profitability of portfolio and overall profitability of the market at the same period of time. Slope of this line (also known as the portfolio beta coefficient) represents the relative volatility of portfolio profitability in terms of the total market profitability (Dzikevičius, 2004). The steeper the slope (higher beta value) is, the more risky portfolio of financial instruments will be. The slope of line of portfolio opportunities is calculated using the following formula (Treynor, 1965):

$$T = \frac{r_i - r_f}{\beta_i}, \quad (1.4)$$

where β_i – is the slope of characteristic line at the same time, which shows the relative volatility of the portfolio.

Greater T value indicates a higher slope and better portfolio for all investors, regardless of their risk tolerance. Investors, reducing risk, will try to maximise this value. Whereas the beta indicates systemic risk and does not say anything about the diversification of the portfolio, this measure is based on the assumption that the portfolio is fully diversified (Dzikevičius, 2004).

In order to compare the value of portfolio T with the total market value of the portfolio, it is necessary to determine whether the portfolio will be over the security market line. The market value of the portfolio is calculated as follows (Treyner, 1965):

$$T = \frac{r_m - r_f}{\beta_m}, \quad (1.5)$$

where r_m is return of the appropriate market index, β_m is equal to 1 (beta of the market) and shows the slope of the stock market. So portfolio, which slope of possibilities line is greater than the slope of the total market portfolio, are above the securities market line, showing better financial results depending on the risk. The essence of Treynor ratio is the same as the Sharpe ratio, but it compares the portfolio's return with only systemic risk, while the Sharpe ratio includes all risks.

M. C. Jensen (1968) applied its own developed methodology in assessing the financial performance of mutual funds. The value of the indicator shows the unit change in the value and difference of the reference index value. α ratio is calculated as follows (Pastor & Stambough, 2002):

$$\alpha = r_i - (r_f + \beta \times (r_m - r_f)). \quad (1.6)$$

Although the appropriateness of the use of this indicator in the scientific literature is discussed, still the statistical error appears. It reduces the ratio alpha and negatively evaluates the individual fund manager's ability to anticipate market trends. This means that the ratio depicts not quite the correct score.

To summarise, beta coefficient, used in Treynor model, only assesses the systemic risk, while alpha coefficient, used in the Jensen model, shows the amount of non-systemic risk. These indicators more closely compare the performance of a mutual fund manager, while the standart deviation is a significant argument for the choice of an investment asset by investors.

Consequently, the calculations of standard deviation for investment return of the selected financial instruments will be carried out in the thesis (in the stocks selection process). The selection of standard deviation for the risk measure allows determining the fluctuation interval of investment asset return: the higher standard deviation will indicate the higher risk of the investment asset.

1.6. Impact Criteria Composition for Stock Market Assessment

It is a need to develop a conceptual framework for stock market selection so that the investment return sustainability would be ensured in the long run. Significant number of various studies prove that macroeconomic indicators influence stock

market returns. Changes of macroeconomic indicators like gross domestic product (hereinafter – GDP), inflation, money supply, exchange rate and others affect the volatility in stock markets; however, there is a lack of fully implemented and proved methods which could be used in comprehensive market selection ensuring stable investment return.

Cagli et al (2010) identified the relation between stock market and gross domestic product. Savry and Broyer (2002) contradicted the idea that the industrial production and factory orders explain the development of Germany real activity in general. Therefore, quarterly GDP growth rates were used as an explained variable in their method. Savry and Broyer (2002) found evidence that sentiment indicators perform better when forecasting the manufacturing sector. The rise of GDP indicating the growth of the USA economy was noticed and the research. It has also resulted in making the USA more attractive for the investors as well as strengthening the US dollar. The significant importance of GDP growth rate on stock markets returns was approved in the study of Horobet and Dumitrescu (2009). In addition to this, Fama (1990) and Schwert (1990) studies are ones of the most cited in the field, approving positive relation between GDP and stock price. Other studies (Mohammad *et al.*, 2009; Hussain *et al.*, 2001) also support the statement that GDP has a positive impact on stock prices. Dimson et al. (2016) conducted a study in order to determine the relation between long-term stock market returns and long-term GDP growth. The study demonstrated that examining the annual growth of GDP is the best way for investors to recognise performance changes during the same period of time. Hereby, changes in stock prices tend to reduce asset structure of companies and influence the expenditure of their borrowing. Consequently, companies borrow and invest less when they have to spend more in order to borrow money. Therefore, the real GDP growth slows down. As a result, alteration of information about future changes of real GDP, may cause instability in the stock market as well as price mutation (Ray, 2012). It can be concluded that stock prices are an influential tool in forecasting future economic activity and actual causality is a result of future GDP growth in current stock prices (Ifionu & Ibe, 2015).

A lot of macroeconomic literature (Koh *et al.*, 2000; Bernanke & Kuttner 2005; Türsoy et al., 2008; Ullah *et al.*, 2014;) pay attention to monetary factors as the prevalent indicators of the stock market returns. The role of monetary and financial indicators predicting stock market returns was analysed by Patelis (1997) whose findings demonstrate that federal funds increase has a significant negative impact on predicted stock returns in the short period while the impact is positive in the long run. That predictability works largely through the effect of federal funds rate changes on anticipated excess returns down the road, rather than dividends or expected returns. The event-study approach, used by Bernanke and Kuttner (2005), was based on daily changes observed on monetary policy decision

dates to uncover the effects on stock prices of unanticipated changes in the federal funds rate. The surprising results of the research are that there is a 25-basis-point cut in the Federal funds rate, which has connection to about one percent increase in stock prices. The analysis largely attributes that response to persistent declines in the equity premium, and to a lesser extent of the relevant cash flows. They do not report, however, the dynamic response of stock prices to the monetary policy surprise, although money supply and inflation have a positive relationship among themselves.

It has been found that central bank interest rates or government securities rate have a mixed impact on stock market returns. Interest rate as a variable is found to be significantly affecting the stock returns by Maysami and Koh (2000), Papapetrou (2001), Akkum and Vuran (2003), Al-Sharkas (2004), Uddin and Alam (2007), Türsoy et al. (2008), Liu and Shrestha (2008) and Ullah et al. (2014). The mentioned authors determined the negative relationship between interest rate and stock prices. The increase of rates of bank deposits leads to the situation, when people redirect their money from the capital market to the banks and this will lead to a decrease in the demand of stocks. However, the opposite situation will happen if the deposit rate decreases. Additionally, when interest rate on deposit increases, loans rate also increases, which has a negative impact on investment, hence the stock prices as well and vice versa (Barakat *et al.*, 2016).

Hereafter, Alam and Uddin (2009) looked into the interest rates of fifteen developed and developing countries during the period from 1988 to 2003. The researchers used both time series and panel regressions, which resulted in the claim that stock prices are negatively related with interest rates for all fifteen researched countries. It was also determined that there is a significant negative relationship between changes of interest rates and changes of stock price, however, this finding appeared only in six research countries out of fifteen (Masduzzaman, 2012).

The stock markets have a tendency to perform negatively and government debt levels seem to rise in the times of financial crises and recessions. Yartey (2008), Adrianaivo and Yartey (2009), Kemboi and Tarus (2012), Aigheyisi and Edore (2013), El-Nadar and Alraimony (2013) do not count external debt as a factor affecting the development of the stock exchange. It has been observed by these authors that the short-run effect of domestic debt, external debt and recurrent expenditure on the value of transactions on the stock market has insignificant importance. This leads to the assumption of the disconnection existence between such elements as domestic debt, stock market development, external debt and government recurrent expenditure in short-run as well as long-run. A significant negative short-run effect on stock market development was noticed in capital expenditure. This factor indicates that increase in government capital expenditure

negatively affects the value of transactions on the stock market (Scott & Ovuefeyen, 2014).

The author proposes to select debt to GDP ratio as a key indicator for stock markets return, due to its positive relation with a long-term stock market return, being more precise, government debt levels are being associated with higher future stock markets returns.

10-year government benchmark yields can be alternatively used as a proxy indicator to monetary policy rates. When the Federal Reserve needs interest rates to fall, U.S. treasuries are being bought. That is the same as increasing demand for the government bonds, which influence increase of their value. When bond values rise, it results in fall of interest rates. It results in lower interest rates putting upward pressure on stock prices. Bond buyers will now get a lower interest rate and therefore return, on their purchases. This leads them to consider buying higher risk stocks in order to get a better return. As a result, economic growth is being boosted by low interest rates. This process leads to higher corporate earnings and higher stock prices. Of course, higher bond yields mean the security and strong economy of the country.

Nevertheless, stock market returns are being affected by a dual effect of inflation and money supply. On the positive note, it adds value to the company. When money supply increases, inflation increases too, as well as expected rate of return. Consequently, when high-expected rate of return is used, company's profits decrease and it causes lower share prices. However, increase in money supply and inflation influence company's profit positively considering dividend and stock prices. Following these reasons, Patelis (1997) analysed the relation between money supply, stock return and inflation. Liu and Shrestha (2008) shared the same opinion regarding existing co-integration between stock prices and macroeconomic indicators like interest rates, industrial production, inflation, money supply and exchange rate. On the other hand, Walter (1988) argued that monetary aggregates could work for measuring money stock in any country. A phenomenon of monetary measures and macroeconomic indicators (employment ratio, national income and interest rates) relationship was also declared by Walter (1988). According to this phenomenon, inflation and interest rates should be a focus of attention for further investigations, so changes in economic activities could be predicted. (Barakat *et al.*, 2016)

Inflation, as variable was approved to be significantly important affecting stock returns as it was investigated by many researchers (Fama & Schwert, 1977; Fama, 1981; Al-Sharkas, 2004; Adrangi *et al.*, 2002; Akkum & Vuran, 2003; Albeni & Demir, 2005; Mutan & Canakci, 2007). Some researchers could not prove positive correlation between inflation and stock market returns. Even though, Buyuksalvarci (2010) argued that there is no significant effect on stock market

return caused by inflation rate, quite a few empirical studies (Flannery & Protopapadakis, 2002; Thalassinou *et al.*, 2006) found some evidence that actually inflation has a negative short run effect on stock returns, while other studies (Masuduzzaman, 2012; Ullah *et al.*, 2014) reported positive long run Fisher effect on stock returns. According to Subeniotis *et al.* (2011), there is no evidence that inflation rate is significant and he explains the negative sign by the short run sample period. Which means that when inflation rises, companies will increase their profits, while purchasing power falls. Essentially, some empirical studies (Fama & Schwert, 1977; Al-Sharkas, 2004) have shown a negative short-run relationship between inflation and the stock market, although positive in the long run, while there is no consensus as to the wealth effect of industrial production on the stock market.

It was observed that when inflation rate is higher than normally expected, the inflation is positive, which is not good for economy as it implies significant impact of stock return on stock market. Diaz and Jareno (2009) made a similar conclusion regarding Spanish stock market, while Mittal and Pal (2011) had comparable results in Indian stock return vitality. Using a VAR model Indian stock market was examined during the period of 1995-2008 and it was found that inflation rate as an observable effect on major stock markets of India. Talla (2013) claimed that inflation has positive and negative effects on stock market. He noted that direction of the relationship between stock market and inflation is determined by both unexpected and expected inflation. Companies have a tendency to increase prices when demand exceeds supply. Furthermore, this increases their earnings, it leads to increase of dividends paid resulting the increase in demand for the company's stock and it eventually increases its stocks value (Barakat *et al.*, 2016).

According to Coleman and Agyire-Tettey (2008), inflation influences investment decisions and savings through different ways. Generally, economic units are distorted by the planning horizon of unanticipated inflation. It also lowers the real interest rate, which holds all other factors constant. Unstable inflationary dynamics heightens uncertainties regarding future prices and investment. Once there is a high degree of uncertainty in investment due to pricing mechanism, people resort to investing in real assets. Others researches also proved the relationship between inflation on stock market returns (Kuwornu, 2012; Reddy, 2012; Barnor, 2014; Pinjaman & Aralas, 2015). It should be noted that as an alternative indicator for inflation measure could be used consumer price index (hereinafter – CPI). Talla (2013) also used consumer price index as an alternative indicator for inflation. In normal economic conditions, an increase in CPI leads to growth in interest rates, which in turn boosts the US dollar, as the higher rates make investment more attractive. Kalyanaraman and Tuwajri (2014) approved the importance of this indicator on stock markets return.

In general, most of the analysed works have shown that the relation between inflation and stock market returns exists. The author propose to examine the effect of CPI on stock market sustainable return in combination with other impact indicators in order to determine the relationship between various factors and stock market return.

The role of industrial production, as a variable in the determination of stock market prices remains an open question, since the results of a number of empirical studies do not definitively determine a significant and reliable statistical relationship between them (Fama, 1981). Shanken and Weinstein (2006) concluded that only Index of Industrial Production is a significant factor for stock markets. It was found by Liu and Shrestha (2008) that there is a co-integrating relationship between industrial production and stock prices. Flannery and Protopapadakis (2002) and Thalassinos et al. (2006) wrote how index is important in stock markets. In terms of industrial production index, the empirical results reveals a detrimental effect as the coefficient has both negative and statistical significance. Nevertheless, although the impact of industrial production on stock markets is ambiguous, this is still in line with previous findings (Subeniotis *et al.*, 2011).

During a research of stock market behaviour, a strong link between stock market prices and both market capitalisation and the economic sentiment indicator (hereinafter – ESI) was exposed. In addition, a positive correlation between stock market return and economic sentiment indicator was found according to studies (Moneta, 2003; Subeniotis *et al.*, 2011). Meanwhile, Baker and Wurgler (2006) noticed the importance of behavioural finance due to approach about future financial activities. It was found that some part of economic sentiment index for investors is positively linked to stock markets. A positive link with stock market indices was also established by the economic sentiment indicator. The key determinant of stock market performance is producer and consumer optimism or pessimis about the economy. When market participants are confident about their future income levels, they are more willing to invest in the stock market. Accordingly, production and inventory levels will be increased by businesses since these elemnts will anticipate higher demand for their products and in turn it wll influence the stock market. The positive fluctuations of market capitalisation index reflects a positive relationship between market capitalisation and stock market indices, which is consistent with both the economic theory and the previously reviewed literature. Since market capitalisation is a result of stock prices multiplied by the number of stocks, it could still be argued, that this index rises in the conditions of stock prices increase as the number or stocks is consistant. Nevertheless, when investor demand increases, stock prices rise and it leads to the conclusion that the demand for stocks positively correlates with the market indices.

Purchasing Managers index (hereinafter – PMI) is widely used to assess and predict economic activity and thus having an impact on financial markets,

including stock markets and it is a leading indicator that can be used as an alternative for Economic sentiment indicator (hereinafter – ZEW). PMI index indirectly covers the whole economy, as it measures the growth of economic activity in the manufacturing sector. ZEW indicator is also a leading one, which is used for evaluation of the prospects of the German Economy (Broyer & Savry, 2002). Studies by Hufner and Schroder (2002) showed that the latter indicators have explanatory power if they are lagged by up to five months which respect to industrial production. The ZEW indicator is usually the first to be released and has a two-month lead over the PMI indicator. Out-of-sample forecast evaluations suggest that ZEW indicator takes over PMI as ZEW indicator provides the best forecasts for industrial production while PMI is a useful guide to economic growth, which strongly correlates with GDP of different countries. On the other hand, the ZEW indicator has some disadvantages like time consumption to correlate the data while PMI is able to correlate three months ahead. This advantage enables traders and investigators to receive a warning about changes in the economic growth cycle and impact stock prices in advance.

A number of scientists widely investigated the effect employment rate on development of stock indices and their return. Employment rate by economists is considered to be one of economic indicators that helps to improve knowledge about conditions of economy. This indicator shows country's ability to make its population work and thereby generate income for its citizens. Good or bad employment reports generally influence stocks rise and fall as investors consider the potential changes in these areas (Singh *et al.*, 2011). Boyd *et al.* (2005) investigation demonstrated the impact of unanticipated unemployment rate on stock returns. The present investigations found that in average, an announcement of increasing unemployment is good news for stocks during economic expansions and bad news during economic contractions. Gonzalo and Taamouti (2017) suggested a reasonable explanation of unemployment rate impact on stock market prices. With a help of Fisher and Phillips curve equations, they have proved that high unemployment rate is followed by monetary policy action of Federal Reserve. When unemployment rate is high, the Federal Reserve decreases the interest rate, which in turn increases the stock market prices. The alternative indicator for employment rate is unemployment rate; Boyd *et al.* (2001) described the importance of unemployment rate to stock returns.

Some investigations were carried out examining the relationship between public investments and stock market return. According to Belo and Yu (2012), if public sector capital increases the marginal productivity of private inputs, the model predicts a positive relationship between the public sector investment rate and the company's risk premium, controlling for the private sector investment rate. Similarly, this model predicts a negative relationship between the private sector investment rate and company's risk premium. In addition, it is advised that

the positive correlation between the stock market and corporate investment could be improved. The standard explanation for this relationship is that marginal product of capital is reflected in stock prices (Baker *et al.*, 2003). There are a number of ties between the stock market and corporate investment policy (Titman *et al.*, 2010).

The literature review on the relationship between oil shocks and stock market activities has shown that changes in the price of crude oil are associated with the fluctuation of stock prices. Recent papers by Hamilton (2009), Kilian (2009), and Kilian, Park (2009), and others, suggested that different price shocks in the crude oil market have distinct effects on the stock market, in a sense that the responses of aggregate stock returns differ depending on the cause of oil supply or demand shocks. Oil shocks have the highest impact on the energy sector, especially on the economies of such countries as Brazil, Russia, China and India. The economic impact on developing countries is generally more positive intense than on industrialized countries. Since oil prices do not affect all the economic sectors, this indicator is not very important, when talking about the overall impact on stock market returns.

The researchers that have investigated the influence of changes in oil prices on stock market returns have determined that changes in oil prices are associated with the fluctuations of stock prices (Hamilton, 2009; Kang & Ratti, 2013). A positive oil-market specific demand shock (indicating greater concern about future oil supplies) significantly raises economic policy uncertainty and reduces real stock returns (Kang & Ratti, 2013). An unpredictable increase in policy uncertainty negatively affects the real stock returns in the United States. Shocks in oil relative prices, redistribute income and influence expectations about inflation and the real interest rate. Daly and Fayyad (2011) studied seven different countries and determined that oil price can forecast stock return better after the latest increase in oil prices. Using DCV and VAR analysis they found that when oil prices rise sharply it forecasts stock fluctuations in the United States, United Arab Emirates and Kuwait but not the United Kingdom, Oman, Bahrain and Qatar. It can be concluded that the relationship between higher oil prices and stock movements can be explained using cash flows and the discount rate. Consequently, higher production costs, interest rate and inflation are relevant factors. Structural oil price shocks have long-term consequences for economic policy uncertainty, and this provides an additional channel by which structural oil price shocks have influence on the stock market.

Together with oil price shocks, the gold and silver prices were analysed by the author as well. Increase in gold and silver prices attracts investors towards the commodity market, which might decrease investor preference towards the equity market. This indicates that a negative relationship is expected between gold and silver, and stock market returns (Patel, 2012). According to Buyuksalvarci (2010),

gold price does not appear to have any significant effect on stock markets. There is apparent evidence that in turbulent periods with economic uncertainty, as stock prices fall, gold price rises and a center of attention is on gold as a safe instrument of investment.

The exchange rate can result in either a positive or a negative impact on stock returns. Ma and Kao (1990) suggested that for a country, which dominates in exports, currency depreciation is expected to have a positive impact on domestic stock market returns. Furthermore, Johnson and Soenen (1998) argued that a depreciation of the currency makes imports more costly and results in a higher domestic price level, which is expected to have a negative influence on stock market returns. This although does not correspond with the findings of Abdullah and Hayworth (1993), who find a positive relation between these two variables.

Frimpong (2009) found out that all macroeconomic indicators with the exception of exchange rate affect stock prices negatively. Aydemir and Demirhan (2009) determined that exchange rate affect all stock market indices. Adebisi et al. (2009) established a causal relationship from oil price shocks to stock returns, and from stock returns to real exchange rate. Liu and Shrestha (2008) also found that a co-integrating relationship exists between stock prices and exchange rate. Gunasekarage et al. (2004) and Adam and Tweneboah (2008) used national currency per United States dollar (USD) as a proxy for exchange rate. As exchange rate is the price of a currency, it will affect net exports (Osamwonyi & Egbayiro-Osagie, 2012). Vejzagic and Zarafat (2013) found that changes in exchange rates would have an impact on the firm's competitiveness as they affect the price of foreign currency, leading to changes in the firm's profits and equity, which in return will lead to price adjustments in the stock market. Consequently, when stock prices increase, they will attract foreign capital and when prices decrease, they will be less appealing to foreign investors and lead to a reduction in corporate wealth and as a result a reduction in the country's sovereign (Vejzagic & Zarafat, 2013; Barakat *et al.*, 2016). Aurangzeb (2012) showed that exchange rate has positive impact on stock market performance. The exchange rate can result in either a positive or a negative impact on stock returns. Moreover, Johnson and Soenen (1998) argued that a depreciation of the currency makes imports more costly and results in a higher domestic price level, which is expected to have a negative impact on stock market returns.

The market size of pension funds also is important indicator that influences the returns of stock market. Meng and Pfau (2010) found that pension fund financial assets have the positive impact on stock market depth and liquidity as well as private bond market depth. Nevertheless, when they split the countries into two groups according to their level of financial development, the impacts are only significant for countries with „high” financial development. Pension funds do not

influence capital market development in the countries with a „low” level of financial development. Because of pension system reform, pension fund assets are growing rapidly and are increasingly providing a source of investment funds to their domestic financial markets. Pension fund investments are expected to increase the availability of long-term funds, enhance competition, induce financial innovation, and improve corporate governance. To the extent that such financial market improvements relate to financial market size and activity, some studies confirm only to an extent the existence of positive impacts from pension funds on the development of stock markets and private bond markets (Raddatz & Schmukler, 2008).

The investment funds market size has been also examined, because mutual funds have played a very important role in stock markets volatility. When mutual funds buy and sell stocks, the prices of those stocks are automatically affected. In fact, because of the size of their investments, mutual funds can have a huge impact on stock prices, in both the short and long run. Mutual fund trading can actively push stock prices up or down on any given day, and the herding effect of mutual funds and other large-scale institutional investors can create long-lasting trends that influence a stock's price over time. Oha and Parwada (2007) examined the association of mutual funds flows with stock market returns in Korea. Results showed positive relationship between mutual funds flows and stock market. Walter and Weber (2006) analysed the aggregate flows of mutual funds and stock returns. Results of the study showed that stocks returns are highly correlated with unexpected cash flow into the mutual funds. With the same pattern, Hsieh et al. (2011) studied different stock markets in Asian emerging countries. The research findings extracted that inflows of mutual funds are attached with positive stock returns and currency appreciation. It was also found that positive feedback affects the Asian stock markets. The primary focus must be on the crisis, how withdrawals of funds affect European and United States of America stock markets. Manconi et al. (2012) found that during the 2007-2008 crisis, fixed-income mutual funds transmitted the crisis from the securitized bond market to the corporate bond market. Open-end mutual funds had a significant impact on the transmission of the 2007-2008 crisis from financial stocks to nonfinancial stocks, resulting in very large temporary price discounts for many nonfinancial stocks. This evidence highlights that even non-leveraged financial intermediaries can play an important role in financial instability and ensuring the sustainability in the long run (Hau & Lau, 2016).

Hedge funds, exchange-traded funds (hereinafter – ETF) and alternative funds have grown substantially in the last decade and their impact on stock markets return increased. These funds make stock market less risky, lower stock market volatility in short-term, because they use more databased investment strategies, their analysts can find out more information about companies than the

average investor can do. At the same time, due to the usage of the same quantitative investment strategies, they have an impact on the risk increase in long-term, what in this situation can be mentioned as asset bubbles. Nevertheless, talking about long term perspective, investment funds ensure the increase in stock market activity due to their size and capitalisation. It can be concluded that mutual funds, as core subjects in distribution of capital, are affecting stock markets. Bond fund effect on equity market should be a centre of attention as well.

The explanation can start with the fact that stocks tend to move in different direction as bonds, so that the increased cost of country debt or worse country credit rating could influence stock prices (Jorion & Zhang, 2007). Dichev and Piotroski (2001) find evidences that rating downgrades generate a significantly larger impact than rating upgrades, investigated the influence of credit rating changes on stock prices of publicly traded companies. Choy, Gray and Ragunathan (2006) studied the impact of Moody's and S&P ratings revisions of 63 companies on the Australian stock market between 1989 and 2003. Their results showed a significant and negative impact for downgrades, and an insignificant impact for upgrades. According to them, companies disclose positive information very quickly, and stock prices immediately reflect such information, anticipating rating changes. Servigny and Renault (2004) observe negative reaction before the rating change date and stock prices fluctuations. It can be explained by the conservatism of the rating agencies and after the change can be explained by market under-reaction, possibly arising from a lower free cash flow to equity after a downgrade, which would increase the cost of funding the company and the time institutional investors may take to decide to divest a certain company's stock. The author also investigated micro fundamental indicators that have an impact on stock market volatility: the average of market P/E, which could be treated as significant for further investigation.

Partly, investment portfolio managers and researchers are well aware of the generally negative relation between the market P/E ratio and stock returns (Weigand & Irons, 2007). The authors examine the relation between P/E ratios and future returns using two measures of the market P/E ratio: the metric more popular among the investing public, using one-year trailing earnings (the P/E1), and the metric favored by academicians, using ten-year smoothed earnings (the P/E10). Campbell and Shiller (2001) also showed that an unusually high market P/E ratio forecasts poor future stock returns, as it is stock prices, not earnings that account for most of the ratio's reversion to its historical mean. High-P/E periods are preceded by accelerating equity returns and declines in both nominal interest rates and stock market volatility. Following these periods, stock returns are marginally higher when earnings growth is strong and interest rates continue falling. In particular, high-P/E periods triggered by temporary earnings declines are followed by low positive stock returns, but returns are negative when earnings grow

rapidly and the market P/E climbs above 20. Following both types of high-P/E events, however, real stock returns are appreciably lower than average for the subsequent decade (Weigand & Irons, 2006).

Drechsler (2011) finds that earnings increase is a persistent phenomenon that can lead to higher share prices. The financial literature is replete with discussions of the relationship between company earnings and stock returns. Nevertheless, much of that literature is concerned primarily with earnings estimates and the effects that earnings surprises and revisions have on stock prices. Companies with high expected earnings growth tend to underperform the market because it is difficult to meet the market's high expectations. Companies with low earnings expectations tend to do better than expected, realising that the stock price already reflects the general consensus about future earnings.

Summarising literature analysis, the following insights could be done about all previously analysed indicators. The importance of GDP growth rate on stock markets returns and the relationship between long-term stock market returns and long-term GDP growth was approved. In addition, it is found that increments in the federal funds rate have a significant negative effect on predicted stock returns in the short term, but a positive effect at a longer period. Most of the reviewed studies have shown that there is a connection between inflation and stock market return. The author propose to examine the impact of CPI on stock market return in combination with other macroeconomic, microeconomic and behaviour indicators. A strong link between stock market prices and both market capitalisation and the economic sentiment indicator (ESI) was exposed during research investigation. Oil shocks have the highest impact on the energy sector and influence the most stocks from this sector. Any significant effect of gold and silver prices on stock market return do not found except evidence that in turbulent periods with economic uncertainty, as stock prices fall, gold price rises and a center of attention is on gold and silver as a safe investment instrument. Other important indicator for stock market volatility – the exchange rate can result in either a positive or a negative impact on stock returns, but for a country dominated by exports, currency depreciation is expected to have a positive influence on domestic stock market returns. Some studies confirm the positive impacts from pension funds on the development of stock markets and private bond markets, as well as the importance of mutual funds on stock markets. The carried out investigations have shown the impact of unemployment rate on stock returns through the announcements of increasing unemployment. The author also analysed the differences between the ZEW and PMI indicators and concluded that ZEW indicator provides the best forecasts for industrial production comparing to the PMI, but at the same time the PMI indicator is used as a guide for economic growth, which strongly correlates with different countries GDP. The author distinguish the usage of P/E market indicator for further investigation.

After the investigations it can be concluded that economic sentiment indicators are more useful in forecasting short-term market return fluctuations and are not significant in long-term or for ensuring stock market return sustainability. Similarly, the usage of Elliot Wave theory can be approved defining this indicator as a supplementary and more suitable for stock market selection but not as a major for investment decisions.

Table 1.2. The influence of indicators on stock market return (created by author, based on investigated research studies)

Indicator	Influence on stock market return	
	Positive	Negative
Real GDP annual growth, %	+	
10-year government benchmark yields, % (the alternative – monetary policy rates)		+
Consumer price index (CPI)	+	+
Inflation	+	+
Gold price		+
Silver price		+
Oil prices		+
Pension funds market size	+	
Investment funds market size	+	
Country credit rating		+
Government debt level (Debt to GDP ratio)	+	+
Employment rate	+	
Unemployment rate		+
Exchange rate	+	+
Economic sentiment indicator (ESI)	+	
Purchasing Managers indicator (PMI)	+	
ZEW	+	
Market capitalisation as percentage of GDP	+	
P/E ratio		+

The indicators, which have positive, negative or both effects on stock market returns, have been investigated (Table 1.2) and the most reasonable set of impact criteria for stock market selection has been suggested.

The author distinguished that the most significant indicators having a positive impact on stock market return are real GDP annual growth, investment funds

market size, purchasing managers indicator (PMI), market capitalisation as percentage of GDP and employment rate. Equally important are such indicators as pension funds market size, economic sentiment indicator (ESI) and the ZEW due to their positive relation to stock market volatility, however, they are more significant in short-term.

On the contrary, it was distinguished that the gold price, silver price, the changes in oil prices, country credit rating, 10-year government benchmark yields, the monetary policy rates, which can be used as alternative indicator for 10-year government benchmark yields as well, unemployment rate and P/E ratio have negative impact on stock market returns. The most significant indicators from this group are unemployment rate and P/E ratio. As it was mentioned before, oil shocks do not have an impact on all economic sectors, their major influence is on the energy sector only. Gold and silver could be used in order to protect investments in the periods of economic crisis, but they do not have a significant impact on stock market returns in normal economic conditions.

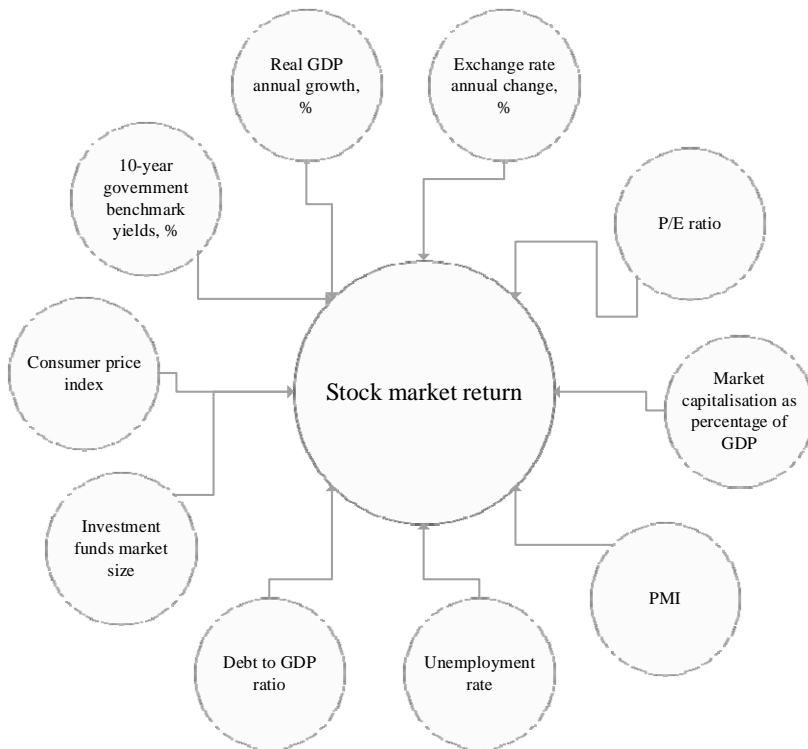


Fig. 1.7. The set of impact indicators (created by author)

It must be emphasised that some indicators are of dual role – they have positive and negative effects on stock market volatility. These indicators are government debt level or alternative to this indicator is debt to GDP ratio, exchange rate and inflation with an alternative indicator for it – a consumer price index. These three indicators have a significant impact on stock market return. It must be noted that the effect of government debt level is insignificant in short-term. Quite a few empirical studies have provided some evidence that inflation has a negative short-term impact on stock returns, while other studies have reported a positive longrun Fisher effect on stock returns.

The analysis of a selected topic showed that there is no unified and general set of indicators, which could be used for detailed stock market selection. Ten indicators that have the greatest influence on stock markets return, which make the set for further market analysis, were revealed: real GDP annual growth, 10-year government benchmark yields, consumer price index, investment funds market size, debt to GDP ratio, unemployment rate, exchange rate (local currency per USD) annual change, purchasing managers indicator (PMI), market capitalisation as percentage of GDP and P/E ratio (Fig. 1.7). The set of these indicators will be identified as impact indicators in the thesis, taking into account that impact indicators are the indicators that have the greatest impact on stock market return in long run. This set of impact criteria will be used for further stock market evaluation.

The next step of investigation should be the formation of the optimal set of impact criteria on stock market return. Having this purpose into consideration, the experts from academic and business societies who rank these indicators according to their importance on stock market return were selected. The results will give the direction for author to carry out further investigation.

1.7. Conclusions of Chapter 1 and Formation of the Tasks of the Thesis

Based on the literature review, the following conclusions can be drawn:

1. An overview of a number of research sources allows a conclusion that a variety of investment methods could be used for different investment strategies formation, but all these methods have their own limitations; in most cases they are not universal and applicable for every financial market evaluation. Accordingly, there is a need to form the investment strategy, which would be a set of different methods and used for financial markets evaluation and the selection of financial instruments.
2. Global financial markets are affected by many factors: economic, technological, social and political, which influence financial markets beha-

viour and the level of investment return. Indicators' volatility and change also cause economic crises. It has been determined that in order to ensure investment return sustainability, it is necessary to identify the factors that have the greatest impact on the return on financial markets return.

3. The carried out analysis of the classical investment methods has made it possible to determine that the application of individual classical investment methods complicates the solution of complex economic problems, since the analysis of big data is particularly relevant in the world, and individual methods fail to perform it effectively. Therefore, their integration creates preconditions for ensuring the sustainability of investment return in the long run.
4. The concept of investment return sustainability has been expanded. It is defined as a stable investment return in the long run, taking into account the market opportunities and changing environmental conditions.
5. A detailed analysis of impact indicators, which have the influence on stock markets return, showed that there is no unified and general set of indicators, which could be used for detailed stock market selection. Therefore, ten indicators were distinguished as a set for further market analysis: real GDP annual growth, 10-year government benchmark yields, consumer price index, investment funds market size, debt to GDP ratio, unemployment rate, exchange rate (local currency per USD) annual change, purchasing managers indicator (PMI), market capitalisation as percentage of GDP and P/E ratio.

In order to achieve the aim of the thesis, the following tasks are formulated:

1. To provide a scheme of an intelligent investment strategy, combining mostly individually used methods for stock market selection, selection of stocks and investment portfolio formation techniques.
2. To establish a methodology for stock markets evaluation, choosing the impact indicators on investment return and to carry out an assessment of selected stock markets.
3. To model an algorithm for stock selection based on the assessment of the financial soundness of companies listed in the stock markets.
4. To empirically verify the intelligent investment strategy using back-testing method and in accordance with real market conditions.

2

Methodology for Stock Market Evaluation and Presumptions for Algorithm Creation

This chapter investigates the application possibilities of multi-criteria methods for stock markets evaluation. Determination of indicators significance and compatibility of expert evaluation has been presented in the chapter. The chapter also presents the methodology for stock markets selection and evaluation. Research results are presented in the journal publications by the author: Rutkauskas & Kvietkauskienė (2013a), Rutkauskas et al. (2014), Kvietkauskienė & Maknickienė (2015), Kvietkauskienė & Plakys (2017), Kvietkauskienė (2017) and conference proceedings by Rutkauskas & Kvietkauskienė (2012), Rutkauskas et al. (2014c), Rutkauskas et al. (2015b), Pašukonytė & Kvietkauskienė (2016), Jokubauskaitė & Kvietkauskienė (2017).

2.1. Tools Selection for Multi-criteria Analysis

Determination of indicators values and their significance is one of the most important stages in multi-criteria analysis of stock markets. The utility degree and

priority are determined after calculation of values and assessment of indicators' significance and applying multi-criteria analysis methods.

The data for multi-criteria evaluation was obtained from the variety of sources: "Bloomberg" laboratory of Kaunas University of Technology, OECD database, World Bank data, Federal Reserve Bank statistic information, ICI statistics, and CEIC data.

Theoretically, the significance of indicators could be determined objectively and subjectively, but in practice, the subjective determination of significance level, based on expert evaluation, is more often used (Kurilov *et al.*, 2016). Subjective significance of indicators, as aggregated average of expert opinions, can be used in the multi-criteria assessment, if the expert opinions are compatible. For this reason, different scientific methods are used for analysing stock markets. The expert evaluation for determining the significance of impact indicators on stock market returns is used in the dissertation.

2.1.1. Instruments for Determination of Indicators Significance and Evaluation of Experts Compatibility

According to economists (Atsalakis & Valavanis, 2009; Akhmetov & Rysaevabgal, 2015, Rutkauskas, 2017, Polanzo-Martinez *et al.*, 2018, Sui *et al.*, 2018), it requires significant work to perform an analysis of financial markets, to evaluate stock markets and to ensure sustainable investment return. Investigations and decisions made in these areas are strategic, because they can predict a future direction of financial markets and investment instruments. Making a mistake in portfolio formation stage may cause the loss of money or other assets like stocks value, property, savings and etc. Therefore, the process of stock market selection is very important for effective portfolio formation and for ensuring investment return in the long run, which described as investment return sustainability. When more than one criterion is included for the selection process, there is a need to incorporate experts to participate in this process. Expert evaluations are applicable in various fields with no exception in the investment area. By determining the importance of the indicators by expert methods, we find out how much one criterion is more important than another is.

The evaluation quality made by experts directly depends on the quality of selecting an expert group because they should have sufficient experience and knowledge in the field of the current trends in science and technology in their industry (Zakharova *et al.*, 2016).

The following tasks were established for the expertise:

- formulation of the purpose for expert evaluation;
- the preparation of plan to process expertise evaluation;
- the creation of the questionnaire;

- expert selection and setting up a group of experts from specialists in investment area of expertise;
- performance of the survey;
- treatment of the results;
- preparation of conclusions of expert evaluation.

The determination of significance of the indicators, using expert evaluation methods, is the most important part, as it would be complicated to evaluate the reliability of the research without it.

In order to determinate the weights of selected indicators, indirect method for expert evaluation was used; it means that experts can evaluate the weight of every indicator without linking one assessment to other evaluations. The highest rating is assigned for the most important indicator. Using this method, the evaluations can be repeated, several parameters can be assigned to the same evaluation.

In case of establishing indirect indicators, the sum of all experts in each i -th indicator is calculated their averages (Podvezko, 2006):

$$s_i = \sum_{k=1}^r c_{ik}, \quad (2.1)$$

where r – the number of experts, s_i – the sum of all experts evaluation of i -th indicator. Calculated averages are normalised, i.e. weights are determined by the formula (Podvezko, 2006):

$$w_i = \frac{s_i}{\sum_{i=1}^m s_i}, \quad (2.2)$$

where m – the number of indicators.

To determine the experts' evaluations compatibility, is another important point using multi-criteria evaluation method. It is frequently occurred phenomena that experts' opinions and their approaches to the solving problem can be different or even contradictory. In order to make decisions based on expert evaluation, it requires ensuring the compatibility of experts' opinions.

In determining the acceptable number of experts, the methodological assumptions formulated in the classical theory of tests are used, which state that the reliability of the aggregated solutions and the number of experts are associated with a rapidly decreasing non-linear relationship. Libby, Blashfield (1978) have proven that the accuracy of the decisions and evaluations of a small expert group of aggregated expert assessments in models with equal weights do not put an end to the accuracy of a big expert group's decisions and evaluations. This means that

when the number of experts is higher than 7, the accuracy of evaluation is higher than 90%, while where the number of experts is further increasing, the accuracy increases only marginally. Therefore, the collected results of the 14 experts' evaluations are sufficient.

The compatibility of two experts can be determined using the correlation coefficient, when the number of experts is greater than two, it is appropriate to apply the concordance coefficient (W) for determination of expert compatibility level. The coefficient may range from 0 to 1. If the opinion of experts do not differ, the value of the concordance coefficient W is close to the unit, if the estimates are contradictory - the value of W will be close to zero.

The first step for concordance coefficient calculation is the determination of the sum of each indicator valuation results of deviation squares (Podvezko, 2006):

$$S = \sum_{i=1}^m \left(\sum_{j=1}^r x_{ij} - \frac{1}{2} r(x+1)r(m+1) \right)^2, \quad (2.3)$$

where x_{ij} – the estimate of expert x according to factor j , r – number of experts, m – number of criterias. Then the maximum possible S value is calculated (Podvezko, 2006):

$$S_{\max} = \frac{r^2 m(m^2 - 1)}{12}. \quad (2.4)$$

The concordance coefficient is often calculated according to the formula proposed by Kendall (1955):

$$W = \frac{12S}{r^2 m(m^2 - 1)}. \quad (2.5)$$

The concordance coefficient can be applied in practice if its limit value is fixed, when experts assessments can still be considered as harmonized. Kendall (1970) has proven, that if the number of objects (in this case – indicators) $m > 7$, the significance of the concordance coefficient can be determined using the χ^2 criterion (Kendal, 1970).

$$\chi^2 = W r(m-1) = \frac{12S}{r m(m+1)}. \quad (2.6)$$

If calculated χ^2 value is higher than χ_{crit}^2 with $v=m-1$ degree of freedom, then expert evaluations are aligned. If $\chi^2 \leq \chi_{crit}^2$, when the expert opinion is not harmonised.

After the determination of selected indicators significance and identification of experts' opinions compatibility, the next step is to select the appropriate multi-criteria method, which will be used for the financial markets evaluation.

2.1.2. Application of Multi-criteria Methods for Financial Markets Evaluation

It is possible to evaluate all of the selected markets taking into account all the previously selected impact criteria on stock market return. However, it is sufficiently difficult to classify markets into more or less attractive for investors taking into consideration the final research findings. In order to identify the most attractive market for investor the author decided to use multiple criteria method, which has the advantage for summative indicator, combining both maximising and minimising indicators that are expressed in various dimensions. Such combination is possible due to the normalisation, when all indicators transform.

In all cases mentioned above, the normalisation is done in corresponding way by tying the values of phenomenon alternatives, such as the i -th indicator. Currently, there is a lot of multiple criteria (both qualitative and quantitative) and assessment techniques (Hwang & Yoon, 1981; Hwang & Lin, 1987; Ustinovičius, 2001; Podvezko, 2008).

Qualitative methods, which are based on experts' opinion, establish one of the best proposed alternatives, or several of the best alternatives. Quantitative methods quantitatively evaluate every alternative and determine the differences between the valuable alternative (Hwang & Yoon, 1981; Hwang & Lin, 1987; Ustinovičius, 2001; Podvezko, 2006; Ginevičius & Podvezko, 2007).

Multiple Criterion Decision Making (MCDM) allows evaluating alternatives for solutions based on many criteria or different goals. MCDM tasks can be divided into two broad categories (Zavadskas, Turskis 2011):

1. Multiple Objective Decision Making (MODM) – the alternatives, which belong to an infinite number of solutions, are under consideration in this area.
2. Multiple Attribute Decision Making (MADM) – the alternatives, which belong to the complete set of solutions, are under consideration in this area, the discrete optimisation methods are used for solution searching and methods based on measuring multidimensional distances (SAW, AHP, TOPSIS, ELECTRE, PROMETHEE, etc.).

These methods are intended for a finite number of alternatives. The result can be expressed in terms of finding the optimal alternative, ranking alternatives from the best to the worst or breaking alternatives down into certain classes.

The basis of all quantitative methods consists of indicators characterizing comparable objects, statistics, or valuation matrix (Ginevičius & Podvezko, 2008):

$$R = \|r_{ij}\|, i = 1, \dots, m; j = 1, \dots, n, \quad (2.7)$$

where m – is the number of indicators, n – the number of comparable objects (alternatives).

All previously, shortly described methods differ in their complexity. The simplest of the used methods, described in scientific literature, are the sum of places (VS) and geometric average methods, more precise methods – SAW and COPRAS and most complicated – TOSPIS, VICOR, MOORA, MULTIMOORA, PROMETEEY, PROMETEE II, ELECTRE. The fact that such a wide spectrum of methods is used for different problem solving shows that these methods have some limitations. Zanakis et al. (1998) carried out the simulation experiment during which evaluated eight MADM methods under different number of alternatives, criteria and distributions. According to experiment results, it was found that the number of criteria had little effect on AHPs and ELECTRE methods. TOPSIS rankings differ from those of SAW more when number of criteria is large, when it also exhibits its fewest rank reversals. ELECTRE produces more rank reversals in problems with many criteria. According to experiment results, he distinguished SAW method as the method that gives the most acceptable results for the majority of single-dimensional problems.

Ginevičius et al. (2014) also analysed the application of MADM methods in social sciences dissertations defended in 2005–2013 in Lithuania and found that SAW and COPRAS methods were used most frequently. Both of them are sufficiently simple and understandable for applying. In comparison with SAW, the method CORPAS has the advantage that it evaluates both maximising and minimising indicators without any transformations, while SAW evaluates only maximising ones. However, CORPAS method in certain cases can be unstable from the point of view of data fluctuation. For financial markets evaluation the author decided to use one of the most commonly used methods – SAW (Simple Additive Weighting) method, which the most obviously describes the meaning of multi-criteria evaluation (Hwang & Yoon, 1981).

Using SAW method, the primary data matrix is formed firstly (Table 2.1). The significance and priority of the analysed indicators are counted in two stages. First of all, the sum S_j of all weighted normalised values \tilde{r}_{ij} for each object (alternative) is calculated using the formula (Ginevičius & Podvezko, 2007):

$$S_j = \sum_{i=1}^m \omega_i r_{ij}, \quad (2.8)$$

where ω_i – the weight of i -th indicator, r_{ij} – the normalised value of i -th indicator for j - m object.

Table 2.1. Initial data for multi-criteria analysis (created by author)

Criteria	Units of measurement	Significance (weight)	Values					
			1	2	...	j	...	n
X_1	m_1	w_1	x_{11}	x_{21}	...	x_{1j}	...	x_{1n}
X_2	m_2	w_2	x_{21}	x_{22}	...	x_{2j}	...	x_{2n}
...
X_i	m_i	w_i	x_{i1}	x_{i2}	...	x_{ij}	...	x_{in}
...
X_m	m_m	w_m	x_{m1}	x_{m2}		x_{mj}		x_{mn}

For the best variant corresponds the highest value of S_j . Comparative variants are arranged in descending order. All criteria should be maximised, otherwise normalisation should be used for minimised indicators.

Second of all, minimisation and maximisation of the indicators are carried out according to the following formulas (Ginevičius & Podvezko, 2007; Podvezko, 2008):

$$\bar{r}_{ij} = \frac{\min_j r_{ij}}{r_{ij}}; \quad (2.9)$$

$$\bar{r}_{ij} = \frac{r_{ij}}{\max_j r_{ij}}, \quad (2.10)$$

where $\max_j r_{ij}$ – the largest i -th indicator's value from all alternatives, $\min_j r_{ij}$ – the lowest i -th indicator's value from all alternatives.

Practically, for all quantitative multi-criteria methods are used positive values of the indicators. However, in practice, there are indicators that may be negative, in this work – the real GDP annual change and unemployment indicators

have positive and negative values. So, these data must be moved up to positive values according to formula (Ginevičius, Podvezko, 2001; 2007):

$$\overline{r_{ij}} = r_{ij} + b_i \quad (j = 1, \dots, n), \quad (2.11)$$

where b_i – i -th variable displacement constant.

The size b_i must to match the condition: $b_i > \left| \min_j r_{ij} \right|$. The movement does not change the distance between values r_{ij} with any constant b_i . However, the ratio of values r_{ij} depends from the ratio b_i .

The analysed problem would be solved completely, if it were possible to move the negative data to positive and maintain the stability of the data element ratio (Ginevičius & Čirba, 2005). Nevertheless, scientists have not yet solved this problem.

To summarise, SAW method reflects the basic idea of multi-criteria methods – combining the values of the indicators and their weights into one size – the criteria of the method. The significance of the indicators (their weights) are determined using this method. The calculation algorithm of the method is uncomplicated and easily realised using simple computer programs, therefore is selected for equity markets evaluation.

2.2. Evaluation of Companies Using Financial Soundness Indicators

In order to reach the main aim of the thesis, the emphasis is based on the analysis of approaches for determining financial stability. Financial stability is a description of the absence of system-wide episodes, when the system is not functioning properly, for example, lack of crises (Solomon & Bucur, 2014). The company's financial balance and stability are achieved, when non-financial assets are funded at the expense of equity capital, while financial assets are funded at the expense of a borrowed capital. It should be noted that the company's financial situation might be classified as:

- stable;
- unstable;
- critical.

Stable financial condition is gained with a sufficient level of owner equity, good quality of assets, sufficient level of return on assets and also liquidity, stable income and wide possibilities of attracting debt capital. Heavily, financial stability

depends on the structure of financial sources and structure of assets of the enterprise, particularly depending on the balance of long-term and short-term assets. The capability of a company to settle payments timely, to finance its operation on an enlarged scale, to withstand contingencies testify about its sound financial situation and on the contrary, violation of payment terms, development of a company increasing accounts payable and other facts testify about unstable and even critical state (Lace & Sundukova, 2010). In addition, the analysis of financial stability, as one of the key goals and management tools of the company, is undoubtedly important, seeking to maximise the economic outcomes of companies, operating in the current business environment.

Quite a great number of existing coefficients intend for characterizing the financial soundness of a company (Bernstein & Wild, 2000; Ross *et al.*, 2005; Brealey *et al.*, 2007; Савицкая, 2005; etc.). However, many of them are derivatives of each other, thus not providing additional information for management.

In order to determine the level of financial stability of an enterprise, the author choose to use a slightly different methodology, proposed by Lace and Sundukova (2010), for determining financial stability. The authors introduced a new concept for description of company financial stability – financial soundness of the company, based not only on the financial independence of the company and on the level of liquidity, but also on the adequacy of the coefficient level to achieve the financial balance of long-term (sustainable) corporate financing. According to this methodology, the higher actual to sufficient ratios (ASRL, ASREA) of the companies show that company has the optimal structure of assets or the optimal level of the liquidity but lower ratios mean that company has the minimal level and companies with lower ratios are not selected for further investment decisions (Lace & Sundukova, 2010).

$$ASRL = \frac{LR}{SLL} \times 100\% , \quad (2.12)$$

where *ASRL* – actual to sufficient ratio (liquidity).

$$ASREA = \frac{OETAR}{SLOETAR} \times 100\% , \quad (2.13)$$

where *ASREA* – actual to sufficient ratio (owner equity to total assets).

The detailed methodology and formulas used for calculations are given in Annex B. Lace, Sundukova (2010) used this methodology to evaluate enterprises in different industrial sectors in Latvia. Taking into consideration the aim of the thesis, this methodology was improved by the author, setting another range for companies' stability assessment (Table 2.2). The carried out experimental research has made it possible to observe that, in the long run, the initial determination of the ranges is not fully appropriate for the evaluation of the enterprises, as

the results may be distorted. For example, using the normal range, described in the methodology, when an enterprise is evaluated in the short-term (quarter or year), the indicator ranges can be closer to zero and the company could be considered as stable. However, when considering a larger time line, we can see the tension, the values of indicators have been increased or decreased and if there is a clear downward trend, then the value of the indicator close to zero does not imply stable situation of company, and on the contrary, there is an indication that the company's activity is becoming unstable. In order to prevent such ambiguities, the range of values were adjusted accordingly for the investment decision-making.

Table 2.2. Proposed ranges for companies' stability assessment (created by author)

Ratios	Range and its meaning (Lace, Sundukova 2010)	Proposed range and its meaning
ASRL, % ASREA, %	Less than 0, the activity of company is unstable, unbalanced; $0 < x < 100$, the company activity is stable, balanced; More than 100, the company activity is stable, but company does not use all of its capabilities.	Less than 0, the activity of company is unstable, unbalanced; $0 < x < 69.99$, the average stability of the company; $70 < x < 105$, the stable company activity; More than 105, the company activity is stable, but company does not use all of it capabilities.

As the thesis focuses on ensuring investment return sustainability in the long run, it is expedient to use modified range of ratios interpretation for determining the stability of enterprises. In the thesis, the methodology discussed above and more detailed presented in Annex B was applied to stock selection algorithm and for selection of stocks into the investment portfolio. All listed companies will be evaluated in selected stock markets. It should be noted that the companies with the sufficient equity capital in long term tend to demonstrate higher stability in the conditions of normal economic environment and would be able to develop their activities despite adverse market conditions.

2.3. Use of Back-testing and Investing Platform as the Tools for Examining Intelligent Investment Strategy

Back-testing method is used in order to interpret the past data and investigate whether the proposed investment strategy is effective. The usage of this method allows to simulate the trading strategy over an appropriate period of time and analyse the results for the levels of profitability and risk. The duration of back-testing period should be long enough in order to include periods of various market conditions, including uptrends and downtrends of the economic cycle. Only one type of market test may result the unique results that may not work well under other market conditions and may lead to false conclusions (Vilkancas, 2017; Gilli et al. 2011; DeMiguel et al. 2009).

Back-testing method has been used in order to confirm the application possibilities of the intelligent investment strategy in the financial markets. The back-testing logic, which was used in the thesis, presented in Figure 2.1.

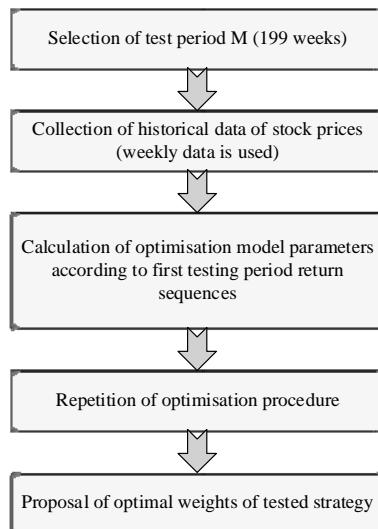


Fig. 2.1. The expert evaluation dependence of the standard deviation upon the number of experts (created by author)

Using the obtained weights, return on portfolio and other key portfolio parameters are calculated for the next week, i.e. $t = M + 1$. The process continues by adding one new period (in this case a week) and rejecting one last period until the entire data period expires.

The testing of formed model is very important stage for the whole investment process. The main hypothesis of the thesis requires investigating investment return sustainability on an individual portfolio level. Real time investment using demo version is a way to ensure the soundness of applicable strategies.

There are a lot of investing platforms such as Zulutrade, Saxo Trader, Oanda, DNB Trade, Meta Trade, etc., that can be used for testing the applicability of various investment strategies. The author uses DNB trade platform, as an investing tool, for examining the intelligent investment strategy due to the following reasons since 2012:

- DNB trade platform has a demo version that reflects the real trading conditions;
- demo version is completely free, has unlimited number of desirable open accounts;
- DNB trade platform is particularly modern and user-friendly, offering many functions that are even carried out in a variety of ways that are most convenient for an investor;
- stock prices are displayed in real time, account summary and key news are continuously updated;
- one of the unique features of DNB platform is the huge number of financial instruments that can be traded in one place, even 13.000 foreign-owned stocks on the 29 largest global stock exchange market;
- there is a possibility at any time to refresh the account and if necessary to begin investment of the same amount, but slightly change the investment strategy or other aspects, there is no need to open a new account;
- the platform can be downloaded and stored on computer, but it is not required. If necessary, it is possible to trade online, so the investor is not obliged to use the new device, download the program again.

In summary, DNB trade platform was chosen due to its functionality and the similarity of the investors operating tools in global capital and currency markets. It is easy to manage investments (buy and sell financial instruments), replicate with technical analysis indicators (graphs and their modifications) and publish required data for fundamental macro analysis and news flow. The process of transaction and the order submission is fully automated. The usage of back-testing method and DNB trade platform will provide the opportunity to examine the effectiveness of proposed intelligent investment strategy in different stock markets and approve or deny the viability of the strategy.

2.4. Models for Investment Portfolio Formation

Investment portfolio is the set of different investment objects, which are used by investors in order to earn the profit and at the same time to minimise the risk. The formation of investment portfolio is very important in investment process. Portfolio performance evaluation has always been a serious question from both academic and practical viewpoints.

One of the widely used classical models for investment portfolio formation is Markowitz theory (modern portfolio theory), which was developed by H. Markowitz in 1952. The efforts of Black (1974) and some other scientists have complemented this theory. Tobin (1965) in his works disseminated the ideas of Markowitz theory and applied them to macroeconomics, while Sharpe (1966) and Mossin (1966) determined that Markowitz idea was the main investment theory. The problem of investment portfolio formation and diversification was examined by Anderson and Frankle (1980), Jorion (1986), De Santis and Gerard (1997). They analysed how many financial instruments should compose a portfolio in order to ensure investment safety. For risk remission, Roll (1980) was the first who proposed to form orthogonal portfolio. Subsequently, Asgharian (2011) has proposed asset allocation models with latent factors based on the portfolio orthogonality principle.

A. V. Rutkauskas (2000) was the first one who introduced the idea of adequate portfolio in Lithuania, and the specific features of this theory were examined in his works (Rutkauskas, 2001, 2005a, 2005b, 2006; Rutkauskas *et al.*, 2009; Rutkauskas, 2017). The essence of this theory is assessment of investment portfolio risk, profitability and reliability. Fuertes *et al.* (2009) investigated the volatility of equity markets by examining whether the importance of daily data usage depends on market conditions and the use of daily GARCH forecasts. While at the same time, Carriero *et al.* (2009) proposed forecasting exchange rates with a large Bayesian vector autoregression (VAR), which they argue is more robust than random walk models, providing better forecasts for most countries over any horizon. Furthermore, Meucci *et al.* (2014) used the ‘Effective Number of Minimum-Torsion Bets’ to evaluate portfolio diversification and compared it to the equal weight approach to portfolio allocation. Zhongbao *et al.* (2018) studied cardinality constrained mean-variance (hereinafter – CCMV) portfolio selection problem and chosen to approximate the CCMV frontier by innovatively applying method of data envelopment analysis.

Hence, many scientists tried to find universal method for investment portfolio diversification and evaluation or improve the extension of Markowitz theory, but this problem has not been solved yet.

The author aims to analyse Markowitz portfolio theory, which is foundation of investment portfolio theories, and adequate portfolio theory, which improved

Markowitz theory adding additional criteria of reliability for investment portfolio evaluation.

At first, Markowitz suggested a concept of effectiveness. In order to analyse the set of efficient portfolios, it is necessary to calculate the expected return and standard deviation of return for each financial instrument of the portfolio. Markowitz quantified how diversification of the portfolio can reduce portfolio risk. His model is based on the expected stock return and risk. In addition, Markowitz's theory has several assumptions (Reilly & Brown, 2006):

- investors look for every investment opportunity as the probability distribution for the expected return on investment for a given period;
- investors seek to maximise the expected benefits for the investment period, and their utility curves show decreasing marginal profitability;
- investors measure portfolio risk as a variation of expected return;
- investors adopt decisions based only on risk and return, thus their utility curves are the function of expected return and a standard deviation of expected return;
- at the same level of risk, investors prefer portfolio with higher returns, and under a fixed rate of return, investors prefer lower risk.

In order to establish the efficiency of investment portfolio it is necessary to calculate the expected return and standard deviation of profitability for every portfolio. The formation of Markowitz model requires the following data:

- expected profitability of each share;
- the standard deviation of the profitability, which measures the risk of each share;
- the covariance – a measure of equity profitability ratio (Kancerevyčius, 2009).

The foundation of Markowitz portfolio theory is based on investor's intention to make a greater return of financial instruments possible in an existing level of risk. Creation of optimal portfolio – is the essence of Markowitz theory. It is necessary to take into account the volatility of stock returns and the variance or covariance assessment for these factors quantitatively (Valentinavičius, 2010):

$$Cov(R_k R_l) = E(R_k - E_k)(R_l - E_l), \quad (2.14)$$

where *cov* – covariance, $R_{k;l}$ – the profitability of shares, $E_{l;k}$ – the average of shares profitability.

However, Markowitz model does not impose the sole optimal portfolio; it defines the efficient frontier, where all portfolios are optimal. These combinations are possible, but not necessarily correct. In order to determine the optimal portfolio sole, the indifference curves are used. These curves depict investors' attitude

to risk and profitability. Indifference curves are linear and parallel. The higher curve means more desirable situation. The task of every investor is to find the portfolio tangent under the best (highest) indifference curve (see Fig. 2.2).

For the above-mentioned reasons, the Markowitz's theory has become the classic work for investment decisions management. According to Markowitz's classical theory, investors construct their portfolios with all assets available in the market; however, extensive empirical studies showed that many investors prefer to limit the number of assets in their portfolio (Goetzman & Kumar, 2008). For this reason, the adequate portfolio theory is analysed on purpose to reduce the gap between theory and practice.

According to Rutkauskas (2006), formation and management of portfolio requires effective evaluation of various portfolio conditions existing on the efficient frontier description of their interaction or analysis of other portfolio characteristics. Portfolio decisions should be achieved when it is impossible to describe the profit possibilities of portfolio not as a point estimated but as their probability distribution. Before examining the concept of adequate portfolio, it should be understood that this is a common set of financial assets in order to determine the reliability of profitability.

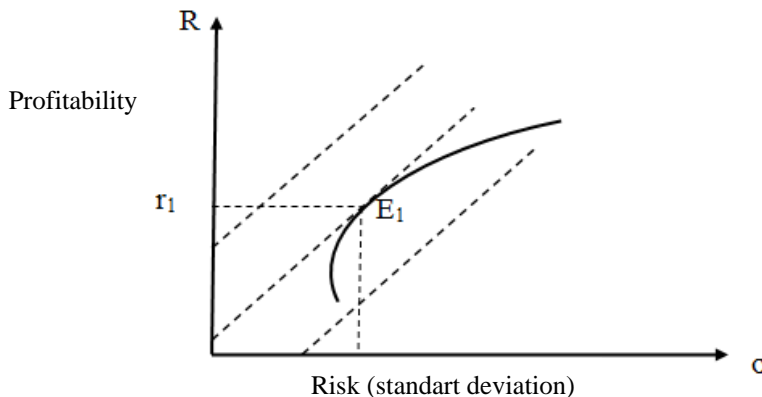


Fig. 2.2. The efficient frontier and the indifference curves (Leipus & Norvaiša, 2003)

Analysed investment portfolio process allows extending the opportunities of Markowitz modern portfolio, because, in author's understanding, the adequate portfolio is a natural extension of Markowitz portfolio. One of the main advantages of investment decisions is assessment of reliability. Standard deviation is widely used among scientists and is not an appropriate tool to describe the ob-

jectives of investor. The effective decisions of modern investment portfolio become the starting point for adequate investment decisions. The propinquity of modern and adequate portfolio is illustrated through effective and maximum areas, as well as three-dimensional utility function of finding the most advantageous portfolio for the investor (Rutkauskas, 2006).

It is possible to determine the efficient frontier of portfolio, knowing the parameters of profitability and risk, where the rational investor should choose the optimal portfolio. The efficient frontier shows the composition of the portfolio combinations that gives the highest return for a given risk, and, similarly, those portfolios have the lowest risk for a given level of return. In order to establish an efficient frontier (in case of more than two securities), one should start from the identification of portfolio set. All the possible combinations of portfolio risk and return presented graphically constitute the efficient surface of portfolios.

Concept of adequate portfolio let investment portfolio holder to see the overall profitability of active possibilities, thus simplified in practice more often encountered the decision-making path. It would be appropriate to compare the Markowitz and adequate portfolio theories (see Table 2.3).

In order to understand the guideline of adequate portfolio theory it is worth to deep inside the geometric image of investment portfolio. The choice of investor should be moved into a three-dimensional plane where the portfolio risk is depicted in abscissa, portfolio profitability possibilities – in ordinate, and the third characteristic - the portfolio profitability reliability – in coordinate (Rutkauskas, 2000). This three-dimensional surface view is called the efficiency zone that is made up of all quintile effective lines (Rutkauskas & Stankevičienė, 2003). According to the adequate theory model, the investor will seek to maximise the guarantee that the profitability will be no less than the selected level. The set of effective lines is defined as isoguarantee of investment portfolio – the line of opportunities surface, connecting points of equal guarantees. If probability of all isoguarantee that the portfolio value is not less than changing value, the investor should choose the maximum of the probability possibility (Rutkauskas, 2003).

The view of three-dimensional effective area especially useful for understanding the influence of distributions of individual investments forms on overall portfolio opportunities distribution form.

Now it can be complemented or concretised the concept of effective (or maximum) zone. Where is all “quantile of risk – profitability possibilities” effective lines for criteria sets of portfolio and perpendicular keeping them in the appropriate level of quintile $p_a = P\{a\}$, we will have the graphic view of effective zone in three-dimensional spaces. The corresponding lines will be isoguarantee i.e. the line, having the same significance of survival function by changing both the profitability and risk values. Thus, effective zone is the unique plait of isoguarantees and survival functions in each risk level (see Fig. 2.3).

Table 2.3. The comparison of classical and adequate portfolio (Rutkauskas, 2000; 2005a)

Markowitz portfolio theory	Adequate portfolio theory
<ul style="list-style-type: none"> determines the efficiency line where the existing portfolios possess maximum expected (average) profitability among the given portfolios of riskiness; each investor's indifference curve allows the choice of portfolio where the investor is able to gain the maximum of average profitability. 	<ul style="list-style-type: none"> determines the efficiency zone where each level of possible portfolio risk possesses the distribution of maximum possibility probability; each investor's utility function could experience such level of risk and distribution of the highest possibilities that maximise the investor's utility.
<ul style="list-style-type: none"> The choice of investment and portfolio investment made in the interaction between profitability average and riskiness of profitability opportunities (often - standard deviation) trends and taking into account the investor's indifference curve of the average profit – in the risk plane. 	<ul style="list-style-type: none"> Profitability possibilities for each investment as well as the rest of the portfolio are examined together with recipient of risk (subject experiencing risk) utility function, which takes into account the possibilities probability distributions.

Together here is submitted the geometric view of three-dimensional model of the utility function. In order to achieve the investment strategy that may be more adequate for the interests of investors, it is necessary to use the diverse possibilities of an adequate investment portfolio.

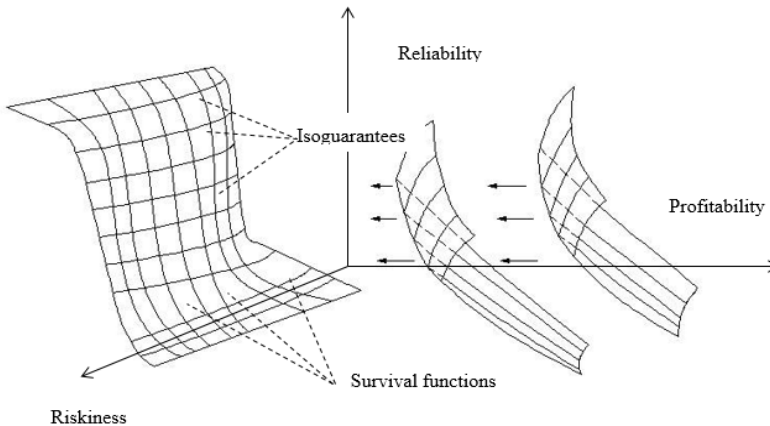


Fig. 2.3. The general view of three-dimensional efficient surface and respective utility functions (Rutkauskas, 2006)

As an adequate portfolio model allows considering any empirical probability distribution with a predictable set of stock return, therefore, this model, as an adequate instrument for taking investment decisions on the stock market, will be integrated into the author's intelligent investment strategy scheme in order to verify the adequacy of intelligent investment strategy.

It should be noted that before making investment decisions, using an adequate portfolio theory, the preparatory steps are carried out – the data are collected and stock selection is carried out. In addition, after that, according to adequate portfolio theory, the optimisation is carried out and system provided the structure of stocks for investment portfolio formation (Fig. 2.4).

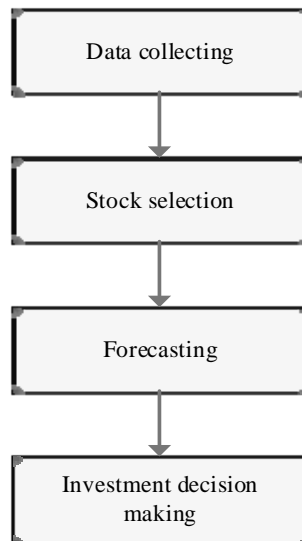


Fig. 2.4. The logic of decision-making using APT (created by author, according to Rutkauskas, 2006; 2017)

Stock selection has been carried out using the methodology, proposed by Rutkauskas (2017), which is based on ranking of the alternatives according to the technical analysis of stock price. The following parameters are used for stocks selection: cyclicity, correlation, kurtosis, skewness, maximum growth, maximum risk, moderate growth and moderate riskiness.

The cyclicity is measured by the correlation of the asset with the market index during the analysed period and the correlation according to its correlation with all remaining portfolio assets. The kurtosis could be measured with the help of the probability distribution. The ratio of distribution mode and mean could be used for skewness measure. The ratio of the asset supply price and the first price over the period considered was used to estimate the maximum growth. The stan-

standard deviation of the distribution was used for maximum risk assessment. The ratio of maximum growth and standard deviation used for moderate growth measure and the ratio of standard deviation and mean used to measure the moderate riskiness. This stock selection logic was chosen as a comparative method that will be used for intelligent investment testing.

2.5. Formation of Intelligent Investment Strategy

The author introduces a scheme of intelligent investment strategy, as a specific investing actions procedure in the current thesis (Fig. 2.8). The created scheme consists of three main stages:

1. The selection of stock markets.
2. The algorithm for stock selection.
3. The scheme of investment portfolio formation and testing.

In order to develop a conceptual framework for intelligent investment strategy in stock markets, it is important to establish a logical model for stock market selection (Fig. 2.5). Short description for each phase is given below.

- *The analysis of impact indicators on stock market return.* The aim of this phase is to analyse the works of researchers, who investigated the impact of various indicators on stock markets return.
- *The set of impact indicators for stock market selection* (see Subchapter 1.6). The aim is to provide the set of impact criteria for stock market selection, which generates stable return in the long-term.
- *Data collection.* The data was collected from Bloomberg laboratory of Kaunas University of Technology and others databases.
- *The choice of experts.* It is important to properly select experts from investment field in two different areas: business and academic communities, as well as compare the results of their evaluation.
- *Determination of impact indicators significance.* The experts should propose the weights for the most important impact indicators that will be used for further investigation.
- *Market evaluation, using multi-criteria evaluation method.* In this stage, the selected stock markets will be evaluated using historical data of determined impact indicators and multi-criteria evaluation method SAW.
- *Stock market selection.* According to the evaluation results, the author would distinguish the best markets that would be used in further investigation.

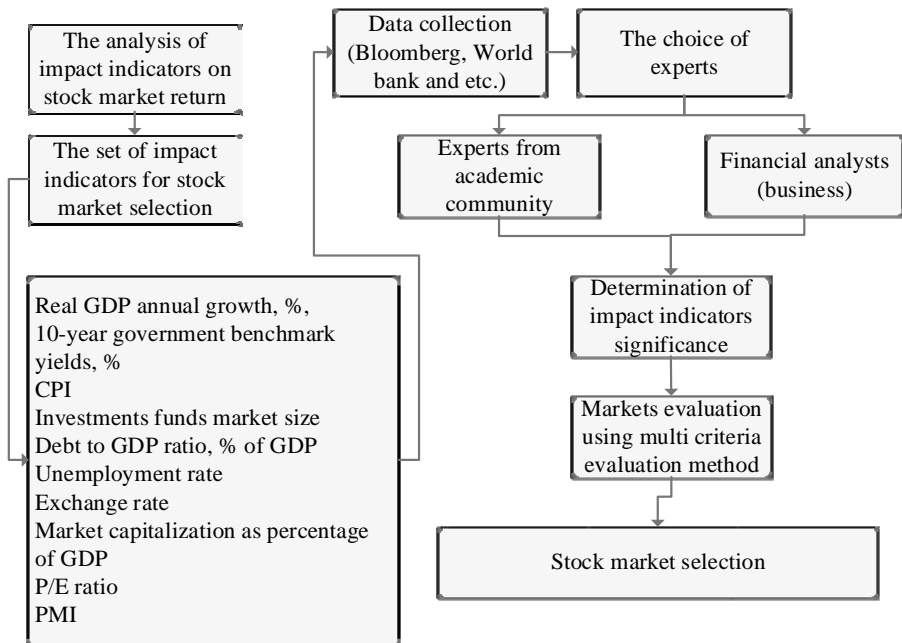


Fig. 2.5. The scheme of stock market selection (created by author)

The second stage is the most important part of intelligent investment strategy. Financial soundness evaluation of listed companies (see Subchapter 2.2 and Annex B) and the evaluation of each stocks price, calculating the return and risk level (standard deviation) is the most important part for the second stage and formation of stock selection algorithm. The stock selection is carried out in the following stages according to second stage of intelligent investment strategy – stock selection algorithm stages (Fig. 2.6):

- Financial soundness evaluation of listed companies. According to methodology, which was described in Subchapter 2.2 and Annex B., all stocks, which are included in the selected index of each country (the list of selected indices, with number of components, for the research is presented in Table 3.15), were evaluated. According to the financial data of every company, the sufficient and actual indicators have been calculated. The final assessment is carried out based on calculated actual to sufficient ratios.
- The return and risk (standard deviation) of each stock price have been calculated, taking into account that stocks with higher return and lower standard deviation are potentially better for investment than others.

- The identification of investment objects. Based on the evaluation results obtained in the first and second stages, the investment objects are divided into the most stable companies, average stability companies, the lowest stability and companies, which are at the bankruptcy zone.
- Financial data update and the redistribution of companies is carried out quarterly, stock prices data is updated weekly. It should be noted that the main set of stocks (in this research was selected fourteen most stable stocks), identified after analysis, is reviewed quarterly.

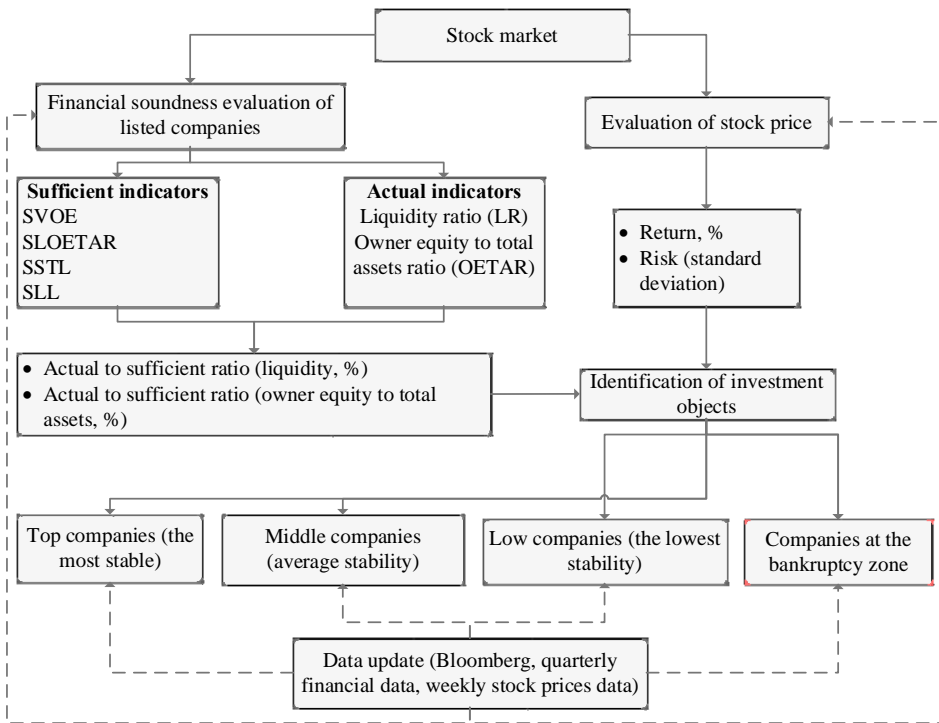


Fig. 2.6. Stock selection algorithm (created by author)

The last stage of intelligent investment strategy is the formation and testing of investment portfolio (Fig. 2.7). Two kinds of portfolios were formed. The first portfolio will be formed according to the results of stock selection algorithm, proposed by the author and the second – according to stock selection, based on ranking of the alternatives according to the technical analysis of stock price, proposed by Rutkauskas (2017). This portfolio will be used for intelligent investment strategy verification. Fourteen stocks were selected for portfolios formation in this research and then carried out the back-testing of portfolios, comparing the IIS

portfolios return and risk with the return and risk of comparative investment portfolio as well as with return and risk of stock market index for every stock market. The structure of portfolios was determined using adequate portfolio theory. In addition, it should be noted that for portfolio formation it could be used not necessarily fourteen stocks, it could be any other variable size.

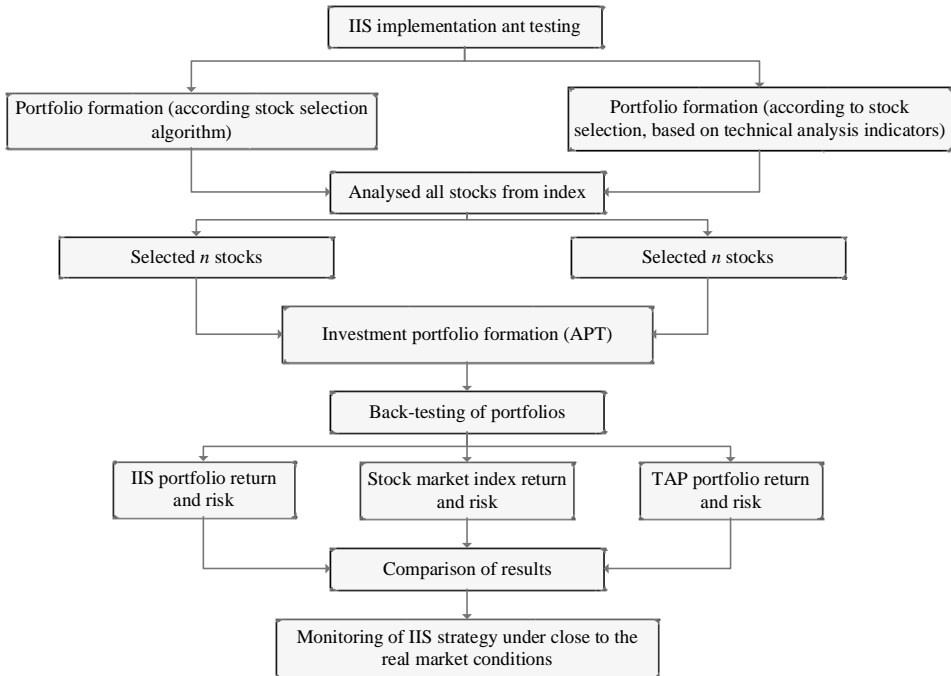


Fig. 2.7. Scheme for investment portfolio formation and intelligent investment strategy testing (created by author)

The combination of all three stages forms the general scheme of intelligent investment strategy, which is presented in Figure 2.8.

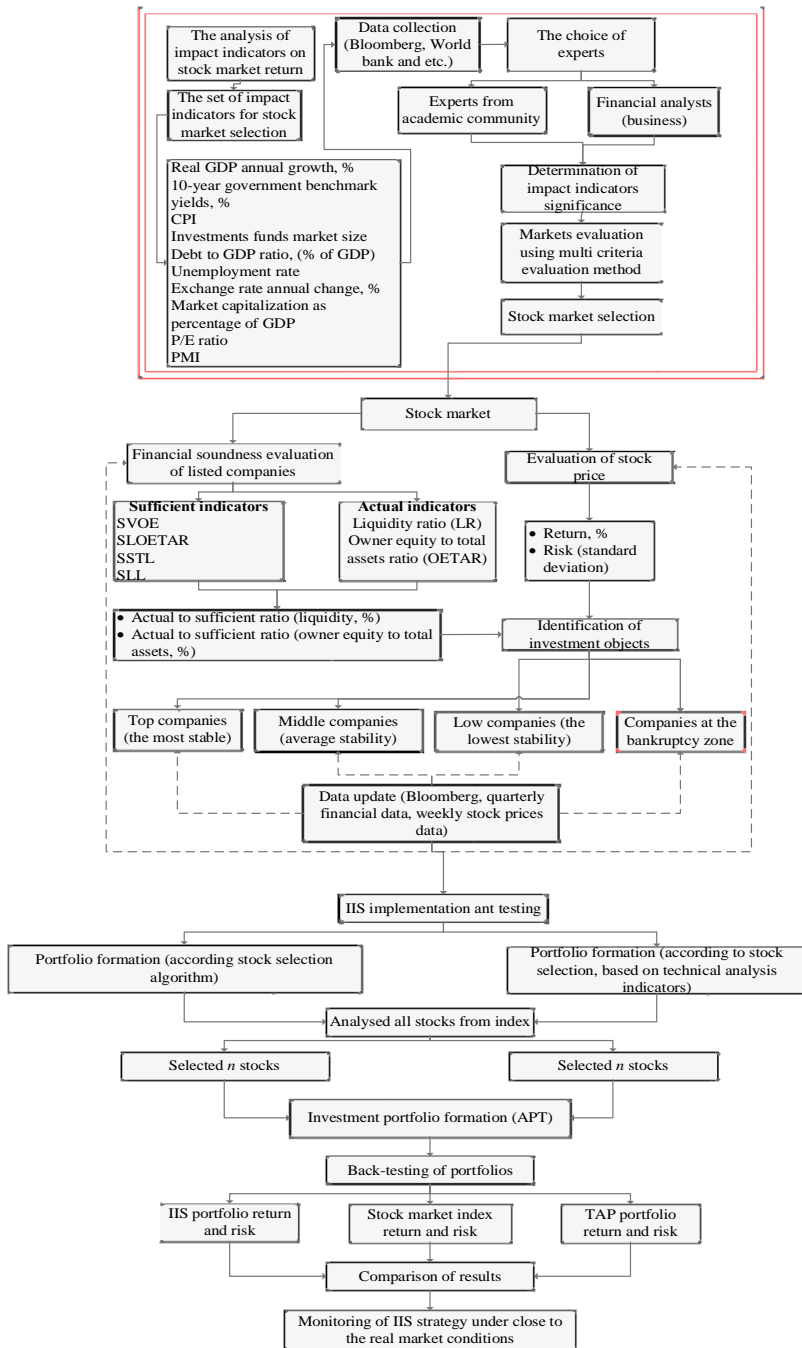


Fig. 2.8. The scheme of intelligent investment strategy (created by author)

2.6. Conclusions of Chapter 2

1. With references to research literature it was determined that when more than one criterion is included for the selection process, there is a need to incorporate experts into evaluation process. Expert evaluation method is applicable in various fields with no exception in the investment area, therefore, was offered to be used as appropriate method for determining the significance of impact indicators on stock markets return.
2. After analysis of different multi-criteria evaluation methods usage in various economic fields, it was established that SAW method describes the meaning of multi-criteria most obviously and it is more often used in practice. As a result of this, SAW method was selected for financial markets analysis.
3. The analysis of the methods, which are used to determine the financial stability of listed enterprises in stock markets, helped to identify the most appropriate method, which appeared to be financial soundness evaluation methodology; and with its help to measure the stability level of enterprises.
4. It was determined that back-testing method is the best method in order to interpret the historical past data and investigate whether the proposed investment strategy is effective or not. DNB trade platform is selected as a tool for examining intelligent investment strategy viability under close to real market conditions.
5. The analysis of investment portfolio formation was carried out and evaluation methods have shown that portfolio performance evaluation has always been a serious question from both academic and practical viewpoints. Many scientists tried to find universal method for investment portfolio diversification and evaluation or improve the extension of Markowitz theory, but this problem still exists. Adequate portfolio theory was suggested to use for investment portfolios formation in order to identify the structure of investment portfolio. Stock selection, based on ranking of the alternatives, according to the technical analysis of stock price, was suggested to use as a comparative method to test the main part of intelligent investing strategy – stock selection algorithm and for verification of intelligent investment strategy.
6. According to the proposed methodology, the scheme of intelligent investment strategy was introduced, which consists of three main stages: the selection of stock markets, the algorithm for stock selection and the scheme of investment portfolio formation and testing.

3

Implementation and Testing of Intelligent Investment Strategy

This chapter presents an experimental investigation of stock markets. It was determined to investigate top stock markets that are the most attractive for investors and suitable for investments during the period considered according to the results of the evaluation. The results of multi-criteria evaluation of financial markets allowed selecting the most stable markets, which are expected to generate higher investment return than others in the future. The scheme for stock market selection has been proposed. Also, this chapter presents the formation of intelligent investment strategy, its implementation and testing. Nineteen investment portfolios were formed according to the proposed stock selection algorithm. These portfolios have been tested using back-testing method. The results of back-testing for each market have been compared with return of benchmark at the same period of time and adequate portfolio theory results. The usage of intelligent investment strategy might help to reach the main goals for every investor. The tests and calculations were performed using data, collected in Bloomberg laboratory of *Kaunas University of Technology*, the data from World Bank, Investment Company Institute, “Amadeus” and other databases. Research results are presented in the journal publications by the author: Kvietkauskienė (2014), Kvietkauskienė & Maknickienė (2015), Kvietkauskienė (2017) and conference proceedings by Kvietkauskienė &

Martinkutė-Kaulienė (2014a), Kvietkauskienė & Vyšniauskas (2016), Kvietkauskienė & Martinkutė-Kaulienė (2016), Kvietkauskienė & Martinkutė-Kaulienė (2017).

3.1. The Investigation of Stock Markets

Every stock market is closely related to the country's economy; therefore, the development of its relation with country's economic development is reciprocal as general improvement in the economic situation creates more assets in the stock market while development of securities market accelerates country's economic growth. It is estimated that after falling of stock prices, we can expect economic stagnation and vice versa, rising stock prices is a sign of a potential growth.

It is well known that the behaviour of financial markets can describe the economic situation in the country. Financial markets demonstrate businesses' opinion about sovereign behaviour in the near future, as stock prices are influenced by investors' expectations. For this reason, changes in stock price are usually examined, as they reflect the changing economic situation. Therefore, investors frequently change their investment decisions not only by observing the equity markets, but also the macroeconomic situation in the country: followed policy of Federal Reserve Bank, public information by Central Bank representatives, forecasts of the World Bank, for instance, even problems in Greece has influence on stock market situation and investor decisions. In particular, the influence of Greek problems is felt in the whole European Union.

According to the fast change and growth of the financial markets, it becomes necessary to create or select right tools that help investors to make their investment decisions and select assets for investment portfolio correctly in order to achieve investment return and avoid risk. Stock price forecast methods are the most debatable topic for investors. Due to their functions in the economy, the stock markets in modern conditions of globalization are becoming very attractive to investors. There is a need to form a potential stock market selection algorithm, according to which investors will be able to form investment portfolios in different stock markets.

According to the scheme (Fig. 2.5 in subchapter 2.5), designed by the author, it is possible to analyse the issue of the market value and to select markets that may potentially generate investment return sustainability for every investor. Investment return sustainability means a stable investment return in long period.

3.1.1. Determination of Stock Markets for Further Analysis

It was considered that in order to get the most accurate results of market selection, the primary stage of market selection mechanism should be the analysis of historical data. The period of 2007–2016 was chosen for stock market selection. Composite leading indicator (hereinafter – OECD) was used for the determination of economic cycles of this period. OECD indicator provides early signals of turning points in business cycles, what shows the fluctuations of the economic activities during long run.

Four stages of business cycle are distinguished:

- Expansion – the leading indicator is increasing and the level is above 100.
- Downturn – the leading indicator is decreasing, but still above 100.
- Slowdown – the leading indicator is decreasing and the level is below 100.
- Recovery – the leading indicator is increasing , but still the level is below 100.

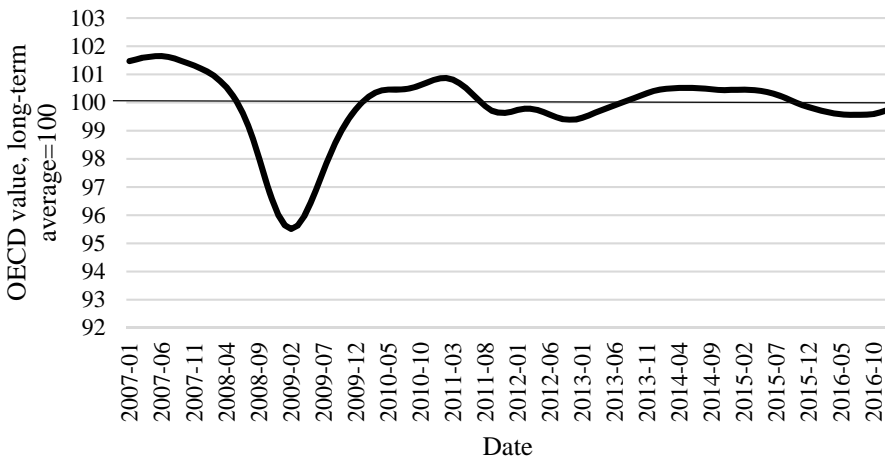


Fig. 3.1. Composite leading indicator during 2007–2016 period (created by author, based on OECD Data 2017)

During the analysed period, stock markets have gone through all phases of the business cycle (Fig. 3.1); therefore, it is expedient to analyse such period in order to formulate long-term investment decisions. This is particularly important step, because solutions must be effective not only during a particular period of the past, but also in fundamentally different situations, both in the stages of a global economic recovery and in the periods of economic recession.

The choice of such periods was influenced by adequate decision-making logic. The markets were chosen globally, 42 global stock markets from Europe,

America, Asia and Australia continents were chosen to analyse (Fig. 3.2). Developed and developing markets were selected for the research.

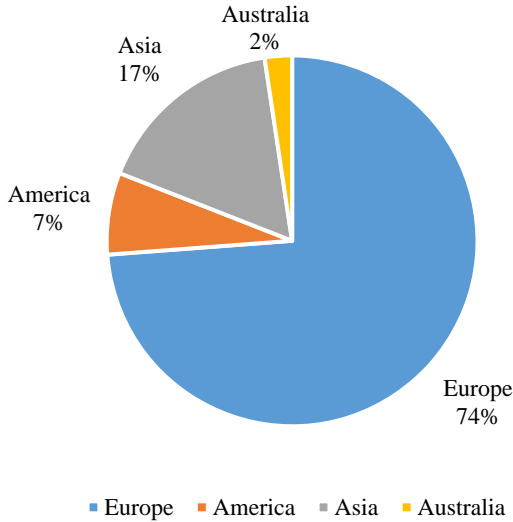


Fig. 3.2. The distribution of selected equity markets by continents (created by author)

The connection between developed and developing stock markets is very important because due to its small scale, developing stock markets are dependent on other markets external effects. The strength of economic relations between countries affects the increase of private capital flows to developing countries; also, the integration of these countries into the global financial market is strengthening (Danilenko, 2008). Selected countries for the research and symbols of their stock market indices are presented in Annex A.

One of the main goals of the research is that an intelligent investment strategy would be able to function in any part of the global stock market, therefore, the author chooses to analyse a large number of countries in the world.

3.1.2. Expert Selection and Determination of Indicators Significance

For the purpose of selecting stock markets that potentially may maintain investment return sustainability for investors, the author has identified 10 impact indicators on stock market return developed in the scientific literature (see subchapter 1.6). The main goal of the expert survey is to carry out an expert evaluation on impact indicators in order to identify the importance of all selected criteria on

stock market return (give weights to indicators). This analysis will give a possibility to evaluate stock markets taking into account all the indicators.

The main criterion for the experts' selection was their professional experience, which means, they have to be not less than three years in the investment sector. Regarding the mentioned criterion, the author selected 20 experts from academic and business sectors that have invaluable experience in investment and collected the answers and evaluations from 14 experts – academicians and business representatives.

Experts had to evaluate and give the weights for 10 previously identified impact indicators (Fig. 1.6) according to their importance on stock market return where 10 – the most important, 1 – the least important indicator. 10 out of 14 were male and 4 of them were female. Experts' distribution by age is presented in Figure. 3.3.

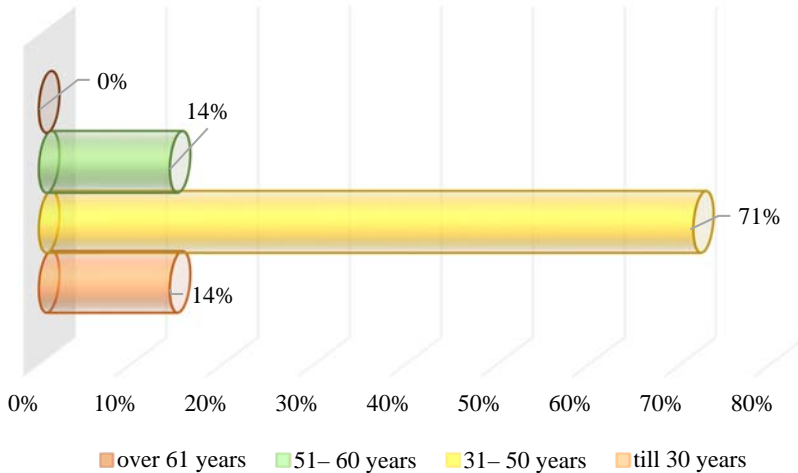


Fig. 3.3. The distribution of age by experts (created by author)

50% of experts are the doctors of science, 42.86 % – have higher university education and 7.14 % – higher non-university education. Seven experts are working at universities pedagogical and scientific work; other seven experts are working in business or in a private sector.

61.54% of experts have more than eleven years of work experience in investment field and 23.08% have more than twenty years, therefore it can be considered that the experts were chosen correctly and the results of their evaluation will be significant in regards to their long-term experience.

It should be noted that the opinions of experts from the business and academic community are different. According to literature review, the most analysed indicators and their impact on stock markets return are the main macroeconomic

indicators such as real GDP annual growth, unemployment rate, debt to GDP ratio, 10-year government benchmark yields. Experts' evaluation of indicators shows a little bit different results, which are presented in Table 3.1.

Table 3.1. Experts' evaluation of impact indicators on stock market return (10 – the highest score, 1 – the lowest score) (created by author)

Indicator/ Expert	1	2	3	4	5	6	7	8	9	10	11	12	13	14
10-year government benchmark yields	3	5	3	6	3	4	10	5	4	9	7	5	6	7
Consumer price index	2	4	5	3	6	4	9	8	8	4	6	3	7	6
Market capitalisation	9	9	9	4	2	4	10	10	5	7	3	7	10	3
P/E ratio	7	10	10	9	1	4	10	8	2	9	1	2	1	10
Investment funds market size	10	8	1	8	1	4	10	10	2	7	9	4	9	1
Real GDP	1	7	4	7	8	8	9	10	7	6	8	2	8	8
Exchange rate change	8	6	2	3	3	4	9	9	2	9	4	6	4	4
Unemployment rate	4	2	7	4	8	6	9	8	2	7	10	6	3	5
Debt to GDP ratio	5	3	6	1	5	6	9	9	2	4	5	8	5	2
PMI	6	1	8	2	1	6	6	6	2	7	2	9	2	9
Total	55	55	55	47	38	50	91	83	36	69	55	52	55	55

The experts' survey shows that the most important indicators on stock market return are real GDP annual growth, market capitalization as percentage of GDP, P/E ratio and investment funds market size (1st – 4th places, the highest weights) and the least important – purchasing managers index (10th place, the lowest weight) (Table 3.2).

Such distribution of the significance of the indicators was determined by the fact that the experts were chosen both as theorists and as practitioners. For example, PMI indicator is widely used among investors, but the academicians give the lowest score for this indicator.

Table 3.2. The significance (weights) of impact indicators (created by author)

Indicator/ Expert	Sum of ranks S_i	Averages	Weights	The places of indicators
10-year government benchmark yields, %	77	5.5	0.097	6
Consumer price index	75	5.36	0.094	7
Market capitalisation as percentage of GDP	92	6.57	0.116	2
P/E ratio	84	6	0.106	3/4
Investment funds market size	84	6	0.106	3/4
Real GDP annual growth, %	93	6.64	0.117	1
Exchange rate annual change	73	5.21	0.092	8
Unemployment rate	81	5.79	0.102	5
Debt to GDP ratio	70	5	0.088	9
PMI	67	4.79	0.084	10
Total	796	56.86	1	

The next step in stock market evaluation process is the assessment of selected markets (countries) according to statistical data of selected criteria and their weights, given by experts.

3.1.3. The Results of Stock Markets Multi-criteria Evaluation Using SAW Method

In order to verify the reliability of the results of expert evaluation, the level of expert consistency was established. The basis for the evaluation consists of expert evaluations of impact indicators (Table 3.1). For this purpose, χ^2 criterion was used (Kendall, 1970).

Table 3.3. The values of χ^2 criterion of expert evaluation compatibility (created by author)

χ^2	χ_{crit}^2 (0.05)	χ_{crit}^2 (0.01)
45.73	16.92	21.67

Calculated value of χ^2 is higher than χ_{crit}^2 . According to Kendall (1970) theory, the experts' evaluation compatibility was verified and all evaluations of ex-

perts have been harmonised, thus it can be concluded that the results are reliable. Calculated value of χ^2 is higher than χ_{crit}^2 . The calculated values of χ^2 , χ_{crit}^2 are presented in Table 3.3. Data of the previously described impact indicators were used for the determination of the most stable markets for investment (see subchapter 1.6).

Table 3.4. The identification of analysed indicators direction (created by author)

Indicator	Direction of the indicator
Real GDP annual growth rate, %	Max
10-year government benchmark yields, %	Min
Consumer price index (CPI)	Min
Investment funds market size	Max
Debt to GDP ratio, % of GDP	Min
Unemployment rate	Min
Exchange rate annual change (local currency per US dollar), %	Min
Purchasing Managers indicator (PMI)	Max
Market capitalisation as percentage of GDP	Max
P/E ratio	Min

As it was mentioned in subchapter 2.1.2, the multi-criteria evaluation method SAW will be used for market evaluation. The first step of evaluation is the identification of indicators direction in order to recognise which indicator is maximising and which one is minimising (Table 3.4). The highest values of maximised indicators and the lowest values of minimised indicators are the best.

Real GDP annual growth usually has a significant impact on stock market return, the real growing GDP change shows not only the healthy economy of country but also the same direction in stock markets, while lower GDP rate has the opposite effect on stock market return, hence the direction of this indicator is maximising. High 10-year government benchmark yields demonstrate country's security and strong economy, but lower yields stimulate economic growth and lead to higher corporate profits and stock price growth, so the direction of indicator is minimising. CPI is the benchmark inflation guide for economy. This indicator reflects the efficiency of the state monetary policy. Lower CPI rate shows the stability of the country, so the indicator is minimising. The direction of investment funds market size indicator is maximising, because the larger size of the investment fund market determines the attractiveness of the investment environment in that country. Lower Debt to GDP ratio shows the stable economic situation of the

country, so the direction of this indicator is minimising. As GDP, the employment rate illustrates the strength of economy, contrary to this indicator is unemployment rate, which is the critical measure for economy's health, so this indicator direction is minimising. Exchange rate annual change (local currency per USD dollar) has an impact on the company's competitiveness as it affects the price of foreign currency, leading to changes in the company's profits and equity, which in return will lead to price adjustments in the stock market. When the relation between local currency rate and US dollar was examined, it was found that the ratio is minimising. Market capitalisation as percentage of GDP indicator has the maximising direction, because the positive fluctuations in market capitalisation index reflect a positive relationship between market capitalisation and stock market indices, therefore it could be argued that this index rises when stock prices grow, as the number of stocks is a constant. P/E ratio has the minimising direction. This indicator is one of the most widely used value indicators from investors. Stocks with lower P/E ratio are perceived as having cheaper current price, hence expected to generate higher return in the subsequent period. Purchasing Managers indicator (PMI) was not included in the evaluation, because the data of this indicator were not available for all selected countries.

The selected testing period is ten years (2007–2016). Also, the following countries were eliminated from the research due to the lack of some data: Slovakia, Singapore, Slovenia, Iceland, Hungary and Argentina. The normalised data of analysed indicators and countries are presented in Annex C (C.1–C.9).

The highest real GDP growth has been captured in China during all the period from 2007 to 2016. Such growth has been caused by increase of China exports, greater consumer spending and capital investment growth. The negative real GDP growth has been observed in Argentina during the same period of time. During analysed period of time China has the strongest growth of real GDP in 2007–2010 as well as the highest normalised value between 2012 and 2016, what shows the stability of the country. Ireland had the highest value of Real GDP in 2014-2015 period, while Turkey had the strongest growth of real GDP in 2011 and 2013 (Fig. 3.4, Annex C.1).

Estonia has the lowest Debt to GDP ratio during the past ten years. At the end of the fourth quarter of 2016, the lowest ratio of government debt to GDP was recorded in Estonia at 9.5 percent, while at the same time in Latvia at 40.1 and in Lithuania at 40.2 percent. In comparison, the highest ratios were recorded in Greece (179 %), Japan (250.4 %) and Italy (132.6%) (Annex C.2).

The countries with the lowest unemployment rates during evaluated period are considered better than countries with the highest unemployment ratios. During 2007–2012 the unemployment rate of Norway was the lowest, so normalised value of Norway during this period the highest (equal to one). South Korea had

the lowest ratio in 2013, Hong Kong in 2014-2015 and Japan had the lowest ratio in 2016 (Annex C.3).

As it was mentioned previously, market capitalization as percentage of GDP ratio is a long-term indicator that allows evaluating the current valuation and expected returns of country stock market. According to the normalised data, during all research period, Hong Kong had the highest ratio, the ratio fluctuated from 1254.5% in 2007 to 995.05% in 2016 years. The lowest market capitalisation ratio was in Latvia (3.23% in 2016) and Slovakia and sought only 5.36% at the end of 2016 (Annex C.4).

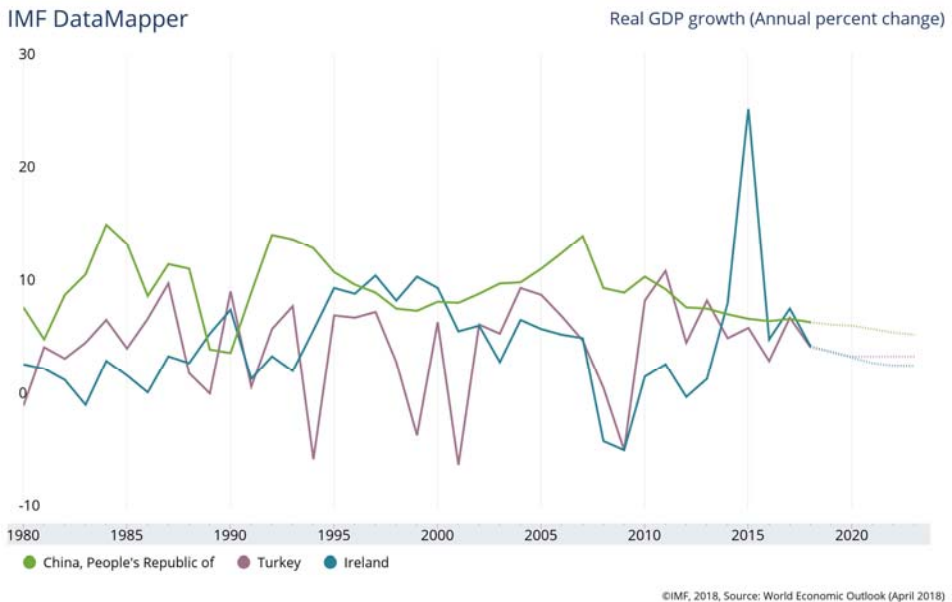


Fig. 3.4. Real gross domestic product growth in China, Ireland and Turkey (IMF, 2017)

The countries with the lowest exchange rates changes (comparing local currency per US dollar) during evaluated period are considered better than countries with the highest exchange rate changes. This indicator is minimised and during analysed 2007–2016 period the lowest exchange rate change was in Hong Kong, so normalised value of this indicator was the highest (equal to one) (Annex C.5).

The countries with the lowest CPI during evaluated period are considered better than countries with the highest CPI. This indicator is minimised and during 2007–2009 CPI of Ukraine was the lowest, so normalised value of Ukraine during this period was the highest (equal to one), while in 2015-2016 Ukraine had the highest CPI ratio (the ratio seeks 205.73 in 2016), this situation was influenced by the political situation in Ukraine. The lowest ratio in 2010–2014 was in China,

while Switzerland had the lowest CPI during 2015–2016 (the ratio was about 98) (Annex C.6).

According to the evaluation of 10-year government benchmark yield (%) of the countries (Annex C.7) and the fact that prices of bonds and stocks move in opposite directions, the most attractive country for investment in stocks was Japan during the evaluation of 2007–2016 period, because it had the lowest 10 year government benchmark yields, with exception of 2012, when the lowest ratio was fixed in Switzerland. The opposite situation was in Russia, the highest values of the ratio were recorded (10-year government benchmark yield in 2016 reach 10.44%).

The countries with the lowest P/E ratio during evaluated period are considered better than the countries with the highest value of ratio. This indicator is minimised and during 2007–2008 the P/E ratio was the lowest in Cyprus, Israel had the lowest ratio during 2009–2010 and in 2012, Russia – in 2011, however, Greece had the lowest ratio in 2013–2015 and Cyprus – in 2016. Normalised values of this indicator were the highest (equal to one) (Annex C.8).

Table 3.5. Calculated S values for all markets (created by author)

Country (market)	S values by the year						
	2007	2008	2009	...	2014	2015	2016
United Kingdom	0.3165	0.3160	0.3392	...	0.3530	0.3309	0.3650
Austria	0.3103	0.3439	0.3541	...	0.3875	0.3367	0.3857
Germany	0.2672	0.2894	0.3228	...	0.4316	0.4004	0.4914
Finland	0.3007	0.3166	0.2919	...	0.3451	0.3031	0.3582
Ireland	0.3252	0.2705	0.2888	...	0.3502	0.3564	0.3722
Norway	0.4029	0.4091	0.4201	...	0.6149	0.3581	0.4508
South Korea	0.3636	0.3867	0.4427	...	0.6401	0.3997	0.4327
Italy	0.2813	0.2807	0.3192	...	0.2766	0.2505	0.2923
Lithuania	0.3779	0.3271	0.1988	...	0.6827	0.3026	0.3138
Netherlands	0.3828	0.4172	0.4181	...	0.4958	0.3347	0.4023
Belgium	0.2795	0.2904	0.3347	...	0.3509	0.2994	0.3654
Brazil	0.2486	0.2791	0.3284	...	0.3335	0.2253	0.7062
United States	0.3142	0.3151	0.3233	...	0.4399	0.3376	0.4118
Latvia	0.3554	0.2688	0.2478	...	0.3348	0.3040	0.3889
Estonia	0.4161	0.3502	0.3326	...	0.3986	0.3866	0.4164

End of Table 3.5

Country (market)	S values by the year						
	2007	2008	2009	...	2014	2015	2016
Sweden	0.2884	0.2980	0.3168	...	0.3384	0.3422	0.3776
Denmark	0.3282	0.3615	0.3308	...	0.3519	0.3451	0.3802
Hong Kong	0.5473	0.6054	0.5879	...	0.6494	0.6201	0.6209
Switzerland	0.3813	0.4133	0.4530	...	0.4554	0.8400	0.4503
Israel	0.2824	0.3022	0.4047	...	0.3505	0.3256	0.4073
France	0.2743	0.2924	0.3261	...	0.3016	0.2890	0.3344
Australia	0.3492	0.3747	0.3862	...	0.3511	0.3179	0.3854
Greece	0.2784	0.2769	0.3238	...	0.3274	0.2917	0.2411
Portugal	0.2649	0.2797	0.3247	...	0.2545	0.2389	0.3169
Poland	0.2615	0.2884	0.3452	...	0.2980	0.2782	0.3570
Russia	0.3426	0.3614	0.3584	...	0.3684	0.3387	0.3305
Croatia	0.2536	0.2659	0.2767	...	0.2337	0.2311	0.2944
Turkey	0.2536	0.2511	0.3034	...	0.2968	0.2742	0.2750
Czech Republic	0.3042	0.3331	0.3299	...	0.3515	0.3788	0.4182
Bulgaria	0.3116	0.3485	0.3911	...	0.2971	0.2965	0.3517
Romania	0.3003	0.3543	0.2756	...	0.3270	0.2966	0.3679
Cyprus	0.4462	0.4802	0.4361	...	0.2522	0.2703	0.3678
China	0.3844	0.4008	0.4653	...	0.4269	0.3928	0.4351
Ukraine	0.3436	0.3193	0.2392	...	0.2232	0.1853	0.2749
Japan	0.3742	0.3844	0.3994	...	0.4748	0.4707	0.5198
Spain	0.2832	0.2753	0.3210	...	0.2529	0.2388	0.2824

The United States had the biggest investment funds market share in 2007, South Korea – during 2008–2010, France – during 2011–2014 and South Korea – in 2015–2016. The Baltic countries and Ukraine had the least share of investment funds at the end of 2016 (Annex C.9).

The results obtained from the expert survey were directly used to select the most potential for investment stock markets. The calculated S values for all markets are presented in Table 3.5. According to the calculated results, the author has ranked the evaluated markets according to S values during analysed period.

In order to evaluate stock markets, the author calculated total scores and distinguished twenty markets that have the highest overall score during the analysed period. The highest score has Hong Kong (357 points). All markets, marked with

green color, will be selected for further analysis. The markets that have score from 160 points and less will not be selected as potential for investment decisions making in stock market.

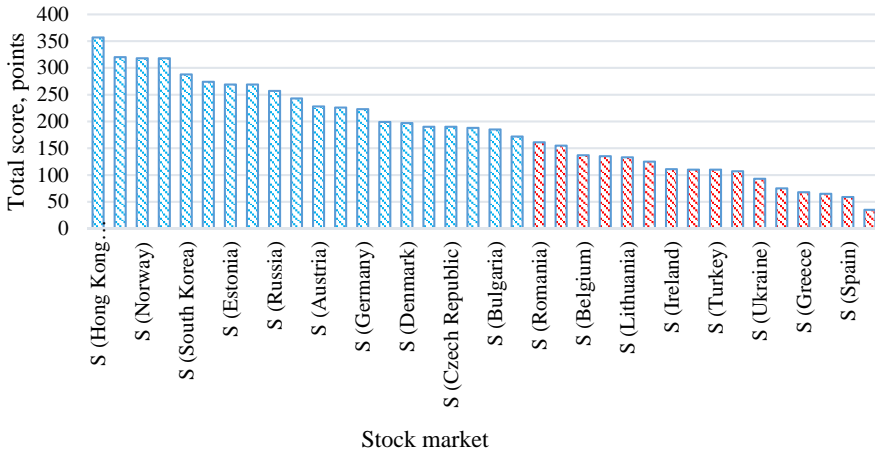


Fig. 3.5. Total score of evaluated markets (created by author)

After processing previously received market test results (Table 3.4), using the SAW method, the following generalisation can be suggested (Fig. 3.5):

- The investment portfolios will be formed in the most stable markets during long-term period in order to maintain investment return sustainability: Hong Kong, Switzerland, Norway, China, South Korea, Japan, Estonia, Netherlands, Russia, Australia, Austria, Israel, Germany, United Kingdom, Denmark, Cyprus, Czech Republic, United States, Bulgaria and Sweden. These markets have the highest overall scores evaluating them by impact indicators.
- Romania, Brazil, Belgium, Finland, Lithuania, France, Ireland, Latvia, Turkey, Poland, Ukraine, Italy, Greece, Portugal, Spain and Croatia, with the lowest overall score (35 points), were not selected for further testing and research due to the instability of some indicators during long-term period, big fluctuations and low market liquidity.
- According to the limitations of PMI data and the expert evaluation that this indicator is the least important and has the lowest impact on stock market return (the weight of indicator was the lowest), PMI indicator was not included in stock market evaluation process.
- Also, some countries were eliminated from the research – Singapore, Slovakia, Slovenia, Iceland, Hungary and Argentina due to the lack of data.

3.2. Investment Portfolio Formation and Testing of Stock Selection Algorithm

The evaluation of stocks and formation of investment portfolios were carried out according to previously suggested by author intelligent investment strategy second and third stages (Subchapter 2.5).

3.2.1. The Selection of Stocks for Investment Portfolios Formation

The stock selection was carried out in the following stages according to the second stage of intelligent investment strategy – stock selection algorithm. (Fig. 2.6). Required data for the stock selection are computed in MS Excel program. The special file contains a programmed spreadsheet with an array of formulas in which the required data (from enterprise balance sheets and profit loss statements) are loaded, when the results of individual computational steps and final results are calculated. The extract from stock selection algorithm is presented in Figure 3.6.

	A	B	FK	FL	FM	FN	FO	FP	FQ	FR
										2016
2	Column1	Column2	owner equity to total assets 2015	SVOOE 2016	SLOETAR 2016	SSTL 2016	SLOI 2016	Cat.of Comp. 2016	PVOL 2016	MPNWC 2016
3	34	STERN GROEP N.V.	31.46214366	311616	0.548999572	37885	5.52889421	Large Company	396943	170654
4	5	HEINEKEN N.V.	76.24801758	18055	0.618374964	3764	1.616896918	Large Company	325408	2322
5	23	AALBERTS INDUSTRIES N.V.	72.69674546	1510291	0.615389699	309274	2.588937318	Large Company	1962786	491417
6	48	VERENIGDE NEDERLANDSE COMPAGNIE	52.30546779	79603	0.595937893	44059	1.113340011	Large Company	126582	4994
7	38	AMSTERDAM COMMODITIES N.V.	68.71124957	234586.5271	0.695767346	77506.723	3.122869825	Large Company	172625.644	164536.688
8	47	HEWLETT ELECTRONICS INTERNATIONA	90.09005757	104267	0.595640076	39079	3.0379609	Large Company	95786	79407
9	4	HEINEKEN HOLDING N.V.	76.24801758	17632	0.603369173	4452	1.367026056	Large Company	33196	1634
10	41	ROYAL REESENK N.V.	64.32038101	138934	0.507156345	71478	2.503535341	Large Company	166475	107471
11	49	EUROCOMMERCIAL PROPERTIES N.V.	51.20974544	1468491	0.52313772	115540		1 Middle sized business	2807083	0
12	2	KONINKLIJKE AHOLD N.V.	114.7695267	6451	0.495288018	2859	1.555788737	n.a.	12549	1589
13	46	BEIER BED HOLDING N.V.	72.72921189	83186	0.710244785	30468	2.165317054	Large Company	63642	53481
14	18	KONINKLIJKE BOSKALIS WESTMINSTE	87.0846626	3734300	0.631501067	1213317	1.201090015	n.a.	5571566	341061
15	1	UNILEVER N.V.	62.44467861	17756	0.369708706	8179	1.5059775	Middle sized business	43859	4168
16	8	KONINKLIJKE DSM N.V.	90.19375832	6889	0.585118093	2528	1.68789557	Large Company	10387	1739
17	16	WOLTERS KLUWER N.V.	60.92307892	2718	0.368942882	1827	1.066881445	Large Company	7247	120
18	36	ACCELL GROUP N.V.	62.55547949	335839	0.539374764	106401	2.311457557	Small business	370180	244457
19	22	USO PEOPLE N.V.	78.65333142	972677	0.468866487	351285		1 Large Company	1221173	0
20	20	SLIGRO FOOD GROUP N.V.	100.7048165	629500	0.621541502	22800	1.973684211	Large Company	790000	222000
21	24	ORANJEWIJD N.V.	60.34268396	424326	0.289188108	841006	1.294962059	Large Company	1248898	218433
22	27	HELMANS N.V.	46.19965961	423420	0.351482954	649464	1.294270352	Large Company	1013272	191118
23	10	KONINKLIJKE DAM GROEP N.V.	59.917486072	1387875	0.282060013	2643854	1.318892226	Large Company	4112861	843123
24	32	KONINKLIJKE VOPAK N.V.	99.27890806	2017700	0.37306782	593500		1 Large Company	5408400	0
25	15	POSTNL N.V.	122.4043716	-385	0.165429866	1285	1.003881051	Large Company	2472	5
26	31	THX GROUP N.V.	93.07594285	560297	0.476353500	265871	2.194771148	Large Company	850566	317655

Fig. 3.6. Extract from the calculation program (source: author)

The results of the United States of America, Sweden, Denmark, Norway, Austria, South Korea, Germany, the United Kingdom and Hong Kong stock markets evaluation presented in Table 3.5–3.13. The evaluations of listed companies in other stock markets are presented in Annex D (D1–D10).

Table 3.6 shows the results of the USA stock market assessment. For the analysis of the USA market, NASDAQ 100 index, consisting of one hundred stocks of listed companies, was selected. According to stock selection algorithm, based on calculated corporate financial stability indicators and evaluation of

stocks return and standard deviation (riskiness), fourteen stable companies during long-term were selected for portfolio formation in the USA market. It should be emphasised that, each indicator had the equal impact in final evaluation of all companies. Estimated stock return and standard deviation were demonstrated in the Table 3.6 using historical data for the last four years. All selected companies have high values of evaluated ASREA and ASRL ratios, that shows the stability of companies.

Table 3.6. The USA equity market companies selected for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
The Priceline Group (PCLN)	89.69	95.13	52.61	0.2282
Amazon.com (AMZN)	82.69	81.56	215.00	0.6784
Google (GOOGL)	85.75	95.13	75.25	0.2522
Charter Communications (CHTR)	92.07	71.28	100.49	0.5547
Intuitive Surgical (ISRG)	92.32	96.45	188.89	0.4599
Tesla (TSLA)	101.23	102.42	73.67	0.2692
Apple (AAPL)	95.07	94.35	156.57	0.3584
Broadcom Limited (AVGO)	100.14	95.87	300.26	1.1414
Baidu (BIDU)	88.54	90.76	52.88	0.1770
NVIDIA Corporation (NVDA)	94.72	91.78	141.09	0.5671
Lam Research Corporation (LRCX)	95.96	91.79	335.40	0.7644
Adobe Systems Incorporated (ADBE)	97.66	96.67	207.88	0.4846
Fiserv (FISV)	94.14	90.74	129.06	0.3897
Facebook (FB)	101.81	101.27	186.07	0.5280

Fourteen stocks of Austria stock market were selected from twenty ATX index components of various industries (see Table 3.7): Lenzig AG (chemicals sector), Schoeller-Bleckmann Oilfield Equipment Aktiengesellschaft AG (oil and gas sector), Voestalpine AG (mining and metals sector), Österreichische Post (transportation sector), Vienna Insurance Group AG (insurance sector), Erste Group Bank AG (banking sector), Verbund AG (electric sector), Wienerberger AG (construction materials sector), Raiffeisen International AG (banking sector), Buwog AG (real estate sector), CA Immobilien Anlagen AG (real estate sector), Raiffeisen Bank International AG (banking sector) and UNIQA Insurance Group AG (insurance sector).

Table 3.7. The Austrian equity market companies selected for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
LNZ.VI	77.52	90.65	138.29	0.9723
SBO.VI	71.72	81.87	7.84	0.1565
VOE.VI	82.74	93.39	61.22	0.1830
POST.VI	84.78	89.14	34.14	0.1388
VIG.VI	78.50	92.09	16.77	0.2052
EBS.VI	87.87	94.44	42.01	0.2001
VER.VI	82.11	91.80	40.62	0.1595
WIE.VI	90.76	91.32	74.75	0.2799
RHI.VI	78.15	81.79	68.18	0.2503
BWO.VI	94.31	97.32	112.84	0.3685
CAI.VI	93.33	95.40	117.21	0.2786
RBI.VI	76.08	82.16	8.15	0.1969
UQA.VI	77.73	73.73	11.92	0.1374

It should be mentioned that only ten companies for investment portfolio formation were selected in Norway stock market (Table 3.8), because the indicators of other stocks were not suitable for these stocks including to investment portfolio. The list of selected companies is exceptional.

Table 3.8. Norway stock market companies selected for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
BMA.OL	104.74	103.99	471.92	2.5749
KIT.OL	104.55	103.62	321.65	1.3874
STRONG.OL	92.08	97.46	95.53	3.0565
GYL.OL	82.39	86.33	84.28	0.1904
NPRO.OL	87.95	81.65	44.05	0.1419
POL.OL	78.68	72.48	6.47	0.1103
BERGEN.OL	79.61	83.65	18.99	0.2365
BOUVET.OL	99.86	100.16	147.68	0.4847
AKVA.OL	102.26	97.60	473.93	1.8970
OTS.OL	75.64	75.87	9.30	0.3201

The selected companies covers various sectors: Byggma ASA (building products industry), Kitron ASA (electronic manufacturing services), StrongPoint ASA (technology hardware, storage and peripherals), Gyldendal ASA (publishing industry), Norwegian Property ASA (real estate operating companies), Polaris Media ASA (publishing), Bergen Group ASA (Industrial conglomerates), Bouvet ASA (IT consulting and other services), Akva Group (industrial machinery) and Oceanteam Shipping (oil, gas storage and transportation). The stock return of selected companies varies from 6.47% (Polaris Media ASA) to 473.93% (Akva Group).

Table 3.9. The South Korea market companies selected for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
003240.KS	73.49	87.57	12.45	0.1167
005930.KS	75.63	73.87	130.78	0.3812
000670.KS	74.63	85.10	5.61	0.1165
035420.KS	77.85	85.87	19.77	0.1417
010130.KS	79.66	86.86	50.97	0.1676
002380.KS	83.20	85.07	13.55	0.1801
097950.KS	86.55	78.90	53.13	0.1322
049770.KS	87.96	91.65	70.28	0.5845
090430.KS	99.69	97.04	127.97	0.9643
081660.KS	81.57	84.50	7.84	0.1679
120110.KS	91.73	85.53	68.81	0.2025
096770.KS	88.38	98.14	75.39	0.2986
036570.KS	99.76	97.04	131.49	0.4334
161390.KS	63.36	80.65	9.95	0.1159

The most stable fourteen companies of South Korea equity market were selected after the analysis of KOSPI index components for portfolio formation (Table 3.9). It should be emphasised that the majority of selected companies could be characterized by a low level of risk and sufficiently high return, excluding Amore-pacific Corporation, which standard deviation seeks 0.9643.

In Sweden equity market (Table 3.10), like in the other markets, it has been chosen to create an investment portfolio from the fourteen most stable companies. Selected companies with a range of values close to 100 mean that their activity is

stable and balanced. Also, the stock prices of selected companies reflect a stable situation of enterprises.

Table 3.10. Sweden market companies selected for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
Boliden (BOL.ST)	73.49	87.57	201.45	0.6721
Svenska Cellulosa Aktiebolaget (SCA-B.ST)	75.93	83.39	241.34	0.6175
Assa Abloy (ASSA-B.ST)	77.89	81.63	73.90	0.2810
Skanska (SKA-B.ST)	82.98	70.63	60.17	0.2171
Tele2 (TEL2-B.ST)	86.82	93.79	96.87	0.2042
Saab Aktiebolag (SSAB-A.ST)	88.61	87.01	15.14	0.2358
Alfa Laval (ALFA.ST)	90.58	91.88	45.07	0.1417
Securitas (SECU-B.ST)	97.13	99.08	136.46	0.4332
Sandvik Aktiebolag (SAND.ST)	98.62	99.43	74.04	0.2747
Lundin Petroleum (LUPE.ST)	102.26	100.27	89.49	0.2542
Autoliv (ALIV-SDB.ST)	95.59	91.09	73.67	0.2236
Astra Zeneca PLC (AZN.ST)	89.72	86.07	43.24	0.1225
Swedish Match AB (SWMA.ST)	91.72	91.09	88.39	0.2115
Svenska Handelsbanken AB (SHB-A.ST)	95.29	90.59	24.77	0.1059

In Hong Kong stock market (Table 3.11), like in the other markets, it has been chosen to create an investment portfolio from fourteen the most stable companies – from financial, technology and other sectors such as Hang Seng Bank Limited, Hong Kong Exchanges & Clearing Limited, Tencent Holdings Ltd., BOC Hong Kong Holdings Ltd., Cheung Kong (Holdings) Limited, CLP Holdings Ltd., Power Assets Holdings Limited, HSBC Holdings plc, Sino Land Company Limited, AIA Group Limited. Selected companies with a range of values from 79 up to 100 and with the best ratios of stock return and riskiness. The stock return of selected companies during analysed period varies from 16.76% (HSBC Holdings) with 0.1352 standard deviation ratio to 274.75% (Tencent Holdings Limited) with 0.6230 risk level. The values of ASREA and ASRL indicators varies from 79% to 104%.

Table 3.11. The Hong Kong stock market companies selected for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
0388.HK	102.31	100.25	111.09	0.3144
0011.HK	99.53	99.29	82.82	0.2091
0700.HK	104.66	99.42	274.75	0.6230
2388.HK	92.95	81.88	84.34	0.2764
0001.HK	82.19	75.82	39.61	0.1245
0002.HK	95.16	97.01	56.90	0.1900
0006.HK	85.11	90.70	32.16	0.0941
0005.HK	79.61	79.27	16.76	0.1352
0823.HK	104.09	100.13	126.92	0.2948
1299.HK	100.47	100.07	94.47	0.2010
0012.HK	102.67	102.57	104.68	0.2316
0066.HK	87.37	94.16	88.73	0.2569
3988.HK	85.37	95.16	44.81	0.1931
3328.HK	84.16	95.42	41.92	0.1918

Table 3.12. Denmark stock market selected companies for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
PNDORA.CO	97.72	98.40	91.94	0.6202
MAERSK-B.CO	78.52	90.46	17.30	0.1689
CARL-B.CO	89.24	101.22	43.49	0.1350
GEN.CO	99.53	99.67	457.83	1.9806
COLO-B.CO	76.90	80.18	31.07	0.1086
CHR.CO	99.61	99.65	178.23	0.4825
WDH.CO	95.83	96.50	75.12	0.2553
GN.CO	78.10	82.81	65.38	0.2053
DANSKE.CO	100.33	100.26	112.63	0.3472
DSV.CO	102.15	101.25	181.07	0.5136
ISS.CO	88.75	82.79	38.79	0.2184
JYSK.CO	83.95	83.85	24.03	0.1269
FLS.CO	82.63	90.97	34.46	0.2080
NOVO-B.CO	86.64	96.01	60.38	0.2637

Fourteen stocks of Denmark stock market were selected from twenty OMXC20 index components of various industries (see Table 3.12), according stock selection algorithm: Pandora A/S, A.P. Møller - Mærsk A/S, Carlsberg A/S, Genmab A/S, Coloplast A/S, Chr. Hansen Holding A/S, William Demant Holding A/S, GN Store Nord A/S, Danske Bank A/S, DSV A/S, ISS A/S, Jyske Bank A/S, FLSmidth & Co. A/S, Novo Nordisk A/S.

Table 3.13. Germany stock market companies selected for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
Linde Aktiengesellschaft (LIN.DE)	85.76	71.41	45.86	0.1358
Adidas Ag (ADS.DE)	129.52	105.33	139.34	0.6016
Volkswagen Aktiengesellschaft (VOW3.DE)	150.60	160.85	15.44	0.1993
Thyssenkrupp Ag (TKA.DE)	89.68	95.13	18.15	0.1467
Fresenius Medical Care Ag & Co. (FRE.DE)	139.65	117.85	80.32	0.4009
Deutsche Post Ag (DPW.DE)	142.43	122.76	72.09	0.1942
Deutsche Telekom Ag (DTE.DE)	105.80	106.76	58.94	0.2178
Deutsche Lufthansa Aktiengesell (LHE.DE)	82.70	81.58	70.69	0.2240
Henkel Ag & Co. (HEN3.DE)	88.54	90.76	51.66	0.2097
Deutsche Börse Aktiengesellschaft (NVDA)	103.18	99.73	86.15	0.2720
Beiersdorf Aktiengesellschaft (BEI.DE)	138.88	119.40	36.33	0.1221
Infineon Technologies Ag (IFX.DE)	109.39	103.71	228.23	0.6091
Basf SE (BAS.DE)	108.95	113.71	33.02	0.1367
Continental Aktiengesellschaft (CON.DE)	104.78	104.17	47.53	0.1427

Thirty companies, which is included in DAX index, were analysed. Among the selected companies, there are also those whose ASRL and ASREA indicators exceed the limit value. Practically all companies in Germany stock market are very stable; their activity is effective, some companies do not use all their manufacturing capacity, therefore solution, which stocks should be included in the composition of the portfolio was straightforward (Table 3.13).

Also, fourteen stocks of the United Kingdom stock market were selected from one hundred FTSE100 index components of various industries (see Table 3.14): Tesco PLC, Unilever PLC, BAE Systems PLC, Vodafone Group PLC, Royal Dutch Shell PLC, Kingfisher PLC, Babcock International Group PLC, Johnson Matthey PLC, GlaxoSmithKline PLC, Barclays PLC, Mondi PLC, Croda International PLC, Land Securities Group PLC, Sky PLC. All selected companies have a low level of risk.

Table 3.14. The United Kingdom stock market selected companies for portfolio formation (created by author)

Name of listed company (code)	ASREA ratio, %	ASRL ratio, %	Stock return, %	Riskiness (stdev)
TSCO.L	81.82	79.16	8.11	0.1346
ULVR.L	97.54	96.37	101.87	0.3290
BAL	84.01	83.70	47.49	0.2412
VOD.L	79.04	78.98	17.67	0.0793
RDSA.L	81.38	82.45	41.95	0.1556
KGFL	79.55	78.06	8.27	0.0792
BAB.L	77.72	76.22	6.70	0.0761
JMAT.L	75.14	75.29	3.45	0.0924
GSK.L	76.09	77.14	3.41	0.1138
BARC.L	80.02	81.67	24.07	0.1236
MNDIL	99.47	98.05	111.41	0.4406
CRDA.L	86.41	88.03	80.40	0.2164
LAND.L	76.60	75.21	7.26	0.1006
SKY.L	78.24	79.49	18.93	0.1116

The suggested stock selection algorithm allows to significantly expanding the scope of investment decisions and is able to adapt to the current market conditions and to select stable business stocks forming the investment portfolio, which in turn, maintains the return sustainability in the long run.

3.2.2. Back-testing of Formed Portfolios

In order to assess the adequacy of the strategy, it is important to compare the proposed model with another model which has already been approved.

The stock selection algorithm (as the major part of Intelligent investment strategy), proposed by author, has been tested using the stock selection, according

to ranking, based on ranking of the alternatives, according to the technical analysis of stock price, proposed by Rutkauskas (2017) and indices of stock markets.

The results of back-testing are used to gauge the effectiveness of the investment strategy. Using this data, the author determines suitability of the investment strategy for the use in real-time conditions.

Testing of strategy adequacy was performed with the historical data of previously selected companies for portfolio formation. First investment portfolio (hereinafter – IIS) has been formed from the best companies stocks in previously selected stock markets according to the stock selection algorithm, which is based on companies' financial soundness evaluation and the evaluation of stocks return and risk. Stock return was calculated as the ratio between the difference between the supply and the first price with the first price expressed in percent. The standard deviation of asset (in this case – stock) return was used for risk measure. The second investment portfolio has been formed and stock selection has been carried out using the methodology, which is based on ranking of the alternatives according to the technical analysis of stock price (hereinafter – TAP), which was described in Subchapter 2.5. These portfolios were used for intelligent investment verification in different stock markets. Fourteen stocks of the most stable companies were selected for portfolios formation and then back-testing of portfolios was carried out, comparing the IIS portfolios return and risk with the return and risk of comparative investment portfolio and return and risk of stock market index for every stock market. The structure of investment portfolios was formed according to the adequate portfolio theory, which was described in Subchapter 2.4. The search for an optimal solution takes place in a three-dimensional space, evaluating the return efficiency, the reliability of the return and the risk of return.

It is important to note that in order to calculate the net return of the portfolio, it is necessary to include the costs, associated with the reallocation of the portfolio, in the calculations. Trade in securities incurred direct and indirect costs. Direct costs include commissions and similar costs, indirect – the difference between purchase and sale price, associated with the liquidity of different stocks, and the costs associated with the impact on prices. In addition, the currency or exchange rate should be taken into account while choosing a particular market. The taxes and currencies of every market are presented in Table 3.15. For example, the commissions in Hong Kong market are 0.15% from trading amount, while in Netherlands – 0.10% from all trading amount. Also, in these markets there are different currencies, so if we buy the stocks of Hong Kong market being in Lithuania, we will also encounter with the exchange rate risk, contrary to the Netherlands, where the euro is the same currency as Lithuanian.

In theory, the usual assumption that it is possible to buy or sell unlimited amount of securities without affecting their prices is unlikely in the real world, especially when selling large shareholding. Therefore, it is important to know how

liquid each of the stock market is. For example, the USA stock market is more liquid than the stock market of the Czech Republic.

Trading taxes for each market were included in carrying out the back-testing of investment portfolios and in assessing return and risk for each portfolio (Table 3.15). After that, the back-testing was carried out for two portfolios on each market. 200 lines of historical stocks closing data (weekly data) have been used for back-testing. The return of portfolios was compared with each other and with index. Back-testing results of Norway, Austria, South Korea, Germany, the United Kingdom, Denmark, the USA, Hong Kong and Sweden stock markets presented as the examples (Fig. 3.7–3.15).

Table 3.15. General information of stock markets and trading conditions (created by author according to DNB Trade platform data)

Stock market	Stock index	Number of index components	Trading taxes	Currency
Hong Kong	HSI	51	0.15%	HKD
Switzerland	SSMI	20	0.10%	CHF
Norway	OSEAX	65	0.10%	NOK
China	SSE50	50	0.15%	CNY
South Korea	KOSPI	731	0.15%	KRW
Japan	NKY	225	0.15%	JPY
Estonia	OMXT	13	0.10%	EUR
Netherlands	AEX	97	0.10%	EUR
Russia	RTSI	50	0.15%	RUB
Australia	AS51	100	0.15%	AUD
Austria	ATX	20	0.10%	EUR
Israel	TA35	35	0.15%	ILS
Germany	DAX30	30	0.10%	EUR
United Kingdom	FTSE100	100	0.10%	GBP
Denmark	OMXC20	20	0.10%	DKK
Czech Republic	PX	50	0.10%	CZK
United States	NDX100	100	0.15%	USD
Bulgaria	SOFIX	15	0.10%	BGN
Sweden	OMXS30	30	0.10%	SEK

The stock selection in Norway stock market was carried out from 65 components of OSEAX index. The higher volatility of the portfolio was observed, but the return of IIS portfolio is two times higher than the return of the index and about 30 percentage points higher than the return of TAP portfolio. This approves the viability of intelligent investment strategy (Fig. 3.7).

The best 14 companies have been selected from 20 listed companies that are included in ATX index of Austria stock market. The behaviour of the methods coincides with the behaviour of the market, but the return of the IIS portfolio is

much higher than the return of index. Thus, stock selection algorithm shows its adequacy and possibilities to adapt in every analysed stock market (Fig. 3.8).

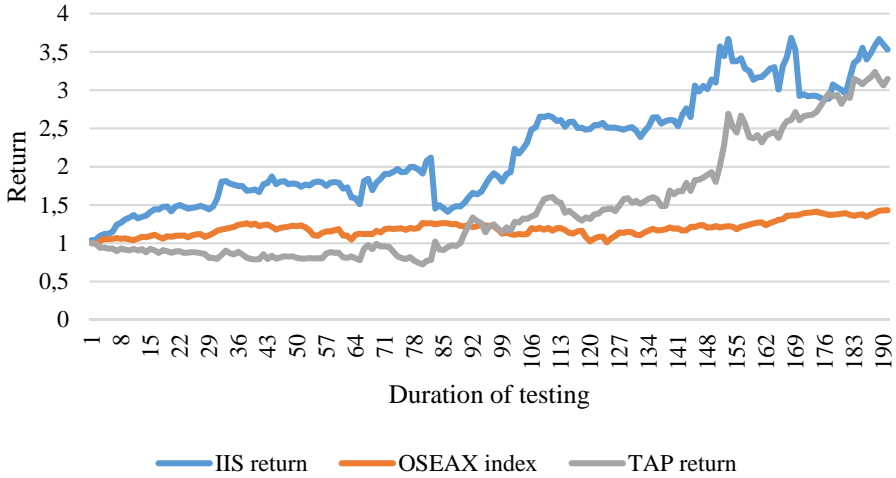


Fig. 3.7. Back-testing results of Norway stock market (created by author)

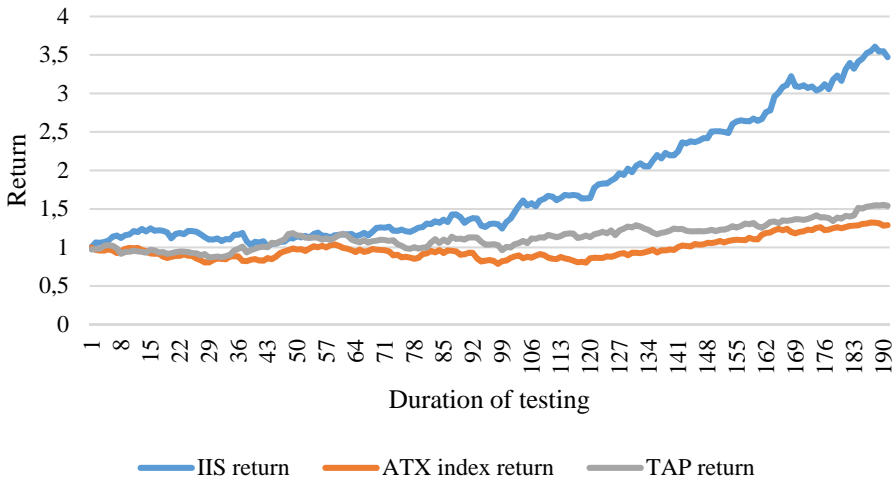


Fig. 3.8. Back-testing results of Austria stock market (created by author)

The benchmark KOSPI index was selected for the analysis of South Korea stock market. KOSPI index is composed of 731 listed companies. As we can see from Figure 3.9, the behaviour of the methods coincides with the behaviour of the market, but the return of the IIS portfolio is much higher. This stock market has

its own peculiarities, but the South Korean economy grew at its fastest rate during analysed period. Kospi index also grew rapidly, so the stock market and South Korean companies can be very attractive for investors.

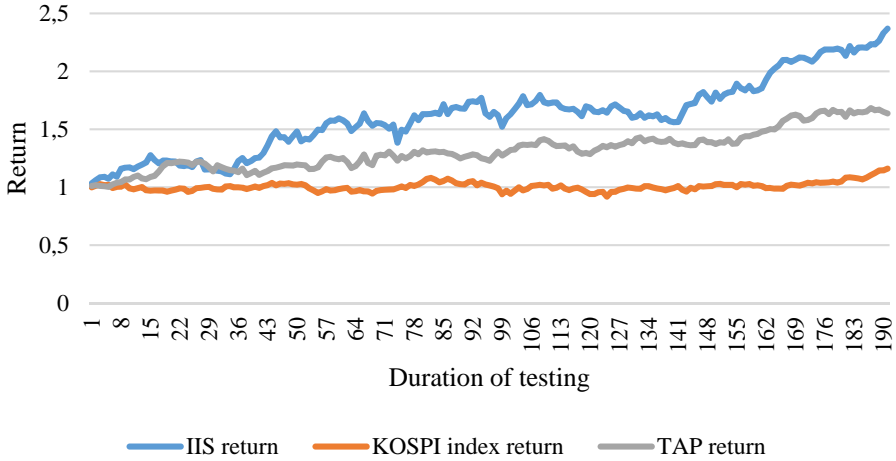


Fig. 3.9. Back-testing results of South Korea stock market (created by author)

The back-testing results of stocks from Germany equity market are the lowest but they reflect the index movement trajectory the best. IIS return is about 30% higher than DAX index return and 9% higher than the return of comparative method (Fig. 3.10).

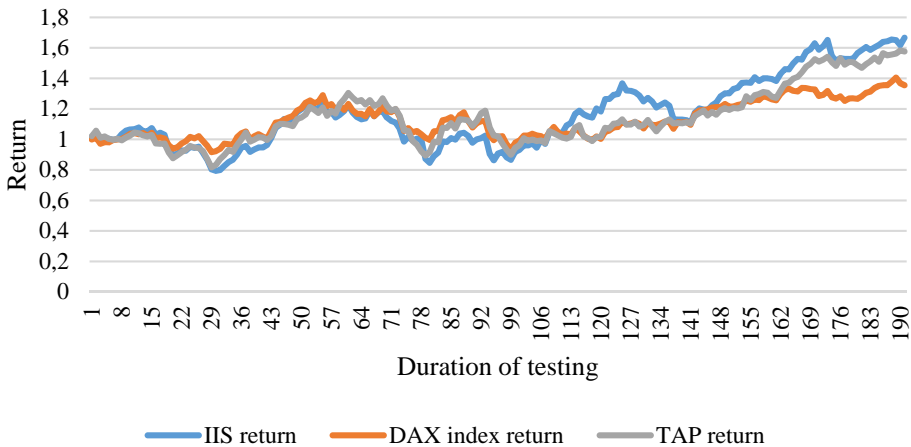


Fig. 3.10. Back-testing results of Germany stock market (created by author)

The viability of IIS in the United Kingdom stock market was checked using results of comparative method and FTSE100 index return. The index consists of 100 stocks. IIS return is about 29% higher than the index return and about 10% higher than the TAP return (Fig. 3.11).

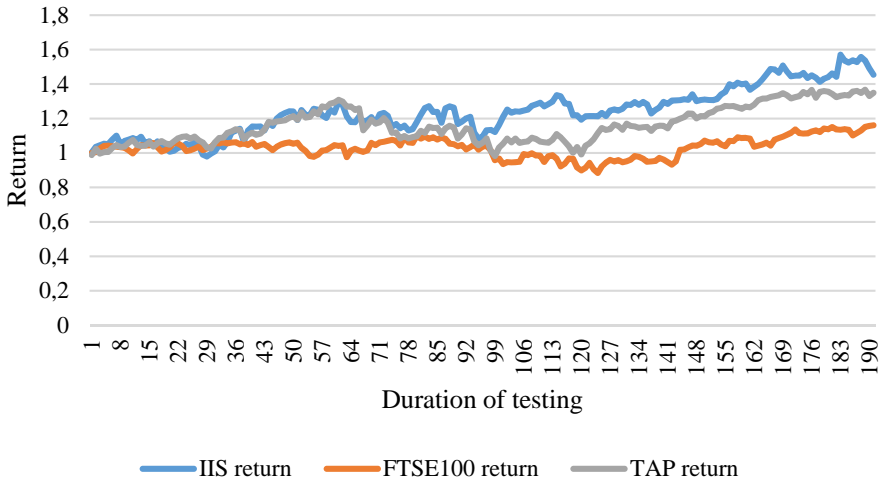


Fig. 3.11. Back-testing results of the United Kingdom stock market (created by author)

Regarding other Nordic stock markets, Denmark stock market was chosen from analysed markets, which were evaluated using stock market assessment. The benchmark selected for the analysis of results is OMXC20 index, which consists of 20 stocks. The results of IIS are higher than index return about 10%, so we can monitor the similar direction of IIS and index. This fact identifies the stability and viability of used strategy (Fig. 3.12).

NDX index (of the USA stock market) is composed from 100 stocks, so all these stocks and listed companies have been analysed in order to select performers and form the investment portfolios. The return of both strategies (or both algorithms for stock market selection) was higher than the return of stock market index. The results of back-testing show the adaptability of IIS in the USA stock market, the return of portfolio is higher than the return of NDX index during analysed period – 38.1% (Fig. 3.13).

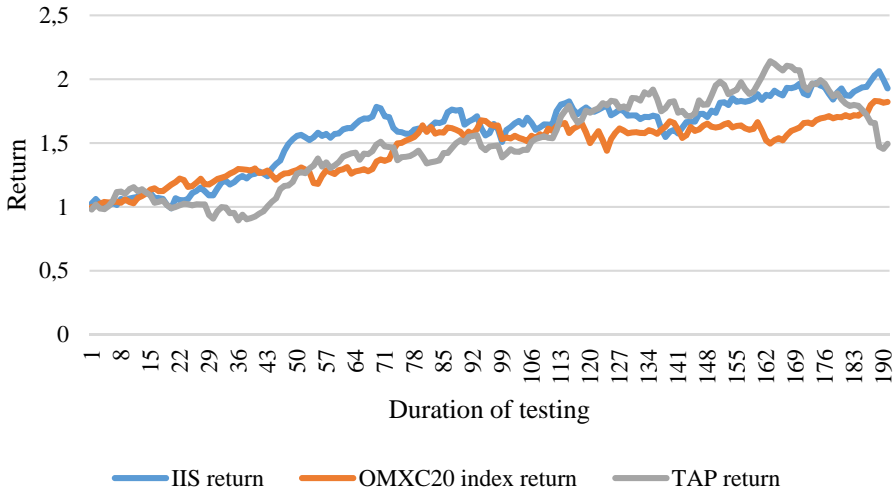


Fig. 3.12. Back-testing results of Denmark stock market (created by author)

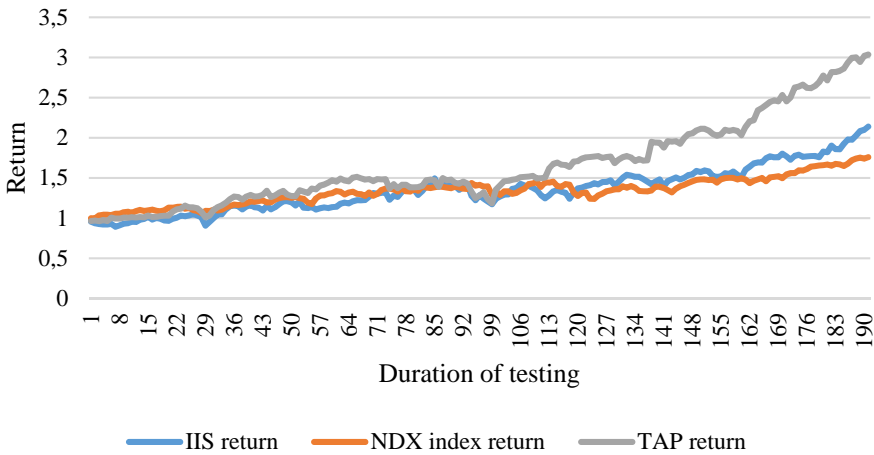


Fig. 3.13. Back-testing results of the USA market (created by author)

HSI index was selected for the analysis of Hong Kong market, the index consists of 51 stocks of listed companies. It can be observed in the Figure 3.14 that both methods have been applied in the same environment, whereas the behaviour of the methods coincides with the behaviour of the market. We can see this also in terms of the direction of movement with the index.

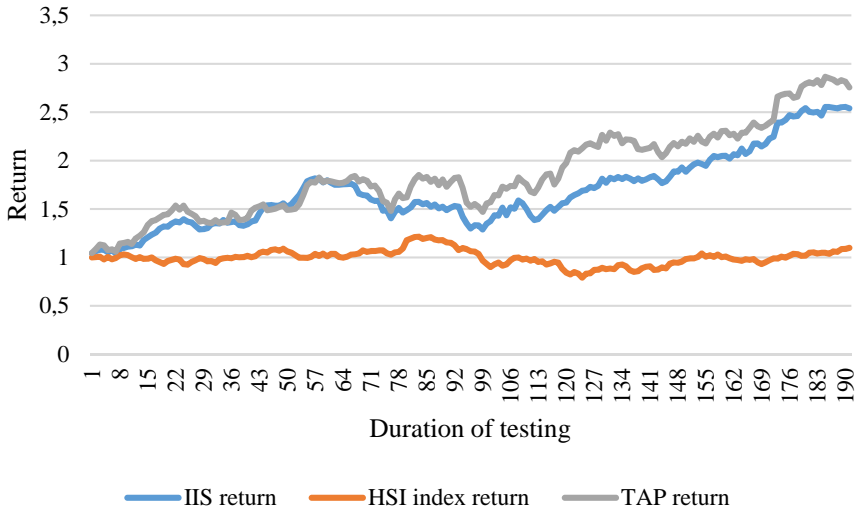


Fig. 3.14. Back-testing results of Hong Kong stock market (created by author)

The benchmark OMXS30 index was selected for the analysis of Sweden stock market. OMXS30 index is composed of 30 listed companies. As we can see from Figure 3.15, the behaviour of the methods coincides with the behaviour of the market, results of IIS return is very far from the results of TAP return, but the return of the IIS portfolio is much higher than index return.

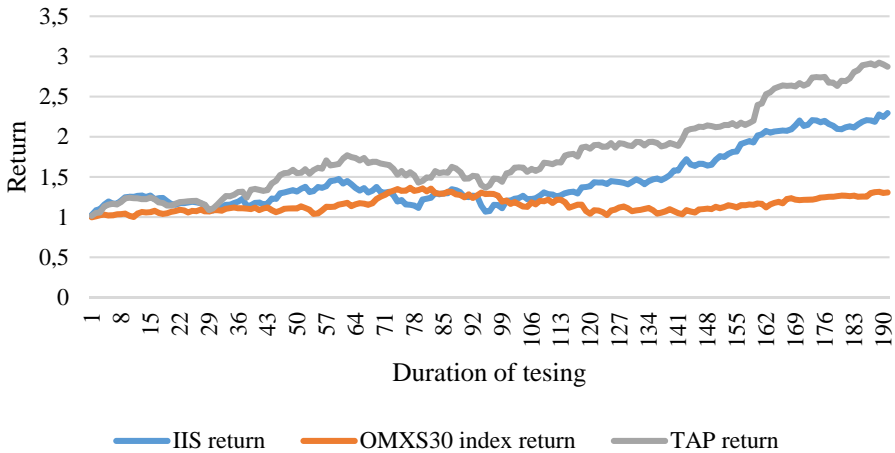


Fig. 3.15 Back-testing results of Sweden stock market (created by author)

Back-testing results in other analysed stock markets presented in Annex E. The following insights can be made based on the results of back-testing in China, Japan, Estonia, the Netherlands, Russia, Australia, Switzerland, Israel, the Czech Republic and Bulgaria equity markets:

- The main index of China stock market is SSE180 but due to the high coverage of the research and a large amount of data, the author has been testing the components from SSE50 index (50 components, this index includes only the companies with large capitalisation). As it can be seen from Fig. E2, Annex E, the results of IIS return is very far from the results of TAP return, but much higher than the index, which in turn demonstrates the ability of the strategy to adapt and operate in any stock market.
- Japan is also one of the largest stock markets of Asia. The main index of Japan stock market is Nikkei225 (NKY). 225 listed companies were evaluated and 14 stocks were selected for investment portfolio formation. Back-testing results showed very similar situation comparing the IIS return with TAP return, but the return was twice higher than the index return during the analysed period (Annex E., Fig. E10).
- Estonian stock market is the only stock market from the Baltic States countries, which has entered the top 20 world stock markets, based on estimates of impact indicators. The stock selection was carried out from 16 listed companies, which are included in OMXT index (Annex E., Fig. E3). OMXT index return was 34.15%, while the return of IIS was more than two times higher than the return of index.
- The IIS, TAP and AEX index return of the Netherlands stock market is practically the same during analysed period. The selection of stock and the formation of portfolios were carried out from 25 components of AEX index. The investment return of two methods is close to index return (Annex E., Fig. E4). The investment return of IIS portfolio seeks 39.14%, the return of benchmark was 41.74%, while TAP return reached 74.12%.
- The back-testing results of the portfolios in Russia stock market have been compared with RTSI index. 50 Russian traded stocks were included to this index. RTSI index generates negative investment return during analysed period (e.g. 4 years), while return of IIS portfolio was positive (Annex E., Fig. E5).
- The best 14 companies have been selected from 100 listed companies that are included in ASX100 index of Australia stock market. The behaviour of the methods coincides with the behaviour of the market, but the return of the IIS portfolio is much higher than the return of index. Thus, stock selection algorithm shows its viability, taking into account trading costs and currency effects and comparing with index return (Annex E., Fig. E6).

- Investment portfolio, which was formed according to the algorithm of stock selection for IIS, shows better results in Switzerland equity market. The selection was carried out from 20 SMI index components. The continuous and stable growth of portfolio return can be observed during the period of evaluation (Annex E., Fig. E1).
- The viability of IIS in Israel stock market was checked using the results of comparative method and TA35 index investment return. The results of IIS and TAP investment return are very similar, but much higher than the return of index. The effectiveness of algorithm and ability to adapt in every market were also approved in Israel stock market (Annex E., Fig.E7).
- It is remarkable that the IIS demonstrates its effectiveness and stability even on the Czech stock market. The PX index (Prague stock exchange) was selected as benchmark. The index consists of only 13 stocks quoted on the Prague stock exchange. IIS return is twice higher than the return of index and other comparative method (Annex E., Fig. E8).
- IIS generated return in Bulgaria stock market has more fluctuations, what is usual in this stock market, taking into account the fact that the market does not have high liquidity. IIS return is much higher than the Sofix index (the composition of index – 15 stock of listed companies) and TAP return (Annex E., Fig. E9).

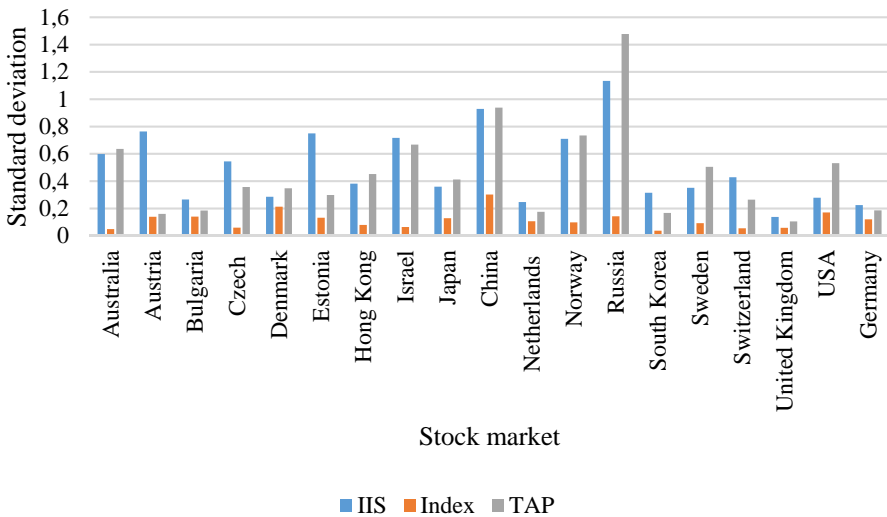


Fig. 3.16. Standard deviation of IIS, index and TAP in different stock markets (created by author)

Historical tests have shown that an intelligent investment strategy is able to adapt to different market conditions and generates statistically significantly better return on investment over a four year period compared to a comparative index and in 70% of cases comparing to the comparative stock selection method.

Another important step, when it is aimed to maintain the investment return sustainability, is to evaluate not only the return of portfolio, but also the risk. For this purpose, the author calculated the standard deviation for each markets (Fig. 3.16). Standard deviation is a useful statistics for comparing the results of investment portfolios and allows determining, how much volatility, or risk is assumed in comparison to the amount of return from investment. The standard deviation is less more than in 50% analysed markets comparing with comparative investment portfolio. This approves the efficiency of intelligent investment use in various stock markets even in cases where the investor seeks a maximum return with minimal risk.

3.3. The Results of Intelligent Investment Strategy Monitoring

The intelligent investment strategy was also tested under close to real market conditions, using DNB trade platform. Investment portfolios were formed in the United States, Denmark, Sweden and Norway stock markets. Also, the integrated portfolio was formed from the stocks of all previously mentioned markets and tested in DNB Trade platform. The portfolios were tested for more than one year, from September of 2016 until December of 2017.

Weekly investing was selected for rebalancing the portfolios, so the active investment portfolio management model is used for investment decisions. Real time investment using demo version is a right way to check the soundness of investment strategy close to real market conditions. Investment results are perented in Tables 3.16–3.21 and Figures 3.17–3.21.

Table 3.16. Risk and average return of Denmark stock market (author calculations)

Denmark stock market	Risk (stdev)	Average return
Portfolio	0.0387	7.92%
Index	0.0663	1.95%

The return of Denmark stock market seeks 9.74% (blue curve), while the index return is 6.65% (red curve) (Fig. 3.17). It is important to note, that the standard deviation of portfolio is about twice lower than the standard deviation of OMXC20 index (Table 3.16), accordingly, the investment return generated by the

portfolio is higher with a lower risk level than the return of the index. Since the scale of the evaluated return has both negative and positive values, the coefficient of variation was not calculated.

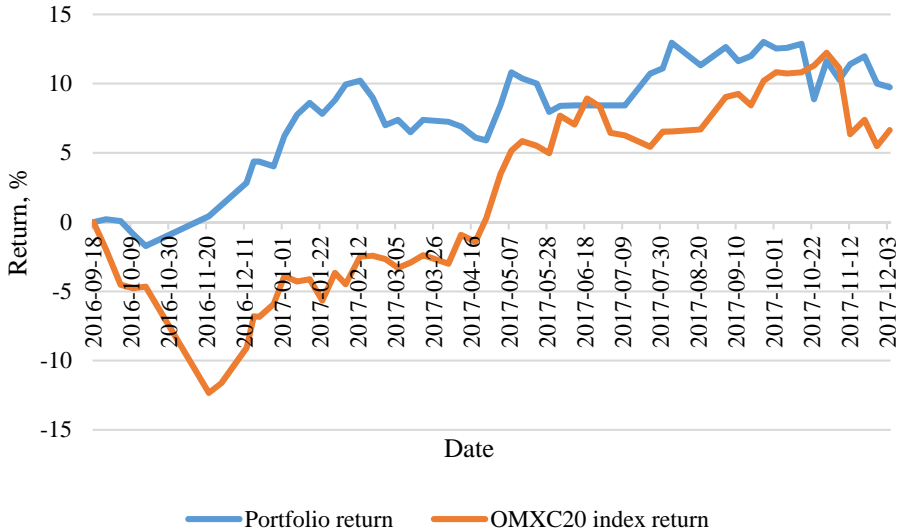


Fig. 3.17. Investment results in Denmark stock market (created by author)

Portfolio return in the USA market reaches 24.99% (blue curve), while the return of NASDAQ 100 index in the same period was about 20.18% (red curve) (Fig. 3.18). Portfolio had more fluctuations during investment period than index. For example, the decline in portfolio value in February 2017 was driven by a price correction, there were no bad news, but stock prices were over-raised by too high a good news flow. However, as prices quickly dropped, they also quickly jumped into the pre-existing level. Consequently, slightly higher fluctuations of portfolio value in the USA stock market have led to higher portfolio risk (Table 3.17).

Table 3.17. Risk and average return of the USA stock market (author calculations)

The USA stock market	Risk (stdev)	Average return
Portfolio	0.0936	9.92%
Index	0.0757	12.21%

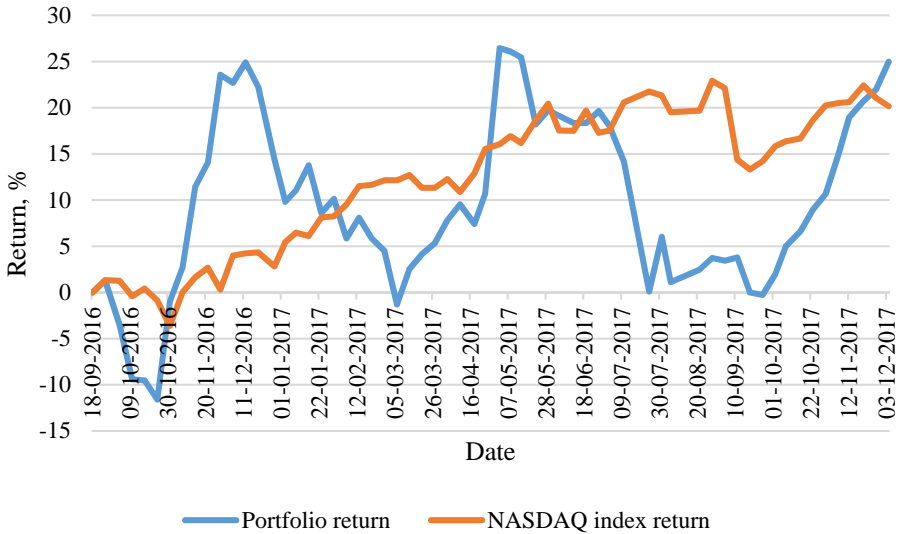


Fig. 3.18. Investment results in the United States of America stock market (created by author)

Thus, it is possible to observe a steady growth of portfolio return compared to the index in Norway stock market, return on investment portfolio is 33.07% (blue curve), while return of index – 29.04% (red curve) (Fig. 3.19). The portfolio’s value trajectory change was close to the index throughout the analysed period. The return generated by the investment portfolio, based on the stock selection algorithm, exceeds the index return with lower risk (the variance coefficient of portfolio is about 3% lower than the variance coefficient of index), which indicates the adequacy and viability of the investment strategy under close to the real market conditions (Table 3.18).

Table 3.18. Risk indicators of Norway stock market (author calculations)

Norway stock market	Risk (stdev)	Average return	Variance coefficient
Portfolio	0.0744	16.54%	0.4499
Index	0.0719	14.97%	0.4803

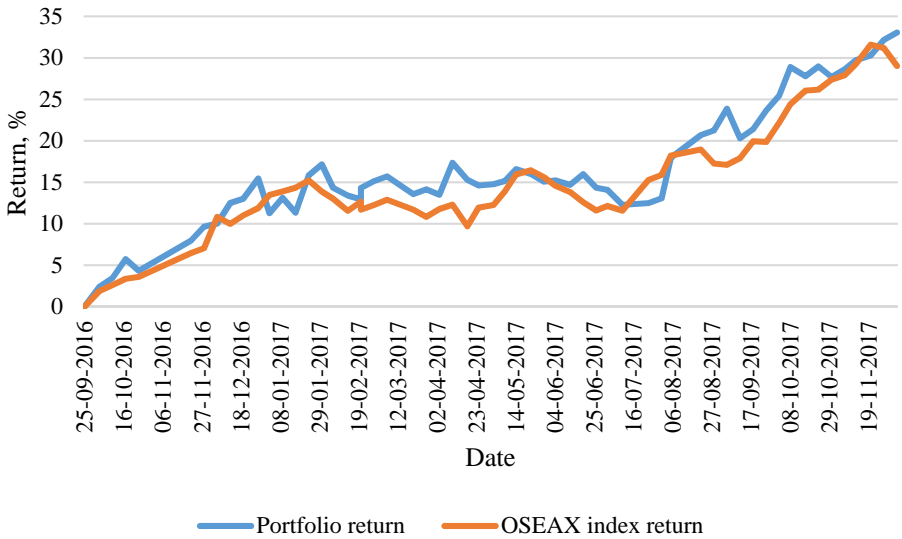


Fig. 3.19. Investment results in Norway stock market (created by author)

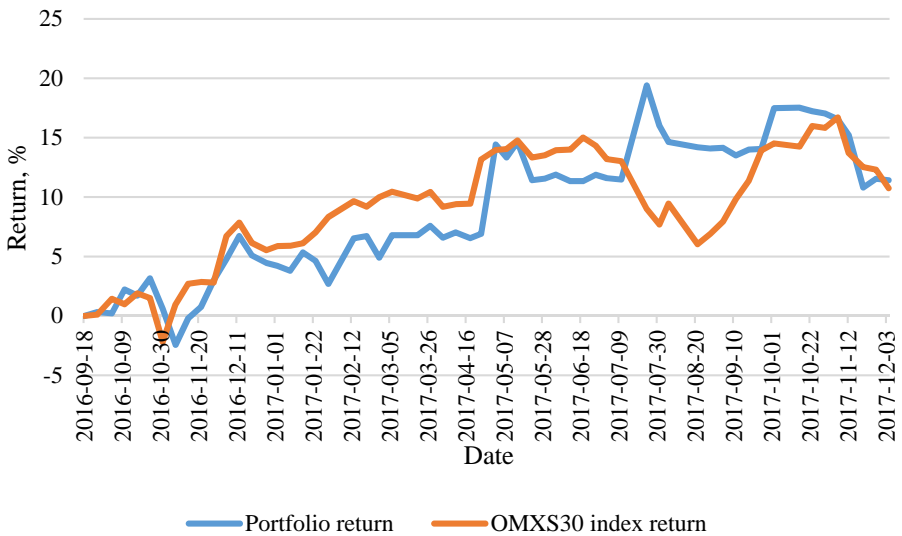


Fig. 3.20. Investment results in Sweden stock market (created by author)

In Sweden stock market, the return of the investment portfolio was 3.22% lower than the return of the index, but the investment return was positive, the return of the period seked 11.43%. It should be noted that investing in this market

was faced with a liquidity problem, because it was hard to buy all the required amount of stocks in some due to insufficient supply of stocks in the markets (Fig. 3.20).

Table 3.19. Risk and average return of Sweden stock market (author calculations)

Sweden stock market	Risk (stdev)	Average return
Portfolio	0.0497	8.84%
Index	0.0566	9.21%

The volatility of portfolio, which consists from Sweden stocks, was 0.0497, while the volatility of index value seeked 0.0566, accordingly, that result approved the viability of IIS in Sweden equity market (Table 3.19).

Table 3.20. Episodes of investment portfolio structure in Sweden stock market (created by author)

Date	Stock	Structure	
		Buy	Sell
2016.09.12	ALFA.ST	0.214	
	BOL.ST	0.2857	
	LUPE.ST	0.3571	
	SAND.ST	0.1428	
2016.09.19	ALFA.ST		0.014
	ALIV-SDB.ST	0.2	
	SKA-B.ST	0.2	
	LUPE.ST		0.1571
	SAND.ST	0.0572	
	BOL.ST		0.2857
...
2017.12.04	SCA-B.ST	0.6333	
	BOL.ST	0.2333	
	LUPE.ST	0.1333	
2017.12.11	SKA-B.ST	0.4	
	SWMA.ST	0.3	
	LUPE.ST	0.0667	
	AZN.ST	0.1	
	SCA-B.ST		0.6333
	BOL.ST		0.2333

As the example of investment decision-making, the episodes of investment portfolio structure distribution during analysed period in Sweden stock market are presented in Table 3.20, the structure of portfolio was rebalanced weekly.

Table 3.21. Risk and average return of the integrated portfolio (author calculations)

Integrated investment decisions	Risk (stdev)	Average return
Portfolio	0.0361	3.49%
Index	0.0315	4.72%

Since the integrated investment portfolio was composed of stocks from different markets, MSCI index was selected for results comparison. The return on the integrated portfolio (compiled for an experiment from four different market stocks – the USA, Norway, Denmark, Sweden) was 1.55% lower than the MSCI index return (Fig. 3.21), but the investment score is positive, which also indicates the effectiveness of the investment strategy.

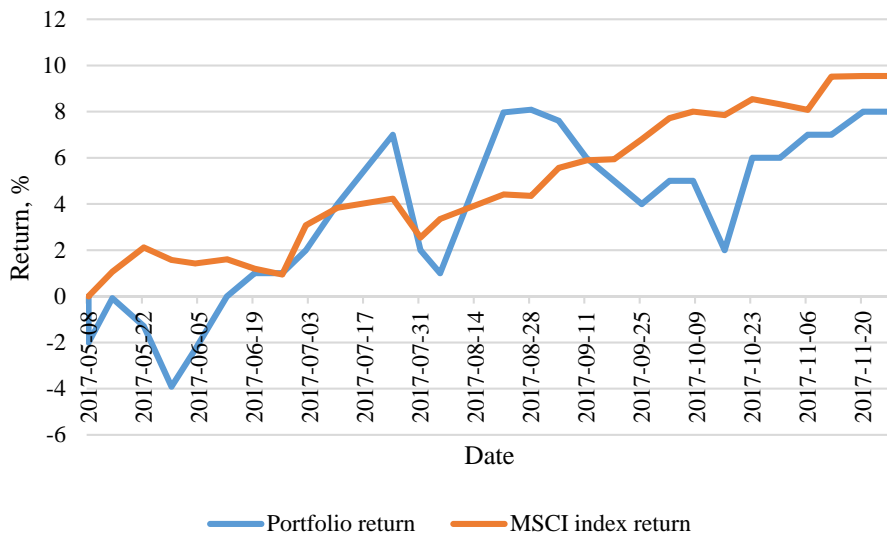


Fig. 3.21. Investment results of the integrated portfolio (created by author)

The standard deviation of portfolio was slightly higher (0.0361) than the standard deviation of MSCI index, which seeks 0.0315, because portfolio value had more fluctuations (Table 3.21). Also, evaluating the results, it should be taken

into account that the index includes stocks from 23 countries, while the portfolio contains only stocks from 4 countries.

3.4. Conclusions of Chapter 3

This chapter revealed that:

1. The pursuit that intelligent investment strategy could function in any stock market led the choice to analyse a large number of countries in the world – forty two stock markets from Europe, America, Asia and Australia continents have been analysed.
2. According to expert evaluation results, the weights for impact indicators significance on stock market return were determined. The evaluation results showed that the most important indicators on stock market return are Real GDP annual growth, Market capitalization as percentage of GDP, P/E ratio and investment funds market size (1st–4th places, the highest weights), the least important – Purchasing Managers index (10th place, the lowest weight).
3. The results of the multi-criteria appraisal of stock markets made it possible to identify potentially the most attractive stock markets for future investments. These markets have the highest overall *S* scores (using the SAW method) evaluating them by impact indicators – Australia, Austria, Bulgaria, China, Cyprus, the Czech Republic, Denmark, Estonia, Germany, Hong Kong, Israel, Japan, the Netherlands, Norway, Russia, South Korea, Sweden, Switzerland, the United Kingdom and the United States.
4. The results of empirical research have shown that proposed stock selection algorithm allows to significantly expand the scope of investment decisions and is able to adapt independently to the current market conditions and to select stable business stocks forming the investment portfolio, which in turn ensures the sustainability of return in the long run.
5. Due to the insufficiency of Cyprus data, the back-testing was carried out in nineteen stock markets, using 200 lines of historical stocks closing data (weekly data). Stock selection, based on alternatives ranking according to technical analysis of stock price, was used as a comparative method for intelligent investment strategy testing. Adequate portfolio theory is proposed for investment portfolio formation and verification of intelligent investment strategy. The comparison of IIS return and risk with return and risk, generated by comparative

method, and stock index return and risk, confirms the intelligent investment strategy adequacy and possibilities to generate the sustainability of investment return during long term period.

6. The investment portfolios also have been tested in Sweden, Norway, the USA and Denmark stock markets close to the real market conditions. The annual return of investment portfolios was close to the index or about 4% higher than the return of the index in the USA and Denmark stock markets that indicates the viability of intelligent investment strategy and possibility to adapt in the real market conditions.

General Conclusions

1. A detailed analysis of scientific literature has shown that global financial markets are affected by many factors: economic, technological, social and political, which influence the behaviour of financial markets and the level of investment return. Their volatility and change also cause economic crises. It has been determined that in order to ensure the sustainability of investment return, it is necessary to identify the factors that have the greatest impact on the return of financial markets.
2. The feasibility study on investment in financial markets has determined that existence of international uncertainties presents new threats to the sustainability of stock return under changing economic environment conditions. The need of ability to analyse large amounts of data has led to the emergence and development of various business intelligence methods and tools. In relation to this, the intelligent investment strategy was developed in the dissertation and it can be interpreted as the supplement of classical methods in the field of investment management and associated with ability to meet institutional investors' desire to effectively manage the investment. The ability of technology to replace human in some processes will create preconditions for achieving sustainable outcome. After examining the issues of sustainable return on investment, the concept of sustainability of investment return has been expanded. The sustainability of

investment return is defined as a stable investment return in the long run, taking into account market opportunities and changing conditions of economic environment.

3. Carried out analysis of the classical investment methods has made it possible to identify that the application of individual methods does not ensure the efficient solution of complex economic problems, since today the analysis of large data is particularly relevant in the world, where individual methods fail to perform effectively. Therefore, their integration creates a basis for a holistic research and provides opportunities for adopting effective investment decisions that will make it possible to achieve the sustainability of investment return.
4. By integrating the most commonly used individual methods for stock market selection, selection of particular stocks and investment portfolio formation, the author suggested the intelligent investment strategy framework that consists of three main steps: selection of stock markets, stock selection and investment portfolio formation, and intelligent investment strategy testing.
5. In order to formulate a methodology for stock markets evaluation, the detailed analysis of impact indicators, which have the influence on stock markets return, was carried out and showed that there is no unified and general set of indicators, which could be used for detailed stock market selection. The scientific literature examines the impact of individual indicators on the return of stock markets. Ten indicators that will make the set for further market analysis was distinguished: real GDP, 10-year government benchmark yields, consumer price index, investment funds market size, debt to GDP ratio, unemployment rate, exchange rate change, purchasing managers indicator, market capitalisation as percentage of GDP and P/E ratio. The usage of this set of indicators allows evaluating the attractiveness of stock markets for investment.
6. The methodology for stock markets evaluation based on the system of experts' multi-criterion-selected factors and the system for evaluating fundamental indicators of individual securities operating on those financial markets have enabled creation of a theoretical basis for a prudent and sustainable investment strategy, thus completing classical investment valuation methods.
7. After analysing the link between different economic indicators and stock markets, a methodology for the evaluation of stock markets has been proposed, selecting the impact indicators and structuring historical stock market data, the analysis and multi-criteria evaluation of global stock markets was carried out, which results allowed to identify twenty reliable stock markets from previously analysed forty two stock markets (Hong

Kong, Switzerland, Norway, China, South Korea, Japan, Estonia, the Netherlands, Russia, Australia, Austria, Israel, Germany, The United States, Denmark, Cyprus, Czech Republic, the United Kingdom, Bulgaria and Sweden), which should ensure the sustainability of investment return in long-term. These twenty markets were used further in the research in order to capture the stock selection algorithm.

8. Designed integrated stock selection algorithm, which forms the second stage of the intelligent investment strategy, based on assessment of the soundness of companies, which were listed in the stock markets. Stock selection algorithm and evaluation of stock prices return and risks create preconditions for the formation of sustainability methodology of investment return and integrated assessment.
9. The created intelligent investment strategy helps to assess large amounts of historical data and, by analysing them independently, to select the most stable stocks for the formation of investment portfolio. The intelligent investment strategy was verified empirically using back-testing method. The results of realisation of the strategy in real market conditions allow concluding that developed intelligent investment strategy justifies the concept of sustainability in real market conditions. The obtained results showed that the return of investment portfolios formed based on the proposed stock selection algorithm in 70% of cases was higher than the return generated by the comparative index and the comparative method during the same period and in 50% of analysed cases the maximum return was achieved with minimal risk. It can be affirmed that the proposed intelligent investment strategy is able to compete successfully with other similar methods in real investment conditions.
10. Formulating long-term investment decisions in equity markets, it is recommended to:
 - analyse the period during which the economy would have gone through all stages of the business cycle;
 - use the proposed set of impact indicators for the evaluation of stock markets;
 - use a longer time series of data in assessing the financial stability of issuers.

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Summary in Lithuanian

Įvadas

Problemos formulavimas

Dėl didėjančių prieinamos informacijos, susijusios su akcijų rinkų ir emitentų veikla, kiekių, sparčiai besiplečiančių akcijų rinkų (didėjanti rinkų kapitalizacija, augantis listinguojamų bendrovių skaičius) ir intensyvėjančių globalizacijos procesų, investuotojams tampa vis sunkiau priimti efektyvius investicinius sprendimus. Dėl šios priežasties konkrečios akcijų rinkos ir jos akcijų parinkimo investiciniam portfeliui formuoti klausimas yra ypač svarbus investuotojams, kurie vienareikšmiškai sutinka, kad vienas pagrindinių investavimo sėkmės garantų yra tinkamai atlikta akcijų rinkų ir akcijų atranka. Mokslinėje literatūroje plačiai analizuojami atrankos kriterijai, ieškoma veiksmingų, darančių didžiausią poveikį akcijų rinkų gražai, siekiama nustatyti geriausią investavimo sprendimams priimti naudojamų metodų derinį, padėsiantį siekti investicinės gražos tvarumo.

Disertacijoje nagrinėjama ir sprendžiama mokslinė problema yra formuluojama taip: nėra vienos, įvairaus išsivystymo lygio rinkoms tinkamos akcijų rinkų vertinimo metodikos, kuria naudojantis galima atrinkti tokias akcijų rinkas ir akcijas, į kurias investuodami subjektai galėtų pasiekti investicinės gražos tvarumą ilguoju laikotarpiu. Nors emitentų finansinių duomenų ir finansų rinkų statistinių duomenų bazės yra labai išsamios ir gali apibūdinti daugybę nagrinėjamo subjekto veiklos požymių, šie duomenys yra ne iki galo panaudojami tvarių investicijų tikslui. Ši problema galėtų būti išsprendžiama tikslingai

pritaikius ir sujungus dažniausiai pavieniui taikomus akcijų rinkų atrankos, konkrečių akcijų parinkimo ir investicinio portfelio formavimo metodus, taip panaudojant turimus statistinius duomenis įvairaus išsivystymo lygio rinkoms vertinti ir akcijų atrankai, siekiant investicinės gražos tvarumo.

Darbo aktualumas

Sparčiai besikeičiančios ekonominės aplinkos sąlygos lemia ir finansų rinkų elgsenos pokyčius. Kuriant integruotus vadybinius, ekonominius, matematinius metodus yra ypač aktualūs didelių duomenų analizės ir verslo intelekto sprendimai. Pavienių metodų taikymas neužtikrina efektyvaus sudėtingų ekonominių problemų sprendimo, todėl jų integravimo galimybės sukuria holistinio tyrimo pagrindą. Finansų rinkų dalyviai turi greitai prisitaikyti prie sparčiai besikeičiančių aplinkos sąlygų – gebėti analizuoti didelius duomenų kiekius, kad galėtų priimti efektyvius investicinius sprendimus. Ilgalaikiai investiciniai sprendimai turi būti efektyvūs, ypatingą dėmesį skiriant ne tik trumpalaikės gražos gavimo prielaidoms, bet ir investicinės gražos tvarumui.

Ypač tai aktualu, kai prekybos apimtys akcijų rinkose sparčiai auga. 2017 m. pabaigoje bendra akcijų rinkos kapitalizacija buvo apie 69 trilijonai dolerių, o tai reiškia, kad akcijų rinka atlieka svarbų vaidmenį pasaulio ekonomikoje. Didžiausios pardavimų apimtys yra labiausiai išsivysčiusiose akcijų rinkose: JAV, Didžiosios Britanijos, Vokietijos, Šveicarijos, Honkongo. Tikintis būtent jose gauti didžiausią gražą, neišnaudojamos kitų rinkų visos galimybės ir netenkama santykinai aukštesnės gražos. Čia ir atsiskleidžia pavieniui taikomų metodų ribotumai – atliekant mokslinius tyrimus analizuojamos ir testuojamos tik pavienės akcijų rinkos, nes tyrimo nuodugnumas reikalauja ir techninių pajėgumų, kurie suteiktų galimybę išplėsti tyrimų lauką ir neprarasti galimybių gauti didesnę gražą kitose, mažiau ištirtose rinkose, tokiose kaip Pietų Korėjos, Bulgarijos ar Estijos, kuriose metinė investicinė graža gali siekti nuo 20 % ir daugiau.

Tinkamai integravus dažniausiai pavienius taikomus akcijų rinkų atrankos, akcijų atrinkimo, investicinio portfelio formavimo metodus, galima sukurti įžvalgią investavimo strategiją, galinčią tapti patikimu įrankiu investuotojui priimant efektyvius investicinius sprendimus bet kurioje pasaulio akcijų rinkoje.

Tyrimo objektas

Disertacinių tyrimų objektas – investicijų graža akcijų rinkose.

Darbo tikslas

Parengti įžvalgios investavimo akcijų rinkose strategijos įgyvendinimo metodiką, sudarančią galimybes investuotojams siekti investicijų gražos tvarumo.

Darbo uždaviniai

Darbo tikslui pasiekti buvo sprendžiami šie uždaviniai:

1. Atlikti globalizacijos veiksnių, lemiančių finansų rinkų elgseną, analizę.

2. Atlikti kritinę efektyvaus investavimo galimybių paieškos teorijų ir metodų analizę.
3. Papildyti gražos tvarumo ir įžvalgios investavimo strategijos koncepcijas.
4. Sudaryti įžvalgios investavimo strategijos schemą, sujungiančią dažniausiai pavieniui taikomus akcijų rinkų atrankos, akcijų parinkimo ir investicinio portfelio formavimo metodus.
5. Atrinkus adekvačius poveikio investicinei gražai rodiklius (angl. *impact indicators*), sukurti akcijų rinkų vertinimo metodiką ir atlikti pasirinktų akcijų rinkų vertinimą.
6. Sumodeliuoti akcijų atrankos algoritmą, kurio pagrindas – akcijų rinkose listinguojamų įmonių finansinio (angl. *financial soundness*) stabilumo vertinimas.
7. Empiriškai patikrinti sudarytą įžvalgią investavimo strategiją grįžtamojo patikrinimo metodu ir artimomis realioms rinkos sąlygoms.

Tyrimų metodika

Siekiant įgyvendinti disertacijoje išsikeltą tikslą, buvo analizuojami ir apibendrinami naujais moksliniai darbai investavimo tematika. Konceptualiosioms nuostatoms, susijusioms su investicinio portfelio teorijos modeliais ir finansų rinkų vertinimo metodais, analizuoti buvo naudojami lyginamosios analizės, loginės ir sisteminės analizės metodai. Akcijų rinkų vertinimui buvo naudoti ekspertinio ir daugiakriterinio vertinimo (SAW) metodai. Akcijų atrankos algoritmo sudarymui naudota finansinio stabilumo vertinimo metodika. Įžvalgios investavimo strategijos taikymo galimybėms atskleisti, buvo naudojami stochastinės optimizacijos (adekvataus portfelio modelis) ir grįžtamojo patikrinimo metodai. Siekiant apdoroti gautus rezultatus, buvo naudojami konkretizavimo, apibendrinimo ir grafinės analizės metodai.

Mokslinis naujumas

1. Išplėtos investicinės gražos tvarumo ir įžvalgios investavimo strategijos sampratos, apibrėžiant investicinės gražos tvarumą kaip stabilią investicijų grąžą ilguoju laikotarpiu, atsižvelgiant į kiekvienos rinkos galimybes ir besikeičiančias aplinkos sąlygas, o įžvalgią investavimo strategiją – kaip gebėjimą prisitaikyti prie skirtingų rinkos sąlygų, taikant integruotų investicinių sprendimų priėmimo metodų kompleksą ir siekiant investicinės gražos tvarumo.
2. Į akcijų rinkų atranką integravus SAW metodą, atskleistos naujos įvairaus išsivystymo lygio akcijų rinkų patrauklumo investicijoms vertinimo galimybės.
3. Atlikus kritinę mokslinių šaltinių analizę ir atrinkus adekvačius poveikio investicinei gražai rodiklius (angl. *impact indicators*), sudaryta akcijų rinkų vertinimo metodika, kuri gali būti taikoma siekiant investicinės gražos tvarumo.
4. Pasiūlytas akcijų atrankos algoritmas, kurį naudojant galima pagreitinti investicinių sprendimų priėmimą, prisitaikant prie sparčiai besikeičiančių rinkos sąlygų,

bei atrinkti tokias investicinio portfelio sudarymui tinkamų įmonių akcijas, į kurias investuojant galima būtų pasiekti investicinės grąžos tvarumą ilguoju laikotarpiu.

5. Remiantis atliktais moksliniais tyrimais sukurta įžvalgi investavimo strategija, sujungianti dažniausiai pavieniui taikomus akcijų rinkų atrankos, akcijų parinkimo, investicinio portfelio formavimo metodus.

Darbo rezultatų praktinė reikšmė

1. Atrinkus adekvačius poveikio investicinei grąžai rodiklius, sukurta akcijų rinkų vertinimo metodika ir integruotas akcijų atrankos algoritmas, kuriuos naudojant galima analizuoti akcijų rinkų didelius statistinių duomenų masyvus ir daryti svarbias išvadas.
2. Suformuota įžvalgi investavimo strategija gali būti lengvai pritaikoma bet kuriam rinkos dalyviui, atsižvelgiant į jam priimtina pelningumo ir rizikos santykį bei rinkos siūlomas galimybes.
3. Pasiūlyta įžvalgi investavimo strategija gali būti pritaikoma studijų tikslams ir tobulinant esamas investavimo strategijas. Taip pat gali būti taikoma kartu su klasikiniiais investicinių portfelių sudarymo metodais, priimant efektyvius investicinius sprendimus ir siekiant investicinės grąžos tvarumo ilguoju laikotarpiu.
4. Tyrimo rezultatus galima naudoti kompleksiskai analizuojant ir kiekybiškai vertinant akcijų rinkų investicines galimybes ir stabilumą.
5. Pasiūlytos įžvalgios investavimo strategijos veiksmingumą patikrinus artimomis realioms rinkos sąlygomis nustatyta, kad ją naudojant galima pasiekti didesnę investicinę grąžą nei to paties laikotarpio indekso grąža.

Ginamieji teiginiai

1. Globalių akcijų rinkų analizei ir vertinimui tikslingai pritaikius suformuotą rodiklių, turinčių didžiausią įtaką akcijų rinkų grąžai, rinkinį, galima nustatyti patikimas ir leisiančias užtikrinti investicinės grąžos tvarumą ilgalaikėje perspektyvoje akcijų rinkas.
2. Siekiant tvaraus investicinės grąžos rezultato, emitentų patrauklumą investicijoms būtina nagrinėti atsižvelgiant į jų finansinio stabilumo vertinimo ir grąžos bei rizikos rodiklius, tokiu būdu formuojant akcijų atrankos algoritmą.
3. Investicinės grąžos tvarumas gali būti pasiektas pasinaudojant įžvalgios investavimo strategijos logika, kurios pagrindas yra dažniausiai pavieniui taikomų akcijų rinkų atrankos, akcijų parinkimo ir investicinio portfelio formavimo metodų sujungimas ir tikslingas pritaikymas.

Darbo rezultatų aprobavimas

Disertacijos tema paskelbta 23 mokslinės publikacijos, iš kurių 6 – žurnaluose, referuojamuose mokslinėse duomenų bazėse, 3 – kituose recenzuojamuose mokslo žurnaluose,

11 – konferencijų straipsnių rinkiniuose, 3 – konferencijų straipsnių rinkiniuose, referuojamuose *Clarivate Analytics Web of Science* duomenų bazėje. Disertacijos rezultatai buvo pristatyti dešimtyje mokslinių konferencijų:

1. 5-ojoje tarptautinėje mokslinėje konferencijoje *Contemporary Issues in Business, Management and Education'2017*. Vilnius, Lietuva, 2017.
2. 20-ojoje jaunųjų mokslininkų konferencijoje *Verslas XXI amžiuje*. Vilnius, Lietuva, 2017.
3. Nacionalinėje mokslinėje konferencijoje *Socialinė įtrauktis ir švietimo įstaigų veikla: sumaniosios edukacijos link*. Vilnius, Lietuva, 2016.
4. 9-ojoje tarptautinėje mokslinėje konferencijoje *Business and Management'2016*. Vilnius, Lietuva 2016.
5. 19-ojoje jaunųjų mokslininkų konferencijoje *Verslas XXI amžiuje*. Vilnius, Lietuva, 2016.
6. Nacionalinėje mokslinėje konferencijoje *Verslumo ugdymo ir konkurencingumo didinimo problemos*. Vilnius, Lietuva, 2015.
7. 4-ojoje tarptautinėje mokslinėje konferencijoje *Contemporary Issues in Business, Management and Education'2015*. Vilnius, Lietuva, 2015.
8. Nacionalinėje mokslinėje-praktinėje konferencijoje *Lietuvos ekonomikos augimo ir stabilumo strateginės kryptys*. Vilnius, Lithuania, 2015.
9. 8-ojoje tarptautinėje mokslinėje konferencijoje *Business and Management'2014*. Vilnius, Lietuva, 2014.
10. 17-ojoje jaunųjų mokslininkų konferencijoje *Verslas XXI amžiuje*. Vilnius, Lietuva, 2014.

Disertacijos struktūra

Darbą sudaro įvadas, trys skyriai, bendrosios išvados, literatūros sąrašas (283 šaltiniai), autorės publikacijų disertacijos tema sąrašas (23 publikacijos), santrauka lietuvių kalba ir 8 priedai. Disertacijos apimtis (be priedų) – 157 puslapiai, tekste panaudota 20 sunumeruotų formulių, 36 paveikslai ir 26 lentelės.

Padėka

Disertacinio darbo autorė norėtų išreikšti savo nuoširdžią padėką mokslinio darbo vadovei, VGTU Finansų inžinerijos katedros docentei dr. Raimondai Martinkutei-Kaulienei už kantrybę ir vertingas mokslines konsultacijas doktorantūros studijų metu. Taip pat norėčiau padėkoti mokslininkui prof. habil. dr. Aleksandrui Vytautui Rutkauskui už mokslines diskusijas ir bendradarbiavimą bei suteiktą galimybę būti mokslo pasaulio dalimi.

Autorė išreiškia ypatingą padėką dr. Modestui Plakiui už įkvėpimą, pagalbą ir skatinančias diskusijas apie disertacijos tyrimą ir jo praktinį pritaikymą.

Veronika Golubeckaitė ir Vaiva Miškinytė nusipelnė padėkos už vertingas įžvalgas – jų kompetencija buvo reikšminga parama gerinant disertacijos anglų kalbos kokybę.

Autorė taip pat yra labai dėkinga savo šeimai: tėvams Česlavai ir Stefanui, vyrui Žilvinui ir sūnui Matui už jų meilę, tikėjimą, paskatinimą sunkiausiais momentais nesusotai ir didelę paramą studijų metu.

1. Investavimo globaliose finansų rinkose galimybių studija

Pirmajame disertacijos skyriuje atlikta literatūros šaltinių disertacijos tematika analizė. Aptartos pagrindinės finansų rinkų funkcijos ir jų tarpusavio ryšiai, nemažą dėmesį skiriant globalizacijos procesų poveikiui finansų rinkoms. Apžvelgta išvalgumo sąvokos reikšmė, apibrėžta disertacijoje vartojamos išvalgios investavimo strategijos sąvokos interpretacija. Didelę šio skyriaus dalį sudaro finansų rinkų analizei taikomų metodų analizė. Aprašyta tvarios investavimo grąžos sąvokų įvairovė, taip išryškinant investicinės grąžos tvarumo užtikrinimo finansų rinkose būtinybę. Skyriuje taip pat aprašyti metodai, taikomi rizikai vertinti. Nagrinėjamas įvairių makroekonominių rodiklių poveikis vertybinių popierių rinkoms.

Nustatyta, kad globalias finansų rinkas veikia daugelis veiksnių: ekonominių, technologinių, socialinių ir politinių, lemiančių finansų rinkų elgseną ir investicinės grąžos dydį. Taip pat nustatyta, kad, siekiant užtikrinti investicinės grąžos tvarumą, būtina identifikuoti veiksnus, turinčius didžiausią įtaką finansų rinkų grąžai. Parodyta, kad klasikiniai metodai, taikomi finansų rinkoms analizuoti ir vertinti, nesugeba prisitaikyti prie sparčiai besikeičiančios ekonominės aplinkos sąlygų ir technologinės plėtros. Dėl šios priežasties tampa ypač aktualus kelių metodų integravimas, siekiant apdoroti ir išanalizuoti didelius duomenų kiekius. Buvo atlikta išsami rodiklių, turinčių poveikį akcijų rinkų grąžai, analizė, kuri parodė, kad nėra bendro rodiklių, kurie galėtų būti naudojami išsamiai akcijų rinkų atrankai, rinkinio. Remiantis atlikta analize, buvo suformuotas poveikio rodiklių (angl. *impact indicators*) rinkinys, kuris bus naudojamas akcijų rinkų atrankai: realaus bendrojo vidaus produkto (toliau – BVP) metinis pokytis, 10 metų trukmės valstybės obligacijų pajamingumas, vartojimo kainų indeksas (toliau – VKI), investicinių fondų rinkos dydis, skolos ir BVP santykis, nedarbo lygis, valiutos kurso metinis pokytis (vietinė valiuta už USD), pirkimo vadybininkų rodiklis (toliau – PMI), rinkos kapitalizacija procentais nuo BVP ir P/E rodiklis. Skyriaus pabaigoje apibrėžtas disertacijos tikslas ir iškelti darbo uždaviniai.

2. Akcijų rinkų vertinimo metodika ir algoritmo kūrimo prielaidos

Antrajame skyriuje pateikta akcijų rinkų vertinimo ir algoritmo kūrimo tyrimo metodika. Disertacijoje pasitelkiamas ekspertinis vertinimas, siekiant nustatyti poveikio rodiklių svarbą akcijų rinkų grąžai (nustatyti svorius). Siekiant nustatyti pasirinktų rodiklių svorį, buvo taikomas netiesioginis ekspertų vertinimo metodas, t. y. ekspertai, vertindami kiekvieno rodiklio svorį, nesiejo vieno rodiklio vertinimo su kitų rodiklių įverčiais. Didžiausias įvertinimas priskiriamas svarbiausiam rodikliui. Taikant šį metodą, vertinimai gali būti kartojami, keliems parametrams galima priskirti tuos pačius įverčius. Ekspertų nuomonių suderinimui įvertinti buvo pasirinkta naudoti χ^2 (Kendal 1970), jis gali būti taikomas praktikoje, jei ekspertų daugiau nei 7. Jei apskaičiuota vertė yra didesnė nei laisvės laipsnis, ekspertų vertinimai yra suderinti; jei mažesnė, ekspertų nuomonės nėra suderintos.

Analizuojant daugiakriterių vertinimo metodų taikymą įvairiose ekonominėse srityse, buvo nustatyta, kad SAW metodas yra vienas iš dažniausiai taikomų metodų, ypač ekonomikos mokslų srities daktaro disertacijose Lietuvoje, dėl to pasirenkamas akcijų rinkoms vertinti.

Siekiant įvertinti listinguojamų akcijų rinkose įmonių finansinį stabilumą, disertacijoje taikyti buvo pasirinktas finansinio stabilumo vertinimo (angl. *financial soundness evaluation*) metodas. Remiantis autorės atliekamais eksperimentiniais tyrimais, buvo pastebėta, kad metode taikomos bendrovių stabilumo rodiklių vertinimo ribos yra tinkamesnės vertinant įmones trumpuoju laikotarpiu. Siekiant ilgalaikių tikslų, atsiranda būtinybė režius pakoreguoti, tam tikslui autorė pasiūlė kitus rodiklių vertinimo režius bendrovių stabilumui vertinti (S2.1 lentelė).

S2.1 lentelė. Siūlomos bendrovių stabilumo rodiklių vertinimo ribos (sudaryta autorės)

Rodikliai	Reikšmių režiai ir jų reikšmė (Lace, Sundukova 2010)	Siūlomi reikšmių režiai ir jų reikšmė
ASRL, % ASREA, %	<ul style="list-style-type: none"> • Mažesnė už 0, įmonės veikla nestabili, nesubalansuota. • $0 < x < 100$, įmonės veikla yra stabili, subalansuota. • Didesnė už 100, įmonės veikla stabili, bet ji neišnaudoja visų turimų savo galimybių. 	<ul style="list-style-type: none"> • Mažesnė už 0, įmonės veikla nestabili, nesubalansuota. • $0 < x < 69,99$, įmonės stabilumas vidutinis. • $70 < x < 105$, įmonės veikla stabili, subalansuota. • Didesnė už 105, įmonės veikla stabili, bet ji neišnaudoja visų turimų savo galimybių.

Ižvalgos investavimo strategijos tikslas – siekti investicijų grąžos tvarumo ilguoju laikotarpiu, todėl tikslinga taikyti modifikuotą rodiklių reikšmių interpretavimo spektrą įmonių stabilumui nustatyti.

Disertacijoje pirmiau aptarta metodika buvo taikoma akcijų atrankos algoritmui įgyvendinti ir akcijų atrankai į investicinį portfelį. Buvo vertinamos visos listinguojamos bendrovės, turinčios pasirinktų akcijų rinkų indeksus. Pažymėtina, kad bendrovės, turinčios pakankamą nuosavą kapitalą ilguoju laikotarpiu, linkusios parodyti didesnę stabilumą normaliomis ekonominėmis sąlygomis ir galėtų plėtoti savo veiklą nepaisant nepalankių rinkos sąlygų.

Grįžtamojo patikrinimo metodas (angl. *back-testing*) buvo pasirinktas norint patikrinti ižvalgos investavimo strategijos taikymo galimybes skirtingo išsivystymo lygio akcijų rinkose. Taikant šį metodą galima imituoti prekybos strategiją atitinkamu laikotarpiu ir išanalizuoti pelningumo bei rizikos lygius. Grįžtamojo patikrinimo laikotarpis turėtų būti ilgas, kad apimtų skirtingų rinkos sąlygų laikotarpius, įskaitant ekonominio ciklo augimo ir nuosmukio tendencijas. Tik vieno ekonominio ciklo tipo rinkos tyrimas gali teikti unikalius rezultatus, kurie gali netinkamai veikti kitomis rinkos sąlygomis ir gali lemti klaidingas išvadas (Vilkancas 2017; Gilli et al. 2011; DeMiguel et al. 2009). Grįžtamojo patikrinimo logika, naudojama disertacijoje:

- bandymo laikotarpio pasirinkimas (M). Pasirinkta bandymo trukmė – 199 savaitės (t. y. ketveri metai);

- istorinių akcijų uždarymo kainų rinkimas, tyrimui naudojami savaitiniai duomenys;
- optimizavimo modelio parametrų apskaičiavimas, remiantis pirmojo bandymo laikotarpio gražų seka;
- optimizavimo procedūros pakartojimas;
- pasiūlyti optimalūs testuojamos strategijos svoriai.

Siūlomo modelio ar strategijos testavimas yra labai svarbus viso investavimo proceso etapas. Realiojo laiko investavimas naudojant bandomąją versiją yra būdas užtikrinti taikomų strategijų pagrįstumą, todėl strategijai testuoti buvo pasirinktas ne tik grįžtamojo patikrinimo metodas, bet ir artimas realioms sąlygoms investavimo strategijos patikrinimas, pasitelkiant DNB prekybos platformą. DNB prekybos platforma buvo pasirinkta dėl jos funkcionalumo ir investuotojų veiklos priemonių panašumo pasaulinėse kapitalo ir valiutų rinkose. Grįžtamojo patikrinimo metodo ir DNB prekybos platformos naudojimas suteiks galimybę išnagrinėti siūlomos įžvalgios investavimo strategijos efektyvumą įvairiose akcijų rinkose ir patvirtinti ar paneigti strategijos taikymo galimybes skirtingose akcijų rinkose.

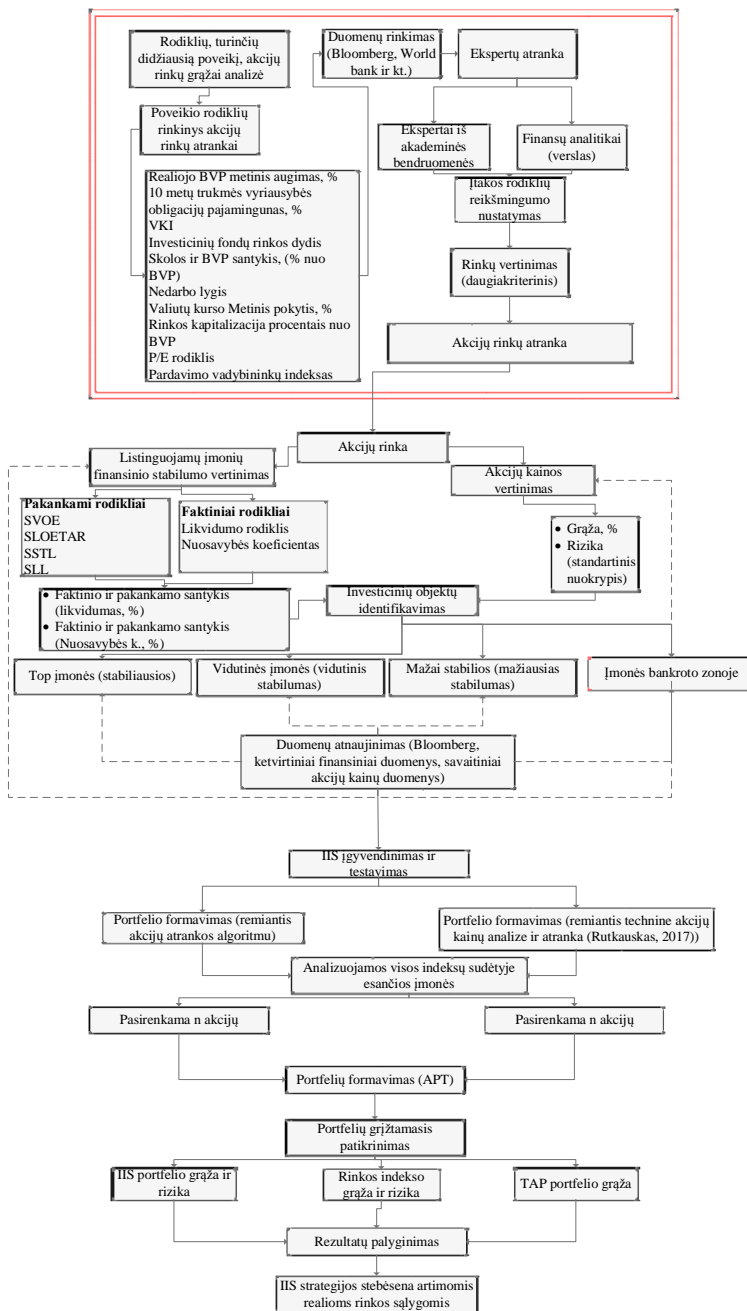
Remiantis investicinių portfelių formavimo metodų pranašumų ir trūkumų analize, sprendimų priėmimui buvo pasirinkta taikyti adekvataus portfelio teoriją, kuri leis testuoti įžvalgią investavimo strategiją.

Įžvalgios investavimo strategijos schema darbe pristatoma kaip konkreti investavimo veiksmų procedūra šiame darbe (S2.1 pav.). Sukurtą schemą sudaro trys pagrindiniai etapai:

- akcijų rinkų atranka;
- akcijų atrankos algoritmas;
- investicinio portfelio formavimo ir testavimo schema.

Pirmajame etape pateikiama akcijų rinkų pasirinkimo logika. Atlikus nuodugnią mokslinės literatūros analizę, buvo pasiūlytas poveikio rodiklių (angl. impact indicators) rinkinys, kurį sudaro šie rodikliai, turintys didžiausią įtaką akcijų rinkų gražai: realaus BVP metinis pokytis, %, 10 metų vyriausybės obligacijų pajamingumas, vartotojų kainų indeksas, investicinių fondų rinkos dydis, skolos ir BVP santykis, nedarbo lygis, valiutos kurso metinis pokytis (vietinė valiuta už USD), rinkos kapitalizacija procentais nuo BVP, P/E rodiklis, pardavimo vadybininkų indeksas. Siekiant įvertinti pasirinktų rodiklių reikšmingumą, buvo atliktas ekspertinis vertinimas. Statistiniai poveikio rodiklių duomenys surenkami iš įvairių duomenų bazių („Bloomberg“, Pasaulio banko, Investicijų kompanijos instituto ir kt.). Daugiakriterinis vertinimo metodas siūlomas taikyti rinkų vertinimui, siekiant nustatyti perspektyviausias investicijoms akcijų rinkas.

Antrasis įžvalgios investavimo strategijos etapas – akcijų atrankos algoritmas, kurio pagrindas – listinguojamų bendrovių finansinio stabilumo įvertinimas ir akcijų kainos vertinimas. Vertinimo rezultatai leidžia suranguoti analizuojamas įmones į stabiliausias įmones, vidutinio stabilumo įmones, mažiausio stabilumo įmones ir įmones, esančias bankroto zonoje. Bendrovių finansinių duomenų atnaujinimas algoritmui atliekamas kas ketvirtį, o akcijų uždarymo kainų atnaujinimas – kas savaitę.

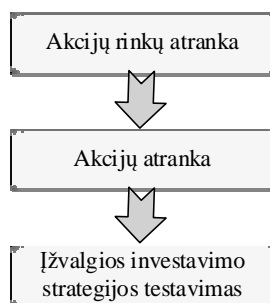


S2.1 pav. Įžvalgios investavimo strategijos schema (sudaryta autorės)

Paskutinis įžvalgos investavimo strategijos etapas – investicinių portfelių formavimas ir įžvalgos investavimo testavimas. Tam tikslui formuojami dviejų rūšių investiciniai portfeliai. Pirmasis portfelis sudaromas pagal autorės pasiūlyto akcijų atrankos algoritmo rezultatus (toliau – IIS), o antrasis – pagal A.V. Rutkausko (2017) pasiūlytą akcijų atrankos logiką, grindžiamą technine akcijų kainų analize. Šis portfelis (toliau – TAP) naudojamas įžvalgiai investavimo strategijai patikrinti. Portfeliui sudaryti pasirinkta keturiolika akcijų, portfelių struktūros paskirstomos remiantis adekvataus portfelio teorija, paskui atliekamas portfelių grįžtamasis patikrinimas, lyginant IIS portfelio grąžą su palyginamojo investicinio portfelio grąža ir kiekvienos akcijų rinkos indeksų grąža.

3. Įžvalgos investavimo strategijos įgyvendinimas ir testavimas

Trečiajame skyriuje pateikti eksperimentiniai ir skaitiniai įžvalgos investavimo strategijos įgyvendinimo ir testavimo rezultatai. Visų pirma pateikiamas eksperimentinis finansų rinkų tyrimas. Buvo nustatytos akcijų rinkos tolesnei analizei ir pateikti poveikio rodiklių reikšmingumo nustatymo pagal ekspertų vertinimus rezultatai ir finansų rinkų vertinimas, taikant daugiakriterį vertinimo metodą SAW. Finansų rinkų daugiakriterio vertinimo rezultatai leido pasirinkti stabiliausias rinkas, kurios, kaip tikimasi, ateityje turėtų generuoti didesnę investicijų grąžą, lyginant su kitomis vertinime dalyvavusiomis rinkomis. Šiame skyriuje pateikiami kai kurie įžvalgos investavimo strategijos efektyvumo patvirtinimo skirtingose akcijų rinkose pavyzdžiai. Taip pat pristatyti įžvalgos investavimo strategijos testavimo rezultatai artimomis realioms rinkos sąlygomis. Testavimai ir skaičiavimai buvo atlikti naudojant Kauno technologijos universiteto „Bloomberg“ laboratorijoje surinktus duomenis, Pasaulio banko, Investicinių bendrovių instituto, „Amadeus“ ir kitų duomenų bazių duomenis. Teorinio modelio eksperimentinis patikrinimas buvo vykdomas trimis etapais (S.3.1 pav.).



S3.1. pav. Teorinio modelio eksperimentinio patikrinimo schema (sudaryta autorės)

Siekiant sukurti įžvalgos investavimo strategijos koncepcinį pagrindą akcijų rinkose, svarbu sukurti logišką akcijų rinkų vertinimo metodiką (S3.1 pav.). Trumpas kiekvieno įžvalgos investavimo strategijos etapo aprašymas pateiktas toliau:

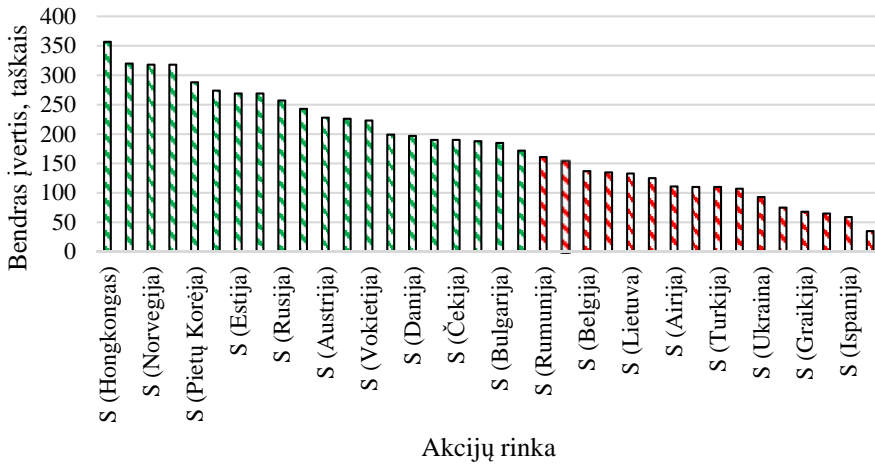
- *Poveikio rodiklių akcijų rinkų gražai analizė.* Šio etapo tikslas – išanalizuoti tyrėjų darbus, kurie tyrė įvairių rodiklių įtaką akcijų rinkų gražai.
- *Poveikio rodiklių rinkinys akcijų rinkų atrankai.* Tikslas – suformuoti poveikio rodiklių rinkinį, į jo sudėtį įtraukiant rodiklius, turinčius didžiausią įtaką akcijų rinkų gražai.
- *Duomenų rinkimas.* Duomenys buvo renkami Kauno technologijos universiteto „Bloomberg“ laboratorijoje, World bank, Investicijų kompanijų instituto ir kitose duomenų bazėse.
- *Ekspertų atranka.* Svarbu tinkamai parinkti ekspertus iš investicijų srities, tam buvo pasirinkti ekspertai iš verslo ir akademinės bendruomenės.
- *Poveikio rodiklių reikšmingumo nustatymas.* Ekspertai suteikia svorius atrinktiems rodikliams pagal rodiklių svarbą akcijų rinkų gražai.
- *Rinkų vertinimas (daugiakriteris).* Šiame etape pasirinktos vertybinių popierių rinkos bus vertinamos naudojant istorinius poveikio rodiklių duomenis ir taikant daugiakriterio vertinimo metodą SAW.
- *Akcijų rinkų atranka.* Remiantis vertinimo rezultatais, yra išskiriamos geriausios rinkos vertinamuoju laikotarpiu, kurios bus naudojamos tolesniam tyrimui.

Pagal pasiūlytą akcijų rinkų vertinimo metodiką galima analizuoti rinkos vertę ir pasirinkti rinkas, kurios gali sukurti potencialiai tvarią investicijų grąžą kiekvienam investuotojui. Investicinės grąžos tvarumas disertacijoje suvokiamas kaip stabili investicijų grąža ilgalaikiu laikotarpiu, atsižvelgiant į kiekvienos rinkos galimybes ir besikeičiančias aplinkos sąlygas.

Akcijų rinkų atrankai buvo pasirinktas 2007–2016 m. laikotarpis. Analizuojamu laikotarpiu akcijų rinkos perėjo per visus verslo ciklo etapus, todėl tikslinga analizuoti tokį laikotarpį, norint suformuoti ilgalaikius investicinius sprendimus. Tai ypač svarbus žingsnis, nes investiciniai sprendimai turi būti efektyvūs skirtingose situacijose – tiek pasaulinio ekonomikos atsigavimo, tiek ekonomikos nuosmukio laikotarpiais.

Vienas iš pagrindinių tyrimo tikslų, kad įžvalgi investavimo strategija galėtų funkcionuoti bet kurioje pasaulio akcijų rinkos dalyje, todėl analizei buvo pasirinkta daugelis pasaulio šalių. Buvo analizuojamos ir vertinamos 42 pasaulio akcijų rinkos: Vokietijos, Austrijos, Prancūzijos, Šveicarijos, Švedijos, Belgijos, Ispanijos, Danijos, Graikijos, Olandijos, Didžiosios Britanijos, Airijos, Norvegijos, Portugalijos, Italijos, Kroatijos, Lietuvos, Latvijos, Estijos, Lenkijos, Turkijos, Čekijos, Bulgarijos, Slovakijos, Rumunijos, Vengrijos, Ukrainos, Islandijos, Slovėnijos, Kipro, JAV, Brazilijos, Argentinos, Honkongo, Izraelio, Rusijos, Kinijos, Singapūro, Japonijos, Pietų Korėjos ir Australijos.

Ekspertų vertinimai parodė, kad didžiausią įtaką akcijų rinkų gražai turi šie rodikliai: realaus BVP metinis pokytis, %, rinkos kapitalizacija procentais nuo BVP, P/E rodiklis ir investicinių fondų rinkos dydis (1–4 vietos, didžiausi svoriai) ir mažiausiai svarbus – pardavimo vadybininkų indeksas (10 vieta, mažiausias svoris). Kitas akcijų rinkos vertinimo proceso etapas – pasirinktų rinkų (šalių) vertinimas pagal poveikio rodiklių statistinius duomenis ir jų svorį, kurį nurodė ekspertai. Kiekvienai rinkai buvo apskaičiuotas bendras laikotarpio įvertinimas balais (S3.2 pav.).



S3.2 pav. Rinkų vertinimo rezultatai (šaltinis: autorė)

Atsižvelgiant į gautus rinkų tyrimų rezultatus, taikant SAW metodą, galima pateikti tokį apibendrinimą:

- Investicijų portfeliams formuoti atrinktos stabiliausios rinkos ilgalaikiu laikotarpiu, siekiant užtikrinti investicinės grąžos tvarumą: Honkongas, Šveicarija, Norvegija, Kinija, Pietų Korėja, Japonija, Estija, Nyderlandai, Rusija, Australija, Austrija, Izraelis, Vokietija, Jungtinė Karalystė, Danija, Kipras, Čekija, JAV, Bulgarija ir Švedija. Šios rinkos turi didžiausią bendrą įvertį, įvertinus jas pagal poveikio rodiklius, didžiausias įvertis – Honkongo (357 balai), mažiausias pasirinktų rinkų įvertis – Švedijos (161 balas).
- Rumunija, Brazilija, Belgija, Suomija, Lietuva, Prancūzija, Airija, Latvija, Turkija, Lenkija, Ukraina, Italija, Graikija, Portugalija, Ispanija ir Kroatija su mažiausiu bendroju balu (35 balai) nebuvo pasirinktos tolesniems tyrimams, nes gauti šių šalių įverčiai buvo mažiausi. Tokį įverčių pasiskirstymą lėmė kai kurių indikatorių nestabilumas ilgalaikiu laikotarpiu, dideli svyravimai ir mažas rinkos likvidumas.
- Atsižvelgiant į PMI duomenų trūkumus ir ekspertų vertinimą, kad šis rodiklis yra mažiausiai svarbus ir turi mažiausią įtaką vertybinių popierių rinkos grąžai (rodiklio svoris buvo mažiausias), PMI rodiklis nebuvo įtrauktas į akcijų rinkos vertinimo procesą. Be to, kai kurios šalys buvo eliminuotos iš tyrimo – Singapūras, Slovakija, Slovėnija, Islandija, Vengrija ir Argentina – dėl duomenų trūkumo.

Antrasis įžvalgos investavimo strategijos etapas – akcijų atranka buvo atliekama tokiais akcijų atrankos algoritmo žingsniais (S3.1 pav.):

- *1 etapas.* Listinguojamų bendrovių finansinio stabilumo įvertinimas. Remiantis metodologija, kuri buvo aprašyta 2.4 poskyryje, buvo vertinamos visos akcijos, įtrauktos į pasirinktą kiekvienos šalies akcijų indeksą.

- 2 etapas. Apskaičiuojami kiekvienos akcijos kainos grąžos ir rizikos (standartinio nuokrypio) dydžiai. Akcijos su didesne grąža ir mažesniu standartiniu nuokrypiu vertinamos kaip potencialiai geresnės investicijoms nei kitos.
- 3 etapas. Investicinių objektų identifikavimas. Remiantis pirmojo ir antrojo etapų vertinimo rezultatais, investiciniai objektai skirstomi į stabiliausias bendroves, vidutinio stabilumo įmones, žemiausio stabilumo ir bankroto zonoje esančias įmones.
- 4 etapas. Finansiniai duomenys atnaujinami ir įmonės perskirstomos kas ketvirtį, akcijų uždarymo kainos atnaujinamos kas savaitę.

Būtinai akcijų atrankos duomenys apskaičiuojami naudojant „MS Excel“ programą. Specialiame faile programuojama skaičiuoklė su masyvu formulių, į kurias įkeliami reikiami duomenys (iš įmonių balanso ir pelno nuostolio ataskaitų), tada apskaičiuojami atskirų skaičiavimo etapų rezultatai ir galutiniai rezultatai.

Kaip pavyzdžiai pateikiami Danijos akcijų rinkos vertinimo rezultatai. Atsižvelgiant į apskaičiuotus įmonių finansinio stabilumo rodiklius ir akcijų grąžos bei standartinio nuokrypio (rizikos) vertinimą, Danijos rinkoje buvo pasirinkta 14 stabilių bendrovių ilguoju laikotarpiu (S3.2 lentelė).

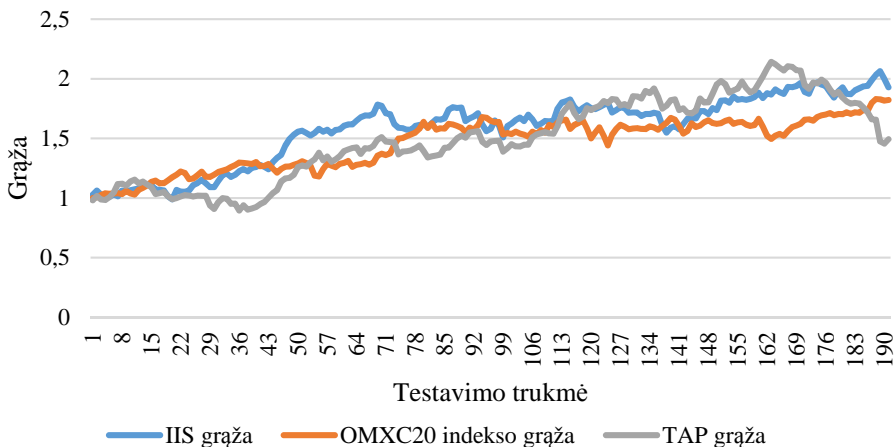
S3.2 lentelė. Pasirinktos bendrovės portfeliui sudaryti Danijos akcijų rinkoje (sudaryta autorės)

Bendrovės pavadinimo kodas	ASREA rodiklis, %	ASRL rodiklis, %	Akcijų grąža, %	Rizika (stdev)
PNDORA.CO	97,72	98,40	91,94	0,6202
MAERSK-B.CO	78,52	90,46	17,30	0,1689
CARL-B.CO	89,24	101,22	43,49	0,1350
GEN.CO	99,53	99,67	457,83	1,9806
COLO-B.CO	76,90	80,18	31,07	0,1086
CHR.CO	99,61	99,65	178,23	0,4825
WDH.CO	95,83	96,50	75,12	0,2553
GN.CO	78,10	82,81	65,38	0,2053
DANSKE.CO	100,33	100,26	112,63	0,3472
DSV.CO	102,15	101,25	181,07	0,5136
ISS.CO	88,75	82,79	38,79	0,2184
JYSK.CO	83,95	83,85	24,03	0,1269
FLS.CO	82,63	90,97	34,46	0,2080
NOVO-B.CO	86,64	96,01	60,38	0,2637

Remiantis trečiu įžvalgos investavimo strategijos etapu (S2.1 pav.), buvo formuojami investiciniai portfeliai ir testuojama įžvalgi investavimo strategija. Remiantis šia schema, buvo formuojami investiciniai portfeliai: investiciniai portfeliai, sudaryti pagal autorės pasiūlyto akcijų atrankos algoritmo rezultatus, ir investiciniai portfeliai, sudaryti pagal akcijų atranką, grindžiamą technine akcijų kainų analize. Šie portfeliai buvo naudojami įžvalgiai investavimo strategijai patikrinti įvairiose vertybinių popierių rinkose. Port-

feliui formuoti atrinkta 14 stabiliausių bendrovių akcijų. Portfelį struktūros buvo paskirtos remiantis adekvataus portfelio teorija ir buvo atliekamas portfelį grįžtamasis patikrinimas, palyginus IIS portfelio grąžą ir riziką su lyginamojo investicijų portfelio grąža bei rizika ir akcijų rinkos indekso grąža ir rizika kiekvienai akcijų rinkai. Visos analizuojamų indeksų sudėtyje esančios akcijos buvo įtrauktos į vertinimą, išskyrus Kipro rinką dėl duomenų nepakankamumo. Paminėtina, kad kiekvienos rinkos keturiolika akcijų buvo atrinkta šiame tyrime, keturiolikos nėra nustatytas fiksuotas dydis, jis gali kisti priklausomai nuo investuotojo poreikių ar rinkos, kurioje formuojami investiciniai sprendimai, specifikos.

Testavimai su istoriniais duomenimis parodė, kad įžvalgi investavimo strategija sugeba prisitaikyti prie skirtingų rinkų sąlygų ir generuoja statistiškai reikšmingai geresnius investicinės grąžos rodiklius 4 metų periodu, lyginant su lyginamuoju indeksu, ir 70% atvejų – lyginant su lyginamuoju investicinio portfelio formavimo metodu. Kaip vieną iš pavyzdžių galima pateikti grįžtamojo patikrinimo testavimo rezultatus Danijos rinkoje (S3.3 pav.).

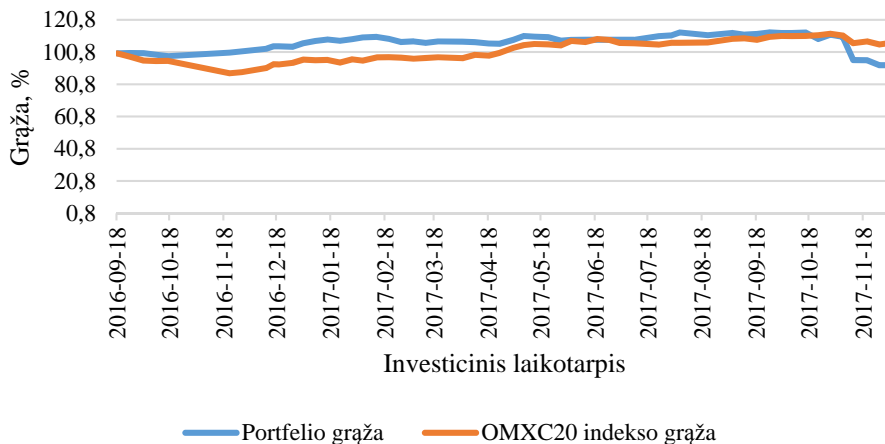


S3.3 pav. Grįžtamojo patikrinimo rezultatai Danijos akcijų rinkoje (sudaryta autorės)

Geriausius rezultatus Danijos akcijų rinkoje rodo investicijų portfelis, sudarytas pagal IIS atrankos algoritmą. Atranka buvo atlikta iš 20-ies OMXC20 indekso komponentų. Pastovus ir stabilus portfelio grąžos augimas gali būti stebimas vertinamu laikotarpiu. Portfelio grąža beveik dvigubai viršija palyginamojo portfelio grąžą su mažesne rizika, portfelio rizika (standartinis nuokrypis) – 0,2862, OMXC20 indekso – 0,2132, palyginamojo portfelio rizika – 0,3479.

Akcijų atrankos algoritmas taip pat buvo testuojamas demonstracinėje prekybos platformoje nuo 2016-09-18 (sprendimai buvo formuojami kiekvieną savaitę). Danijos rinkoje suformuoto portfelio grąža siekia – 9,74 % (mėlyna kreivė), indekso – 6,65 % (raudona kreivė). Portfelio, suformuoto remiantis akcijų atrankos algoritmu, grąža viršija indekso grąžą, tai rodo investavimo strategijos adekvatumą ir efektyvumą realioje rinkoje

(S3.4 pav.). Taip pat svarbu pažymėti, kad apskaičiuota portfelio rizika (standartinis nuokrypis), kuris yra 0,0387, yra maždaug du kartus mažesnis už OMXC20 indekso standartinį nuokrypį (0,0663), todėl portfelio sukaupta investicijų grąža yra didesnė, o rizikos lygis mažesnis nei palyginamojo indekso.



S3.4 pav. Investavimo rezultatai Danijos akcijų rinkoje (sudaryta autorės)

Gauti strategijos grįžtamojo patikrinimo ir realizavimo artimomis realioms rinkos sąlygomis rezultatai leidžia daryti išvadą, kad įžvalgios investavimo strategijos taikymas yra efektyvus. Gauti rezultatai parodė, kad investicinių portfelių, suformuotų remiantis pasiūlytu akcijų atrankos algoritmu, grąža 70 % atvejų buvo didesnė už palyginamojo indekso ir palyginamojo metodo generuojamas grąžas tuo pačiu laikotarpiu bei 50 % atvejų maksimali grąža buvo pasiekama su minimalia rizika.

Bendrosios išvados

1. Atlikta mokslinių literatūros šaltinių analizė parodė, kad globalias finansų rinkas veikia ekonominiai, technologiniai, socialiniai ir politiniai veiksniai, kurie formuoja finansų rinkų elgseną ir lemia investicinės grąžos dydį. Minėtų veiksnių nepastovumas sukelia ekonomines krizes. Nustatyta, kad, siekiant investicinės grąžos tvarumo, būtina nustatyti veiksnius, turinčius didžiausią įtaką finansų rinkų grąžai. Ypač tai svarbu besikeičiančiomis ekonominėmis sąlygomis, egzistuojant tarptautiniams neapibrėžtumams, kai kyla naujų grėsmių akcijų grąžos tvarumui.
2. Būtinumas gebėti analizuoti didelius duomenų kiekius lėmė įvairių verslo analitikos metodų ir priemonių atsiradimą bei plėtrą. Atsižvelgiant į tai, disertacijoje

sukurta įžvalgi investavimo strategija gali būti traktuojama kaip klasikinių metodų papildymas investicijų valdymo srityje ir siejama su gebėjimu patenkinti institucinių investuotojų norą veiksmingai valdyti investicijas. Sistemos gebėjimas kai kuriuose sprendimų priėmimo procesuose pakeisti žmogaus vaidmenį sudarys galimybių pasiekti tvarų rezultatą. Nagrinėjant tvarios investicinės grąžos problematiką, disertacijoje pateikta praplėsta investicinės grąžos tvarumo samprata, apibrėžiant investicinės grąžos tvarumą kaip stabilią investicinę grąžą ilguoju laikotarpiu, atsižvelgiant į rinkos teikiamas galimybes ir besikeičiančias aplinkos sąlygas.

3. Atlikta klasikinių investavimo metodų analizė leido nustatyti, kad pavienių metodų taikymas neužtikrina efektyvaus sudėtingų ekonominių problemų sprendimo, nes pasaulyje yra ypač aktuali didelės apimties duomenų analizė, ko pavieniai metodai nesugeba veiksmingai atlikti, todėl jų integravimas sukuria holistinio tyrimo pagrindą ir suteikia galimybių priimti efektyvius investicinius sprendimus, leisiančius siekti investicinės grąžos tvarumo ilguoju laikotarpiu.
4. Integravus dažniausiai pavieniui taikomus akcijų rinkų atrankos, konkrečių akcijų parinkimo, investicinio portfelio formavimo metodus, buvo suformuota įžvalgios investavimo strategijos schema, kurią sudaro trys pagrindiniai etapai – akcijų rinkų atranka, akcijų atranka ir investicinio portfelio formavimas bei įžvalgios investavimo strategijos testavimas.
5. Siekiant suformuoti akcijų rinkų vertinimo metodiką, buvo atlikta detali poveikio akcijų rinkų grąžai rodiklių analizė, kuri parodė, kad nėra bendro rodiklių rinkinio, kuris galėtų būti naudojamas detaliam akcijų rinkų atrankai, mokslinėje literatūroje yra tiriamas pavienių rodiklių poveikis akcijų rinkų grąžai. Remiantis atlikta plačia moksline analize, 10 rodiklių, turinčių didžiausią įtaką akcijų rinkų grąžai buvo nustatyti: realaus BVP metinis pokytis, 10 metų trukmės vyriausybės obligacijų pajamingumas, vartotojų kainos indeksas, investicinių fondų rinkos dydis, skolos ir BVP santykis, nedarbo lygis, valiutos kurso metinis pokytis, pardavimo vadybininkų indeksas, rinkos kapitalizacija procentais nuo BVP, P/E rodiklis ir leisiančių visapusiškai įvertinti akcijų rinkų patrauklumą investicijoms.
6. Akcijų rinkų vertinimo metodika grįsta ekspertų daugiakriteriškai atrinktų ir įvertintų veiksnių sistema bei tose finansų rinkose veikiančių atskirų vertybinių popierių fundamentalių rodiklių vertinimo sistema leido sukurti įžvalgios ir tvarios investicijų strategijos teorinius pagrindus, taip papildant klasikinius investicijų vertinimo metodus.
7. Išnagrinėjus įvairių ekonominių rodiklių ir akcijų rinkų grąžos sąsajas, sudaryta akcijų rinkų vertinimo metodika, parenkant adekvačius poveikio investicinei grąžai rodiklius (angl. *impact indicators*). Istorinių akcijų rinkų duomenų susistemimas, globalių akcijų rinkų analizė bei daugiakriteris vertinimas leido iš 42 analizuotų akcijų rinkų identifikuoti vertinamuoju laikotarpiu 20 patikimų ir leisiančių siekti investicinės grąžos tvarumo ilgalaikėje perspektyvoje akcijų rinkų: Honkongas, Šveicarija, Norvegija, Kinija, Pietų Korėja, Japonija, Estija,

- Olandija, Rusija, Australija, Austrija, Izraelis, Vokietija, Didžioji Britanija, Danija, Kipras, Čekijos respublika, Didžioji Britanija, Bulgarija ir Švedija. Šios rinkos toliau buvo naudojamos akcijų atrankos algoritmui aprobuoti.
8. Sumodeliuotas integruotas akcijų atrankos algoritmas, sudarantis antrąjį išvalgios investavimo strategijos etapą, kurio pagrindas – akcijų rinkose listinguojamų įmonių finansinio stabilumo (angl. *financial soundness*) ir akcijų grąžos ir rizikos vertinimas, sukuria prielaidas tvarios investicinės grąžos metodologijos formavimui ir kompleksiniam vertinimui. Rodiklių integravimas į algoritmo sistemą leidžia suranguoti įmones į stabilias, vidutinio stabilumo, mažai stabilias ir esančias ties bankroto riba. Tam tikslui buvo papildyta įmonių stabilumo vertinimo metodologija, nustatant kitus galimų reikšmių režius įmonių finansinio stabilumo lygiui nustatyti.
 9. Sudaryta išvalgi investavimo strategija: pirmuoju etapu, taikant akcijų rinkų vertinimo metodiką, kompleksiskai vertinamas akcijų rinkų patrauklumas investicijoms pasirinkti laikotarpiu, antruoju, naudojant akcijų atrankos algoritmą, analizuojami ir vertinami dideli kiekiai istorinių duomenų ir atrenkamos stabiliausias akcijos portfeliumi formuoti. Pasiūlymą patikrinimo metodą, empiriškai patikrinta išvalgi investavimo strategija. Gauti strategijos realizavimo realiomis rinkos sąlygomis rezultatai leidžia daryti išvadą, kad išvalgi investavimo strategija pagrindžia tvarumo sąvoką realiomis rinkomis sąlygomis. Gauti rezultatai parodė, kad investicinių portfelių, suformuotų remiantis pasiūlytu akcijų atrankos algoritmu, grąža 70 % atvejų buvo didesnė už palyginamojo indekso ir palyginamojo metodo generuojamas grąžas tuo pačiu laikotarpiu bei 50 % atveju maksimali grąža buvo pasiekama su minimalia rizika. Galima teigti, kad pasiūlyta išvalgi investavimo strategija sugeba sėkmingai konkuruoti su kitomis panašaus pobūdžio taikomomis metodikomis realiomis investicinėmis sąlygomis.
 10. Formuojant ilgalaikius investicinius sprendimus akcijų rinkose, rekomenduojama: analizei pasirinkti laikotarpį, per kurį ekonomika būtų praėjusi visus verslo ciklo etapus; akcijų rinkų vertinimui naudoti pasiūlytus poveikio rinkoms rodiklius; vertinant emitentų finansinį stabilumą, naudoti ilgesnę duomenų laiko eilutę.

Annexes¹

Annex A. Selected countries for research and their indices

Annex B. Methodology for company's financial stability

Annex C. Normalised data of analysed indicators and countries

Annex D. Selected companies for portfolio formation (using stock selection algorithm)

Annex E. Back-testing results in stock markets

Annex F. Declaration of academic integrity

Annex G. The coauthors agreements to present publications for the dissertation defence

Annex H. Copies of scientific publications by the autor on the topic of the dissertation

¹The annexes are supplied in the enclosed compact disc

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