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THE APPLICATION OF UTILITY FUNCTION FOR INVESTMENT DECISION-MAKING

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Abstract. The authors of the paper pay great attention to the impact of globalization on financial markets, because financial markets are the leaders of the ongoing process of globalization. Due to the increasing number of investors the amount of investments is increasing as well. Moreover, the wide interest of investment is being noticed within the population, companies and even countries. While at the same time the number of investment management companies is increasing in global markets. So, there is a need to prepare the conceptual investment foundations and methods in the global financial markets. The authors suggest using utility function for identification of opportunities offered by the market. The application of utility function allows identify the most suitable markets for investors, evaluating them according to four criteria: utility, profitability, reliability and riskiness. The indicator of utility level, which ranks selected market according to potentially best investment opportunities for investors, is proved plenty efficient.

Keywords: investment, utility, uncertainty, risk, financial market, globalization.

JEL classification: G11, G17.

1. Introduction

Financial markets, the integral component of globalization, which, in turn, is the intersection of variety of reasons and contingencies, for their understanding requires assessment of knowledge and skills of fundamental market behavior under uncertainty.

The large capital of financial markets is a dominant interest in the whole world interest; therefore the globalization process occurs driven by global capital interests (Held *et al.* 2002). The driving force of globalization is the globalization of financial markets, so it is important to adequately recognize the movement of capital forms and motives in financial markets. Capital flows are accompanied by advanced capital solutions and emerging interest of individuals.

Financial markets are the leaders of the ongoing process of globalization. The number of investments is increasing due to the growing scale of investment. What is more, the interest in investments is growing among population, companies and states, while at the same time the number of investment management companies is increasing in global markets. So, there is a need to ensure a sustainable investment return and use the conceptual investment foundations and methods in global financial markets.

The problem of research. The utility function can be one of the potential ways of finding the most suitable markets for investors that are examined by many researchers using a variety of investment models, concepts, studies.

The purpose of this paper – to identify the most suitable markets for individual investors in stock market using the utility function.

The goal of the work can be achieved by setting following objectives:

- to analyse the theoretical aspects of financial markets through the prism of interrelationship and the impact of globalization on the financial markets;
- to identify investment opportunities in different global capital markets, based on investment fund industry practise by using utility function;
- to submit the logical model of financial markets selection for further investments.

The methods of inquiry: the analysis of primary sources data, the study of secondary data and scientific literature, rendering of graphical data and influence, simulation of financial markets, utility function, multicriteria evaluation.

2. Influence of globalization on financial markets

The main mission of financial markets is to open the way for financially active population to actively participate in the management of finance and in making financial decisions.

The significance of financial markets for every financial system of the state is one of the most important because the functioning of other economic sectors depends on its success. Financial markets play the special role of creating the conditions for financial resources to move where their utilization efficiency would be the greatest.

In this way financial markets help to increase the production and its efficiency. Financial markets also affect the welfare of consumers because it allows them to acquire what they need over time. In this case the sources of investment funding would disappear and technical progress as well as business development would stop. So, the opportunity to reduce unemployment or create new jobs would be lost. Stopped technical progress hinders the growth of production volume and all of these things lead to slower growth of the economy (Rutkauskas, Kvietkauskienė 2013).

In recent decades the phenomena of globalization found themselves in the centre of academic community and the public media spotlight. The necessary information for management decisions is accumulated by responsible assessment of positive opportunities and inventorying the causes and conditions of globalization.

Many scientists understand and define globalization as a process, taking place in the social environment and covering the variety of public, state and social structures areas of activity and their environment that occurs with intensification of mutual relationship and movement of time and the flow globally (Kilbourne 2004; Najam *et al.* 2007; Stiglitz 2002).

Beck (2001) puts forward the idea that globalization is not a choice of business, countries or organizations; it is therefore necessary to analyze not only the economic effects of globalization, but also political and cultural. If globalization is compatible with all institutions in each country, then all its influenced results will be unpredictable and unstable, so it is necessary to examine the nature of globalization.

Many researchers (Friedman 2000; Marquardt 2001, 2002) in their works 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 for influence of people's daily lives. This is the core moments of the positive effects of globalization.

However, in another side of the visible and the negative effects of globalization on the lifes of people all over the world are global pollution, international cultural conflicts, and natural disasters.

According to Held *et al.* (2002), the large capital of financial markets is dominant in the interests all over the world; therefore, the process of globalization takes important place in the global equity interests.

Whereas the passing force of globalization is globalization of financial markets, it is important to know the adequate form of capital movement in financial markets. Capital travels are accompanied by innovative capital solutions and emerging individual interests. Therefore, it is particularly important to understand the anatomy of the decision formation in global capital market.

Many scientific works present the arguments which identify globalization as phenomenon which leads to substantial changes in the world and create a new business environment where business or economy entities retake the leading business solutions (Dicken 2009; Held *et al.* 2002; Bhagwati 2007; Moore 2000).

But the main thing is that here you can look for what you can win after cognizable globalization revealed opportunities in financial markets.

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 D. Held *et al.* (2002), submitted thoughts about three main schools of hyperglobalists, skeptics and transformationalists. These schools can not be equated with traditional affinities but the definition of globalization in this work is defined on the basis of each school approach.

Of course, the influence of globalization is more important to the financial markets of developed countries. Increasing impact of financial globalization can promote the imbalance for all the countries of the financial markets and lead to financial crises.

A wide set of indicators to determine the extent and consequences of globalized finance are used. The international financial flows are also mentioned.

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.

Hyperglobalists and skeptics submit their arguments that existence of functioning global capital markets has leaded the equalization of return on financial assets around the world. Various empiri-

cal studies state that in the group of the largest national economies exist global (real) interest rates 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 (Story, Walter 1997).

Globalization is an exclusive feature of modern financial markets because around the world the 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; they also effectively operate with their resources in international markets.

3. The application of utility function to market selection

The selection of multicriteria features and evaluation of opportunities' practical application are very important problems, which particularly receive strong emphasis on mathematics, mechanics and other 'quantitative' sciences. However, the attention should be paid to the problems of social sciences, where a large part of the factors examined only qualitatively and therefore direct analysis of multicriteria causes a lot of questions (Rutkauskas, Stasytytė 2011).

In this work in order to explore and identify the opportunities, offered by the market for investors, the impact of globalization on financial markets of stocks was taken into account and based on the authors' previous researches (Rutkauskas 2000, 2006; Rutkauskas, Kvietkauskiene 2012), considering the approach that the rate of return pertaining to financial assets is a probability distribution of return possibilities.

In order to effectively allocate available resources in financial markets, it is important to identify the opportunities offered by the markets, the profitability and risk level – in this way the markets will be selected where investors, by taking the appropriate level of risk, will receive the complex of utility and reliability.

Risk can be defined as effect of uncertainty on objectives (Hopkin 2010). As it is known, uncertainty is present in financial markets, so investors all the time encounter with uncertainty, and in this case take the risk.

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. Also, 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 (Beckert, Berghoff 2013).

In this case, in order to achieve successful investment decisions, one should appeal to the survival function, which would allow evaluating each opportunity offered by the market by the size of possibility and guarantee of this size. This scheme will enable quicker comparing to other models and methods, review of market opportunities. The choice of useful options for entity is associated with equivalent recovery of utility function.

Whereas the utility is associated with efficiency, reliability and risk, it is possible to invoke the utility function:

$$U = \frac{f(e) \times f(p)}{f(r)}, \tag{1}$$

where f(e) – efficiency, f(p) – reliability, f(r) – risk.

Anatomy of investment portfolio possibilities and technique specifying how to find the possibilities of the highest efficiency is available in Fig. 1.

There are two circumstances that affect the possibility with highest probability and possibility with highest efficiency distribution. It is understood that possibility with highest probability is conditioned of objective market conditions and the possibility with highest utility – it is the entity (market participant) expression of objectives and characteristics. Therefore, the parameters of mentioned layout should be a very important argument in choosing financial instruments.

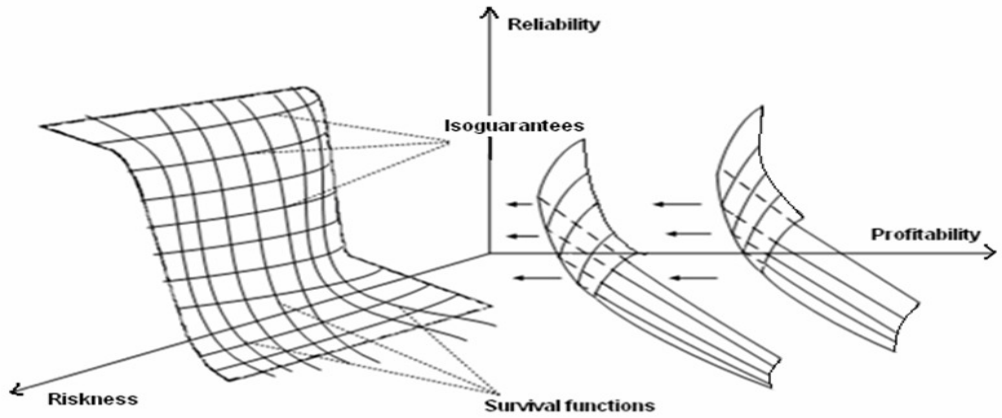

Fig. 1. The general view of three-dimensional efficient surface and respective utility functions (Source: Rutkauskas, *et al.* 2013)

In this work, return p of asset ξ during the period *t*, starting at the moment *t*, asset value during the period τ ratio of the value of the underlying security moment *t* setting the model was chosen as setting model:

$$P_t = \frac{\xi_{1+t} - \xi_t}{\xi_t}, \quad (2)$$

Relative size P_t, where all members have the same changes in the course of time, should generate asset prices using market data and comparable with each other indicators that allow obtaining an objective estimate of the underlying security returns over a long period of time. Utility function N with individual possibility can be identified by the product of the size *x* of the possibility and the guarantee, measured by the survival function *P* $\{\xi > x\}$:

$$N(x) = x \times P, \quad (3)$$

where $P\{\xi > x\}$ – survival function.

Further market analysis can be continued in view of already existing markets possibilities probability distributions. Since the possibilities probability distribution and utility function of each market shows only what the market offers for investors and what is useful, but not necessarily the option with the highest probability that is most useful, it should be examined to find which option is the best according to its size and guarantee.

In order to select the utility function which is actually the most useful, it is necessary to take into account the profitability and reliability. Utility function depends on the efficiency and reliability, and reliability is associated with risk, so from the available data the so-called survival functions are calculated and plotted.

On the basis of calculations and diagrams each market can be ranked according to the investor's utility function approach.

It is possible to evaluate all of the selected markets taking into account all the criteria of utility functions: efficiency, profitability reliability and riskiness. However, it is sufficiently difficult to classify markets into more or less attractive for investors seeing the final results.

In order to identify the most attractive market for investor the authors decided to use multiple criteria method, which has the advantage for summative indicator, combining both maximizing and minimizing indicators that are expressed in various dimensions. Such combination is possible due to the normalization, when all indicators transform.

In all cases the normalization is done in corresponding way by using the values of phenomenon alternatives, such as the indicator *i.* Currently, there is a lot of the same variety multiple criteria (both qualitative and quantitative) assessment techniques (Hwang, Yoon 1981; Hwang, Lin 1987; Ustinovičius 2001).

Qualitative methods, which are based on experts' opinion, establish one of the best of proposed alternatives, or several of the best alternatives. Quantitative methods quantitatively evaluate every alternative and determine the differences between the valuable alternative (Ginevičius *et al.* 2008; Ginevičius, Podvezko 2007; Podvezko 2006; Ustinovičius 2001; Hwang, Yoon 1981; Hwang, Lin 1987; Zavadskas, Kaklauskas 1996).

SAW method is one of the qualitative methods, which will be used for further evaluation of market indicators (utility, reliability, profitability, riskiness).

SAW (Simple Additive Weighting) method the most obviously describes the meaning of multicriteria evaluation (Hwang, Yoon 1981):

$$S_j = \sum_{i=1}^{m} \omega_i \overset{\approx}{r}_{ij}, \quad (4)$$

where ω_i – weight, according to importance, r_{ij} – the value of indicator.

4. Model of appropriate financial markets selection for investment decisions

Every stock market is closely related to the country economy; therefore the development of its relationship with the country's economic development is reciprocal, because the general improvement in the economic situation has done the stock market more active. On the other hand, the development of the securities market accelerates the country's economic growth. It is estimated that after a fall in stock prices we can expect economic stagnation and vice versa – rising stock prices is a sign of potential growth.

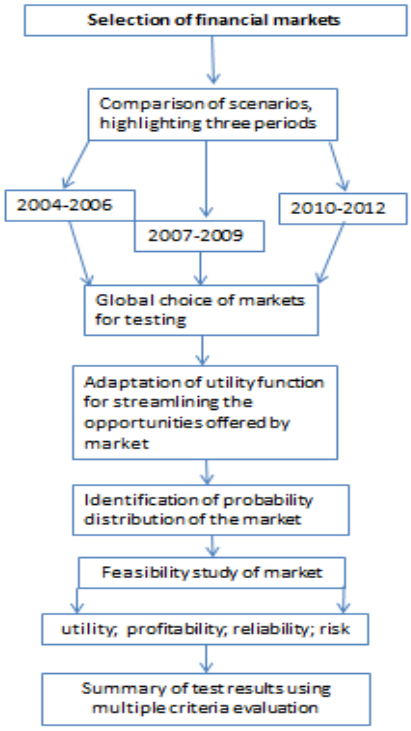

Fig. 3. The model of appropriate financial markets selection (source: compiled by authors)

The view that the behaviour of financial markets can deal with country economic conditions is widely known. Financial markets show the companies' opinion about the behaviour of national economy in the near future as the most directly exposed, i.e. stock prices, are caused by investors' expectations. For that reason changes in the stock price usually are examined, as they reflect the changing economic situation.

Therefore investors frequently change their movement direction of the shares not only observing the equity markets, but also the macroeconomic situation in the country: followed policy of Federal Reserve Bank, public speeches by Central Bank representatives, forecasts of World Bank, even the problems in Greece have influence on stock market situation and investor decisions.

In order to develop a conceptual framework for investment decisions in global financial markets of stocks, it is important to establish a logical model for market selection.

The authors have developed a scheme, according which it is possible to analyse the issue of the market value and to select markets using the utility function. Short description for each phase of model (Fig. 2):

- **Comparison of scenarios, highlighting three periods.** The aim of this phase – to choose the long period for market analysis, dividing it into three different market corrections: stable market period, the recession and the period of market growth after economic crisis.
- **Global choice of markets by specific criteria** represents the financial market selection and identification based on the effects of globalization on financial markets.
- **Adaptation of utility function for streamlining the opportunities offered by the market**. The aim is to determine the possibilities offered by the market for investor, by using modelling of financial markets.
- **Identification of probability distribution of the stock prices in the market.** It is important to identify the possibilities' probability distribution that will be the ground for further market analysis – determining the survival and utility function.
- **Feasibility study of market**. The application of survival function should allow assessing the opportunities offered by the market.
- **Utility, profitability, reliability, and risk**. These indicators should be identified at the time of evaluation of utility function. It should be done by the ranking of markets, processing and assessing the utility, reliability, profitability and riskiness.
- **Summary of test results using multiple criteria evaluation.** The aim is to choose the multicriteria evaluation method that would allow rationally grouping and assess the previous estimates.

This model allows analysing the issue of the market value and selecting markets that may potentially generate the investment return.

5. The process of market selection

5.1. Market analysis comparing different investment cycles

The thesis that stock prices mimic rises and falls in the business cycle can be strongly supported. With few exceptions, research shows that stock prices

lead the level of economic activity (Dzikevičius, Vetrov 2012).

The accuracy of historical data analysis depends of the selected period. The periods of market corrections were chosen for detailed analysis. A 9-year period was selected and divided into three market sub-periods:

- 2004 – 2006 years (the period with small fluctuations). The economy of 2004 year was one of the best since 2000, new workplaces were created, the S & P 500 index has grown, not only economic indicators have improved, but also investment, stock market has grown. 2006 year was a year of economic boom (very high economic growth).
- 2007 – 2009 years (the explosion of the largest economic boom and financial recession period). The year 2007 was a bit calmer, the economic upswing has slowed, as well as the trading in stock markets, while the public recession of United States has already started in December, and many countries were already included globally in 2009. Underlining the equity markets, it may be noted that even in the middle of 2007 the Dow Jones index increased to 14.164, while in March 2009 it lost more than 50% of market value (its value dropped to 6.600). Such sudden decline in two years was experienced not only by this market, but also by most of the others, as well as by the entire world economy.
- 2010 – 2012 years (the period of markets growth after economic crisis). In 2010 the global economy showed the first signals of recovery, applied measures lead the stabilization of economy. Reviewing the year 2012 in the financial markets, it is possible to make the following insights: this year has been a relatively good year for returns. The equity indices of the major countries of the world have managed very acceptable gains – the UK 6.5%, the US 12.5%, Europe 13.5%, Japan 10%, Hong Kong 22%. Asian equity markets, except for China, once again delivered the best returns for global investors.

The choice of such periods was influenced by adequate decision-making logic. In the first stage the stock markets are selected, i.e. their indices are compared with each other in three different periods. Markets were chosen globally.

In order to embrace the markets globally, the American market has been tested in the first stage of selection, but it is not appropriate to compare and evaluate the markets due to a very large market capitalization differences. It is also very difficult to measure the financial effect, because S&P index also contains the rest of the other markets' listed shares.

5.2. Analysis of different markets

Compared among themselves, based on measured profitability and the degree of risk, the following markets will be evaluated: Japanese, United Kingdom, French, German, Australian, Hong Kong, Korean, and Switzerland.

These markets were assessed in three different periods: 2004-2006, 2007-2009 and 2010-2012.

In order to identify markets, potentially suitable for investment, an average of profitability and risk (standard deviation) was calculated for each market in 2004-2012 years period (Table 1):

Table 1. The average profitability and riskiness during 2004-2012 period, based for research criterias (source: compiled by authors)

Market	Profitability	Risk (st. deviation)
United States	2,07%	0,118
Japan	-5%	0,161
United Kingdom	1,55%	0,111
France	-3,29%	0,151
Germany	7,93%	0,166
Switzerland	-1,24%	0,188
Hong Kong	4,11%	0,146
Korea	18,79%	0,186

First of all, a situation can be observed stating that annuall profitability completely does not correlate with market capitalization, which means that higher market capitalization does not mean higher profits. Thus, if investors prefer markets with higher investment capitalization, such behavior is not always rational.

The evaluation of these results allows doing such assumptions:

1. South Korean market was the most profitable market among all appropriates, but the level of risk was also the highest among all markets during the analysed period.
2. Switzerland market was the most risky market and had the negative profitability during the analysed period.
3. As the results show, the German market was the most reliable during the analysed period.

Based on the analysis of markets, the most suitable markets for investment according to profitability and risk have been identified: German, United Kingdom and USA markets. The analysis of investment funds' results during 2012 years showed where the largest part of capital is transferred. So, the largest part of investment is trans-

ferred to the United Kingdom, German, French and Swiss markets. Preliminary investment markets established for both phases are almost the same markets.

5.3. The adaptation of utility function for streamlining the opportunities offered by selected global markets

In order to explore and identify what opportunities are offered for investors by the markets, the impact of globalization on financial markets was taken into account and it was based on the previous conducted research (Rutkauskas, Kvietkauskienė 2012), based on the view that assumption of the financial rate of return on assets is the possibilities' probability distribution.

The modelling of financial markets (optimization of utility function) has been used in this stage of financial markets' analysis. The historical data (closing price of market index) of markets and the percentage data of weekly changes were used for markets' testing by Simulation programme.

The maximum utility possibilities of all markets and possibilities that have the biggest probability in distribution have been described (i.e. obedient to) with sufficient accuracy and reliability by the following continuous and discrete probability distributions: Gumbel, Potency, Inverted Gamma and Entire Uniform (Table 2).

Table 2. Probability distributions of the markets (source: compiled by authors)

Market (index)	Probability distribution
USA (S&P 500)	Inverted Gamma (0.04, 2.00)
Germany (DAX)	Inverted Gamma (0.06, 2.00)
France (CAC 40)	Inverted Gamma (-11.0000, 11.0000)
Switzerland (SSMI)	Gumbel (0.30, 1.03)
Japanese (N225)	Entire Uniform (-10.0000, 6.0000)
Korea (KS11)	Entire Uniform (-12.0000, 6.0000)
United Kingdom (FTSE)	Entire Uniform (-10.0000, 8.0000)
Honkong (HIS)	Gumbel (0.38, 1.44)

The utility function has been used for markets' analysis. The application of this function will allow asses the opportunities, offered by market, according to opportunities, which are provided by the guarantee.

Table 3 Analysis of market indicators, evaluating their utility, reliability, profitability and riskiness (source: compiled by authors)

	2004-2006	2007-2009	2010-2012	2004-2006	2007-2009	2010-2012	2004-2006	2007-2009	2010-2012	2004-2006	2007-2009	2010-2012
Index	**Utility**			**Reliability**			**Profitability**			**Riskiness**		
S&P 500	14	20	27	1.42	0.62	1.49	1.27	3.2	1.8	0.16	0.1	0.1
CAC 40	18	10	28	1.06	0.25	1.07	2.72	5.15	8.34	0.16	0.13	0.32
DAX	16	18	26	3.51	0.29	1.59	0.63	6.17	1.88	0.14	0.1	0.15
FTSE	12	13.25	25.5	1.39	0.31	1.08	0.43	4.2	7.06	0.05	0.1	0.3
HIS	12,5	34	18	1.38	1.06	0.98	0.36	9.58	3.1	0.04	0.3	0.17
KS11	22,5	20	22	2.37	0.38	1.18	0.56	6.22	4.06	0.06	0.12	0.22
N225	16	10	20	1.6	0.37	1.13	0.5	2.69	3.51	0.05	0.1	0.2
SSMI	14	8	18	1.57	0.3	1.11	0.89	3.94	2.43	0.01	0.15	0.15

It is necessary to take into account the profitability, reliability and riskiness in order to select the utility function, which is actually the most useful.

According to the calculations, every market can be ranked due to the utility function from the investor point of view (Table 3).

However, there is a problem of assessing numerical expressions obtained by the research (2004-2012 period) and choosing the most advantageous and most promising markets for investor. Therefore, there is a need to approve the obtained results using multicriteria evaluation methods. Authors use SAW method (see (4) formula) for market assessment. It was assumed that all indicators (utility, reliability, profitability, riskiness) are equally important; each weight is equal to one.

Table 4. Assessment indicators of markets, evaluated by SAW method (source: compiled by authors)

Index	Utility	Index	Reliability	Index	Profitability	Index	Riskiness
HIS	64.5	DAX	5.39	CAC 40	16.21	SSMI	0.31
S&P 500	61	KS11	3.93	HIS	13.04	N225	0.35
DAX	60	S&P 500	3.53	FTSE	11.69	S&P 500	0.36
CAC 40	56	HIS	3.42	KS11	10.84	DAX	0.39
FTSE	50.75	N225	3.1	DAX	8.68	KS11	0.4
N225	46	SSMI	2.98	SSMI	7.26	FTSE	0.45
SSMI	40	FTSE	2.78	N225	6.7	HIS	0.51
KS11	22	CAC 40	2.38	S&P 500	6.27	CAC 40	0.61

After processing the previously received market test results (Table 3), using the SAW method, the following generalizations can be done (Table 4):

1. Hong Kong, USA and German markets can be assessed as the most attractive to the investor by utility indicator. The utility

indicator of Korean stock market is the lowest compared with other markets.
2. The German market is the most reliable, the least reliable – French market.
3. The German and Japanese markets are the safest and generate stable investment return, evaluating markets according to profitability and risk level.
4. The evaluation of four criteria: utility, reliability, profitability and riskiness, allows distinguishing the two most attractive markets for investors – Germany and the USA.

6. Conclusions

1. Investment should be seen as very responsible financial transaction with the future of entity, country or region. Enforcement of this transaction must remain to financial markets, institutions, which may direct for entities investment social and economic balance through the interests of investors. Either financial market should guarantee a rational utilization of the resources for the future.
2. Considering the attributes of market globalization, the markets of Japan, United Kingdom, French, German, Australian, Hong Kong, Korean, and Switzerland was selected for future analysis. The appropriate market analysis was done evaluating the capitalization of markets, profitability and risk, given short insights. The German market can be assessed as the most reliable among appropriate markets.
3. The level of utility indicator was sufficiently effective and ranks the selected markets by potentially best investment opportunities for investors on the basis of different cycles in the market. The application of utility function taking into account the reliability, utility, profitability and risk, has led to a more sustainable financial investments result in financial markets during the periods of market corrections.
4. Based on results of utility, profitability, reliability and riskiness indicators, the German, French and USA markets can be selected for further investment.
5. The created model allows to analyse the data of markets in long period and to select the potentially best markets for investment according to reliability, utility, profitability and riskiness.

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