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**RETURN-BASED STYLE ANALYSIS AND ITS
APPLICATIONS IN CASE OF GLOBAL DEVELOPED
EQUITY MUTUAL FUNDS**

Master's Thesis

Supervisor: Lecturer Fabio Filipozzi

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I declare I have written the master's thesis independently.

All works and major viewpoints of the other authors, data from other sources of literature and elsewhere used for writing this paper have been referenced.

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ABSTRACT

The title is: Return Based Style Analysis and its Applications in Case of Global Developed Equity Mutual Funds

The characteristics of compositions of eighteen Global Developed Equity Mutual Funds were identified using the Return-Based Style Analysis technique in order to evaluate funds and their differences from benchmark and to recognize the sources of outperformance.

The findings suggest the following: 1) in general, results show that RBSA method is applicable for the Global Developed Equity Mutual Funds; in specific periods (such as economic downturn) the explanatory power of the regression model decreases and therefore it can be useful to pair RBSA with an alternative model, as for example the Holding-Based Style Analysis; 2) by using RBSA model it is possible to differentiate periods when benchmark and/or fund managers are changing; 3) RBSA can be useful to discover the sources of under/outperformance of mutual funds. In the case of the eighteen funds analyzed, both style drifts and market timing explain the relative performance of different funds.

Keywords: Holdings-Based Style Analysis, Return-Based Style Analysis, Global Developed Equity mutual funds, fund categorization, multicollinearity.

INTRODUCTION

In the last years Information Technology has developed significantly, up to the point that people can trade securities without leaving their homes, simply using an Internet bank service or some special trading platforms from their home computers. Investment education is also more available nowadays and therefore people understand that risk diversification, aversion, investment portfolio and style are not just terms from other universe, but necessary elements of investing.

In this thesis attention is paid to the style analysis techniques, what are used by institutional investors, in order to understand what types of investments they are buying and how they fit into their existing portfolios, to classify, purchase or construct managed investments and to monitor them for style drift. Style analysis is also used for constructing peer groups and for selecting appropriate style specific benchmarks.

This is a topic that should be of interest for most people who let mutual funds handle their personal wealth or pension liabilities, as this techniques help to determine the impact out of benchmark investments (which are usually used by fund managers in order to increase the return) as well as the impact of market timing (investor's ability to identify the best times to be in the market and when to get out). These techniques help investors to make a more informed and considered decision when choosing funds.

The aim of this master's thesis is to develop a model, what describes the return of mutual funds using one of the style analysis methods (Holdings-Based Style Analysis (hereafter HBSA) or Return-Based Style Analysis (hereafter RBSA)), which are used to identify and describe the characteristics of an investment portfolio, to evaluate funds and their differences from benchmark and to recognize the sources of outperformance.

According to the main topic the author also tries to find out answers to four subtopics.

First, the author tries to find out the best combination of indices that describes fund return. Secondly, to evaluate the added value of the fund manager. Thirdly, to identify how consistent are the fund managers in using the same benchmark. Finally to ascertain different mutual funds style drifts.

Style analysis in Program R (a language and environment for statistical computing and graphics) are carried through in order to find the answers and confirmations to all these topics.

As there is a large range of different mutual funds and this thesis has only limited capacity, the author has decided to choose specific asset class. For this—thesis Global Developed Equity mutual funds (may contain small part of Emerging Market) are chosen.

In this study two main style analysis methods (Holdings-Based Style Analysis and Return-Based Style Analysis) are examined and compared. One of them, which is less costly, is simple to use and still gives reliable results, is chosen for testing Global Developed Equity mutual funds.

The thesis is divided into four main parts. In the first of them, the main theoretical concepts of HBSA and RBSA approaches, their pros, cons and limitations are presented.

The model and key assumptions of techniques selected based on the information in the first chapter are presented in the second chapter. The main limitations of the method are thoroughly analyzed and several solutions to improve confidence are presented.

In the third chapter empirical analysis is done, where a description of different filters is applied for selection of mutual funds. Also there was made a selection of indices representing the asset class and made a multicollinearity test, to verify, that the selected indices are appropriate for RBSA analysis.

Finally, in the fourth chapter RBSA graphs for analyzed funds are presented, as well as main results, findings and issues for further research.

The author wants to thank her colleague Lehar Oha (Senior Analyst at Swedbank AS) who provided the necessary data for analysis and helped with developing the rolling RBSA analysis in program R. The Author also wants to thank her supervisor Fabio Filipozzi for all the instructions, remarks and advice, which helped her to write current thesis.

All the mutual funds and indices data used for 60-month rolling RBSA, as well as the R model, are attached on a CD.

1. STYLE ANALYSIS TECHNIQUES

Before defining “style analysis” it is necessary to understand what “style” is. CFA glossary defines style as: “A natural grouping of investment disciplines that has some predictive power in explaining the future dispersion in returns across portfolios”.

According to Fung and Hsieh investment style consists of three elements: 1) strategy (shows how long and short security positions are combined, to reflect the strategy’s objective), 2) location (tells us which assets the strategy is applied to) and 3) risk management (2001, 5). Style refers to how these positions are levered and managed. So investment style is the dominant principle used to classify, analyze, and to build up investment portfolios.

According to Jeremy Siegel style investing refers to "rotate between small and large and value and growth stocks“ (1998, 103). But in real life there are not only small, large, value or growth investment styles, there are only general agreements, which state that a range of differing investment styles does exist and despite similarities between descriptions of investor types, there is no uniformly accepted classification of equity styles. And those, which are most commonly used, allow a wide range of strategies to be employed under the broad umbrella of their classification (see for example Brown, Goetzmann 1997 and Chan *et al* 2002).

“Style analysis is an attempt to explain the variability in the observed returns to a security portfolio in terms of the movements in the returns to a series of benchmark portfolios designed to capture the essence of a particular security characteristics such as size, value and growth” (Equity and ..., G-34).

Style analysis is most frequently used when individual investors wish to determine a portfolio’s style independently, to be able to understand what type of investments they actually buy and how these fit into their portfolio. But it is also used by money managers and financial advisors to monitor investments, to verify whether the investment managers remain true to their intended style or sees better opportunities elsewhere, or are using more risky asset classes in order to get a higher return.

It is necessary to identify which style a manager use for creating a diversified portfolio. Only a few investors put all their money into a specific equity. Instead they combine different investment styles and they build up a portfolio tilted to the some particular style, which is not very far from chosen benchmark. For example in case of Global Developed Equity portfolio one possible benchmark would be MSCI World Index.

Another objective for identifying manager style is to determine, whether he is worthy to be paid a management fee or not. And he is worth, when he has a skill and in order to get to know if he has such a skill, it is necessary to find proper benchmark for the manager and to compare manager's portfolio performance against the chosen benchmark. If manager has a skill, then the net performance of the portfolio will be quite similar to the benchmark's performance. Some very good and skilled managers may outperform the market and have return even over the benchmark.

To determine a manager's style it is necessary to analyze the assets that the manager has in his portfolio. So we need to use style analysis. Style analysis is a method, which helps to identify and describe the characteristics of an investment portfolio and to determine what type of investment behavior the fund manager applies when making investment decisions. On the basis of the identified characteristics, style analysis shows that a portfolio manager follows a certain investment style.

There are two main methods for analyzing portfolio style: the first one is the Return-Based Style Analysis (hereafter RBSA) and the second is called Holdings-Based Style Analysis (hereafter HBSA). Between proponents of these two approaches there has been much debate, most of which has focused on the relative accuracy of these two methods in describing a fund's allocation among asset classes or equity styles (see for example Buetow *et al* 2000 and Rekenhaller *et al* 2004).

In this master's thesis these two approaches are explained and compared in the following chapter and only one of them, which is less costly, is simple to use and still gives reliable results, is chosen for testing Global Developed Equity funds.

1.1. Holdings-Based Style Analysis

Holdings-Based Style Analysis (hereafter HBSA), is called a "bottom-up" approach, because it is based on the underlying assets amongst a given portfolio and it consists out of

analyzing each security of analyzed portfolio. All the securities are studied and ranked according to the different characteristics that allow their style to be described and after that, in order to obtain the whole style of the portfolio, the results are aggregated at the portfolio level.

To perform this kind of analysis two sets of data are needed:

- 1) security database that contains the characteristics of each security being analyzed,
- 2) a record of the security holdings of each fund being analyzed.

Each database must contain the requisite data for each time period being studied. On the basis of these aggregated datasets of underlying securities, the HBSA identifies the characteristics of a certain portfolio. For this reason, HBSA is often referred to as “fundamental” or “compositional” analysis (see for example Rekenhaller *et al* 2004 and Dor, Jagannathan 2002).

The databases needed to perform Holdings-Based Style Analysis are expensive to obtain and keep up to date. Because of this, there are only few investment research firms that have the needed datasets and perform Holdings-Based Style Analysis. One of such firms is Morningstar Inc. (an organization that deals with the identification of a fund investments, more information on their website www.morningstar.com), which has developed a so called “Style Box” that provides a good summary of how investment style of different funds can be estimated.

However Holdings-Based Style Analysis has many critics as well.

1.1.1 The difficulties with Holdings-Based Style Analysis

Le Sourd (2007) states in her article that Holdings-Based Style Analysis suffers from three fatal errors, which are listed below:

1. HBSA requires a lot of data, which is usually complicated to provide. Style analytics need to have an access to reliable and representative information of the fund’s investment policy concerning the fund composition. This information needs to include the list of assets, that the fund is made up of and their respective weights. The portfolio composition should be known throughout the whole analysis period, not just from the beginning. Furthermore, this information must be updated monthly, in order to get the latest data for the portfolio. In most cases, the information available is only partly updated and is provided at an annual

frequency. There is another obstacle in making fund analysis: portfolio managers usually prefer to keep the details of their portfolios, either for practical reasons or because they want to keep this information confidential and therefore refuse to provide to external agencies all the details regarding fund's composition and weightings. If there is no database available for all portfolios with all information on their holdings at monthly frequency, then the HBSA method will provide inferior result and could not be used.

2. Even if complete information about the fund holdings is available, another problem arises: the methodology requires that the style characteristics (such as value-growth and market capitalization (small, mid, large)) of each security is identified. But numerous studies, such as Lucas and Riepe (1996) and Chan *et al* (2002) have highlighted the difficulty in classifying securities according to their characteristics. For example, if a domestic mutual fund invests in stocks, which get their revenues from selling goods to foreign countries, then they are influenced by foreign countries. And if these foreign countries suffer under recession, then the domestic fund will be affected. In this way, domestic fund responds to the same factors as international equity fund does. This situation makes it difficult to identify which style characteristics should be applied.
3. The third problem Le Sourd (2007) points out is more a problem of rating agencies than of the HBSA method, however it has to be taken into account when choosing between different methods. Most of the time, after collecting and analyzing fund holdings, the rating agency consolidate their results into different style categories. HBSA method makes it possible to identify the risk of each position in the funds and based on that they gather funds into broad categories to make a comparison. But sometimes a portfolio does not contain purely one style (growth or value, large cap or small cap), but has something in between. Also, the rating agency has to put the fund into a specific category, where is impossible to consider the specific risk taken by the fund. This reduces potential accuracy of the risk approach previously adopted. As a result, the comparisons between the funds that belong to one of these categories are not reliable, as these funds may have differences in some of their characteristics.

Despite all the critics there are many studies, such as Kaplan (2003), Rekenhaller *et al* (2004), which confirm that HBSA method generally produce more accurate results and allow for deeper style analysis, than RBSA method, which is presented in following chapters.

1.2. Return-Based Style Analysis

Returns-based style analysis was first introduced by William F. Sharpe in two articles “Determining a Fund’s Effective Asset Mix” in 1988 and "Asset allocation: Management style and performance measurement" in 1992. Sharpe originally used the terms “effective asset mix” and “attribution analysis” describing his methods. But nowadays the term “Return-Based Style Analysis” is used to describe the Sharpe’s method.

Sharpe defined his model as following: “The use of quadratic programming for the purpose of determining a fund's exposures to changes in the returns of major asset classes is termed style analysis” (1992).

RBSA is a mathematical optimization technique that estimates a combination of predetermined benchmark indices, which most closely replicate the actual performance of a fund over a specified time period at best. The combination of indices that are obtained as a result is called style benchmark.

Due to the importance of style analysis and relative inexpensiveness of returns data, RBSA model is largely used among institutional investors and consultants. For example Zephyr Associates Inc was the first company, which implemented RBSA in their software (more information about the company and their software on website: www.styleadvisor.com).

According to Lucas and Riepe the biggest strengths of RBSA are the following: it requires only return data, which can be easily obtained from the external sources and it is less costly and can be conducted more quickly as it is based on a more timely information (1996, 8).

1.2.1 The difficulties with Return-Based Style Analysis

RBSA same as HBSA method has also a number of problems, which came out during different researches and analysis. The most relevant are presented below.

1. The main concerns are related to multicollinearity between indices and asset classes. According to DeFusco *et al* “multicollinearity occurs when two or more independent variables (or combinations of independent variables) are highly (but not perfectly correlated with each other” (2004, 473). And according to Pattarin, *et al* the significance of any results are questionable, if indices used in style analysis are highly correlated (2004, 362).
2. There is made an assumption that style exposures stay constant over the sample period, but it is not a case in practice (Lucas, Riepe 1996, 16-17).

Lastly, Buetow and Ratner (2000) found that RBSA is not a good technique to determine the actual holdings of a portfolio. They used RBSA technique with different funds (such as Vanguard Aggressive Growth Fund, Fidelity Low-Priced Stock Fund, Ariel Appreciation Fund, Fidelity Mortgage Securities, T. Rowe Price Equity-Income Fund, Putnam New Opportunities Fund) and their findings: “...show conclusively that the RBSA results do not represent the holdings of portfolios accurately.” They further claim: “...using RBSA approach without fundamental analysis results in gross miscalculation of assets.”

But Atkinson *et al* found that much of the fundamental data used by Buetow and Ratner was incorrect. In two cases (Vanguard and T. Rowe Price) they demonstrated “...even with R&B’s large palette and poor selection of indexes, we could get good results if we simply used the proper optimization model (adjusted R^2)” (2001, 12). Buetow and Ratner used the standard model instead, which is generally appropriate for only five or less indexes (in Buetow and Ratner’s model there were 10 indexes).

In case of Vanguard, Fidelity Low-Priced, and Ariel funds Buetow and Ratner used inaccurate fundamental information. There were two mistakes:

- 1) poor index selection – according to Sharpe indices have to cover the universe of selected stocks and optimization model, in their research they did not,
- 2) using not proper optimization model.

Atkinson *et al* (2001) have demonstrated that with the proper index selection and the proper optimization model, RBSA gives very accurate results, which can be confirmed by correct fundamental information.

1.3. HBSA versus RBSA

Taking into account all advantages and disadvantages of two previously presented methods the author of this thesis will choose one method, which she will test on Global Developed Equity mutual funds.

From a theoretical point of view, the HBSA method seems to be better. The analysis results are in correspondence with the portfolio's characteristics, which is held by the money manager, and therefore liable to influence his future performance. But on the other hand, HBSA method requires more information about the portfolio than the RBSA does and it will obtain more accurate information, as long as the data is reliable and exhaustive. Therefore it appears, that the main problem for this methodology is data availability.

Furthermore, the main weakness of the HBSA method is that the character of the classifications is often subjective. Since the style analyses performed within this approach are specific to each manager, it is difficult for them to be reproduced by an external third party.

RBSA has an obvious strength - it requires only reliable return data of the funds studied and not the actual allocation at every point in time. This makes the analysis a lot less time-consuming and costly, since the analyst can avoid collecting holdings data for every mutual fund in the sample, data that is perhaps not always available on a monthly basis or unreliable.

From a practical point of view, it is better to run the risk of statistical error (which may appear with RBSA) than to rely on a manager's stated investment style he declares or put into the fund's name (which is needed for HBSA analysis). This problem has been pointed out by diBartolomeo and Witkowski (1997), who found that 40% of the funds studied were in a category other than the one declared.

As previously in this thesis was mentioned, the style of a fund may not be stable over time, so the category in, which the fund is classified, may differ from its current style category. Kim *et al* (2000) study shows that only 46% of the 1043 funds they considered had investment attributes that were consistent with the fund's stated objectives, while 54% of the funds were misclassified. Over one third of the funds were severely misrepresented. Over the three-year period covered by the study, 57% of the funds that survived changed their investment style at some point and only 27% of funds held their investment attributes throughout the period.

Taking into account all previous pros and cons of both methods, the author decided not to choose the HBSA method, as it is time consuming and expensive (as it requires a long history of all the stock holdings to perform holdings-based analysis), and becomes increasingly difficult when trying to determine a manager's style over multiple time periods. It would be quite complicated to get all the necessary information for testing Global Developed Equity funds with HBSA method. Therefore the author decided to choose Return-Based Style Analysis, because any potential problems with categorizing holdings and funds incorrectly are avoided, which is a positive characteristic of the method. RBSA is cheaper and takes less time to reach required result.

In chapter 1.2.1 several problems of using the RBSA method were presented. But almost all of them could be controlled by several techniques. For example the presence of multicollinearity between indices can be examined by a cross-correlation indicator, which makes sure that the relative influence of each style index is faithfully determined and will grant robustness to the results, by obtaining coefficient estimates that are not sensitive to the sample of data used.

There are also numerous statistical tests, which can help to improve confidence in RBSA results. For example, Lobosco and diBartolomeo (1997) have developed a test, which makes it possible to examine whether the regression coefficients, such as the portfolio weights for the style indices, are significant. The adequacy between the fund's returns and the benchmark's returns can be controlled with the adjusted R-squared. The higher the adjusted R-squared coefficient is, the greater the ability of the passive style portfolio is, i.e. the customized benchmark, to explain the fund's performance. If this coefficient of determination is lower than an acceptable threshold, it means that the analysis has to be performed with another set of style indices that is likely to provide a better representation of its investment style.

Finally, the main shortcoming of RBSA is that the fund style is assumed to remain constant during the analysis period. But also this problem can be circumvented in several ways. One possible method is performing rolling regression over successive sub-periods to get the evolution of fund style throughout the whole period. Another was proposed by Swinkels and Van Der Sluis (2002) who used Kalman filter in their research, consists in explicitly incorporating style changes in the model to get dynamic style exposure throughout

the whole period. This will considerably improve the accuracy of style exposures for funds, which tend to change their style over time with relatively high frequency.

2. RETURN-BASED STYLE ANALYSIS METHODOLOGY

2.1. Sharpe's original RBSA model

The original model proposed by Sharpe has following equation:

$$R_i = [b_{i1}F_1 + b_{i2}F_2 + \dots + b_{in}F_n] + e_i, \quad (1)$$

where:

R_i = the return on asset i ,

F_{i1} = the value of factor 1,

F_{i2} = the value of factor 2,

F_{in} = the value of the n 'th (last) factor,

e_i = the "non-factor" component of the return on i ,

remaining values (b_{i1} through b_{in}) = the sensitivities of R_i to factors F_{i1} through F_{in} .

And the key assumptions of Sharpe model include:

- the non-factor return for one asset (e_i) is assumed to be uncorrelated with the non-factor return component for any other asset (e.g. e_j). In effect, the factors are the only sources of correlation among returns,
- the sensitivities to factors (b_{i1} to b_{in} values) are required to sum to 1 (100%),
- short selling is prohibited ($b_{i1}, b_{i2}, \dots, b_{in} \geq 0$).

In Sharpe's (1992) original analysis where style analysis was performed for 395 funds (4 utility funds, 161 growth equity funds, 118 growth and income equity funds, 34 small stock funds, 19 balanced funds, 54 bond high-quality funds and 5 convertible bond funds) he used a wide range of asset classes, including four U.S. equity indices (see Table 1) as the independent factors in the regression model. Each asset class is represented by the returns on a market capitalization index - a type of market index whose individual components are weighted according to their market capitalization, so that larger components carry a larger percentage weighting. The indices were chosen specially due to the fact that each index can be tracked with a passive strategy (it should not include any active component).

Table 1. Asset Classes in original Sharpe model

Asset Class	Description
Bills	Cash-equivalents with less than 3 months to maturity Index: Salomon Brothers' 90-day Treasury bill index
Intermediate-term Government Bonds	Government bonds with less than 10 years to maturity Index: Lehman Brothers' Intermediate-term Government Bond Index
Long-term Government Bonds	Government bonds with more than 10 years to maturity Index: Lehman Brothers' Long-term Government Bond Index
Corporate Bonds	Corporate bonds with ratings of at least Baa by Moody's or BBB by Standard & Poor's Index: Lehman Brothers' Corporate Bond Index
Mortgage-Related Securities	Mortgage-backed and related securities Index: Lehman Brothers' Mortgage-Backed Securities Index
Large-Capitalization Value Stocks	Stocks in Standard and Poor's 500-stock index with high book-to-price ratios Index: Sharpe/BARRA Value Stock Index
Large-Capitalization Growth Stocks	Stocks in Standard and Poor's 500-stock index with low book-to-price ratios Index: Sharpe/BARRA Growth Stock Index
Medium-Capitalization Stocks	Stocks in the top 80% of capitalization in the U.S. equity universe after the exclusion of stocks in Standard and Poor's 500 stock index Index: Sharpe/BARRA Medium Capitalization Stock Index
Small-Capitalization Stocks	Stocks in the bottom 20% of capitalization in the U.S. equity universe after the exclusion of stocks in Standard and Poor's 500 stock index Index: Sharpe/BARRA Small Capitalization Stock Index
Non-U.S. Bonds	Bonds outside the U.S. and Canada Index: Salomon Brothers' Non-U.S. Government Bond Index
European Stocks	European and non-Japanese Pacific Basin stocks Index: FTA Euro-Pacific Ex Japan Index
Japanese Stocks	Japanese Stocks Index: FTA Japan Index

Source: (Sharpe (1992))

2.2. Limitations of RBSA method

At this stage it is necessary to come back to limitations of RBSA method, which were presented in chapter 1.2.1. and to find suitable solutions, in order to get reliable, accurate and serviceable model. Although, in chapter 1.3. general techniques were already presented for reducing measurement inaccuracies, in the following chapters they are explained in a more detailed way.

2.2.1. Time-varying portfolio exposures

First of all it is necessary to choose the appropriate time period for the analysis. A longer time period could be analyzed only in a very small sample of funds, as there could be problems with finding the necessary data (for example young funds do not have necessary data).

Lau states that style analysis requires 60 consecutive monthly returns (2007, 126). According to Kim *et al* three years period is sufficient (2000, 312). Brown and Goetzmann (1997) used 24 months. The author of this thesis will make an analysis with 15 years long period. This will also show how consistent are the fund managers' in following the same style benchmark.

When analyzing financial time series data using a statistical model, a key assumption is that the parameters of the model are constant over time. However, the economic environment often changes considerably, and it may not be reasonable to assume that a model's parameters are constant. Sharpe (1992) acknowledges that RBSA, as every other statistical model, results are sensitive to the sample period, therefore to assess the model's stability over time Sharpe suggests conducting RBSA over rolling periods. That means that a fixed amount of monthly data will be used to conduct RBSA. The sample period is moved one month forward and once again the model is regressed against the fixed number of monthly data. Sharpe used sub-samples of 48 months of data in his researches. Using rolling time periods highlights consistency in style of a particular fund over time (Lucas, Riepe 1996, 14).

When period chosen raises another problem. In some cases inconsistencies in style should be evident when using rolling periods. Lucas and Riepe found four possible cases in which rolling periods cannot be used (1996, 16-18):

- fund management – changes in the style of the fund or active management decisions due to timing or sector rotation (for example when changes in the style of the portfolio or in management are made),
- changes in the character of underlying securities,
- noisy (incorrectly calculated) data,
- ineffectually selected indices.

Therefore it might be necessary to divide the sample period into sub-periods. Lau (2007) proposed to use Chow test to determine the significance of the style consistency between different sub-periods. Formula of Chow test is following:

$$F = \frac{(RSS_R - RSS_{NR})/k}{RSS_{NR}/(n-2k)} \quad (2)$$

where:

RSSR = residual sum of squares of the model on all data,

RSSNR = sum of residual sum of squares of the models on the two subset of data,

k = number of restrictions.

2.2.2. Multicollinearity of asset classes

According to Sharpe (1992) the asset classes chosen for RBSA analysis should have the following characteristics:

- mutually exclusive: a security should not be included in more than one asset class factor,
- exhaustive: as many securities as possible should be included in the appropriate asset classes,
- returns of asset classes should have low correlations or in cases where the correlation is meaningfully high, standard deviations of asset classes should be significantly different, as not to cause multicollinearity.

Lucas and Riepe extended the list with one more point, namely the index has to be in accordance with a good benchmark criterion: it must be investible; must be specified in advance; should be a passive index that is exhaustive; and must be easy to construct (1996, 5).

If the correlation between the indexes is high, it is necessary to evaluate the standard deviations of the indexes. And if it is also high, then both indexes cannot be used in the same analysis. Otherwise it will distort the results of the regression analysis.

However, there could be another problem: in some cases the indexes, which have to be used (as there is no better index), have high correlation and standard deviation and attempting to use other indexes may result other problems (for example data mining).

To appraise the problem of the level of multicollinearity, two researchers, Vestergen and Redin computed the variance inflation factor (hereafter VIF), which assesses the severity of multicollinearity. It provides an index that measures how much the variance of an

estimated regression coefficient is increased because of collinearity. And a high collinearity between two variables is a signal of multicollinearity and that means that the variable should be dismissed. (Vestergen, Redin 2009, 14-15)

Vestergen and Redin performed VIF “...by running a regression where the explanatory variables are used as dependant variables, one at a time, with the rest being explanatory variables.

After having run as many regressions as there are explanatory variables, one is able to see whether any of these variables are highly linear in the rest of the variables combined. If so, that explanatory variable is redundant and should be dropped.” (2009, 14)

VIF is calculated as following:

$$VIF = \frac{1}{(1-R^2)} \quad (3)$$

However, there is still a place for debate: which cut-off value for VIF should be used. In the study (*Ibid.*) researchers found that value as high as 10 is a signal of multicollinearity, as well as Montgomery and Peck (1982, 300), while Miles and Shevlin suggest a cut-off of 4 (2001, 130).

Considering conflicting options of other researchers result, a value of 10 is chosen as a benchmark to be indicative of multicollinearity (but also a higher level of potential multicollinearity are accepted due to the explanatory nature of the thesis). A lower VIF may yield superior results and has better explanatory power.

Another possibility to minimize multicollinearity between asset classes was proposed by Lobosco and DiBartolomeo, who emphasized the importance of limiting the number of indices, may increase the extent of higher correlations between indices that influence the volatility of the active return of each index (1997, 83). In other words it is better to use as few indices as possible and as many as it is needed to cover the researchable universe then the probability of multicollinearity existence decreases.

Many researchers have used this limitation. For example Lau used only six asset classes in RBSA: large capitalization stocks, medium capitalization stocks, cash, government bonds, corporate bonds and international bonds (2007, 127). Vestergen and Redin used also only six asset classes: cash, bonds, domestic equity, foreign equity, absolute return and private equity (2009, 12).

So the main idea of using different asset classes should consists of using different indices, which represent different investable universe of the category. And according to Buetow and Ratner: "...one has to use portfolio-specific benchmarks to correct for problems of multicollinearity" (2000, 27).

3. EMPIRICAL ANALYSIS

For this master's thesis the author uses Sharpe's Original RBSA Model (see equation 1) and the only limitations are: 1) the sensitivities to factors are required to sum to 1 (100%), 2) short selling is prohibited ($b_{i1}, b_{i2}, \dots, b_{in} \geq 0$). Analysis is made with 60-month rolling periods using daily data in program R.

On the legend in the bottom left corner of each rolling RBSA model, mean values are presented of each asset class over the whole period. For example on Figure 7 MSCI Daily TR Net North America USD = 55% means that the mean value of all yellow columns presented on the plot is 55 percent.

3.1. Selection of mutual funds to be analyzed

For this thesis the author decided to choose Global Developed Equity mutual funds. All the data for this research is chosen from Bloomberg. The author used daily data of each fund.

In initial sample there were 711 different mutual funds, which all are described as Global Developed Equity mutual funds. However some of the funds are traded in US dollars and some other currencies such as Swedish crown, UK pounds, Norwegian crown etc., data taken from Bloomberg is already converted into Euro, so the currency exposure is not a case for this sample. To get reliable data some criteria rules were set to filter out inappropriate funds.

First of all, the author decided to filter out all the funds, which do not have data for period from 1st January 1999 to 31st December 2013, as this period is decided to be chosen as observed period. After that filter there are left 71 mutual funds.

The second and third filters are used to remove all mutual funds, which have last update date the earliest in March 2014 and market status other than ACTIVE. In order to specify all currently investible funds in this sector and to be sure that these fund details (such

as monthly data, benchmark, manager, sum of assets under management etc.) are regularly updated. After this filter only 62 mutual funds remain.

The next step is to remove from the sample all the funds, which have not specified their primary benchmark index or have specified as their primary index something different than MSCI World, MSCI World EUR and MSCI World USD. After this step there are still 22 funds left.

The next filter is used to identify all the funds that have assets under management over \$100 billion. After this filter there are 19 Global Developed Equity funds left and future research and test of RBSA technique is done using these funds (see Appendix 1).

However, even after applying all this filters there is still shortage in data. The last fund UBS Lux Equity Fund - Eco Performance CHF has inaccuracy in data: some daily (and even monthly) prices are missing (see Figure 1), so the performance cannot be calculated and RBSA analysis is therefore impracticable in this case. So there are only 18 funds left in a sample.

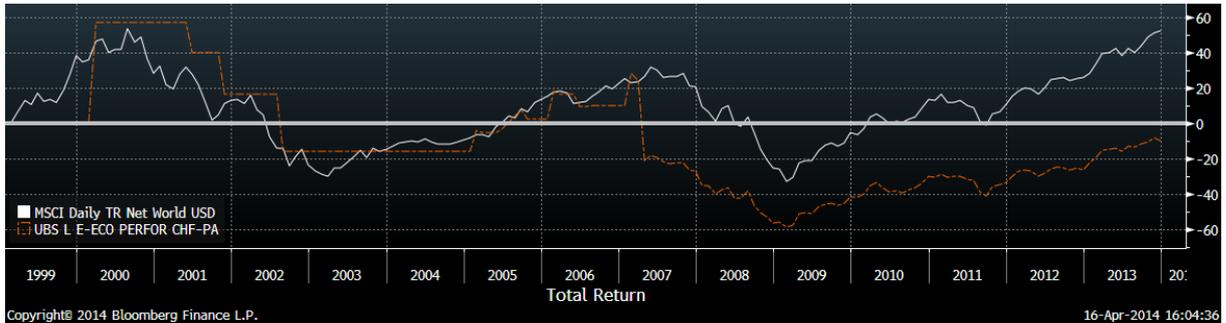


Figure 1. UBS Lux Equity Fund - Eco Performance CHF Fund vs. MSCI World Index return
Source: (Bloomberg)

As the following research should be done with mutual funds daily return and the data, which is obtained from Bloomberg has only daily prices, it is necessary to calculate daily returns with following formula:

$$\text{Daily return} = \left(\frac{\text{day } n-1}{\text{day } n} - 1 \right) \times 100\% \quad (4)$$

3.2. Selection of indices representative of asset class

All the mutual funds, which are presented in Appendix 1, have the same benchmark index - MSCI World Index, which is a free float-adjusted market capitalization weighted index. It is designed to measure the equity market performance of developed markets. As of November 27, 2013 the MSCI World Index consists of the following 23 developed market country indices: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States (Index Definitions).

Sharpe stated that indices have to cover the universe of selected stocks. According to MSCI global equity universe (using the MSCI Market Classification Framework), which covers developed markets consist of three parts, which are represented by following indices (MSCI Developed...; see their return on Figure 2):

- 1) MSCI Daily TR Net North America USD index (Canada, United States),
- 2) MSCI Daily TR Net Europe USD index (Europe and Middle East: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom),
- 3) MSCI Daily TR Net Pacific USD index (Australia, Hong Kong, Japan, New Zealand, Singapore).



Figure 2. MSCI Developed Markets Indexes return

Source: (Bloomberg, as of 25.03.2014)

Every mutual fund may have a little part of cash, to identify this in further analysis, it is necessary to use a cash index. The author decided to use JPM Cash Index Euro Currency 3 index.

However all the fund presented in Appendix 1 have MSCI World Index (which consist of developed country indices) as their benchmark index, they may have also a little part of Emerging Market, to identify that MSCI Daily TR Net Emerging Markets Growth USD index is going to be used (see their return graphs on Figure 3).



Figure 3. MSCI Daily TR Net Emerging Markets Growth USD Index and JPM Cash Index Euro Currency 3 index vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

All together there are five indices, which represent global equity universe. But before using them a multicollinearity test should be done, in order to be sure that analysis results are reliable.

3.3. Multicollinearity test of chosen indices

Correlation matrix of chosen indices is presented in Figure 4, where NDUEEGF is MSCI Daily TR Net Emerging Markets Growth USD index, JPCAUS3M - JPM Cash Index USD 3 Month index, NDDUNA - MSCI Daily TR Net North America USD index, NDDUE15 - MSCI Daily TR Net Europe USD index and NDDUP - MSCI Daily TR Net Pacific USD index.

NDUEEGF	JPCAUS3M	NDDUNA	NDDUE15	NDDUP	
1,0000	0,0552	0,7517	0,7941	0,7460	NDUEEGF
	1,0000	0,3346	-0,0520	0,2119	JPCAUS3M
		1,0000	0,8215	0,7138	NDDUNA
			1,0000	0,6595	NDDUE15
				1,0000	NDDUP

Figure 4. Correlation matrix of MSCI indices

Source: (compiled by the author)

As one may notice, correlation between some of the indices is relatively high, and there may be multicollinearity between these indices, therefore VIF test is done with researchable indices using 60-month rolling periods (see Figure 5).

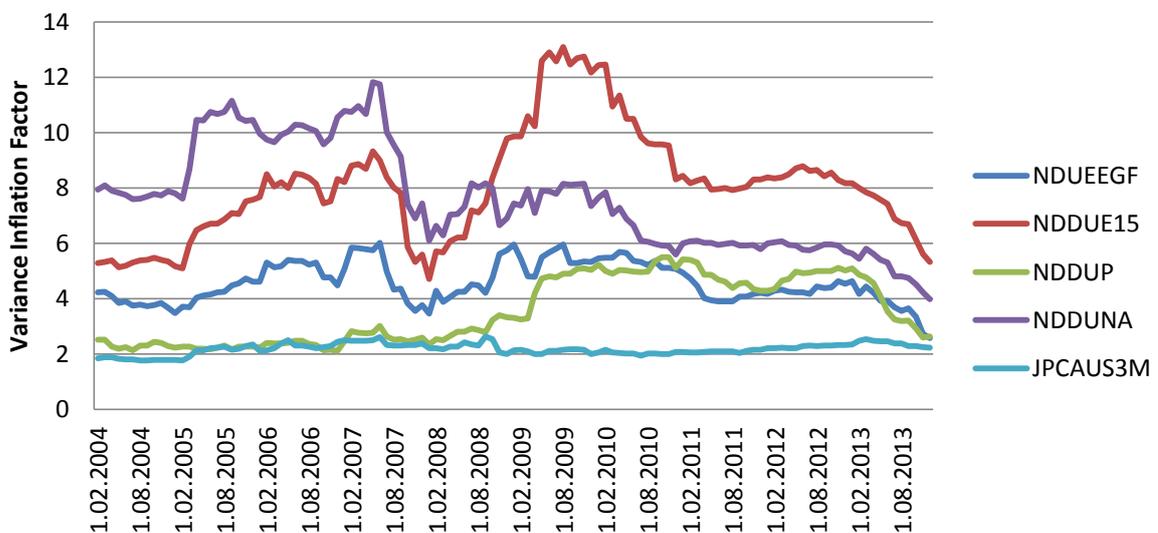


Figure 5. Variance Inflation Factor values of MSCI indices

Source: (compiled by the author)

Looking at Figure 5 the main thing that stands out is a higher than 10 points VIF value of two indices: North America and Europe. Even though these indices could not be thrown away from the research as this are the main components of MSCI World index and not using these indices would be a fundamental mistake. Besides these indices have higher VIF value in different periods and only for a short time.

Further investigation of Figure 5 points out several interesting facts.

- 1) Looking at rolling VIF, it can be seen that it changes through the time, which means that using the VIF method only on the full sample (how it is usually used) is not a good approach,
- 2) There is a drop of VIF in 2007: when the crisis comes, the dependence of the return of one region against the others decreases, which makes diversification a good idea,
- 3) Last few years VIF is very low. It is difficult to interpret it, but still it may indicate that today it is good to have a diversified portfolio and it is even more than necessary to do style analysis when choosing funds.

However both correlations between some of the indices as well as VIF of two indices are relatively high, the author still decides to use these indices due to the following reasons.

Firstly, other researchers who used RBSA method in their analysis used indices, which had even higher cross-correlation. For example Allen *et al* in their research stated that chosen indices are appropriate within the RBSA, however correlation between Australia DataStream market - accumulation index, MSCI World ex AU - Accumulation index, is as high as 0,822 and &P/ASX 300 property trust index – Accumulation correlation with Australia DataStream market - accumulation index and MSCI World ex AU - Accumulation index is 0,582 and 0,538 (2010, 12).

In Lau research correlation coefficients between asset classes were even higher: return for 1-month Bankers' Acceptance rate and return for 7-day offer rate of Kuala Lumpur Inter-Bank Market – 0,82 and the Second Board index and Exchange (Main Board) All Share index – 0,81 (2002, 17), but this indices were still used.

Secondly, there are many researches, which are made using such indices as Russell 1000 Growth, Russell 1000 Value, Russell 2000 Growth, Russell 2000 Value (see for example Mason *et al* 2010 and Chan *et al* 2002). Some researchers add also some kind of cash index, such as Citigroup 3-month T-bill (as is used in Zephyr's style analysis). However, the author of this thesis did not find any article with correlation matrix of this funds, she decided to make it herself. The only difference is that instead of using Citigroup index she used iBoxx USD Treasuries Total Return Index (this indices should not have considerable differences). Results are presented in Figure 6.

RU10GRTR	RU10VATR	RU20GRTR	RU20VATR	ITRROV	
1,0000	0,9434	0,9452	0,9161	0,7085	RU10GRTR
	1,0000	0,9089	0,9504	0,7275	RU10VATR
		1,0000	0,9582	0,6390	RU20GRTR
			1,0000	0,6755	RU20VATR
				1,0000	ITRROV

Figure 6. Correlation matrix of Russell indices

Source: (compiled by the author)

Correlations between presented indices are very high, but they are still used in style analysis, despite Sharpe’s main assumption that “The non-factor return for one asset ... is assumed to be uncorrelated with that of every other...” (1992).

Thirdly, the best possibility to check if the style indices chosen are appropriate to be used in analyzing Global Developed Equity mutual funds is to make an analysis on primary benchmark index MSCI World. In theory chosen style indices should replicate the benchmark index, which means that R^2 has to be nearly 1 (100%), which means that all movements of MSCI index are completely explained by movements in the style indices. The analysis made (using 60-month rolling period) in program R showed that periodical changes are very small, changes in graph are smooth (see Figure 7), explanatory power is very high (lowest value is 0,99970, see Figure 8).

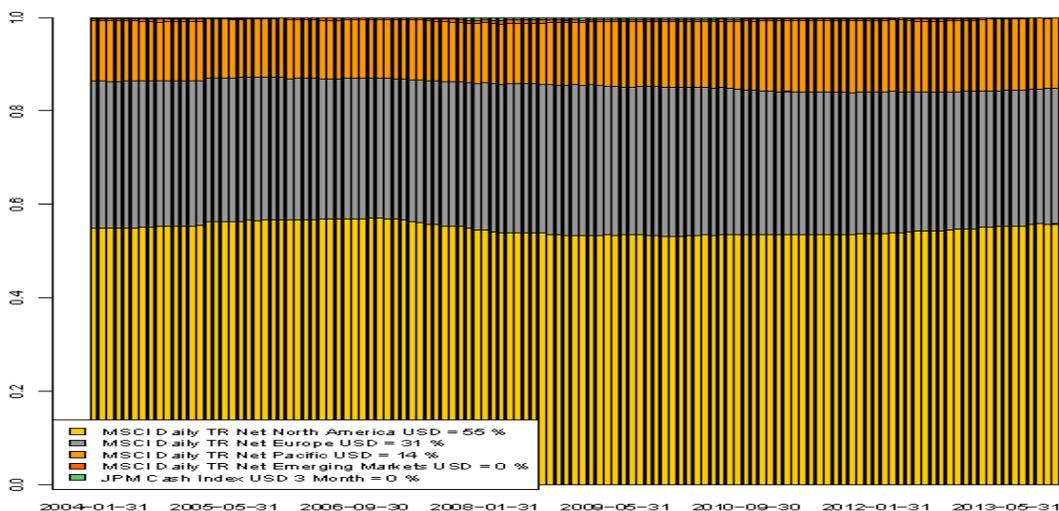


Figure 7.60-month rolling RBSA for MSCI World index

Source: (compiled by the author)



Figure 8. R^2 of MSCI World index with 60-month rolling period

Source: (compiled by the author)

And finally, descriptive statistic (R^2) appeared to be high (over 80%) in analysis of majority of Global Developed Equity mutual funds (see chapter 4 and Table 2).

Considering all previously mentioned facts, the author concludes, that analysis method chosen could be used in further analysis, as no interfering factors was found.

4. EMPIRICAL FINDINGS

Before itemization of results it is necessary to take a look at what style indices have been doing during the researchable period. Looking at the returns of three components of MSCI World at Figure 9 it could be seen that all the indices have reacted to the market movements in a quite similar way - all three yield curves hike during second half of the year 2003 till the second half of 2007 and decline during the economic recessions (in 2000-2003 and 2008).

However investors who had invested into North America during the financial crash in 2008 lost less and had higher performance during the last 5 years than those, whose money was in Pacific and Europe assets.



Figure 9. Total return of MSCI World index components during 1999-2013 years

Source: (Bloomberg)

Looking at Figure 10 it is noticeable, that returns of MSCI World and Cash indices have relatively little difference, which may indicate that there is no matter, which asset class between this two fund managers prefer. However the decisions whether to invest into Emerging Markets or not and the main question "When?" matters, as having this asset during the crisis would have brought bigger losses while investing into this assets during other periods would have given higher performance.

Following in Table 2 are presented average compositions of observable funds as well as annual returns for fifteen and six years (including last financial crisis), lowest and highest values of explanatory variable or R^2 and annualized standard deviation of return. Funds in the Table 2 are sorted by 6-years annual return in descending order.



Figure 10. Total return of MSCI World index vs. Cash and Emerging Markets indices during years 1999-2013

Source: (Bloomberg, as of 25.03.2014)

As it could be seen on the Table 2, only few funds have managed to perform higher return than the benchmark has, this fact is with the correspondence with CBSNews.com article where they state that: “For the past three-year and five-year periods, 86 percent and 75 percent of large-cap funds underperformed, 80 percent and 90 percent of mid-cap funds underperformed, and 67 percent and 83 percent of small-cap funds underperformed, respectively. And there were no asset classes where a majority of active managers outperformed” (Active managers...).

However some of the funds have managed to outperform the benchmark during the whole 15-years observable period slightly underperforming last 6 years (see WMPGLEA LX Equity or Wellington Management Portfolios Luxembourg - Global Research Equity Portfolio) with making only small changes in portfolio composition.

All funds have very similar standard deviation (the biggest difference from the benchmark is nearly 6 %).

Table 2. Composition, annual return, R^2 values and annualized standard deviation of observed mutual funds

Bloomberg ticker	Composition (%)					Annual Return 15 y (%)	Annual Return 6 y (%)	Range of R^2 values (%)	Annual σ (%)
	North America	Europe	Pacific	Emerging Market	Cash				
NDDUWI Index	55	31	14	0	0	4,20	4,43	99,97-99,99	14,98
SCHGLEC LX Equity	45	30	19	5	2	3,97	5,31	93-98	15,23
MIGGLOI LX Equity	17	25	24	30	4	8,41	4,67	60-90	20,91
WMPGLEA LX Equity	52	28	7	12	1	5,52	4,36	95,5-98,2	16,25
ABEMCAA LX Equity	24	37	21	14	4	3,89	3,89	86-95	16,03
JPMGEFA LX Equity	40	32	14	13	2	3,65	3,86	91,3-97,6	16,13
BIEQUIT LX Equity	28	22	21	20	8	2,49	3,81	78,0-85,5	16,36
SAREQSI LX Equity	29	33	23	12	4	3,27	3,58	86-95	15,10
SKAEQGI LX Equity	47	22	21	7	2	1,47	3,49	84-96	15,89
FIDLINI LX Equity	35	32	17	16	1	2,93	3,32	87,0-96,5	16,86
INGLWDP LX Equity	44	33	9	14	1	2,37	3,23	91,9-97,5	16,05
CAPCIFI LX Equity	44	29	13	12	2	4,40	2,93	91,0-96,5	16,89
LIBIGEI JY Equity	45	31	7	16	0	5,21	2,71	92,3-97,6	16,73
SKAVARL SS Equity	46	31	12	10	2	2,49	2,68	92,0-96,8	16,05
HUTLAND SS Equity	49	24	13	13	1	-0,64	2,06	86,0-95,5	16,79
MELINTI ID Equity	2	28	18	45	7	6,32	2,03	75-94	19,70
AKKMULA GR Equity	13	55	16	12	4	5,58	1,32	81,8-92,4	15,31
IWK3461 LX Equity	47	27	15	7	3	-0,32	-0,27	86-95	14,86
ALLGLAI LX Equity	55	20	6	18	0	3,20	-2,63	89,8-96,1	17,20

Source: (compiled by the author, data from Bloomberg as of 25.03.2014))

However interesting finding is that the fund with the highest 15 years return has the highest standard deviation (see MIGGLOI LX Equity of BlackRock fund), while the fund which has constantly performed negative return has the smallest standard deviation (see IWK3461 LX Equity or BNP Paribas L1 fund). More detailed overview of empirical findings of observed funds is given in following subchapter.

4.1. Results of 60-month rolling RBSA for analyzed funds

The first fund analysis is done with is BNY Mellon Global Funds PLC - Opportunities Fund and its allocation could be seen on Figure 11. Most of the time the observed outcomes are relatively poorly replicated by the model and less than eighty-five percent of the variation in the response variable can be explained by the explanatory variables (see Appendix 2). And the reason for such differences could be found on fund's factsheet, where it is stated that the fund uses as it benchmark FTSE All World TR Index, which invests into emerging and developed (all world) countries, so different style benchmarks should be used in case of this fund (BNY...).

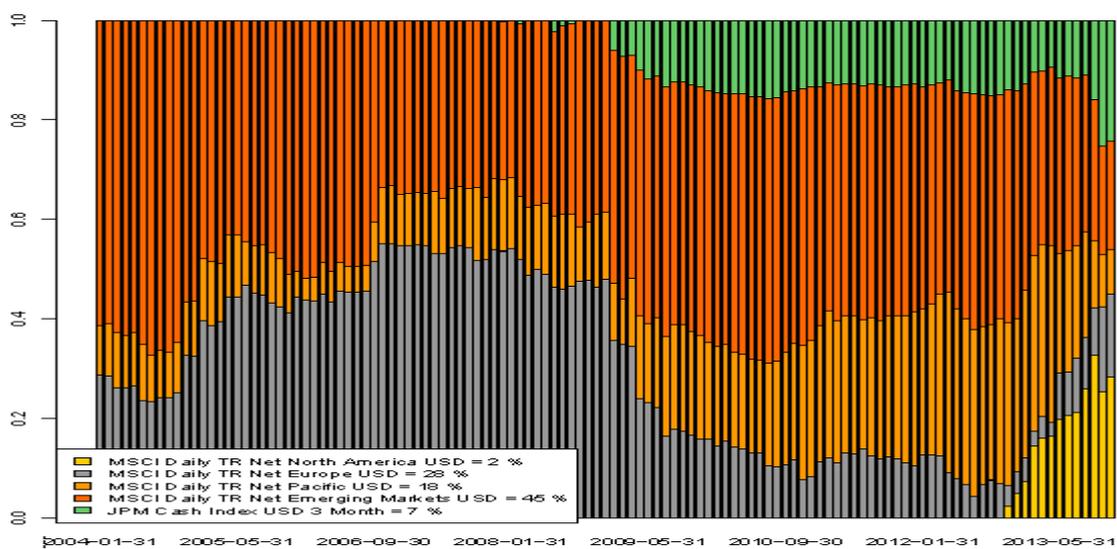


Figure 11. 60-month rolling RBSA for BNY Mellon Global Funds PLC - Opportunities Fund

Source: (compiled by the author)

Despite the fact that the fund has different benchmark it is rather strange, that RBSA outcome for the fund has only a small part of North America. According to the factsheet of BNY Mellon it invests 52,8% into North America as at 31 March 2014, according to RBSA model it is only around 30%. Therefore R^2 level of 75-85% (which is almost for the whole period, see Appendix 2) is clearly too inadequate and therefore could not be used.

This fund has quite high 15-years return (6,32%), which could be explained by high proportion of Emerging Market, which has had high return till the end of year 2007. However having this asset class in the portfolio during the financial crash in the year 2008 caused a drastic decline in performance and therefore 6-years return is only 2,03%.

The R^2 of the SEB Fund 1 - SEB Global Fund model is very high (92%) till the second half of the year 2011 and after that decreases drastically to 84% (see Appendix 3). Also the proportions of asset allocation (see Figure 12) have changed at the second part of the year 2012, which could be related to manager change in the middle of the year 2012 (Offshore Mutual / SEB...).

Total return of SEB fund is relatively low (see Table 2), which could be influenced by high transaction costs and keeping investors money in Cash (especially recent years, when MSCI world index was more successful than Cash index), as well as decreasing part of Emerging Market and Europe.

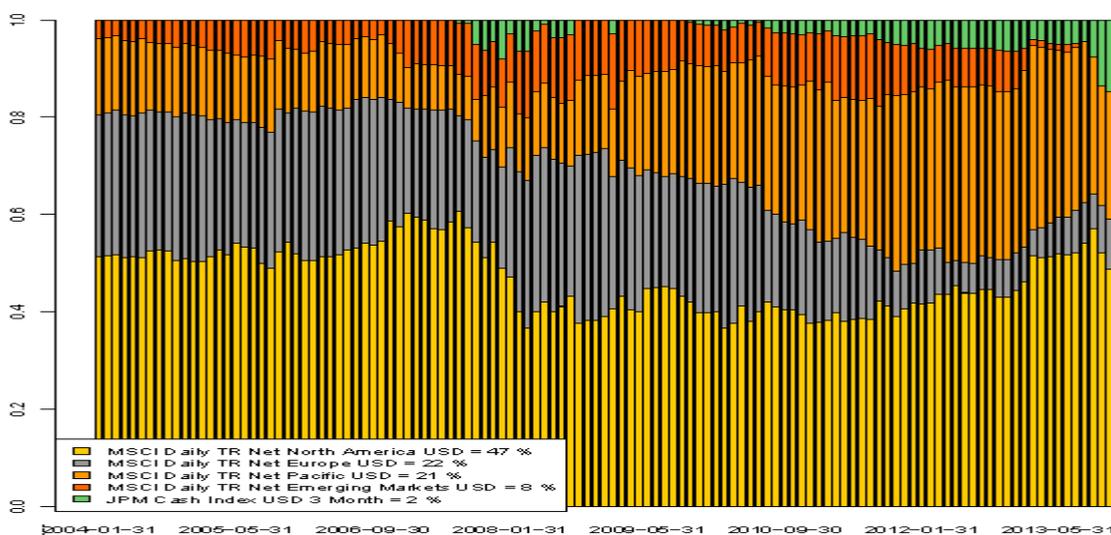


Figure 12. 60-month rolling RBSA for SEB Fund 1 - SEB Global Fund

Source: (compiled by the author)

Aberdeen Global - World Equity Fund is the second highest (after Akkumula Fund) fund, which has overweight in Europe, also Pacific, Emerging Markets and Cash proportions are relatively high, while proportion of North America is twice as low as in benchmark (see Figure 13).

The R^2 of that fund is relatively high – over 86%, which means that the RBSA model fits for use in case of this fund (see Appendix 4). This fund has also stable return of 3,89% for both observable periods (6 and 15 years).

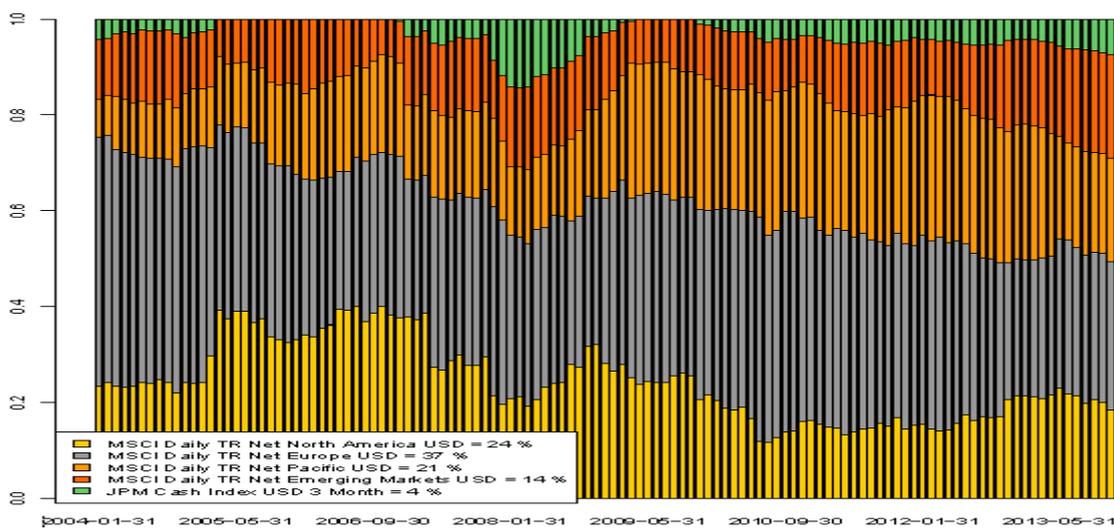


Figure 13. 60-month rolling RBSA for Aberdeen Global - World Equity Fund

Source: (compiled by the author)

R^2 for Schroder International Selection Fund - QEP Global Core fund is over ninety-three percent (see Appendix 5), which means that the regression line of RBSA model approximates the real data points of that fund very precisely and both fund's and benchmark's yield curves are almost identical during the whole observable period (see Appendix 5).

Moreover, the fund has the highest 6-years return of 5,31%, which could be simply explained by having quite low proportion of Emerging Market during the financial downturn and increasing it right after the crash (see Figure 14). Was it just a luck of the fund manager or in-depth study of the market, is questionable, but managers of this fund are definitely worthy to be paid the management fee.

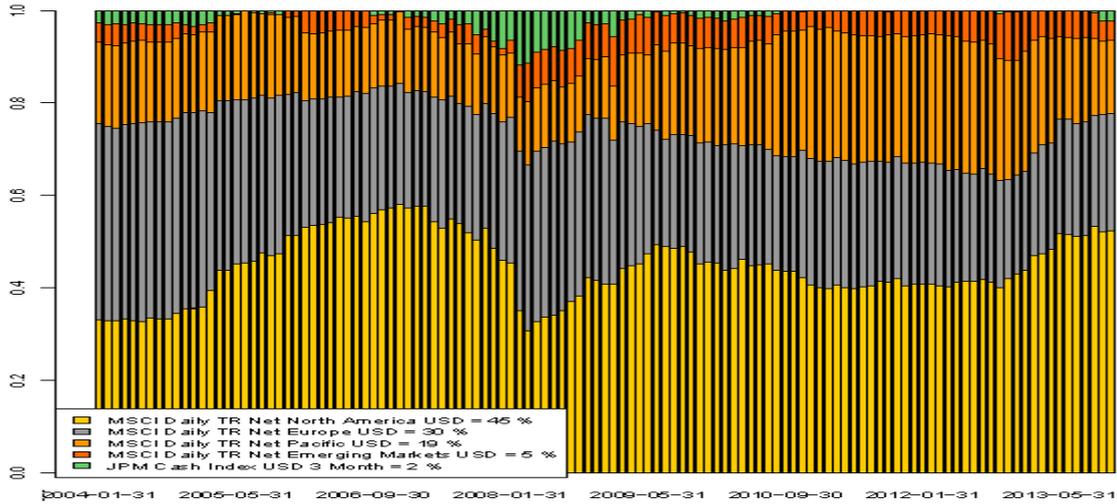


Figure 14. 60-month rolling RBSA for Schroder International Selection Fund - QEP Global Core

Source: (compiled by the author)

R^2 of the Capital International Global Equity fund (which rolling RBSA is on Figure 15) is relatively high (over 91%, see Appendix 6) and therefore RBSA model is worth to be used in case of this fund.

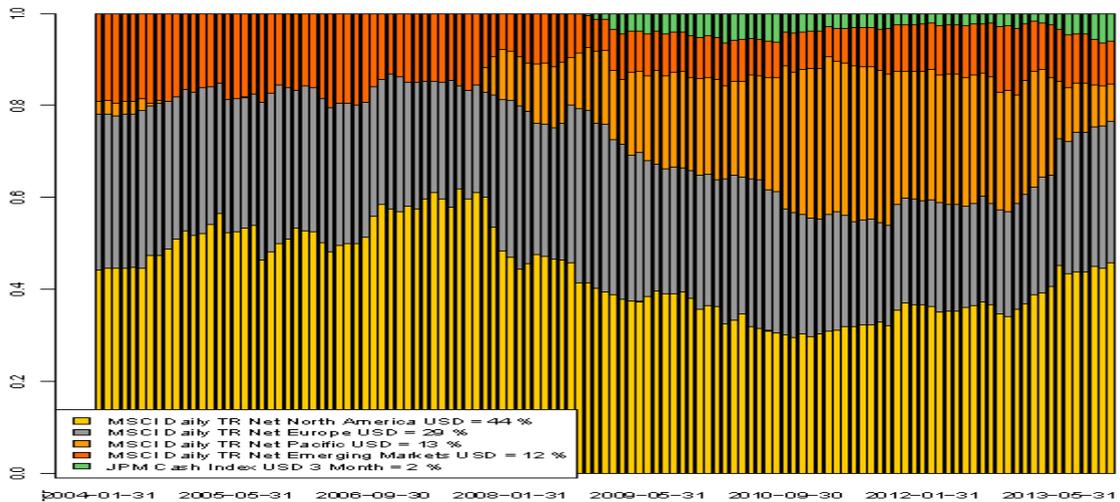


Figure 15. 60-month rolling RBSA for Capital International Global Equity

Source: (compiled by the author)

Capital International Global Equity fund is one of the funds, which managers were worthy to be paid a management fee, as it has constantly outperformed the benchmark before the financial crisis (see Table 2). However keeping quite high proportion of the assets under management in Emerging Markets during the recession conducted to deeper drop of yield curve in year 2008 (see Appendix 6) and therefore have negatively influences the 6-years total return.

As it could be seen on Figure 15, fund manager decided to increase the proportion of Pacific by cutting North America, which had better performance during the last few years. But keeping money in the Money Market instead of Emerging Market (as the fund has done it before the crash) conducted to loss of some revenue.

R^2 of the next fund (Wellington Management Portfolios Luxembourg - Global Research Equity Portfolio, which 60-month rolling RBSA is on Figure 16) is the highest in the sample and has the value of 95,5% – 98,2% during the whole 15 years period, which indicates that the model explains all the variability of the response data around its mean (see Appendix 7) and fund has had the same style benchmark for this period.

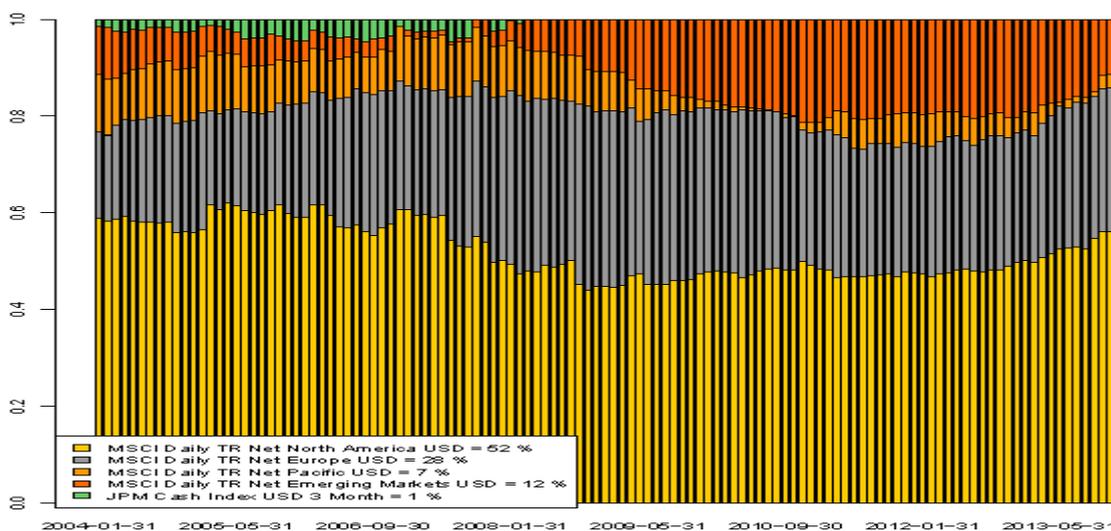


Figure 16. 60-month rolling RBSA for Wellington Management Portfolios Luxembourg - Global Research Equity Portfolio

Source: (compiled by the author)

However, it is stated on the fund’s prospectus that “...the Portfolio, over time, will not be oriented towards any particular investment style“ (Wellington...) it is seen on Figure 16

that the underlying stock selections are quite close to the ones used in MSCI World index. The only difference is that Wellington managers decided to cut the proportions of North America, Europe and Pacific and to invest also into Emerging Markets, which has previously been a good idea, as fund managed to increase investors money in total of 123,13% (38,3% over the benchmark), however during the last 6 years the fund has slightly underperformed the index (minus 0,51%, see Table 2), which could be explained by keeping money in Emerging Market and Europe during the crisis.

As it could be seen in case of Fidelity Funds – International Fund there is an upsurge in graph of R^2 (see Appendix 8) and the reason of it is manager change on 1st of January 2005 (Fidelity International). The same change is also remarkable on Figure 17, where part of Europe is twice as high as after that date.

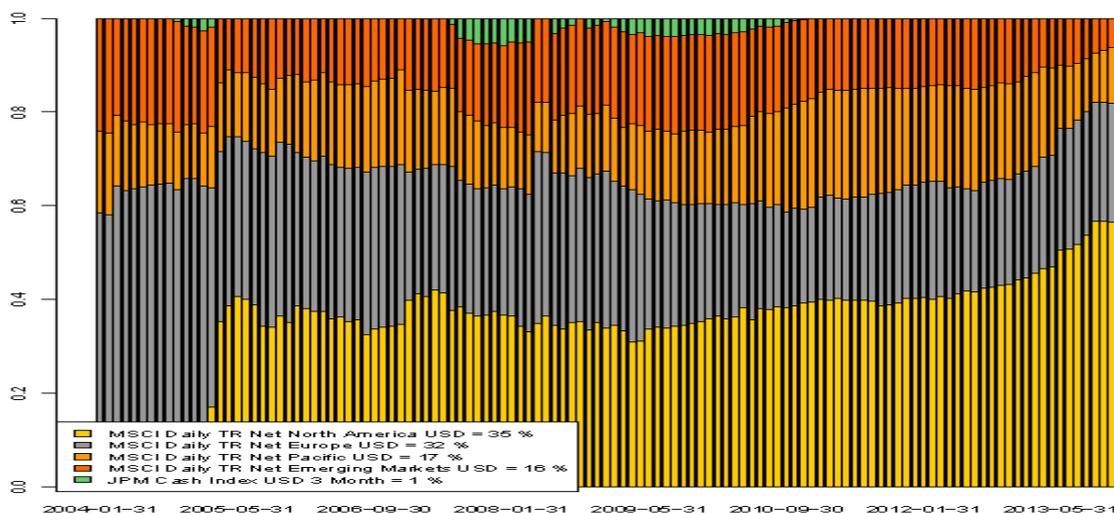


Figure 17. 60-month rolling RBSA for Fidelity Funds - International Fund

Source: (compiled by the author)

Return of Fidelity funds is moving quite in a same way as the benchmark's return for the whole observed period (see Appendix 8), however the return of the fund is slightly under the return of the benchmark as for 15-years period as well as for 6-years (see Table 2), which could be also explained by the fact, that Fidelity fund had considerable part of the assets in Emerging Market during the financial downturn. During the last few years fund has decreased the part of Emerging Market while it has been one of the most profitable assets. Do the fund manager wish to be closer to the style benchmark or is it a vision that Emerging Market will

drop in the near future we will see, but so far all the decisions among fund management did not bring any profit to the fund.

Data points of Handelsbanken Globalfond fit RBSA statistical model over 90% (see Appendix 9), so the result of Handelsbanken Globalfond 15 years return the lowest of the sample – fund has underperformed the benchmark by 93,92% (see Table 2) and fund is unable to outperform the benchmark since the year 2002, which is strange as the fund has proportions of underlying assets quite close to the benchmark (see Figure 18). The only reason could be in the high commissions.

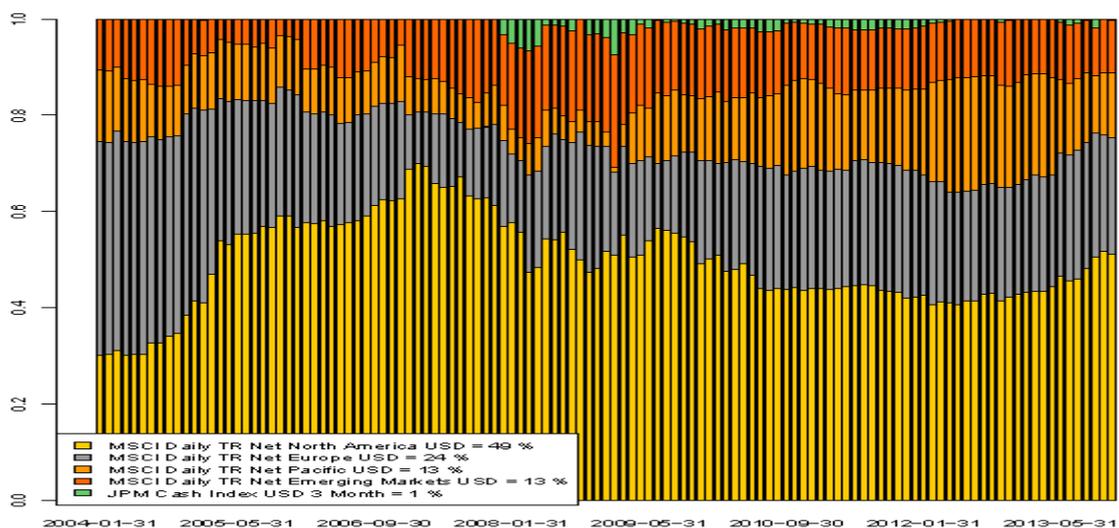


Figure 18. 60-month rolling RBSA for Handelsbanken Globalfond

Source: (compiled by the author)

BlackRock Global Funds - Global Opportunities Fund is the only fund, which has outperformed the benchmark for the whole researchable period. Its 15 years performance managed to outperform the MSCI World index by 149,16% (233,99% vs. 84,83%), which makes plus 4,21% on yearly basis. 6-years return is not so spectacular, but has still the second result among researchable funds (see Table 2).

On Figure 19 it could be seen that the proportion of Emerging Market is almost the same during the crisis and post-crisis periods, which could be also interpreted as a management style, however keeping money in Cash instead of North America was definitely a wrong decision.

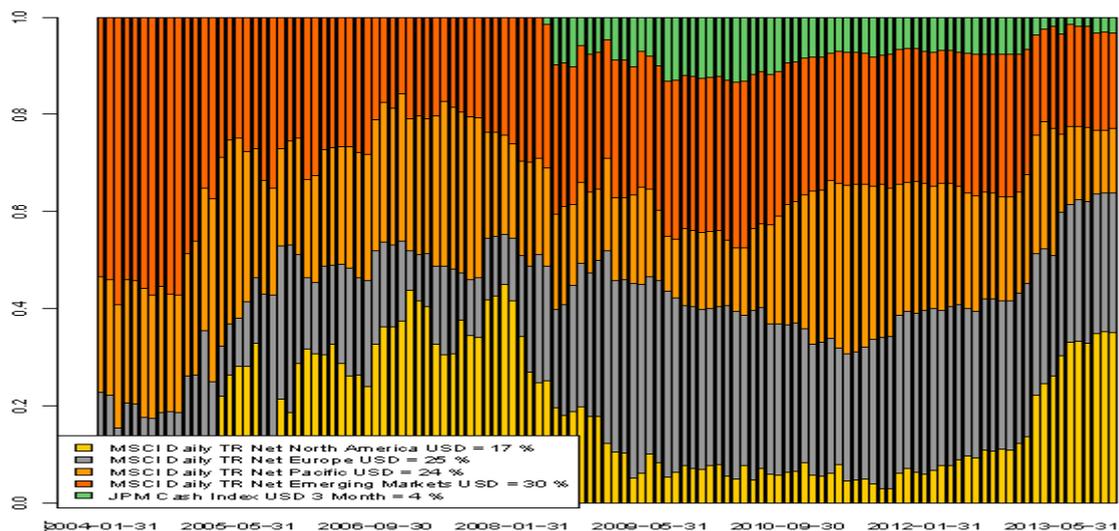


Figure 19. 60-month rolling RBSA for BlackRock Global Funds - Global Opportunities Fund
 Source: (compiled by the author)

On this fund’s factsheet states: “Effective 31 December 2009, the Benchmark changed from S&P Global Broad Markets Index to MSCI AC World (net) (USD) Index” (Blackrock...). And it is actually seen on Figure 19, that the style has been changed – there are smooth changes in rolling period values and R^2 becomes higher (see Appendix 10).

There are several changes during the period 2008-2009, which are induced by changes in funds’ style benchmarks, which was changed for three times (*Ibid.*) and previously there were totally different style benchmarks and therefore other indices should be used for analyzing period before the year 2010.

The regression line of RBSA model approximates the real data points of Skandia Varlden very precisely, as R^2 for that fund is over ninety-two percent (see Appendix 11), but managers of that fund are not worthy to be paid the management fee, as they have managed to perform only half of the benchmark’s return as for 15 years period as well as for the last 6 years, which is quite strange, as there are only minor differences from the benchmark. This leads to a conclusion, that fund has very high fees or has managed to choose the worst securities among the asset classes. Composition of that fund could be seen on Figure 20.

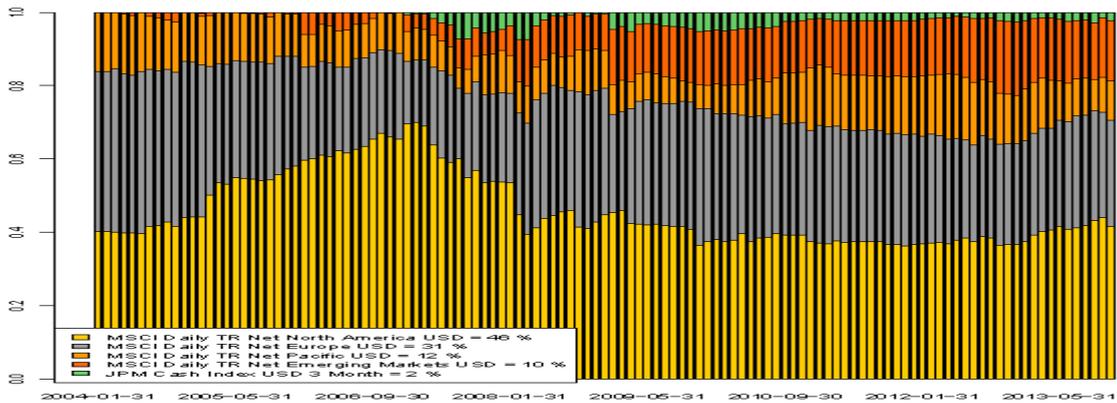


Figure 20. 60-month rolling RBSA for Skandia Varlden

Source: (compiled by the author)

Looking at the R^2 graph of AllianceBernstein - Global Growth Trends Portfolio/Luxembourg (Appendix 12) it indicates that the regression line of the model fits the data of the fund very closely, R^2 is during the whole period higher than 90%. However return of the fund is relatively low, as the fund lost almost 80% of its total return during the financial crisis period (end of 2007- beginning of 2009). AllianceBernstein is the only fund whose managers have decided not to invest their money into Pacific and to increase proportion of North America and Emerging Market instead (see Figure 21), while both asset classes seem to be the most expensive nowadays.

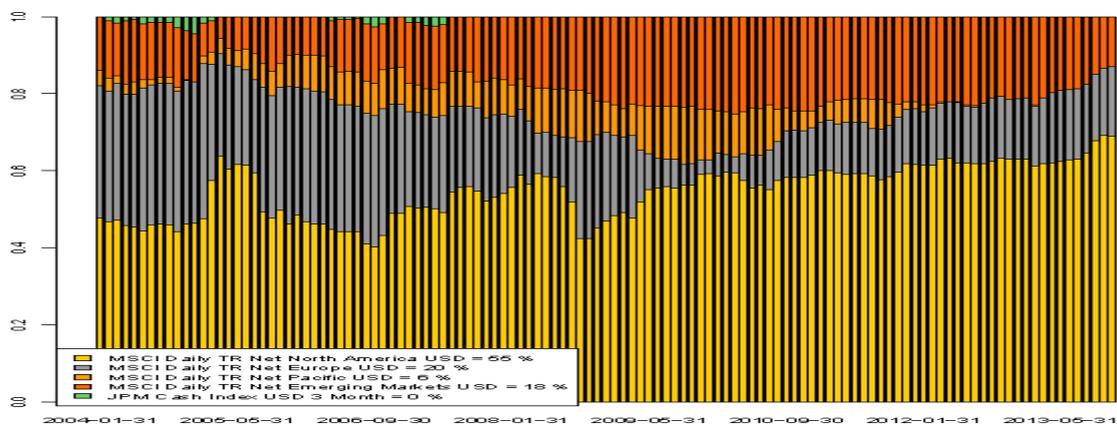


Figure 21. 60-month rolling RBSA for AllianceBernstein - Global Growth Trends Portfolio/Luxembourg

Source: (compiled by the author)

Return of the JPMorgan Investment Funds - Global Select Equity Fund is moving in a similar manner as the benchmark for the whole period, but all the time it has performed lower return to the investors (see Appendix 13). And even change of the management team on the 31st of January 2009 (which can be also seen on Figure 22) has not helped to make higher performance (Offshore Mutual / JP Morgan...). It may be that this fund has to pay a very high fee as well.

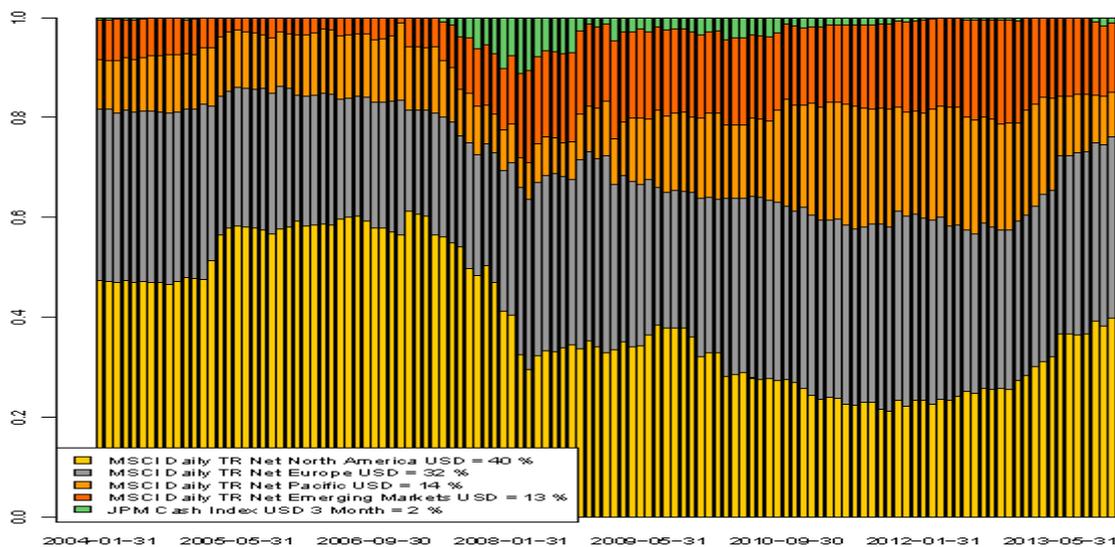


Figure 22. 60-month rolling RBSA for JPMorgan Investment Funds - Global Select Equity Fund

Source: (compiled by the author)

JPMorgan fund has increased proportion of the Emerging Market after the financial downturn, when it was the best time to buy this asset class, but return of the fund is still lower than the benchmarks one, which may indicate that the fund manager has made a wrong choice and chosen the less profitable securities among the asset classes.

The reason could be also in decreasing proportion of North America and decreasing Europe, as Europe has had slightly lower performance during the last years than the North America.

Using RBSA model in case of this fund is reasonable, as the R^2 is very high (see Appendix 13).

Sarasin Investmentfonds SICAV - Sarasin EquiSar Global fund has also very high R^2 - over 92% after the year 2005 (see Appendix 14). The reason of lower R^2 for the first period could be explained by the change of manager in the year 2002 (Offshore Mutual / Sarasin...). 60-month rolling RBSA outcome on Figure 23 could be also divided into two parts – before and after manager change.

Looking at the graph of MSCI World index vs. Sarasin EquiSar Global fund returns (Appendix 14) it is noticeable, that the fund has underperformed the benchmark almost all the time, but during the financial crises in 2008 dropping of the fund was smaller than the benchmarks one, which may indicate that the fund has very diversified portfolio.

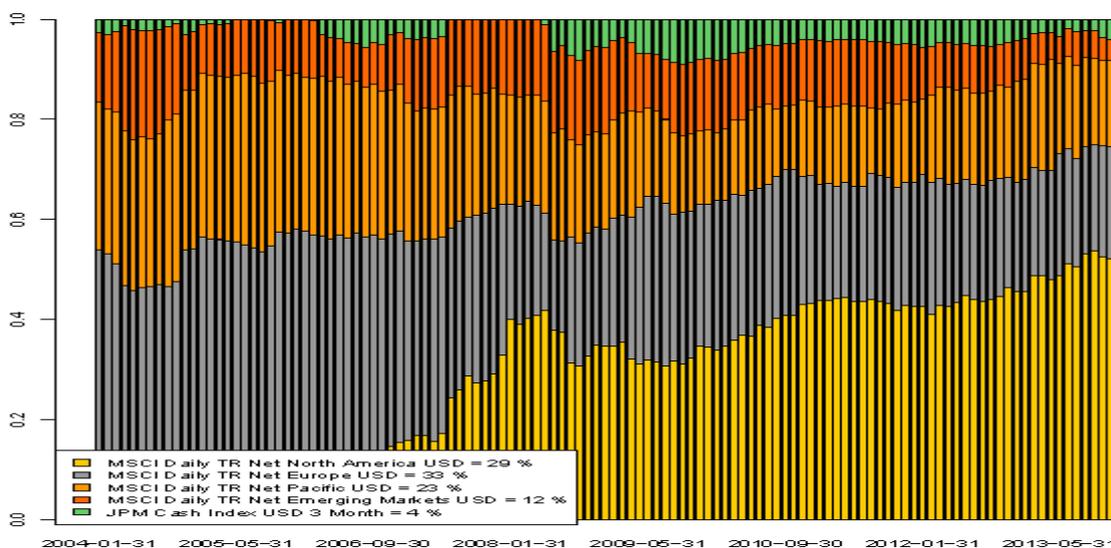


Figure 23. 60-month rolling RBSA for Sarasin Investmentfonds SICAV - Sarasin EquiSar Global

Source: (compiled by the author)

The data of the next fund ING L Invest fund is also very close to the regression line of RBSA model (R^2 is over 92%, see Appendix 15). From Figure 24 it is also seen that North America and Europe proportions have been unchanged during the whole observable period.

However return of ING L Invest fund keeps constantly underperforming the benchmark and all the trials to combine proportions of Emerging Markets and Pacific have been ineffective. So one of the ways to outperform the benchmark would be to change the underlying assets among the asset classes, which have higher return and lower fees

(management, transaction, initial etc. fees) or to keep the same assets as the MSCI World index has.

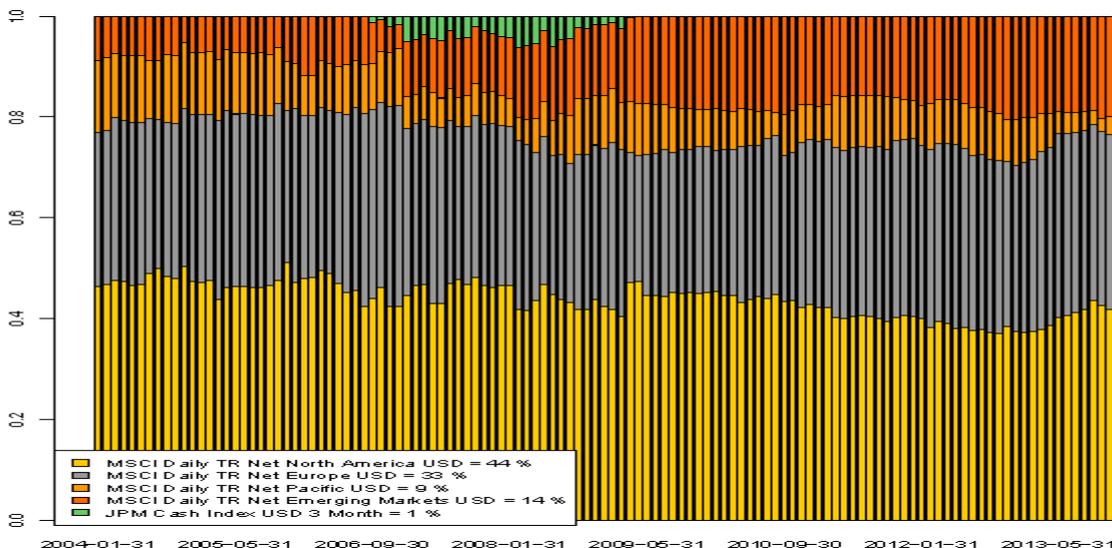


Figure 24. 60-month rolling RBSA for ING L Invest - World

Source: (compiled by the author)

The next fund BNP Paribas L1 - Equity World is the only fund, which has both 15 and 6 year negative return, which is caused by financial crisis in 2008 (see Appendix 16 and BNP...). Total return for that period was minus 40%. Comparing fund's composition to the one of the style benchmark, it could be inferred that manager's idea to invest into Emerging Markets was a mistake at least the timing was wrong, as manager decided to buy Emerging Market securities just before the crisis when this asset class was overvalued and decided to sell just before its price raised.

However, looking at Figure 25 seems that BNP Paribas L1 portfolio managers have recognized their mistake and during the last four years are keeping weights of portfolio assets very close to the MSCI World index.

RBSA model describes the BNP Paribas L1 fund's composition at level over 90% most of the time, especially after financial crisis (see Appendix 16), which means that the model is valid for using in case of this fund.

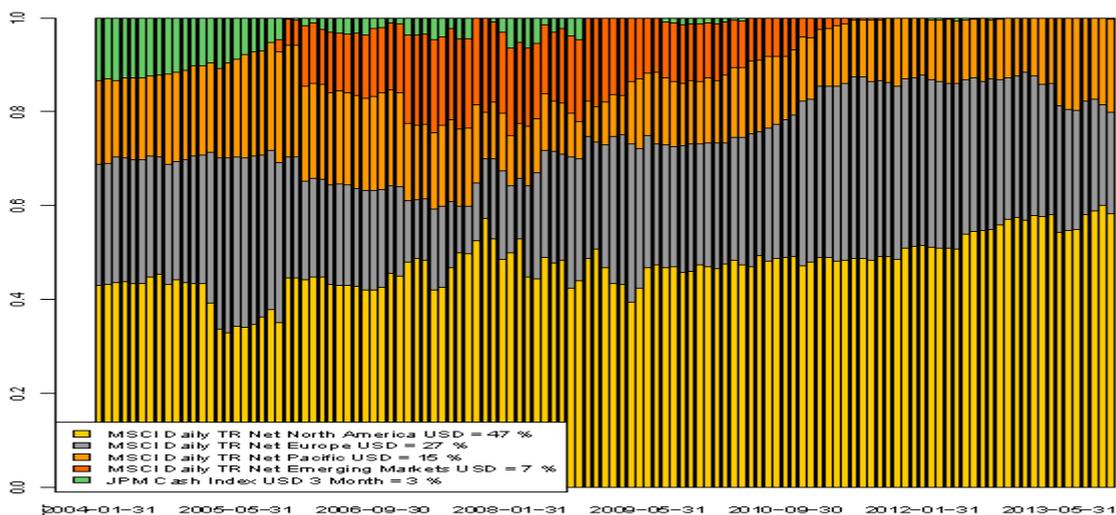


Figure 25. 60-month rolling RBSA for BNP Paribas L1 - Equity World

Source: (compiled by the author)

Observed outcomes of DWS Akkumula mutual fund (Figure 26) are relatively closely replicated by the model - most of the time R^2 is over 88% (see Appendix 17). The fund manager has decided to decrease proportion of North America and to increase part of Europe (fund has the highest proportion of Europe among the sample) and Emerging Markets - this is the reason why fund's 15 years return is higher than the benchmark's one (113,61% vs. 84,83%, see Appendix 17 and Table 2).

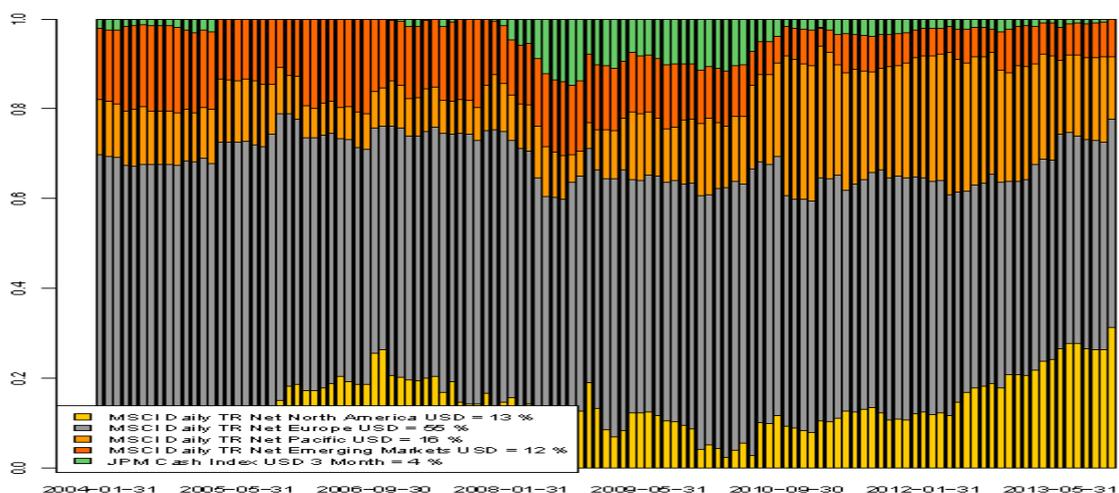


Figure 26. 60-month rolling RBSA for DWS Akkumula

Source: (compiled by the author)

However during the financial downturn, it was not a profitable decision of DWS Akkumula managers and fund's yield curve drop in the year 2008 was steeper than the benchmark's one.

R^2 , which is over 96% for most of the studied period for STANLIB Funds Ltd fund (Figure 27), indicates that the regression line almost perfectly fits the data (see Appendix 18). This fund is also quite close to the benchmark in terms of its asset class composition.

Total return of STANLIB Fund 113,61% (+28,78% vs. benchmark) for 15 years period indicates that the strategy taken by the fund managers has been successful. However keeping investors money in Emerging Markets during the crash was unprofitable decision, as this asset class had the deepest fall in the year 2008 and therefore 6 years return remains under the benchmark's return (see Table 2).

This fund could be also considered as a good investment, as it has quite stable composition during the last 5 years and its return is also higher than the benchmarks one. If investors do not take into account the financial downturn period, they would invest into it.

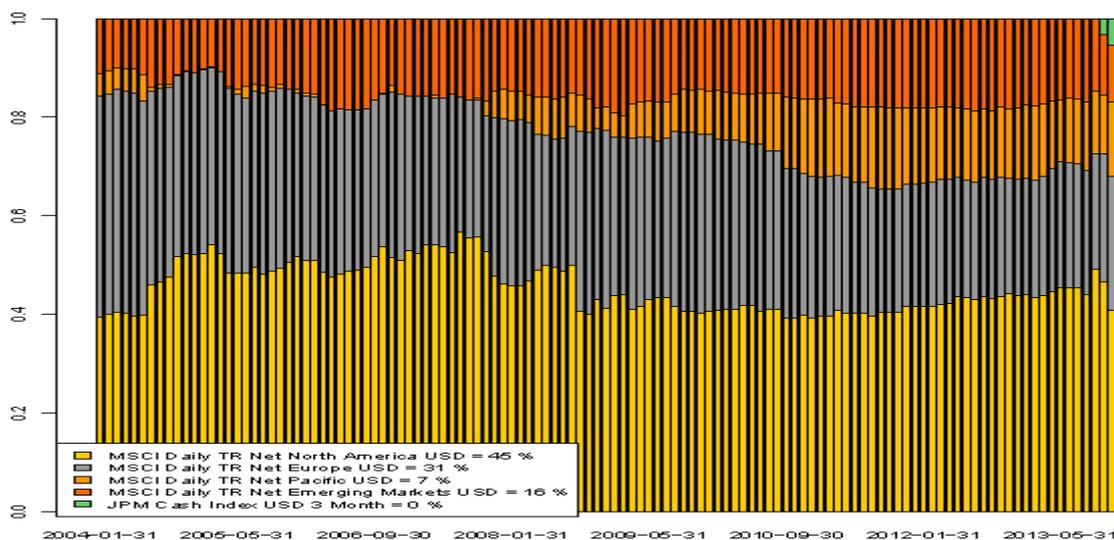


Figure 27. 60-month rolling RBSA for STANLIB Funds Ltd - Global Equity Fund

Source: (compiled by the author)

The RBSA model fits also the last fund from the sample Kaupthing Manager Selection - Global Equity Fund as its R^2 is over 80% for the whole period and last six years it has been over 90% (see Appendix 19).

In the financial statement of the fund states that before June 2011 the fund was a self-managed investment company, later they decided to appoint a management company (Kapauthing...). But as the fund was actively changing its assets and proportions of the assets the whole time, then it is rather complicated to see a difference. Besides the change had no impact on the performance of the fund (or if had then rather negative) especially the last few years.

Kaupthing Manager Selection - Global Equity is one of the funds, which has the greatest differences from style index, as it has on average 8% of money in Cash (see Figure 28). Fund has also increased its proportion of Emerging Market just before the crash. Therefore the fund has constantly underperformer the benchmark.

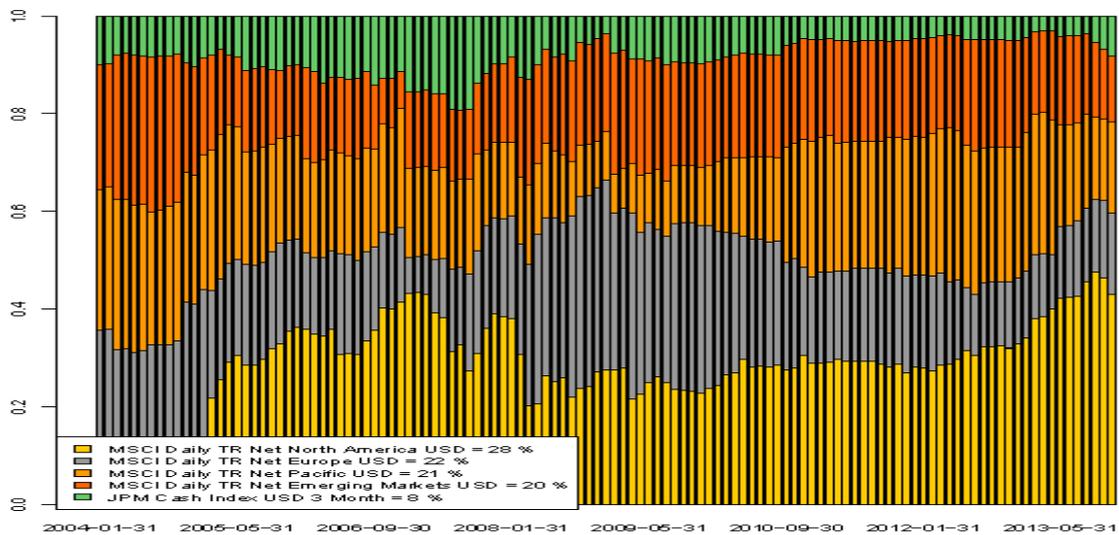


Figure 28. 60-month rolling RBSA for Kaupthing Manager Selection - Global Equity

Source: (compiled by the author)

4.2. Findings and suggestions

The major finding, which the author discovered is that none of the funds actually have invested investors' money according to the style benchmark - all the funds have somehow deviated from it. All the funds are trying to deviate from the benchmark in order to outperform it and to have higher return, but as research has shown only few of them are able to constantly outperform the style benchmark. In current research only one fund (BNY

Mellon Global Funds PLC) has constantly outperformed the benchmark; however it has actually a different style benchmark and got into sample due to an error in Bloomberg system.

If institutional investor wants to make a diversified portfolio and for example she already has done RBSA with other asset classes and has found the funds, which fit to her portfolio and the only missing piece of puzzle, is Global Developed Equity mutual fund, which she wants to have in her portfolio. And if she already has Emerging Market funds in her portfolio, she does not want to have this type of assets in any other fund, then it would be quite complicated to find missing fund, especially if she wants to have a fund, which has outperformed the benchmark.

Looking at the funds from the sample, only few of them (SEB Fund 1 - SEB Global Fund and BNP Paribas L1 - Equity World) have no Emerging Market assets (at the recent period, previously they used to have them), but none of them actually has performance even nearly similar to the MSCI World index (second fund has even negative return for the whole period).

Of course this result is not absolute, since in the sample there are only funds, which have existed for at least 15 years. The author assumes that there are other funds, which were incorporated later and have made investments more closely to the benchmark. Therefore the author suggests making another RBSA for a shorter period (3-5 years, with 12-36 month rolling periods) in order to recognize the funds, which have no investments into Emerging Market and have higher return than the benchmark. However this analysis will not show the complete truth about the funds, as economic downturn period's performance will be missing from the observable period. But it would be in accordance with Lau (2007), Kim et al (2000) and Brown and Goetzmann (1997) who propose using 24-60 month long periods for RBSA.

In authors opinion there is only one fund in the sample - Schroder International Selection Fund - QEP Global Core, which could be chosen as investment, as it is quite close to the benchmark (also the R^2 is very high, which means that the result is reliable) and has relatively high return (comparing with other funds from the sample, which have the same style benchmark).

Overall the author found that the RBSA method really works, as R^2 for all the funds is over 85% and all the periods when R^2 is under 85% are substantiated (manager change, other benchmark) and this technique is really simple in use and quite cheap as well (the only expense is Bloomberg license fee). This finding is in accordance with Sharpe's statement that

RBSA with asset classes as independent variables can be used to determine the style of a fund (Sharpe 1988, 1992).

However the author met the limitation of the method as well: multicollinearity problem arose during the analysis especially during the economic deterioration (during end of 2007-beginning of 2009) when R^2 for most of the funds decreased significantly (for example in case of DWS Akkumula fund explanatory power of RBSA method decreased by 10%, see Appendix 17).

So the author concludes that explanatory power of RBSA method decreases in times of economic downturn, as price for majority of securities decreases dramatically and therefore correlations between the returns are too similar and RBSA method could not differentiate returns of different assets. Therefore other methods (for example HBSA) should be used in complex with RBSA for analyzing economic downturn periods or some developments to RBSA method should be done. Also using shorter period (excluding 2007-2009 years prices) could be one of the possibilities.

The author suggests that further research is needed to recognize, which developments of the model could be done to increase its explanatory power during the financial depression periods.

The author also found some relations between asset classes, namely if funds have invested into Emerging Market assets, then the timing has high importance, as all of the funds, which had Emerging Market securities during the crash in their portfolios had lower performance, while those who invested straight after the crash got higher return. Only few funds have managed to find the right time to invest into Emerging Market and to perform higher return. Was it by chance or money managers have predicted such market changes is questionable.

Another deviation from the style benchmark, which funds used, was keeping investors' money in Cash, but it did not make any difference as MSCI World and Cash indices have almost the same return for observable period. In authors opinion it is not worth to have investors money in Cash (or any other Money Market asset or deposit) as clients can keep their money on their accounts (for example as overnight deposit or some longer term deposits) without paying management fee (which is usually calculated as a percent from assets under management).

Keeping investors' money in Cash is reasonable only while all the other Markets perform negative return (what usually happens during the financial downturn), but as 60-month rolling RBSA graphs show only few funds (such as International Selection Fund - QEP Global Core and DWS Akkumula) have increased the proportion of Cash during that period, while others have increased it and do not want to decrease (such as BNY Mellon Global Funds PLC - Opportunities Fund and BlackRock Global Funds - Global Opportunities Fund).

Therefore author's recommendation to all investors would be to avoid such funds, which have too big proportion of Cash, as these funds want to obtain management fee for just keeping investors money on their account (while banks usually pay for that). So it is extremely necessary to make style analysis in order to identify, how much money mutual funds are keeping in Cash.

Moving further, the author has recognized one more important aspect. Looking at 60-month rolling RBSA for MSCI World index (Figure 7), it is seen that the proportions of different asset classes are very stable during the whole observable period, while other 60-month rolling RBSA figures are quite colorful and proportions are changing quite actively. According to French the costs of active investing are large and a passive market portfolio produces a higher return than the aggregate of all active portfolios, therefore it is important to think about passively managed investment strategies (2008, 1561).

Taking into account these two aspects it is getting clearer why observed funds have so low performance – they are changing underlying so frequently, that they are unable to gain higher return, as transaction cost, out of pocket fees and market commissions are so high. Therefore it is also extremely important to make RBSA analysis before taking some mutual fund into portfolio, in order to see how actively the fund changes his assets.

CONCLUSION

The author of this master's thesis has achieved the main goals she set for herself during the writing of this work: the style analysis method, which identifies and describes the characteristics of an investment portfolio, was developed. The Return-Based Style Analysis technique used in current research allowed to evaluate the funds and their differences from the declared benchmark, as well as to recognize the sources of outperformance.

The author also managed to find out the best combination of style benchmark components that were able to describe the MSCI World index return by almost 100% (descriptive statistic R^2 values for 60-month rolling periods are 99,97-99,99%) and all other researchable funds by at least 85%. The Style benchmark was represented by five following indices: three main indices, which represent the MSCI World index return: MSCI Daily TR Net North America USD, MSCI Daily TR Net Europe USD, MSCI Daily TR Net Pacific USD and two additional indices MSCI Daily TR Net Emerging Markets Growth USD (represents investments into Emerging Market assets) and JPM Cash Index USD 3 Month (represent investments into Money Market assets).

The model used in this research was also successful in identifying the consistency of fund managers in tracking the same benchmark. Only a few funds have changed the benchmark during the period, however most of the funds were changing the assets among the different asset classes as well as the weights of the different asset classes, which makes it more expensive for the investors, as transaction cost are relatively high. Also the total return has suffered from such changes.

The model was also appropriate for highlighting the periods when a fund used another style benchmark as well as periods when a fund management was replaced, as the compositions of the funds changed during these periods.

And finally the model was capable to ascertain different mutual funds style drifts. All the funds have some of them and only a few of them (for example RBSA for BNP Paribas L1 - Equity World fund) have decided to keep close to the style benchmark after losing significant amounts of money during the financial crash. But keeping the same assets as a

benchmark index has without any style drifts is also quite costly for the client (managers can use passive strategies only in case of the fees being very low, otherwise it is costly for the client). It is impossible to outperform the benchmark without differentiating from it due to high out of pocket fees, markets commissions and transaction cost, which are not taken into account by benchmark indices.

However there are also some limitations of the model. RBSA method is less reliable in times of economic downturn, since the explanatory power of the model decreases slightly during the period of financial downturn (from the end of 2007 till the beginning of 2009). And the reason stands in the prices of securities, what decrease dramatically during the crash. Therefore the correlations between the returns are too similar and the RBSA method could not differentiate returns of different assets.

The author suggests that it is more useful (but costly) to pair RBSA with the other methods (for example Holdings-Based Style Analysis) to analyze extreme movements of the market, as other techniques could yield additional information not captured by the RBSA method. Another suggestion is to develop the RBSA method to improve the explanatory power during the economic downturn periods (therefore further research is needed).

However almost all funds, which were under research, have not been able to outperform the benchmark and have a lower return due to already presented reasons (management fees, many trades, high transaction costs), but also due to timing of Emerging Market assets. The RBSA helps to uncover the exposure of different funds to emerging markets equities, as the prices of emerging market equities have had a deeper fall during the financial crises. All the funds, which have had this asset classes in their portfolios, have lost more than those what were invested according to the benchmark. But those funds, which increased investments into Emerging Market straight after the crash have an overall higher return. The RBSA allows, in this case, studying the ability of fund managers using market timing to produce a better performance than the benchmark.

The author understands that the reason for such results can stand in the selected funds and therefore it is proposed to undertake more research, using more Global Developed Equity mutual funds in a sample that has a shorter period of time (3-5 years, which excludes the financial downturn period) with shorter rolling periods (12-36 months) in order to find more funds with higher return and with lower consistency of Emerging Market assets.

The use of 3-5 year periods will increase the sample of the funds, since not all of the funds have a 15-year history, as it was required for the current research. But this will also lead to misleading results, since the use of a 5-year period excludes economic downturn period, and an annual return for the funds would be on average higher, also it would not reflect information about the losses mutual funds incurred during the crash. On the other hand the description capability of the model would improve.

To sum up the author recommends using the RBSA technique to all institutional and individual investors, as it helps to identify real asset allocations among the chosen funds and yields a possibility to create a diversified portfolio, that is essential to the current time, especially when uncertainty in financial markets is so high.

RESÜMEE

TOOTLUSEL PÕHINEV STIILIANALÜÜS JA SELLE RAKENDAMINE GLOBAALSETE ARENENUD AKTSIATURGUDE INVESTEERIMIS- FONDIDE NÄITEL

Marina Merilaid

Käesolevas magistritöös on pööratud tähelepanu stiilianalüüsi tehnikatele, mida kasutavad institutsionaalsed investorid, selleks et tuvastada, mis tüüpi varasid nad tegelikult ostavad ning kui hästi need sobivad olemasolevasse portfelli. Samuti on stiilianalüüs kasutatav selleks, et liigitada ja konstrueerida juhitavaid portfelle, valida spetsiifilisele stiilile sobiv võrdlusindeks ehk *benchmark* ning jälgida ja tuvastada kõrvalekaldeid võrdlusindeksist.

Uuritav valdkond peaks huvitama kõiki, kes usaldavad oma raha investeerimis- ja pensionifondide hallata, kuna see tehnika võimaldab tuvastada *benchmarki* väliste investeeringute (mida fondijuhid kasutavad, et suurendada fondi tootlust), kui ka turu ajastamise (fondijuhi oskus osta väärtpaberid „põhjast“ ning müüa „tipust“) mõju tootlusele. Lõppkokkuvõttes annab see investoritele vajalikku informatsiooni läbimõeldud ja kaalutletud investeerimisotsuse tegemiseks.

Selle lõputöö peamiseks eesmärgiks on välja töötada mudel, mis selgitab investeerimisfondide tootlust, tuvastab ja kirjeldab investeerimisportfelli karakteristikuid, hindab fonde ning nende erinevust võrdlusindeksist ja tuvastab kõrgema tootluse allikaid.

Lähtuvalt põhieesmärgist on püstitatud alaküsimused: 1) leida parim indeksiite kombinatsioon, mis kirjeldab fondi tootlust, 2) hinnata fondijuhi poolt loodud lisandväärtust, 3) uurida kui järjepideva on fondijuhid võrdlusindeksi valikus, 4) teha kindlaks fondide kõrvalekaldeid stiilist.

Stiilianalüüsi põhilisteks tehnikateks on Holding-Based style analysis (vara osakaaludel põhinev stiilianalüüs) ning Return-Based style analysis (tootlusel põhinev

stiilianalüüs). Uurides põhjalikult mõlema meetodi teoreetilisi kontseptsioone, tugevusi ning piiranguid, otsustas autor teise meetodi kasuks, sest selle kasutamine on oluliselt lihtsam, odavam ning kiirem.

Kuna magistritööl on piiratud maht, otsustas autor valida ühe kindla varaklassi, milleks on globaalsetele arenenud aktsiaturgudele suunatud investeerimisfondid, mille võrdlusindeksiks on MSCI World, kasutades viieteistkümne aasta andmeid. Kogu uurimus on tehtud programmis R ning töös kasutatud algandmed ja mudel on salvestatud CD-le, mis on tööle lisatud.

Autor peab tehtud tööd edukaks, sest tema poolt püstitatud eesmärgid said täidetud. Tehtud stiilianalüüsi mudelil on väga hea kirjeldusvõime (R^2 on üle 85% kõigi uuritavate fondide puhul). Mudel võimaldab tuvastada kõik perioodid, kui fondidel võrdlusindeks muutus või toimus fondijuhi vahetus. Samuti on selgelt eristatavad erinevad kõrvalekalded *benchmarkist*.

Magistritöö autor tuvastas ka selle mudelile omase piirangu, nimelt langeb mudeli kirjeldusvõime majanduskriisi aegsel perioodil (kuna kõikide indeksite tootlused muutuvad sarnaseks ning mudel ei ole võimeline neid eristama) ning seetõttu oleks soovitatav kasutada tootlusel põhineva stiilianalüüsi tehnika kõrvalt ka mõnda muud analüüsivahendit (näiteks osakaaludel põhinevat stiilianalüüsi), mis aga teeb analüüsi oluliselt kallimaks. Või proovida arendada töös uuritud analüüsitehnikat.

Enamus uuritavatest fondidest ei suutnud teha isegi ligilähedaselt samasugust tootlust nagu oli MSCI World indeksil. Seda põhjustasid fondide kõrged tasud ja fondijuhtide soov eristuda võrdlusindeksist investeerides arenevate turgude väärtpaberitesse. Paraku oli arenevate turgude kukkumine 2008. aastal (majanduskriisi ajal) oluliselt suurem, kui teistel varaklassidel. Samas need fondid, mis valisid õige ajastuse ning suurendasid arenevate turgude osakaalu vahetult peale kukkumist, suutsid teenida suuremat tulu (sest arenevad turud suutsid taastuda suhteliselt kiiresti). See tulemus näitab, et arenevatesse turgudesse investeerimise ajastusel on väga oluline mõju tootlusele.

Mudel näitas, et ükski uuritavatest fondidest ei investeerinud vastavalt valitud indeksi stiilile, kõikides fondides esineb kasvõi mingil perioodil arenevate turgude varasid. See tulemus näitab, et stiilianalüüsi tegemine enne investeerimisfondi soetamise on äärmiselt oluline, vastasel juhul võib tekkida olukord, et portfellis (milles soetatav fond on vaid osa) on ühe varaklassi osakaal liiga suur, mis omakorda põhjustab vähese diversifikatsiooni riski.

Autor mõistab ka seda, et tulemus ei pruugi olla lõplik, sest analüüsitud sai vaid kaheksateistkümnest fondist koosnevat valimit. Muutes uuritavat perioodi lühemaks suureneks valim oluliselt ning autor usub, et suuremast valimist on tõenäosus leida suurema tootlusega ning väiksema arenevate turgude sisaldusega fonde oluliselt suurem. Seetõttu peab autor vajalikuks teha uut analüüsi lühema perioodi kohta ning suurema valimiga.

Samuti peab autor vajalikuks teha uuringut kasutades teisi varaklasse, et tuvastada, kas tootlusel põhineval stiilianalüüsil on sama hea kirjeldusvõime ka muude parameetrite kasutamisel.

Üleüldse autor soovib tootlusel põhineva stiilianalüüsi kasutamist kõigile institutsionaalsetele ja erainvestoritele, kuna see on väga hea vahend uuritavate fondide varade jaotuse identifitseerimiseks ning teeb võimalikuks tõepoolest diversifitseeritud portfelli koostamise, mis on eriti aktuaalne tänapäeval, kui teadmatus finantsturgude suhtes on kõrge.

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APPENDICES

Appendix 1. Table of Global Developed Equity Indices Chosen for the Future Research

Bloomberg ticker	Long name	Last update date	Market status	AUM in USD	Index
MELINTI ID Equity	BNY Mellon Global Funds PLC - Opportunities Fund	24.03.2014	ACTV	115,5183	MSCI WORLD
SKAEQGI LX Equity	SEB Fund 1 - SEB Global Fund	24.03.2014	ACTV	868,0081	MSCI WORLD
ABEMCAA LX Equity	Aberdeen Global - World Equity Fund	24.03.2014	ACTV	3639,2360	MSCI WORLD
SCHGLEC LX Equity	Schroder International Selection Fund - QEP Global Core	24.03.2014	ACTV	1013,0010	MSCI WORLD
CAPCIFI LX Equity	Capital International Global Equity	24.03.2014	ACTV	1015,6360	MSCI WORLD
WMPGLEA LX Equity	Wellington Management Portfolios Luxembourg - Global Research Equity Portfolio	24.03.2014	ACTV	355,8859	MSCI WORLD
FIDLINI LX Equity	Fidelity Funds - International Fund	24.03.2014	ACTV	1813,6700	MSCI World USD
HUTLAND SS Equity	Handelsbanken Globalfond	24.03.2014	ACTV	309,7283	MSCI WORLD
MIGGLOI LX Equity	BlackRock Global Funds - Global Opportunities Fund	24.03.2014	ACTV	158,8417	MSCI WORLD
SKAVARL SS Equity	Skandia Varlden	24.03.2014	ACTV	259,9486	MSCI WORLD
ALLGLAI LX Equity	AllianceBernstein - Global Growth Trends Portfolio/Luxembourg	24.03.2014	ACTV	742,8791	MSCI WORLD
JPMGEFA LX Equity	JPMorgan Investment Funds - Global Select Equity Fund	24.03.2014	ACTV	207,1252	MSCI WORLD
SAREQSI LX Equity	Sarasin Investmentfonds SICAV - Sarasin EquiSar Global	21.03.2014	ACTV	307,4170	MSCI WORLD
INGLWDP LX Equity	ING L Invest - World	24.03.2014	ACTV	247,9168	MSCI WORLD
IWK3461 LX Equity	BNP Paribas L1 - Equity World	21.03.2014	ACTV	139,1241	MSCI World EUR
AKKMULA GR Equity	DWS Akkumula	24.03.2014	ACTV	4527,9240	MSCI World EUR
LIBIGEI JY Equity	STANLIB Funds Ltd - Global Equity Fund	21.03.2014	ACTV	1954,5620	MSCI World USD
BIEQUIT LX Equity	Kaupthing Manager Selection - Global Equity	21.03.2014	ACTV	144,1301	MSCI World EUR
UBF1 GR Equity	UBS Lux Equity Fund - Eco Performance CHF	25.03.2014	ACTV	145,2091	MSCI WORLD

Source: (Compiled by the author, data from Bloomberg, as of 25.03.2014)

Appendix 2. Characteristics of BNY Mellon Global Funds PLC - Opportunities Fund



Figure 29. R² dynamics for BNY Mellon Global Funds PLC - Opportunities Fund

Source: (compiled by the author)

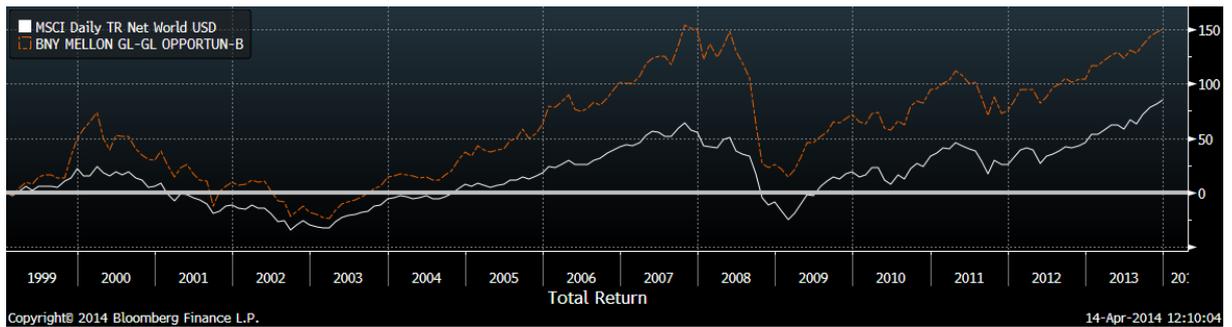


Figure 30. BNY Mellon Global Funds PLC - Opportunities Fund return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 3. Characteristics of SEB Fund 1 - SEB Global Fund



Figure 31. R^2 dynamics for SEB Fund 1 - SEB Global Fund

Source: (compiled by the author)

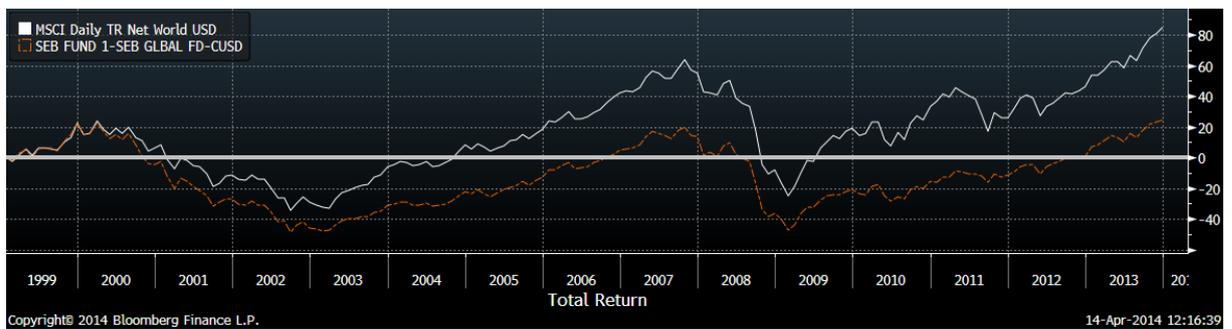


Figure 32. SEB Fund 1 - SEB Global Fund vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 4. Characteristics of Aberdeen Global - World Equity Fund



Figure 33. R^2 dynamics for Aberdeen Global - World Equity Fund

Source: (compiled by the author)



Figure 34. Aberdeen Global - World Equity Fund return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 5. Characteristics of Schroder International Selection Fund - QEP Global Core



Figure 35. R^2 dynamics for Schroder International Selection Fund - QEP Global Core

Source: (compiled by the author)

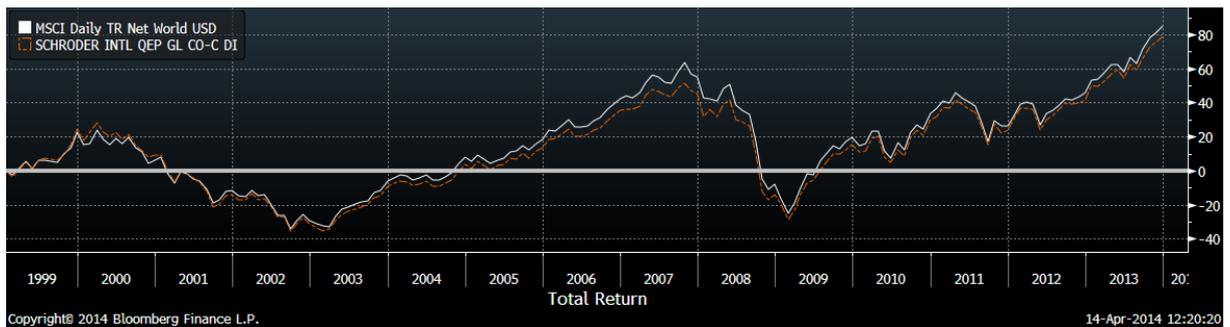


Figure 36. Schroder International Selection Fund - QEP Global Core return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 6. Characteristics of Capital International Global Equity



Figure 37. R^2 dynamics for Capital International Global Equity

Source: (compiled by the author)



Figure 38. Capital International Global Equity return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 7. Characteristics of Wellington Management Portfolios Luxembourg - Global Research Equity Portfolio



Figure 39. R^2 dynamics for Wellington Management Portfolios Luxembourg - Global Research Equity Portfolio

Source: (compiled by the author)



Figure 40. Wellington Management Portfolios Luxembourg - Global Research Equity Portfolio return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 8. Characteristics of Fidelity Funds - International Fund



Figure 41. R^2 dynamics for Fidelity Funds - International Fund

Source: (compiled by the author)



Figure 42. Fidelity Funds - International Fund return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 9. Characteristics of Handelsbanken Globalfond

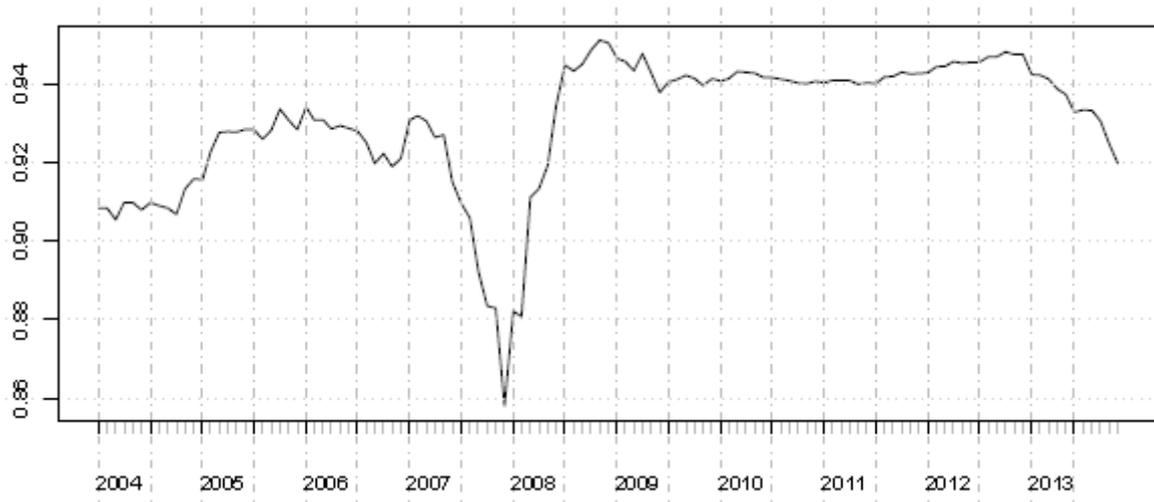


Figure 43. R^2 dynamics for Handelsbanken Globalfond

Source: (compiled by the author)

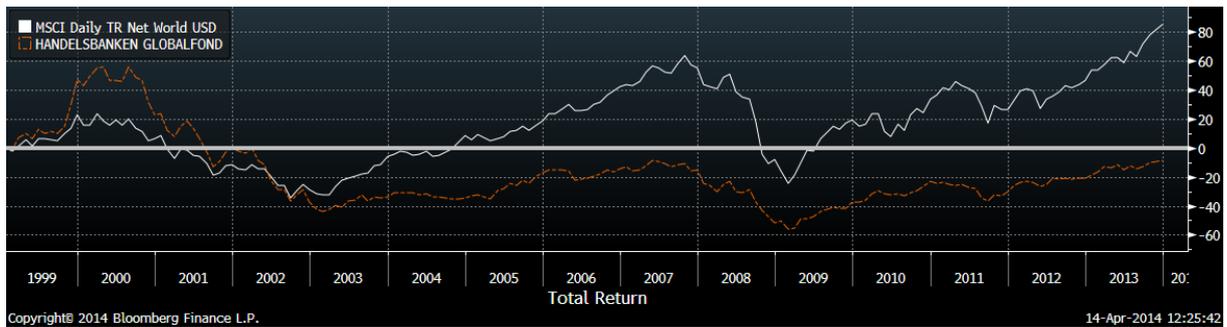


Figure 44. Handelsbanken Globalfond return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 10. Characteristics of BlackRock Global Funds - Global Opportunities Fund



Figure 45. R^2 dynamics for BlackRock Global Funds - Global Opportunities Fund

Source: (compiled by the author)



Figure 46. BlackRock Global Funds - Global Opportunities Fund return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 11. Characteristics of Skandia Varlden



Figure 47. R^2 dynamics for Skandia Varlden

Source: (compiled by the author)

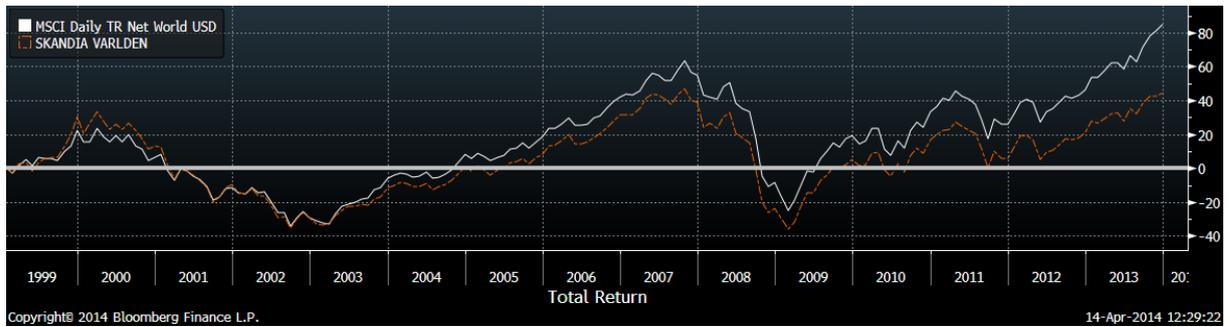


Figure 48. Skandia Varlden return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 12. Characteristics of AllianceBernstein - Global Growth Trends Portfolio/Luxembourg

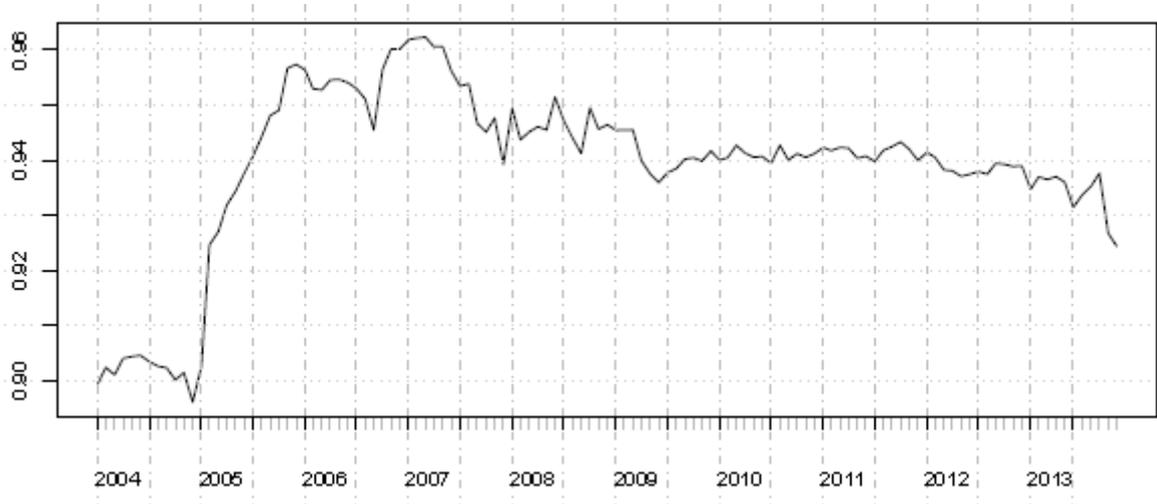


Figure 49. R^2 dynamics for AllianceBernstein - Global Growth Trends Portfolio/Luxembourg
Source: (compiled by the author)



Figure 50. AllianceBernstein - Global Growth Trends Portfolio/Luxembourg return vs. MSCI World Index return
Source: (Bloomberg, as of 23.05.2014)

Appendix 13. Characteristics of JPMorgan Investment Funds - Global Select Equity Fund



Figure 51. R^2 dynamics for JPMorgan Investment Funds - Global Select Equity Fund

Source: (compiled by the author)

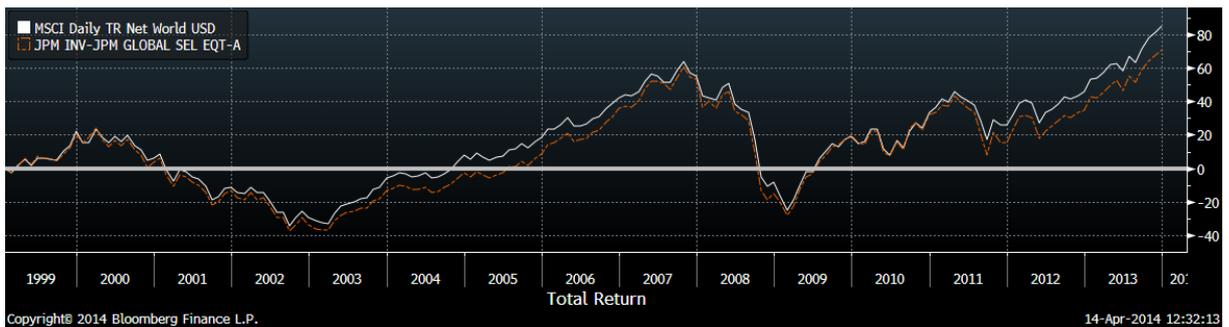


Figure 52. JPMorgan Investment Funds - Global Select Equity Fund return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 14. Characteristics of Sarasin Investmentfonds SICAV - Sarasin EquiSar Global



Figure 53. R^2 dynamics for Sarasin Investmentfonds SICAV - Sarasin EquiSar Global
Source: (compiled by the author)



Figure 54. Sarasin Investmentfonds SICAV - Sarasin EquiSar Global return vs. MSCI World Index return
Source: (Bloomberg, as of 23.05.2014)

Appendix 15. Characteristics of ING L Invest – World



Figure 55. R² dynamics for ING L Invest – World

Source: (compiled by the author)

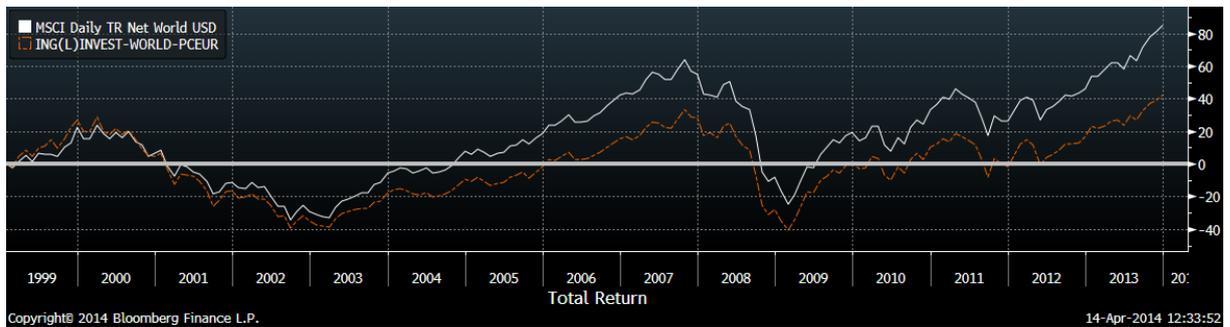


Figure 56. ING L Invest – World return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 16. Characteristics of BNP Paribas L1 - Equity World



Figure 57. R^2 dynamics for BNP Paribas L1 - Equity World

Source: (compiled by the author)



Figure 58. BNP Paribas L1 - Equity World return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 17. Characteristics of DWS Akkumula



Figure 59. R^2 dynamics for DWS Akkumula

Source: (compiled by the author)



Figure 60. DWS Akkumula return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 18. Characteristics of STANLIB Funds Ltd - Global Equity Fund



Figure 61. R^2 dynamics for STANLIB Funds Ltd - Global Equity Fund

Source: (compiled by the author)



Figure 62. STANLIB Funds Ltd - Global Equity Fund return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)

Appendix 19. Characteristics of Kaupthing Manager Selection - Global Equity



Figure 63. R^2 dynamics for Kaupthing Manager Selection - Global Equity

Source: (compiled by the author)

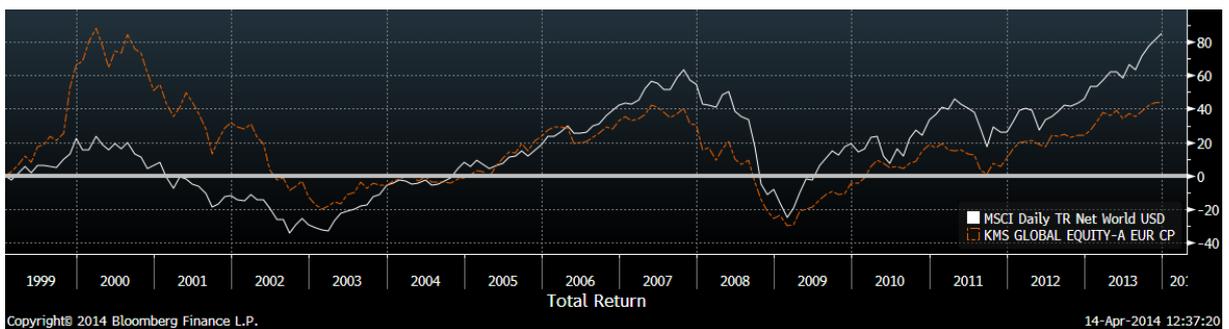


Figure 64. Kaupthing Manager Selection - Global Equity return vs. MSCI World Index return

Source: (Bloomberg, as of 23.05.2014)