HEDGE FUNDS AND THEIR STRATEGIES
- AN INVESTIGATION ABOUT CORRELATION MARKET NEUTRALITY AND THE IMPROVEMENT OF PORTFOLIO PERFORMANCE

MASTER PROGRAM “ACCOUNTING AND FINANCE”
Acknowledgement:

The authors would like to thank Barclays Bank and Greenwich Alternative Investments for supporting this paper with their hedge fund data. Moreover they want to thank Lehman Brothers for providing its Lehman Global Aggregate Bond Index that is not available over Datastream or Yahoo Finance. Also big thanks go to Håkan Bohman and Rickard Olsson, who supported this paper with their knowledge in research methodology and portfolio analysis. Last but not least, the authors want to thank Sandra Eckel, who helped the authors to integrate the theoretical knowledge of portfolio analysis into a functional portfolio analyser, programmed in Excel VGA that is partly based on Rickard Olsson’s portfolio optimizer for stocks.

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Abstract

Reading the daily financial news, it becomes quite obvious that hedge funds are receiving huge attention by financial analysts and politicians. Many people fear the influence of hedge funds on single companies as well as on the global economy. This study does not judge the behavior of hedge funds. Instead, it focuses on the nature of hedge funds and their mystique image. Especially the common view of their market neutral performance is of interest, which is theoretically achieved through the use of derivatives and short positions. In this thesis the feature of market neutrality is investigated in depth, since it can improve the overall performance of investors’ portfolios in bull as well as in bear markets through diversification effects.

Therefore the hedge funds and their environment, the capital markets, are examined from an academically point of view by emphasizing on the following research questions:

1. Are hedge funds performing market neutral in bull and bear markets?
2. To what extent should they be included in optimal risky portfolios according to Modern Portfolio Theory and advanced performance measurement tools, considering their degree of market neutrality?

This study is based on extensive knowledge of financial and econometric theories. Capital market theories, modern portfolio theory, hedge fund data and econometric knowledge about time series analysis build the basis for further investigations and are necessary to understand the characteristics of hedge funds and hedge fund data.

In order to be able to deal with the shortcomings of hedge fund data, an analytical framework for the preparation of data is created that enables the authors to start with the analysis of these questions. The framework is applicable to all kinds of hedge funds presented in this thesis and enables the reader to test further hedge fund classes by himself.

In a quantitative study the created framework is applied to 2160 hedge funds of Barclays Hedge Fund Database, which builds the basis for analyzing market neutrality. Further input for the portfolio optimization consists of 19 hedge fund indices, which were provided by the Greenwich Alternative Investment Hedge Fund Database and 4 benchmark indices for the stock and bond market.

The analysis consists of two different parts. For the first research question various correlation and return matrices are constructed, which shall provide information about market neutrality of hedge funds. A correlation matrix also serves as important input for the portfolio analysis and therefore builds the basis for the analysis of the second research question. This shall provide some fundamental recommendations about the weighting of diverse hedge fund classes in optimal risky portfolios.

The conducted analysis demonstrated clearly the following findings:

1. Market neutrality has to be rejected for most hedge fund strategies. It is only attainable through strategies, which focus more on arbitrage and/or the bond market and therefore seems to be more a by-product than an actually provoked feature.
2. Only two strategies, equity short and convertible arbitrage, managed to beat the benchmark and to improve the overall performance of the portfolio when taking the specific return distribution of hedge funds into account.
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Symbols of Formulas

Α  Autocorrelation Coefficient of Lag 1
β  Beta
Cov(X,Y)  Covariance of X and Y
d(t)  Deviation of Time
E(r)  Expected Return
N or n  Number of Securities
R_F or r_F  Risk-free Return
R_P or r_P  Return of Portfolio
ρ_{x,y}  Correlation Coefficient of X and Y
S  Standard deviation of a sample
Σ  Standard Deviation
Σ^2  Variance
V_b  Value old
V_e  Value new
W or w  Weight of Security in Portfolio Value-at-Risk
z_{CF}  New Critical Value
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<td>ARMA</td>
<td>Auto-Regressive-Moving-Average</td>
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<td>CAL</td>
<td>Capital Allocation Line</td>
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<td>Capital Asset Pricing Model</td>
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<td>CML</td>
<td>Capital Market Line</td>
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<td>DF</td>
<td>Dickey Fuller Test</td>
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<td>EMH</td>
<td>Efficient Market Hypothesis</td>
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<td>H(0)</td>
<td>Null-hypothesis</td>
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<td>Hedge fund</td>
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<td>Integration of order 1</td>
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<td>MSCI</td>
<td>Morgan Stanley Capital International</td>
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<td>MSR</td>
<td>Modified Sharpe Ratio</td>
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<td>MVaR</td>
<td>Modified-Value-at-Risk</td>
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<td>p.a.</td>
<td>Per annum</td>
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<td>PACF</td>
<td>Partial autocorrelation function</td>
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<td>Security Exchange Commission</td>
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<td>TIPS</td>
<td>Treasury Inflation Protected Securities</td>
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<td>VaR</td>
<td>Value-at-Risk</td>
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GLOSSARY

Auto-correlation
The correlation of a variable with itself over successive time intervals. It is also referred to as serial correlation².

Alpha
The abnormal rate of return on a security in excess of what would be predicted by an equilibrium model³.

Alpha/Jenson Index
A risk adjusted performance measure that shows the return in excess of the market return. To create alpha is the objective of hedge fund managers⁴.

Arbitrage
Performing a zero-risk, zero-net investment strategy, which still generates profits⁵. Zero-net investment implies short selling and afterwards repurchasing of securities so that a flat position is achieved, but with no risk associated to the profit. Possible through mispriced securities. See short and flat positions.

Bear market
A prolonged period in which investment prices fall, accompanied by widespread pessimism⁶.

Beta
Measures systematic risk, i.e. risk in relation to the market and it appears in the CAPM to estimate the expected return of an investment⁷.

Bull market
The opposite of bear market. It is characterized through increasing prices and optimism.

Covariance/Correlation
The covariance describes how much returns of two risky assets move together. Therefore it is a measure for the diversification potential of an asset. A positive covariance indicates that returns are actually moving together. A negative covariance indicates that returns are moving inversely. Because the covariance is difficult to interpret, the correlation coefficient is derived from the covariance. It scales the covariance. A coefficient of +1 involves a perfect positive correlation; a coefficient of -1 implies a perfect negative one⁸. Correlation refers only to the strength of a linear relationship between two random variables. It cannot measure non-linear relationships and does not involve causality.

Flat position
If you had no positions in the U.S. dollar or your long and short positions canceled each other out, you would be flat or have a flat book⁹.

Fund of funds
For this paper defined as a fund that invests in other hedge or mutual funds. It is also accessible for smaller investors.

³ Bodi/Kane/Marcus (2005), p.1047.
⁴ Bodi/Kane/Marcus (2005), p.868.
⁵ Bodi/Kane/Marcus (2005), p. 1047.
⁶ Bear Market.
⁷ Bodi/Kane/Marcus (2005), p. 283.
⁸ Bodi/Kane/Marcus (2005), p. 177.
⁹ Flat Position.
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<td>Index fund</td>
<td>A mutual fund that holds shares in proportion to their representation in an index. Index funds represent a low-cost passive investment strategy for all kinds of equity investors. It has the same risk-return relationship as the index and makes no attempt to create outperformance. One risk of index funds is the so-called tracking error, i.e. the possibility to deviate from the index due to time reasons or transaction costs.</td>
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<td>Intrinsic value</td>
<td>The actual value of a security, as opposed to its market price or book value.</td>
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<td>Kurtosis</td>
<td>It’s a measure of the outcomes of a distribution. A high kurtosis means a higher probability of large gains or losses. A normal distribution has a kurtosis of 0 or 3, depending on the formula.</td>
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<td>Leverage</td>
<td>Using debt capital in combination with equity capital in order to boost profits, since costs of capital for borrowed capital are less than for equity.</td>
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<td>Long position</td>
<td>Describes the position, which is attained through the purchase of a security. It is conducted, when the investors has positive expectations of the development of the market or security. Selling the security at its climax creates a profit.</td>
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<td>Market neutrality</td>
<td>In this paper a correlation coefficient of around zero to stock or equity markets.</td>
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<tr>
<td>Marking to market</td>
<td>Regular valuation of an asset based on current market values.</td>
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<td>Skewness</td>
<td>It’s a measure of the symmetry of a distribution. A negative (positive) skewness implies that large losses (profits) are more probable. A normal distribution has a skewness of zero.</td>
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<td>SEC</td>
<td>It’s a relatively small federal agency, headquartered in Washington with the aims to protect investors, to maintain fair and efficient markets and to facilitate capital formation.</td>
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<td>Short position</td>
<td>Opposite position of long. See short sales also.</td>
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<td>Short Sales</td>
<td>Short selling means to borrow securities from a third party and immediately selling them in expectation of a stock decrease. At the end of the decrease, securities are repurchased and returned to the lender. The spread of sales price and repurchase price, less the transaction costs and interests, shall earn a profit. This is a bearish strategy.</td>
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10 Bodi/Kane/Marcus (2005), p. 52.
11 Intrinsic Value.
14 Bodi/Kane/Marcus (2005), pp. 799-801.
16 SEC.
**Tender offer**  
A takeover bid in the form of a public invitation to shareholders to sell their stock, generally at a price above the market price\(^\text{18}\).

**Tracking error**  
The tracking error measures how much a fund deviates from a specific benchmark, due to time reasons and transaction costs. See also index fund\(^\text{19}\).

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\(^{18}\) Tender Offer.

1 INTRODUCTION

This first chapter derives the research question from important background information about the history and development of the hedge fund industry. The objectives are specified and the delimitations are outlined. Because of the large amount of definitions these can be found in the glossary.

1.1 BACKGROUND INFORMATION

When Alfred W. Jones constructed the first version of a hedge fund (HF) in 1949 by using short sales to protect his portfolio against declining share prices and by using leverage to increase its performance\textsuperscript{20}, nobody would have imagined how controversial this kind of funds would be discussed in the future. Their huge growth in administrated capital as well as in numbers of funds, incredible excess returns, financial power to influence companies and the lack of transparency and governmental control are only a few arguments that come in one’s mind when thinking about HFs nowadays.

Nearly all issues regarding today’s controversial discussions about the advantages and disadvantages of HFs are based on their specific nature and their mystique image. Due to their diversity, no overall definition of HFs is available in current literature. Therefore a description of their characteristics and mystique image has to suffice.

HFs can be seen as actively managed portfolios of investments. The word actively, mirrors their main goal to generate abnormal returns, irrespectively how the market is performing\textsuperscript{21}. In order to earn those returns, HF managers apply sophisticated investment strategies, such as leverage, the use of derivatives\textsuperscript{22} and long-short positions\textsuperscript{23}. These possibilities enable HF managers to create “option-like returns”\textsuperscript{24}. Looking for the alpha, they need to operate flexible in domestic as well as in international markets. Their legal structure facilitated the development of their mystique image. HFs are mostly private investment partnerships, which only give access to a limited number of investors\textsuperscript{25}. These investors have to be able to afford the high minimum pay-ins, the higher-than-average compensations of fund managers and have to bear additional contract rules. Those additional rules usually force investors to keep their capital in the fund until a specified time in the future, before they get the allowance to terminate their investment in the fund. Therefore mainly big institutional as well as wealthy private investors are privileged to access HFs and to profit from their performance. Their legal nature prevents a registration at the SEC or similar supervision authorities\textsuperscript{26}. Therefore, they are still excluded from most obligations to provide information. This makes HFs scarcely regulated and obscure.

Due to the ability to go short and to use derivatives the quite common view has arisen that HFs can behave market neutral, hence “offer an investment that has low to zero correlation with most traditional portfolios”\textsuperscript{27}. This means that returns of HFs can be low or even uncorrelated with the movements of the market. A correlation with market movements

\textsuperscript{22} Boyson (2002), p.3.  
\textsuperscript{23} Asness/Krail/Liew (2001), p. 2.  
\textsuperscript{24} Fung/Hsieh (2001) p. 313.  
\textsuperscript{25} Liang (1999), p. 72.  
\textsuperscript{26} Liang (1999), p. 72.  
\textsuperscript{27} Asness/Krail/Liew (2001), p. 2.
depends among others on the investment strategy of the specific fund and the bullishness or bearishness of the underlying market. It is questionable whether this widespread opinion truly reflects reality regarding all different kinds of HFs or if this is merely a prejudice fostered by the funds themselves. A famous example that supports these doubts is Amaranth, a HF that lost in one week 5 and in one month nearly 6.4 billion US Dollars, which was 65-70% of its former accumulated capital. Amaranth did not hedge its market exposure, in this case, the exposure to the oil market. This example challenges the common view of HFs being able to perform market neutral in bear and bull markets, due to their abilities of using derivatives and other investment tools to hedge uncontrollable risk.

The reader has to internalize that a security that features market neutrality in form of low correlations with a benchmark is desirable because of diversification effects. The integration of a market neutral security in a portfolio can reduce the whole risk of the portfolio and ensure a secure profit in bull as well as bear markets. Thus the low correlation with the overall equity market enables an investment to increase the expected return of a portfolio, while reducing its risk at the same time. Therefore this study investigates the market neutrality of HFs based on correlation coefficients and connects this investigation with modern portfolio theory afterwards.

In the past, several studies already investigated this important ability of HFs in similar respects. The reasons to perform a new test are changes in the global economy and in the HF industry as well as new knowledge about time series analysis and econometrics.

Already during the nineties the HF industry experienced an exponential growth and the assets under management grew from approximately US$40 billion in the end of the eighties to more than US$650 billion in 2003. In recent years the boom continued. According to the Hedge Fund Research Group “HedgeFund.net” total estimated assets managed by HFs in year 2006 amounted US$1.9 trillion. This represents an increase of 24%, even topping the growth of 18% in 2005. Since investors are not satisfied with traditional investment products, more and more mutual fund managers become alpha managers to satisfy the growing demand. This gigantic growth has serious consequences. For instance, some HFs began to refuse to accept new investors, due to the fact that additional capital would decrease the overall performance, when too less market inefficiencies exist. Contrary to those, other HFs went public to raise even more capital. The first one was the HF of Fortress Investment Group, with an accumulated capital of nearly 30 billion US Dollars. It gained more than 630 million US Dollar through its IPO in February 2007. It is obvious that this fund had not reached its capacity limit yet. By going public small private investors will be able to invest in those HFs simply by buying their shares. At the same time a registration at the SEC or similar authorities becomes necessary, which entails disclosure obligations. This will broaden the capital sources of HFs and accelerate the growth even more.

As mentioned above HFs are operating in national as well as in international markets seeking for the alpha. The globalization intensively affects the efficiency of capital markets and therefore the ability of funds to perform market neutral and the portfolio creation itself. The capital markets, like all other markets, become more and more interrelated and dependent. Since the markets move closer together the correlation between assets in different markets

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28 CBC News.
29 Oranika, Hedgeco.net (2007).
31 Oranika, Hedgeco.net (2007).
32 Warsager, AssetSight, Inc, p. 2.
33 CNBC News.
increases. Therefore, on the one hand, it becomes more difficult for funds to perform market neutral, but on the other hand, if they manage to do so, they are all the more valuable to investors and portfolio constructors. As indicated in the example, to perform market neutral is especially important in bear markets, when prices decline. Unfortunately, in bear markets the correlation between assets rises. Hence the diversification effects and the market neutrality are lost when they are needed most. A general market decline seems to negatively affect most companies in a similar way. This phenomenon is called diversification meltdown.\footnote{Kloy (2007), p. 12.}

These developments make older studies pretty much obsolete. Therefore this new study will be of particular interest for portfolio constructors as well as institutional and wealthy private investors, who want to improve the return-risk relationship of their portfolios. In some countries, where the law is less strict, this paper is also of interest for small private investors, since there, they face less legal restrictions when it comes to investing in HFs\footnote{E.g. Australia has quite relaxed laws.}.

For a proper understanding of HFs, HFs’ performance, their behavior according to market movements and their role in investors’ portfolios, several issues have to be considered. In order to cover all those issues, several different theories are necessary. This study introduces relevant theories that describe the capital markets and the construction of optimal risky portfolios. Moreover the knowledge about analysis of time series has improved. Current knowledge made it clear that older studies produced spurious results. Finally the characteristics and strategies of HFs are explained, which are necessary for performance interpretation. All these different theories will build a well-funded basement for investigations of market neutral behavior and the optimization of portfolios, including HFs. Not all HF classes are affected by the outlined developments in the same way. Hence they have to be examined separately. Since even sub-strategies, which will be introduced in the paper as well, are quite dissimilar, each single one should be tested for market neutrality and its use in efficient portfolios. As mentioned before, both aspects are interrelated.

\section*{1.2 Research Questions}

Considering the mentioned developments of HFs and their importance for optimal risky portfolio creation, this paper will deal with the following questions:

1. Are hedge funds performing market neutral in bull and bear markets?
2. To what extent should they be included in optimal risky portfolios according to Modern Portfolio Theory and advanced performance measurement tools, considering their degree of market neutrality?

\section*{1.3 Research Objectives}

According to the research question this study has basically two major objectives:

1. Investigating the correctness of the common believe that hedge funds behave correlation market neutral.
2. Providing investors and portfolio managers with guidance of how to improve the risk and return relationship of their optimal risky portfolios by using hedge funds.
1.4 Delimitations of the Study

One factor why HFs have such a mystique image is that their data is hardly available. Only being an accredited investor or the payments of huge annual fees, which cannot be afforded by normal students, allow access to HF databases. Due to the fact that the authors did not fulfill the requirements of accreditation and that USBE could not provide an account for a HF database, the collection of data was a very time and effort consuming process. Although the authors tried very hard to get access to as many databases as possible by addressing them via e-mail, most databases refused to reveal any information.

Nevertheless the authors were able to collect data from Barclay’s Database\textsuperscript{36} and Greenwich Alternative Investments\textsuperscript{37}, which contain data of 3024 HFs and 25 HF indices. Moreover one has to admit that some databases include 4-6 thousand different HFs and still do not cover all existing ones, which are approximately 9000 nowadays\textsuperscript{38}. For most HF classes, this is no problem, but some are underrepresented. The authors will make the readers aware of problematic classes with small sample sizes. As mentioned in the research objectives, this paper focuses on correlation market neutrality. There are other concepts like “tail neutrality” or “variance neutrality”\textsuperscript{39}, which are not considered in this study because of physical and time limitations.

Finally the optimizer and therefore the recommendations that are given regarding the structure of optimal risky portfolios have some restrictions. The optimizer can only handle three time series at the same time. So each optimization process only includes one single hedge fund index (HFI) and two market indexes. That is why an index that contains all HF classes has to be used to estimate an overall efficient portfolio including all HFs, bonds and stocks. No statements can be made about the weights of specific HF classes in this portfolio. Software, which is able to perform such tasks, is rare and much too expensive for students to afford.

1.5 Disposition

Chapter 2 - Research Considerations
In this chapter the authors describe and motivate the choice of the topic and of the methodological approach. The thesis workflow is presented as well.

Chapter 3 – Financial Theories
This chapter introduces relevant financial theories and literature, which are necessary to understand the analysis, the results and the whole context of the paper.

Chapter 4 – Econometric Theories about Time Series Analysis
These theories are necessary to understand the context of the analysis and the data preparation. They are the basis for the analytical framework that is applied in chapter six.

Chapter 5 – Secondary Data Description
The gathered data is described in great detail.

\textsuperscript{36} http://www.barclaygrp.com/products/databases/btg.html.
\textsuperscript{37} http://www.greenwichai.com.
\textsuperscript{38} E.g. Quarles (2006).
\textsuperscript{39} Patton (2005), p. 1.
Chapter 6 – Pre-Analysis – A Framework for Data Preparation
The single HFs data has to be adjusted before it is possible to conduct the analysis. The preparation process is outlined and explained in this chapter. The necessary knowledge was provided in chapter four.

Chapter 7 – Analysis
This chapter outlines the analysis procedure in great detail. It describes how the results, that are presented and interpreted in the following chapter, have been created.

Chapter 8 – Results and Interpretation
The results regarding both research questions are presented and interpreted step by step.

Chapter 9 – Conclusions
The research questions are answered and the objectives fulfilled. The most important findings are highlighted.

Chapter 10 – Future Research Suggestions
Issues that came up during the process of this thesis and which should be investigated further by future research are presented. All listed issues can be connected to this work.

Chapter 11 – Credibility Criteria
This chapter assesses the robustness of the results by providing information about reliability and validity. Generalizability is discussed as well.
This chapter will provide the reader with insights of how the authors decided to approach the problem. It also includes background information about the authors, in order to support the readers understanding of theory and methodology choices.

**Figure 2.1 - Thesis Workflow (self-made)**

*Figure 2.1* outlines the thesis workflow and the overall procedure that led to the research questions and ended with answering them. An extensive theory review is the basis of this thesis. Financial theories are necessary in order to understand hedge fund performance and portfolio optimization processes in general. The econometric theory provides analysis tools for the preparation and evaluation of secondary performance data. Therefore the whole theory part defines the examined constructs and explains the necessary knowledge to understand the results and to follow the previous analysis. After the gathering of data, literature and needed analysis tools, particularly the portfolio optimizers, an analytical framework is developed to prepare the single HF data. This framework illustrates step by step how secondary HF data has to be applied for a clean and trustworthy analysis. After that, the data is analyzed.
Correlation matrices and rankings are created to answer the first question. Then the optimizers are applied and performances based on two different measures are calculated to answer the second research question. In the results, the outcomes of the analysis are presented and interpreted. The conclusions refer back to the research questions and objectives.

2.1 BACKGROUND OF AUTHORS, CHOICE OF SUBJECT AND THEORETICAL PRECONCEPTIONS

Both authors have chosen to join the Erasmus-Socrates Program in order to take the advantage of studying abroad in the Master Program “Finance and Accounting” at the Business School of Umeå (USBE). During the program, it became quite clear that the authors were very interested in the financial markets with their underlying theories as well as the different investment possibilities. Moreover Roland Muske’s work in the field of alpha porting provided the authors already with a deeper knowledge of portfolio management. This interest was fomented by the nearly daily discussion of advantages and disadvantages of HFs in the financial press.

Above all, the Assistant Professor Rickard Olsson infected the authors with his enthusiasm and interest in portfolio management. His course introduction with the article “The Greatest Return Stories Ever Told”40 made the authors wonder how these huge abnormal returns could be achieved. All this leaded the authors to the decision to investigate the behavior of HFs according to market movements and their role in portfolio management.

The preconceptions of the authors developed mainly through gained knowledge from advanced financial courses, like Corporate Finance, Investments and Multinational Finance. Moreover, basic courses in statistics provided the researchers with the basic knowledge for the analysis process. Of course this represents only the basis of knowledge, which was further extended by research in advanced fields about financial market theory and statistics, exclusively to perform this study.

These preconceptions and the knowledge undoubtedly affected the choice of the relevant theories, since the authors were already aware of some of the necessary theories they had to consider. It also affected the acquisition of needed tools, in this case, particularly the use of the adjusted portfolio optimizer, which original version was provided by the Assistant Professor Rickard Olsson during the Investments course at USBE.

To prevent a distortion of the work through prior knowledge the authors did a lot of additional literature research to get a complete picture of present theories and knowledge. Therefore the prior knowledge merely facilitated the gathering of information but did not bias the process. The analysis itself is based on hard quantitative data41 and incorporates statistical and econometric methods, which are unaffected by subjective or personal influences.

2.2 RESEARCH PERSPECTIVE

First of all the research perspective has to be considered. This is a very important issue, due to the fact that it significantly affects the gathering and analysis of data. Therefore it is essential to match the research question(s) and objectives with the research perspective.

Regarding the research questions and objectives, it seems appropriate to choose two perspectives that are quite closely related. Firstly, the perspective of a rational and risk-averse

41 See page 48 how this influences the econometric part of this thesis.
investor, who wants to find superior investment tools and therefore investigates the risk and return of HFs compared with the stock and bond market, was selected. Secondly, the same issue is approached from the perspective of a rational portfolio constructor, who wants to build optimal risky portfolios for these investors by exclusively considering the risk and return of the available assets. Since rationality as well as the absence of unethical behavior is assumed, both perspectives are interchangeably. The perspectives of gamblers and speculators are left out.

2.3 RESEARCH PHILOSOPHY AND SCIENTIFIC APPROACH

Since this study investigates the performance of HFs and their influence on rational portfolio management, the research question already indicates that a positivistic approach has to be used. The positivistic epistemology is justified due to the fact that hard financial data is processed in a quantitative study. The numerical data is analyzed systematically by applying objective statistical methods and the results will leave little room for subjective interpretation. The empirical analysis is based on already existing knowledge about financial markets and statistical theories. The statistical methods are applied to test specific features of the capital market theories and to further complete the picture of modern portfolio theory in regard to HFs. Hence a deductive approach is being used.

The combination of a positivistic epistemology with a deductive approach using quantitative methods is common and straightforward. The last step of the deduction contains some inductive elements, which is often the case in fruitful deductive research. So the overall aim of this paper is to provide objective results that can be exploited to add additional theory to the already existing knowledge.

Moreover one has to mention that all the collected data for the analysis is secondary data. This means that the authors themselves did not collect the data, but it is provided by official databases, which were founded and are administrated by professional data collectors. In this case the HF data relies on the Barclays’ and Greenwich Database. Fortunately the data fulfil all necessary requirements to perform a sound analysis.

2.4 RESEARCH DESIGN AND CLASSIFICATION OF THE RESEARCH OBJECTIVES

As mentioned before, this study has a quantitative nature, using a deductive approach with positivistic epistemological orientation. Considering these issues together with the research questions and objectives, it becomes obvious that the study includes three different kinds of objectives. First of all, this study involves a descriptive part that provides information about HF strategies and performances. Furthermore, it has an explanatory character, due to the fact that the strength of the relationship, or synchronization, between different time series is investigated. The third kind of research objective is a normative one, since the aim is to provide information about to what extent different HF classes should be included in efficient portfolios.

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In general, the research design provides a framework for the collection and analysis of data. The one executed in this thesis has many characteristics of a cross-sectional design, since this design makes it possible to assess different subjects in a single point in time. In this study, the authors compare different HF strategies with a specific benchmark that represents the market. To cover more than one circumstance or characteristic an array of cross-sectional designs is necessary to cover a large variety of cases. The thesis is interested in the relationships between several variables and data collection is performed at a single point in time. To find patterns, a “rectangle”, i.e. a matrix consisting of cases and observations for each kind of HF, is the appropriate form of data structure. This is quite typical for cross-sectional designs. The same applies to the objective to give recommendations about efficient portfolio construction regarding HFs.

2.5-choice of database

“Choosing” a database as a normal student is perhaps the wrong term. The reason for this will be explained in the following. As mentioned before HFs feature a mystique image. This mystique image is caused on the one hand by the exemption from registering at the SEC and on the other hand through the limited access to HF databases. Only accredited investors or qualified purchasers get access. Accreditation requirements are often either a personal wealth of 1’000’000 US-Dollar or a net income over the last year of 200’000 US-Dollar. The requirements for qualified purchasers are even higher. This shall insure that only possible investors get access to sensible performance data. Most databases offer their data for an annual fee, which lies in a range of 2’000-5’000 US-Dollar. Since both authors do neither fulfill the requirements for accreditation, nor could they afford the annual payments, other ways had to be considered.

The authors wrote many e-mails to several different HF and HFI databases. Among others were HedgeFund.Net, HedgeCo, CISDM Alternative Investments Database, HFR Database, Eurekahedge, HedgeWorld, Morningstar, TASS Hedge Fund Database, MAR Database (Managed Account Reports), Barclays’ Alternative Investments Database and Greenwich Alternative Investments Database. The aim was to get at least one HF database for the first research question and one HFI Database for the second research question. Moreover they should cover similar periods in order to compare the findings of samples and indices. Every database was contacted by each author on its own and with a time difference of 2-3 weeks in order to increase chances.

The results were demotivating. Even twice contacting did not result in a response in most cases. Some replied, but the reply just contained a reference to their minimum fees and some even thanked us for advancing the idea of some kind of academical access. Three databases responded positively. After several more emails, in order to prove that the authors fulfill the requirements of being a student and that only anonymous HF data would be published, the authors received the database of Barclays and of Greenwich. Getting the access of the third one was a laborious way, which took nearly 6 weeks. After the authors finally got the data, it could not be included anymore, since the remaining time would not have been sufficient for another analysis. Therefore this database does not want to be named in this paper.

But those two databases fulfilled both purposes of the authors. Barclays’ database covers more than 3000 HFs, living ones as well as dead ones, and Greenwich Alternative Investments Database contains 25 global HFI s. Moreover both started in the 1990s and last till

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46 Breyman/Bell (2003), pp. 48 ff.
now, so that the time periods match. Thus an objective analysis can be conducted, due to a large variety of HFs and HFIs.

2.6 **CHOICE OF OPTIMIZERS**

The same problems about getting access to a database occurred regarding the attempts to get a portfolio optimizer. But here, the options were even more limited. The authors wanted an optimizer, which takes the special performance characteristics of HFs into account. Only two companies, alternativsoft\(^{48}\) and laportesoft\(^{49}\), provide such software. Since those companies were not interested in providing their software to students and other available shareware did not fulfill the requirements of the authors, other alternatives had to be sought out. Assistant professor Rickard Olsson developed an Excel based optimizer, which the authors already used in one of their finance courses at the D-level. With his allowance and advice, and with the help of the mathematics and computer science student Sandra Eckel, who is familiar with the Visual Basic Editor, it was possible to adjust this optimizer. In the end, the new optimizer was able to take the additional HF characteristics into account. This was done by the replacement of the simple standard deviation as the relevant risk measure by a more sophisticated risk measure, the Modified Value-at-Risk (MVaR), which will be introduced in the following chapter.

2.7 **CHOICE OF THEORIES**

Given the range and complexity of the research area in general, a large variety of theories is able to contribute aspects to the extensive analysis executed in this study. Some information about the choice of relevant theories is provided in the following, in order to prepare the reader for the following chapters and to direct the focus on the most important kinds of theories. The authors are well aware that too much and complex theory will cause the reader to lose the red thread of the research paper, but too less theory will decline the scientific value. Therefore this thesis will limit the amount to a well-chosen variety of theories, which are shortened to the most important factors regarding the following study. This should enable the reader to evaluate the empirical and analysis part. Thus, this paper will, whenever this is possible, use theories that D-Level students in Finance should know. Furthermore, statistical measurement tools, that were used by other researchers as well, are introduced in the theory section.

First of all the authors chose to introduce two mutual exclusive capital market theories, EMH and Behavioral Finance, in order to provide the reader with sufficient understanding of how natural and legal persons theoretically act on the market and what outcomes their action will cause. This is essential to understand and justify the behavior as well as the performance of HFs. It builds, so to say, the basis of all other investigations. Next to these two theories, no other general ones exist, that could have been taken into account.

Moreover an understanding of HF characteristics is essential. Therefore different HF classes are introduced, which shall provide the reader with an objective view of the return creation and the risk taking of different HF strategies. This knowledge is important for a later justification of the results. The authors chose to separate the classes through their level of risk. Here only those kinds of funds that are available in the gathered database and applied in the later analysis are presented.

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\(^{48}\) Alternativesoft.

\(^{49}\) Laportesoft.
In order to understand the framework of data preparation and the analysis itself, several econometric theories have to be introduced. The question of market neutrality is investigated with the correlation approach, which is the most common one in scientific researches of this kind. Another approach, which is also very interesting, but unfortunately not applicable in this study, is the cointegration approach, which is introduced in the chapter “Future Research”. Therefore only the correlation approach is introduced in the theoretical part. Before a correlation analysis can be applied the time series itself has to be investigated. Therefore the authors chose to explain theories that are particularly necessary for time series analysis of HFs and that are needed to follow this study.

For portfolio considerations, the Markowitz Portfolio Theory and Modern Portfolio Theory in general are chosen, since older theories are of no value today. A lot of extensions of the presented CAPM and the Markowitz model exist today. Due to the complexity of these extensions and their missing advantage regarding the relevant research questions, they are not considered. Last a performance measurement tool has to be chosen, in order to rank different efficient portfolio and to draw a conclusion. The authors chose two, the Sharpe Ratio (SR) and the Modified Sharpe Ratio (MSR). The first one is the most common one in practice as well as in modern research and is needed already to understand the underlying theory. The latter is an extension of the first one that was developed particularly for the investigation of HFs and similar assets.

2.8 ORIGIN OF THEORIES AND SECONDARY SOURCES

The enclosed references are all collected through the search in sources of Umeå University Library. Thus the collected literature and articles come either through the search in ALBUM or the databases Business Source Premier and Emerald Full text. Also Google Scholar was used, especially when the above named sources could not provide a full text file. A variety of different search terms were used. The most important ones were hedge funds, bias, alpha, beta, modern portfolio management, EMH, Behavioral Finance, cointegration, non-stationary time series, market neutrality and correlation. Further, available books from the University Library were used, particularly to grasp and facilitate the econometric implementation of the analysis. Since the authors are German, a few sources that were used are in German language.

2.9 CRITICISM OF REFERENCES

The authors are well aware of the fact that some models they use are in some extend controversial in their assumptions and that some sources are actually quite old. Regarding theories that are controversial, the authors did their best to use these sources only in the extent in which they correspond to each other. Concerning the age of some resources, one has to admit that the Markowitz Portfolio Model was continuously enhanced and builds one of the cornerstones in Modern Portfolio Theory nowadays. Thus there exists no real alternative. Furthermore, one could criticize that financial theories and models are only approximates of the real world, hence they will never cover reality to 100%. This is valid for scientific research in general, especially in the field of finance. Moreover a thesis on the master level is expected to have a quite high level of theory.

Nevertheless the authors tried throughout the whole study to provide the reader with the best theoretical information, in regards of up-to-dateness, relevance and understandability.

50 Before 1952 Markowitz Portfolio Theory
Also, the limitations of a secondary data analysis could be mentioned\textsuperscript{51}. But in the present case no other way of conducting the research is possible, due to the fact that a “normal researcher” gets no access to primary data of HF's. Thus one has to deal with the disadvantages as well as the advantages of secondary analysis. The disadvantages of using secondary data are small in this case. The data blends with the purposes it was gathered for. On request, the contact person, who transmitted the data, provided further information. The communication was fast and straightforward.

\textsuperscript{51} Breyman/Bell (2003), pp. 219-220.
3 FINANCIAL THEORIES

This chapter provides the theoretical background that is needed to understand the context of the research questions and all financial aspects of the thesis. In order to help the reader to grasp the structure of this part an introducing figure is presented first. Although all theories are relevant for comprehension, some directly refer to one of the research questions. This is also indicated in the figure.

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Guideline of Relevant Underlying Theories

<table>
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<tr>
<th>General Guideline</th>
<th>Guideline with Specific Theories</th>
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<tbody>
<tr>
<td>Market Theories for the understanding of characteristics of markets</td>
<td>Efficient Market Hypothesis</td>
</tr>
<tr>
<td>Introduction of hedge funds</td>
<td>Behavioral Finance</td>
</tr>
<tr>
<td>Introduction of the concept of correlation based market neutrality</td>
<td>Hedge Fund definition</td>
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<td></td>
<td>Description of HF classes</td>
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Necessary for Answering the First Research Question and Objective

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<tr>
<td>Introduction to Modern Portfolio Theory and performance measurement</td>
<td>Markowitz Portfolio Selection Model</td>
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<td></td>
<td>CAPM for further knowledge of relationships of markets and securities</td>
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<td></td>
<td>Risk adjusted performance measurement</td>
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</table>

Necessary for Answering the Second Research Question and Objective

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Figure 3.1 - Guideline of Relevant Underlying Theories (self-made)
3.1 UNDERLYING MARKET THEORIES

In order to understand the performance and strategies of HFs one has to consider the consistence of their environment, the capital markets. This paper will focus on the two most discussed and used theories, the EMH and Behavioral Finance. Both make conflictive statements. Due to the fact that these are two very complex theories, this paper will focus on the most important issues regarding the research questions and objectives.

3.1.1 EFFICIENT MARKET HYPOTHESIS = EMH

The Efficient Market Hypothesis was developed by Eugene Fama during his PhD. thesis in 1965 and was published afterwards under the title “Behavior of Stock-Market Prices” in the Journal of Business. Shortly after that, he rewrote his thesis into the more common known article “Random Walks in Stock market prices” and finally concluded his work in a groundbreaking paper, called “Efficient Capital Markets: A Review of Theory and Empirical Work” in 1970. The basic assumption of EMH is that security prices in the capital markets always fully reflect the available information and follow an unpredictable random walk. Regarding those papers as a whole, he classified the markets into three efficiencies, weak, semi-strong and strong. Under the weak form only historical data is incorporated in the prices and therefore technical analysis will fail in generating excess returns, but abnormal returns can still be generated by fundamental techniques. Semi-strong efficiency means that historical and current data, so called publicly available data, are available to all investors and that some forms of fundamental analysis will still provide excess returns. Under the strong form, all information, also insider-information, is available and it is only possible to earn higher returns by having good fortune or taking higher risks. Hence Fama sees the strong form of efficiency “as a benchmark against which deviations from market efficiency can be judged”. This means that even under the assumption of efficient markets, the market prices do not have to equal the “true” value of the investment at any time. Deviations are possible but they have to be random and are therefore useless for the creation of expected outperformance. Moreover he introduces the idea of normal distributed decisions of investors. This means that some deviations from true values will provide lucky investors with outperformance while other investors suffer from underperformance. As a whole, both effects will offset each other, so that in end the market is still efficient. This is also true if some investors do irrational decisions. In this case professional rational investors, so called arbitrageurs, will welcome the chance and smooth stock prices immediately. Nevertheless Fama had to admit that the “monopolistic access to information for corporate insiders and specialists”, like human market makers, represents an exception from the assumption of (strongly) efficient markets.

This view of capital markets was long time seen as the most important theory in finance. But the existence of some phenomena, so-called market anomalies, cannot be explained by the EMH adequately. The market crashes in 1987 (US, Europe), 2000/01 (World) and recently in 2007 (Asia) are only some examples. But also the small cap effect, which shows that small

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52 Fama (1970), most of the article.
56 Fama (1970), pp. 404-413.
57 Fama (1970), pp. 404-413.
companies are not accurately priced on the market, due to the focus of investors and analysts on large enterprises can be mentioned. Another example is the January effect, which shows that prices tend to increase more in this month, because of the trading behavior of large investors. They purchase securities, which were sold in large amounts by other investors in the end of December. This sale of securities is due to tax advantages that the companies want to attain in the end of the fiscal year. Also, the EMH fails to explain the excess returns generated by some managers despite limited arbitrage possibilities. The magnitude and persistence of these returns suggest something else than luck to be the reason for them. Since HFs try to generate alpha, i.e. to beat the market, and charge higher management fees than mutual funds for offering this service, the existence of HFs is not consistent with the assumption of strong market efficiency. In markets where prices follow a random walk, outperformance cannot be generated systematically. Some HFs actually do fit into the argumentation of the EMH, since they try to focus on less efficient markets to generate alpha, like the ones that pursue emerging market strategies. But until now, most HFs operate in mature and quite efficient markets. Like mentioned before, the EMH is not able to explain their existence since these markets are assumed to be efficient and therefore the alpha sources, which are exploited by the funds, should not be present. The EMH mentions the role of arbitrageurs. They are able to create outperformance at the costs of investors, who act irrational. In fact, a lot of HF strategies involve arbitrage transactions. But the EMH sees irrational decisions as an exception and states that a limited amount of arbitrage possibilities exist. Most investors are assumed to be rational, considering all available information. That is why this argumentation is not able to provide an explanation of the prosperous HF industry as well. A newer theory that is able to do so by assuming highly irrational investors will be introduced in the following.

3.1.2 Behavioral Finance

As mentioned above Behavioral Finance is a newer approach. Daniel Kahneman was awarded the Nobel Prize in 2002 for his contribution in developing this theory. He was one of the first\(^\text{59}\), who considered psychological issues regarding the decision making process and is still one of the most active researchers in this field. In general, Behavioral Finance is a combination of the fields of economics and psychology. Shefrin (2002) argues that particularly three issues, which are completely different from EMH assumptions, make this obvious\(^\text{60}\). First, members of Behavioral Finance believe that people will make errors, if they use so-called heuristics instead of rational models in order to analyze data. Heuristics are rules of thumb, which ease investing decisions. E.g. an investor, who will not invest in a fund with a bad performance during the last years, but in a fund, which was constantly developing well, uses a heuristic. Behavioral Finance states that a large amount of people follows those rules of thumb at the capital markets. Subjective and biased heuristics result in sub-optimal portfolios. Contrarily EMH argues that people use systematical and rational methods of analysis only. The second issue that is investigated by Behavioral Finance is about the circumstances, which influence decision-making processes. Shleifer (2000) calls this a “\textit{frame}”. Thus Behavioral Finance analyzes, how people are influenced by “\textit{form and substance}”, like timing pressure, need for liquidity, changing laws etc. The last issue combines the first and second one and asks if, and how, errors and frames influence security prices. This is supported by Behavioral Finance, but negated by the EMH.

Thus the main purpose of Behavioral Finance is to investigate the “\textit{fallibility in competitive markets}”\(^\text{61}\). Traditional theories only observe that some people are acting irrational or do not

\(^{59}\) Kahneman/Tversky (1979).

\(^{60}\) Shefrin (2002), pp. 4-5.

have the same quality of information or knowledge as others. Shleifer defines the Behavioral Finance observation as follows: “Behavioral finance goes beyond this uncontroversial observation by placing the biased, the stupid, and the confused into competitive financial markets, in which at least some arbitrageurs are fully rational. It then examines what happens to prices and other dimensions of market performance when the different types of investors trade with each other”. This leads to very interesting outcomes, like market bubbles, herd behavior and, above all, the under- and overestimation of fair values with the possibility to gain abnormal returns. In conclusion, one should not consider markets as efficient if psychological effects are taken into account for describing the behavior of humans. Hence, this model can better explain HFs, which benefit from market inefficiencies like arbitrage, over- and underestimations and bubbles.

To justify the authors’ choice of adopting Behavioral Finance as the main underlying theory despite the existence of the EMH a quote of Warren Buffet, the richest and most successful investor by today may be considered, “I’d be a bum on the street with a tin cup if the markets were always efficient”.

3.2 HEDGE FUND THEORY

In the previous section the environment, in which HFs operate, has been introduced. Further, the theoretical discussion about the general possibility to perform market neutral and to generate outperformance was presented. This section introduces the HFs themselves. First, a more detailed description of HFs in general than it was possible in the introduction is outlined. After that, the relevant HF classes and their strategies to create (out)performance are presented.

3.2.1 HEDGE FUND DESCRIPTION AND DEFINITION

There is no uniform definition of the term “hedge fund” in current literature. Also a legal definition, an industry-wide definition or a definition by the SEC or similar authorities is lacking. The term matches to a large variety of different fund strategies that are discussed in the following subsection. These strategies do not even have to involve hedging. HFs are usually structured as limited partnerships, with the general partner being the portfolio manager, making the investment decisions, and the limited partners as the investors. This legal form exempts the funds from a wide range of legal requirements and regulations. However as already indicated in previous parts, several funds decided recently to register at the SEC in order to facilitate capital rising.

Therefore for this paper a HF is defined as any registered or unregistered, privately-offered, managed pool of capital with currently only wealthy, financially sophisticated investors as target customers and which is associated with the following characteristics:

- Subject to the same market rules as any trader.
- HFs are a part of the alternative investments universe.
- Possibility to use derivatives and leverage. The allowance to perform short sales separates HF managers from mutual fund managers.
- HFs use different degrees of leverage. Some strategies are not viable without large amounts of leverage; other strategies do not involve leverage at all.

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64 HedgeCo.
65 Plummer (2007).
66 Plummer; these customers meet the SEC definition of an “accredited” investor.
67 They are sometimes referred to as “long-only” managers.
• Performance is measured in absolute terms (returns), not relative to a benchmark.
• The returns come from different sources in different proportions. Thus the “absolute return” consists of returns from the underlying markets and alpha sources. The target absolute return is always higher than that of a passive strategy.
• Different kinds of fees are charged. Most common ones are a 1-2% p.a. fee of asset under management and a 20% p.a. fee of profits.68
• HF managers almost always invest in their own funds. This hinders the HF managers to take uncontrollable risks.69
• Some widespread opinions are: Their superiority in bear markets, low correlation with equity markets, high return potentials and usefulness for diversification.

3.2.2 HEDGE FUND STRATEGIES AND STYLES

In this section the different HF strategies and styles are introduced. Introducing the different kinds of strategies is important, since the analysis will examine HFs dependent on their strategy. Knowing the different HF classes also makes it possible to predict several outcomes of the analysis and to compare expectations with actual findings. The basic characteristics of HFs are their “location” and strategy. Location describes “where” the manager trades, i.e. the choice of asset classes. Strategy refers to “how” the manager trades, i.e. how are those asset classes used to create returns.70 Style comprises both features, e.g. global macro implemented with bonds.71 This paper focuses on strategies only. Although the different strategies are well described in current literature, by HF databases or HFs themselves, no uniform structure of HF strategies can be found. Many different classifications are used in current theory:72

• Directional vs. non-directional funds
• Funds based on arbitrage or speculation,
• Market speculating, market hedged, market independent and market neutral
• Relative value, event, equity hedge and global
• Global, event and market neutral

These different classifications show the complexity and variety of the HF industry. An own classification is illustrated in Figure 3.2.

The selected classification for this paper is based on the objective to test market neutrality and on the goal of covering the fund strategies that can be found in the received database. The applied structure is a modification and extension of the classification described by Singer or by the famous HFI provider CSFB/Tremont. Other strategies are not included in the later analysis and the framework will be applied to these strategies only. See Appendix 4 for the development of classes over time.

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70 Fung/Hsieh (2002), p. 3.
73 Agarwal, Naik (2000), pp. 3-26; Directional strategies like global macro and long-short equity use strategies that are successful if the market develops in a specific direction.
76 Kat (2003), pp. 72-83.
3.2.2.1 RELATIVE VALUE

Relative value strategies try to profit from price inefficiencies by buying undervalued securities and short selling overvalued securities. They offer the lowest capacity since existing arbitrage possibilities cannot cover the increasing demand for HFs\(^79\). Relative value strategies try to minimize some market exposure inherent in the underlying market, e.g. the stock market\(^80\). Then they focus on the remaining exposure and inefficiencies and are therefore less risky and more sought after than other classes. Market neutrality of these classes can be expected. Subcategories are explained in the following.

3.2.2.1.1 Equity Market Neutral

These strategies attempt to create zero net exposure to the market by offsetting any long equity positions with short equity positions of an equal US$ amount. The return comes from the relative mispricing of the selected securities. Already the name indicates that market neutrality is expected to be high.

\(^{78}\) Compare Bessler/Drobetz/Henn p. 10.
\(^{79}\) Maier/Altwegg (2005).
\(^{80}\) CISDM Research Department.
3.2.2.1.2 Convertible Arbitrage
Funds using this strategy buy and sell the securities of the same issuer. Usually fund managers go long in convertibles, like convertible bonds, while taking a short position in another security of the issuer, which is usually the underlying common stock. The return is created through the spread between both positions. The relative volume of this strategy compared to the whole capital invested in HFs is very low. These funds are expected to show a low or zero tandem movement with the market.

3.2.2.1.3 Fixed Income Arbitrage
“Fixed income arbitrage funds, buy treasury bonds, and sell short other bonds to replicate the bonds purchased in terms of rate and maturity.” Therefore offsetting positions are created and the exposure to interest rate risk is neutralized. Furthermore returns are generated through exploiting mispricing of fixed income securities and their derivatives in the global market. If the fund focuses on mortgage-backed fixed income securities the same strategy is sometimes labeled mortgage-backed security strategy.

3.2.2.1.4 Statistical Arbitrage
A long portfolio of undervalued and a short portfolio of overvalued stocks are created through statistical analysis and quantitative selection criteria. Both positions approximately offset each other. The positions change often because the over and under valuation of the selected securities does not persist over a long period of time. Due to the low exposure, these funds are also expected to be market neutral. A common sub strategy is called “pairs trading”.

3.2.2.1.5 Multi Strategy Arbitrage
This strategy tries to explore all kinds of arbitrage and therefore includes all other strategies that were presented in this subsection.

3.2.2.2 Event Driven
These strategies try to take advantage of specific events. All kinds of events that create large price movements are potentially relevant. The opportunities are exploited by using instruments like long and short common and preferred stock, bonds, options and credit default swaps, sometimes also higher levels of leverage. These managers believe that the market cannot evaluate the present situation in a proper way. It is assumed that all event driven funds are independent of market movements. Event driven strategies are clearly circumscribed in current literature and practice.

3.2.2.2.1 Distressed Securities
Distressed Security strategies involve investing in companies that are in financial distress. These companies face bankruptcy, perform a reorganization of some kind or are just emerging from bankruptcy. The most common procedure is to buy those securities at discounted prices and harvest profits if the reorganization turns out to be successful. In case of bankruptcy, HFs can still achieve a positive return if senior debt was bought that can be served from the

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82 Füss/Hermann (2005), p. 31.
liquidation value. This strategy also includes the short selling of securities of a company, which situation is getting even worse. Another possibility is to provide newly reorganized companies that just emerged from bankruptcy with equity, the so-called “orphan equity”.

3.2.2.2 Merger Arbitrage
Merger Arbitrage involves investing in companies that face an acquisition or a merger. Alternatively companies that are preparing spin-offs, or are subject to a tender offer, are targeted. Assuming that most acquisitions tend to be a failure in the long run, a very common strategy is to “long the acquiree, short the acquirer”.

3.2.2.3 Opportunistic Strategies
Opportunistic strategies focus on buying undervalued securities or markets and selling overvalued ones, without the attempt to minimize the underlying market exposure. Therefore hedging risk is not much a part of their operations. Their return is therefore a mixture of alpha sources and market returns. They are labeled opportunistic because these strategies involve beliefs contrarily to the ones that prevail in the market, particularly when some special events lie ahead. The correlation of most of these HFs with the underlying market is expected to be higher than in the case of the classes described before.

3.2.2.3.1 Long Short Equity
The very first HF created by Alfred W. Jones belonged to this category and it is still the most typical one. The general idea is to buy undervalued stock and to short sell overvalued stock. In bull markets the HF invests in stocks and attempts to harvest the returns that are provided by the overall market development. In this circumstance the HF is managed like an index fund. In bear markets the fund executes short sells in order to benefit from decreasing prices. So, in theory, the fund has nearly the same performance in bull and bear markets, apart from the interest the fund has to pay to the provider of the securities for the short sale. It is expected that this kind of HF is negatively correlated in bear markets only. The fund is able to invest in all kinds of securities in different markets. Since this strategy has a high capacity, it is the HF class with the highest volume. This class must not be confused with relative values strategies and in particular with equity market neutral strategies, which have been explained in the previous sub-section. Indeed, some sources assess long-short-equity strategies and relative value strategies as subgroups of market neutral strategies. This is problematic since long-short equity strategies should behave positively correlated in bull and negatively in bear markets. Therefore long-short equity is exposed to market movements, instead of performing market neutral. Different sub-strategies of long-short equity exist, but since these are often summarized under the term “long-short equity” they are just briefly mentioned in the following. Equity long bias and equity short bias strategies emphasize on either long or short positions respectively. Aggressive growth strategies usually have a long bias and focus on investing in companies with strongly growing earnings per share that are identified through technical or, more often, fundamental analysis. Value strategies involve fundamental analysis in order to compare the actual share price with the intrinsic value of the company.

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87 Van Money Manager Research, LLC (2005).
88 See Glossary.
Managers using this strategy believe in stock prices that are fluctuating around the intrinsic value and in temporarily appearing disequilibria. Value strategies are somehow connected with event driven strategies, since events affect both, share price and intrinsic value. Sector strategies simply focus on a certain sector, branch or industry.

3.2.2.3.2 Emerging Markets
The emerging market strategies are solely defined by geography and are quite heterogeneous. The managers emphasize on investing in securities issued by companies or governments from countries with less developed economies and financial markets. These economies are defined by per capita Gross National Product and the markets tend to have a higher volatility and inflation. The most famous security regarding these strategies is the Brandy Bond, a bond that is issued by governments from the corresponding countries. Currently, emerging markets are mostly located in Latin America, parts of Asia and the Middle East. These strategies can be labeled opportunistic, due to the fact that no possibility of short selling exists in most emerging markets and therefore hedging is very restricted.

3.2.2.3.3 Global Macro
Managers following these strategies employ a top-down approach to create the portfolio and attempt to realize profits from the movements of whole asset classes or markets. Stock selection is not performed at all. The managers keep track of interest rates, currency prices, government policies, inflation rates and commodity prices to predict future trends in these markets. The attractiveness of different markets regarding Global Macro strategies may vary over time. Thus managers have to be familiar with most, or all, global security markets. Since these strategies often involve a large amount of leverage and operate in a highly complex environment they are regarded as highly volatile and extremely risky.

3.2.2.3.4 Market Timing
Managers using this strategy use models and intuition to predict market movements. The results are used to shift capital from one segment to another in order to profit from rising prices and to avoid losses at the same time. If the managers focus on mutual funds in order to save transaction costs these managers are called mutual funds switchers.

3.2.2.4 SPECIAL STRATEGIES
These strategies do not fit in one of three categories above and have to be looked at separately.

3.2.2.4.1 The Pipe strategy
The pipe strategy got its name from the “pipe” sector. The term “pipe” is a shortcut for private investments in public entities. The pipe sector is sometimes called the Reg D sector and therefore the strategy is also known as the Reg D HF investment strategy. This sector refers to a market, in which so-called Reg D investors buy securities directly from the public entities.
company that issued it, after individual price negotiations. Usually the securities are acquired at a discount to current value, due to their high level of risk and their temporal illiquidity\textsuperscript{103}.

This is possible because of the Regulation D of the Securities Act written in 1933, which makes it possible to sell some unregistered securities to qualified investors\textsuperscript{104}. The idea behind this rule was to enable companies in financial distress to raise capital and keep on going, but there is also much potential for misusing the given leeway. The most questionable ways to make use of the Regulation D are so-called “death-spiral” or “toxic” converts. These convertible bonds allow the pipe investor to convert their bonds for more stock, if the price of the stock declines\textsuperscript{105}. Of course, only companies in serious trouble issue such securities. Pipe investors usually short sell the shares they will get after conversion, since they are not allowed to trade the pipe securities in the public market for a certain period of time\textsuperscript{106}. This short sale depresses the share price even further, providing the investor with more shares and so on. This “death-spiral” destroys the value of the equity at the costs of existing shareholders until the pipe investors extracted all remaining value out of the company before it has to announce bankruptcy. Fortunately, the amount of death-spiral converts decreased considerably in recent years because of bad publicity\textsuperscript{107}. The only risk the pipe investor has to face when investing in these converts is that he might not be able to borrow enough shares to short sell all securities he will receive, hence keeping some of the decreasing or worthless securities\textsuperscript{108}. But even without death-spiral converts the pipe strategy is quite profitable through arbitrage trades. Due to the bad reputation of this strategy it is often disguised and included in a multi strategy\textsuperscript{109}.

3.2.2.4.2 Blanks

This is not an independent group or strategy. The authors decided to form an own group of all HFs that did not provide any information about their strategy. Deleting those HFs would have meant to loose over 20\% of HF data. Thus one can see this group more as a portfolio of different HF strategies that can be included in the analysis without making any conclusions regarding the type of strategy.

3.3 CORRELATION BASED MARKET NEUTRALITY

After HFs have been introduced and their strategies to create returns that can be generated independently from the underlying market have been outlined, the theoretical concept of market neutrality has to be considered. Since this theory directly refers to the analysis of the first research question, it is of particular importance to interpret the corresponding results.

There are many ways to define market neutrality and all of them are potentially of interest for risk-averse investors. Dollar neutrality, variance and value-at-risk neutrality are some examples\textsuperscript{110}. Since they are not relevant for this study an explanation can be omitted\textsuperscript{111}. This thesis deals with the very basic concept of correlation neutrality. The relationship between the HF returns and a market index is expressed by the correlation coefficient. There are two

\textsuperscript{103} Huemer (2004).
\textsuperscript{104} Huemer (2004).
\textsuperscript{105} Huemer (2004).
\textsuperscript{107} Huemer (2004).
\textsuperscript{109} Huemer (2004).
\textsuperscript{110} For information about these concepts see Patton (2005).
\textsuperscript{111} For information about these concepts see Patton (2005).
possible definitions of correlation neutrality\textsuperscript{112}. One says that HF returns have to show a correlation with the underlying market around zero in order to be named market neutral. In the other definition a correlation around zero or below is sufficient. This last definition evolved because of the favorability of low and negative correlations, since this is what investors seek for. As mentioned in the introduction, most assets show highly positive correlations. Even though this paper investigates the diversification power of HF's to answer the second research question, it still regards the first definition as relevant for this study. From the point of view of the authors, a highly negative correlation does not indicate correlation market neutrality. Even though it might be desirable, it still implies that market movements influence the asset. To assume a correlation close to zero as the relevant indicator is therefore theoretically sounder. For purposes of this study the degree of correlation is more important than looking at critical values. However, in order to define a border, this paper assumes that all correlation coefficients in the interval from [-0.1; 0.1] indicate market neutrality. This is a quite strict assumption but reasonable when emphasizing on diversification potential. Diversification effects will be discussed later in this chapter.

The relevant markets, the HF's have to be compared with, are the stock or equity markets. Here, the correlations between assets are high and increasing because of the globalization. So being market neutral in regard to the stock market is a real challenge. That is why the term “market neutrality” usually refers to the market neutrality in regard to the stock market. The correlation to the bond market is tested in this paper as well, but here, market neutrality can be expected. Rising interest rates cause investors to shift capital from the stock to the bond market. This leads to a lower demand for stocks and a higher one for bonds. Therefore low correlations are not surprising. Additionally, since bonds offer lower returns than stocks, investors seek for assets that deliver a high return and are able to reduce the risk of their stock portfolios at the same time. So market neutrality to the stock market is important since all assets that provide high returns also tend to show high correlations in regard to this market.

“The correlation is probably one of the most widely used, yet also one of the most frequently misused statistics in the natural and behavioral sciences”\textsuperscript{113}. Thus the authors see a need to give a short explanation for the inexperienced reader.

In general, correlation deals with the issue, how two or more variables are related to each other. This paper will deal with the most common known and easiest case by comparing two variables, HF's and market benchmarks, regarding their return and standard deviation. The strength of the linear relationship between those two variables is measured by correlation coefficients with ranges from \(-1 \leq \rho \leq 1\). Correlation is calculated by using the covariance and the standard deviations of each variable. The formula of the so-called Bravais/Pearson Correlation Coefficient looks like the following:

\[ \rho_{X,Y} = \frac{\text{cov}(X,Y)}{\sigma_X \sigma_Y} \]

According to the research questions and objectives the results should show that at least one HF strategy/class has a correlation to a specific equity market benchmark of almost zero. Such a result would prove market neutrality for this certain class. If the majority of HF's would feature market neutral, or almost market neutral, correlation coefficients, the common view of market neutrality can be affirmed; otherwise it has to be rejected.

\textsuperscript{112} Patton (2005), pp 5-6.
\textsuperscript{113} Carroll (1961) and Chen/Popowich (2002), p. 1.
\textsuperscript{114} Bodi/Kane/Marcus (2005), p. 177.
Regarding optimal portfolio creation a correlation coefficient of less than 1 between the included assets is desirable, due to the fact that this would decrease the standard deviation of the whole portfolio through diversification. This will be explained further in the section that introduces the Markowitz portfolio selection model. But one has to be careful in the use of correlation. One important issue, which has to be considered when applying correlation analysis, is the difference between relationship and causality. Relationship and causality are not the same. Relationship takes only the considered variables into account; causality instead implies for example a third variable that may influence the other two ones. One simple example makes this issue clearer. It is quite clear that time and distance are perfectly correlated to each other, when the third variable speed is constant. But still, no one would argue that time causes distance\textsuperscript{115}. Due to the fact that only relationships are of interest, there is no need for defining dependent and independent variables in this study. Additionally it is important to bear in mind that correlation measures linear relationships only and therefore cannot reveal non-linear ones.

3.4 MODERN PORTFOLIO THEORY

In order to evaluate how HF s should be included in optimal risky portfolios, one has to be familiar with Modern Portfolio Theory. This theory is based on several separately developed theories. First Markowitz developed his Portfolio Selection Theory, which basically gives insights in the decision making process of one investor regarding his portfolio. This framework was subsequently expanded, but still contains its original fundamental ideas and assumptions. After that, Sharpe and Lintner picked up the idea of the Markowitz Portfolio Selection Theory and developed the Capital Asset Pricing Model (CAPM), an equilibrium model. Since then more and more theory is added. This paper will mainly deal with the Markowitz Model and in certain parts with the CAPM.

3.4.1 MARKOWITZ PORTFOLIO SELECTION THEORY AND EFFICIENT PORTFOLIOS

Markowitz starts out his study by rejecting the former assumption that creating efficient portfolios solely involves a maximization of discounted anticipated returns without considering risk\textsuperscript{116}. According to this obsolete way of thinking, it would be possible to maximize portfolio value by merely picking the security with the highest expected return. Instead, he realized that creating efficient portfolios is a matter of optimization, not maximization. The risk-return relationship can be improved through diversification. His static model states the rule “to diversify among all those securities, which give maximum expected return”\textsuperscript{117}.

Diversification is another way to deal with portfolio risk, next to hedging. “To diversify” means to reduce the risk of the portfolio by utilizing the inter-correlation of at least two risky securities. By investing the available capital in many different assets the risk of the overall portfolio becomes less than the risk of any single asset considered in isolation\textsuperscript{118}. The Markowitz Portfolio Selection Theory is based on the standard deviation as the relevant risk measure. This diversification effect occurs as long as the securities do not show a perfectly positive correlation. In a two-security case, the correlation coefficient between the securities has to be less than +1 in order to lower the risk of the portfolio that consists of these two

\textsuperscript{115} Chen/Popowich (2002), p. 5.

\textsuperscript{116} Markowitz (1991), p. 470.

\textsuperscript{117} Markowitz (1952), p. 79.

\textsuperscript{118} Bodi/Kane/Marcus (2005), p. 174.
securities. If both securities show a perfectly negative correlation, the risk of the respective portfolio can be eliminated completely. Therefore, theory states the lower the correlation, the greater the benefit\textsuperscript{119}.

To understand this behavior the formulas of the risk and expected return of portfolios that consist of only two assets are illustrated:

\textbf{Expected Return}\textsuperscript{120} \[ E(r) = w_1 \cdot E(r_1) + w_2 \cdot E(r_2) \]

\textbf{Variance}\textsuperscript{121} \[ \sigma^2(p) = w_1^2 \cdot \sigma_1^2 + w_2^2 \cdot \sigma_2^2 + 2 \cdot w_1 \cdot w_2 \cdot \rho_{12} \cdot \sigma_1 \cdot \sigma_2 \]

As can be seen in Formula 3.2 the expected return of the portfolio is simply the weighted average of the returns of the single securities in the portfolio. This is not the case when looking at the standard deviation. The correlation coefficient in Formula 3.3 is the reason for the diversification effect.

To complete the picture it is necessary to mention that to diversify cannot eliminate or reduce all kinds of risk. Risk that can be diversified is called unique, nonsystematic or firm-specific risk. Risk that cannot be diversified away is called market risk, systematic risk or just nondiversifiable risk. If some of the portfolio risk is market risk, it cannot get eliminated completely through diversification. The reason why diversification does not affect market risk is that this risk comes from market wide risk sources that affect all companies in the same way\textsuperscript{122}. For instance, changes in technologies, that cause a whole industry to decline, represent systematic risk.

As one can imagine finding the optimal weights of securities in a portfolio is therefore a laborious process, which can only be done by portfolio optimization software, considering the immense number of different securities, which are available in practice. Thus Markowitz Portfolio Selection Theory is particularly important for large institutional investors like banks, pension funds or insurance companies that invest large amounts of capital in a great variety of securities or assets. However, also small private investors should diversify their portfolio dependent on their risk aversion and transaction costs, which are ignored in theory.

Such software uses the return-variance rule. This means, it calculates first all attainable combinations of given securities, which will result in a kind of bubble in the standard deviation-expected return graph. To do this, an input matrix, which consists of variances, expected returns and all covariances between the assets, is needed.

In the second step the minimum-variance frontier of risky assets will be calculated by looking for “minimum variance for given return or more”\textsuperscript{123}. The first two steps can be seen in Figure 3.3.

\textsuperscript{119} Bodi/Kane/Marcus (2005), p. 233.
\textsuperscript{120} Bodi/Kane/Marcus (2005), p. 175.
\textsuperscript{121} Bodi/Kane/Marcus (2005), p. 178.
\textsuperscript{122} Bodi/Kane/Marcus (2005), p. 224.
\textsuperscript{123} Markowitz (1952), p. 82.
The third step is now to eliminate all inefficient combinations to get the so-called efficient frontier, which is usually a curved line of all efficient portfolio combinations available for the investor. All portfolios that lie on the efficient frontier provide the best possible risk-return combinations. There are no other portfolios that give a higher return for the same risk or a lower risk for the same return. The inefficient portfolios on the minimum-variance frontier, which have the same risk, but less return than other possible portfolios, all lie beneath the minimum variance portfolio. Hence, this part of the minimum-variance frontier has to be eliminated to keep the efficient part of the curve only. The minimum-variance portfolio is the portfolio with the lowest variance of all. After this calculation the efficient set will be only half of the curve in Figure 3.3. The efficient frontier can be expanded through the negligence of the restriction that the weight of each asset in the portfolio has to be positive. The negligence of this restriction implies the allowance of short sales. This has to be emphasized since the optimizer that is applied later to investigate the second research question also lacks this restriction. This makes sense since investors who are allowed to invest in HFs are often also allowed to perform short sales themselves.

The forth step involves to find the optimal risky portfolio, by considering the risk free asset, which has a standard deviation of zero. This optimal portfolio is the tangency point of the Capital Allocation Line (CAL) with the steepest possible slope and the efficient frontier. The CAL is a straight line originating at the risk-free return and features a slope as follows:

**Formula Slope alias Sharpe Ratio**\(^{125}\)

\[
SR = \frac{R_P - R_F}{\sigma}
\]

The slope is an important performance measure that will be introduced in the last part of this chapter. It is called the reward-to-variability ratio, or just Sharpe Ratio (SR). By mixing the optimal risky portfolio with the risk-free asset, the investor can chose an own optimal portfolio that lies on this CAL. He will do that on the basis of his particular risk aversion and utility. So the consistence of the optimal risky portfolio is independent from the personal preferences of the investor.

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\(^{124}\) Modelled after Markowitz (1952), p. 82.  
\(^{125}\) Bodi/Kane/Marcus (2005), p. 203.
preferences of the investors. This phenomenon is called the separation property. It will be very important for the interpretations of the results of the second research question, since the personal preferences of investors are ignored. In this study the optimal risky portfolio symbolizes the portfolio every rational investor wants to hold, if only HFs, stocks, bonds and treasury bills or TIPS\textsuperscript{126} ($R_F$) would be available on the market. For practical reasons other risky assets like commodities are not considered. Figure 3.4 illustrates the result of the portfolio selection process.

![Figure 3.4 Efficient Frontier of Risky Assets with the Optimal CAL\textsuperscript{127}](image)

### 3.4.2 CAPITAL ASSET PRICING MODEL (CAPM)

The CAPM is presented here to get a better understanding of the terms “alpha” and “beta”, which have been mentioned sometimes in the text and which are briefly explained in the glossary. A deeper understanding from a strict theoretical point of view will contribute to the comprehension of the theory part so far and particularly to the comprehension of the following discussion about risk-adjusted performance measures.

As mentioned above the CAPM is based on Markowitz early work and is an equilibrium model. Its underlying assumptions go one step further. Its most important assumptions are the existence of rational mean-variance optimizing investors, who all use the Markowitz portfolio selection model and who are shortsighted in their investment planning. Further it is assumed that investors are price-takers, since their individual wealth proportion is small compared with the overall wealth. Everybody can borrow and lend at the same risk free rate. In the original version of the theory taxes and transaction costs are ignored and the investment universe is restricted to publicly traded assets. The final assumption that is derived from the previous ones is that investors have homogeneous expectations about future developments. These assumptions follow some implications. One is that all investors will hold the same market portfolio, consisting of all non-risk-free assets. This market portfolio lies on the efficient frontier and is the tangency point between efficient frontier and the optimal CAL. This CAL that goes through the market portfolio is called the capital market line (CML). Another

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\textsuperscript{126} See also chapter seven.

\textsuperscript{127} Modelled after Bodi/Kane/Marcus (2005), p. 244.
implication introduces the so-called beta, which is the sensitivity of an individual asset to the mentioned market portfolio M.

\[
\beta = \frac{\text{Cov}(\sigma_i, \sigma_M)}{\sigma_M^2}
\]

A beta of 1 indicates that a security has the same sensitivity and consequently the same risk and expected return as the market. Therefore the risk premium, i.e. the expected return in addition to the risk free return of an asset can be calculated by using its beta:

\[
E(r_i) - r_f = \beta_i \left( R_M - R_F \right)
\]

With a small adjustment the famous expected return-beta relationship is derived:

\[
E(r_i) = r_f + \beta_i \left( R_M - R_F \right)
\]

The beta of the market portfolio with itself is assumed to be 1 and the alpha is defined as the difference between a harvested and a theoretically expected rate of return, regarding the taken risk. Graphically this relationship and its connections to the alpha and beta figures can be expressed in the Security Market Line (SML). Figure 3.5 illustrates this relationship.

![Security Market Line (SML)](image)

**Figure 3.5 - Expected Return - Beta Relationship (SML)**

The problem of CAPM is that it is based on nearly the same assumptions as the EMH. Therefore assumptions like perfectly efficient capital markets, which imply rational behavior of investors and no arbitrage possibilities, would not match our previous assumptions of

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128 Bodi/Kane/Marcus (2005), p. 283.
129 Bodi/Kane/Marcus (2005), p. 283.
130 Bodi/Kane/Marcus (2005), p. 288.
131 Modelled after Bodi/Kane/Marcus (2005), p. 291.
capital markets. In fact several investigations have shown that the real SML is flatter than suggested by the model, i.e. the slope that was found by regression analysis was lower than the theoretical one of $r_m - r_f$, and the intercept larger than the risk-free rate.

But still, the basic idea is essential for the following study and calculations. The authors want the reader to understand that beta shows the volatility of a security according to market movements and that alpha is the (positive or negative) excess-return of a security, which means the difference between its actual return and its expected return predicted by an analysis model. Thus beta risk, also called market risk, is able to explain that part of the return, which can be generated by investing in assets from a risky market, often the stock market. Alpha symbolizes the part that cannot be explained by market movements. Therefore a positive alpha indicates market neutral performance and expresses the ability to beat the market. It is a measure that can only be interpreted in relation to a benchmark that usually represents a particular market\textsuperscript{132}.

\subsection*{3.4.3 Risk Adjusted Performance Measurement of Portfolios}

Many years ago, before the connection of return and risk became clear, performance evaluation merely involved the calculation of historic portfolio returns and a good portion of trust in the portfolio manager\textsuperscript{133}. Several events and developments changed this circumstance outright. One factor was the poor performance of some HFs and the vanishing trust of investors in the skills of fund managers\textsuperscript{134}. More objective evaluation tools were needed. The simplest measures only consider the return of the portfolios. Therefore they are labeled one-dimensional. The most basic formula to measure returns is presented in the following:

\begin{equation}
\text{Return}^{135} \quad r_p = \frac{V_e - V_h}{V_h}
\end{equation}

The portfolio return equals the difference between the portfolio values at the end and the beginning of the period, divided by the value at the beginning of the period. This formula is only valid in the absence of deposits or withdrawals during the period. In these cases either money or time weighted returns have to be calculated\textsuperscript{136}.

As mentioned in the previous section, the CAPM states that higher returns can only be gained by taking higher levels of (nondiversifiable) risk. Therefore it is not enough to look at the return without being concerned with the level of portfolio risk\textsuperscript{137}. Hence performance evaluation used in this study is based on two-dimensional performance measures, which consider risk and return at the same time.

It is difficult to evaluate two different efficient portfolios, which have neither the same returns nor the same risk. In this case the investor is not able to just choose the portfolio, which features the same risk but a higher return, or the same return but a lower level of risk. Hence a performance measurement tool has to be introduced that confronts risk and return in a way that makes a comparison of two different risk-return portfolios possible.

\begin{footnotesize}
\begin{enumerate}
\item Spremann/Gantenbein (2001), p. 10.
\item Spremann/Gantenbein (2001), p. 2.
\item Spremann/Gantenbein (2001), p. 2.
\item Spremann/Gantenbein (2001), p. 4.
\item Spremann/Gantenbein (2001), pp. 4-6.
\end{enumerate}
\end{footnotesize}
The most famous ones are the Treynor measure, also called the reward-to-volatility measure, the Jensen measure, also known as Jenson’s alpha, and the SR, also called the reward-to-variability measure.

The SR is one of the most widely used performance measures today. It was already introduced during the presentation of the Markowitz portfolio selection theory. It represents the slope of the CAL. Therefore finding the CAL with the steepest possible slope equals to maximize the SR. This ratio and one of its derivatives are discussed in detail in the following. The reasons for presenting theoretical insights in these two measures are that the optimizers in the analysis of this study apply these performance measurement tools. Therefore the reader has to be familiar with the application in order to understand the analysis and interpretation of the outcome.

3.4.3.1 THE SHARPE RATIO (REWARD TO VARIABILITY MEASURE)

As already mentioned the SR can be calculated the following way:

\[
    \text{Sharpe Ratio} = \frac{R_p - R_F}{\sigma}
\]

It shows the risk premium of the portfolio per unit of total risk. Total risk includes systematic (nondiversifiable) and unsystematic (diversifiable) risk and is represented by the portfolios’ standard deviation. This kind of risk is the one Markowitz dealt with, since at least some parts of that risk can be diversified away. Higher SRs indicate better performance. For poorly diversified portfolios, the standard deviation is higher and therefore the SR turns out to be lower.

This measure is most appropriate when an investor has invested his entire capital in a single fund. In this case the investor only cares about the total risk of his portfolio and the diversification of the fund. The application of the original SR is problematic when it comes to performance evaluation of HFs and portfolios that include them. A modified measure has to be used to get more accurate results.

3.4.3.2 THE MODIFIED SHARPE RATIO AND RETURN DISTRIBUTIONS OF HEDGE FUNDS

In current theory and practice the returns of financial securities, like stocks and bonds, are assumed to be normally distributed. Indeed this is valid for most financial assets. Such assumptions justify the usage of performance measurement tools like the SR, which are solely based on the first two moments of a return distribution, average return and standard deviation. The confrontation of returns and standard deviation in one performance measure enables an investor to compare different securities with each other that differ in both categories.

But unlike most stocks and bonds, HFs show no normal distributed performance charts. The use of derivates causes an asymmetric return distribution and so-called fat tails. The distributions can only be properly described by looking at the third and fourth moment, the so-called skewness and kurtosis. “For a risk-averse investor, negative skewness and positive excess kurtosis are unattractive, because they generally indicate a higher probability of large losses than in the case of normally distributed returns.” Thus negative skewness and positive excess kurtosis increase the probability of large losses, which can even cancel out the

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138 Bodi/Kane/Marcus (2005), p. 203.
139 Bodi/Kane/Marcus (2005), p. 868.
compounded positive returns of previous years\textsuperscript{143}. Metaphorically speaking, fat tails is an expression for thicker ends of a distribution. This means that the investor bears more risk, since the occurrence of extreme values is more likely. A negative skewness makes things worse, since it affects the distribution in a way that makes only negative extreme values more likely and not favorable positive ones. The occurrence of fat tails is connected to the occurrence of a positive kurtosis. Unfortunately this is often the case regarding HFs. Therefore applying performance measurement tools that only focus on the first two moments of a distribution will underestimate the associated risk with HFs. Hence the authors introduce a Modified Sharpe Ratio (MSR) that includes all four moments. For further illustration the reader is recommended to look at Figure 3.6 that shows a negative skewness and Figure 3.7 that shows a sample of distributions of a HF, a stock and a bond.

![Negatively Skewed Distribution](image)

**Figure 3.6 - Negative Skewed Distribution**\textsuperscript{144}

![Example Distributions to Show Fat Tails and Kurtosis](image)

**Figure 3.7 - Example Distributions to Show Fat Tails and Kurtosis**\textsuperscript{145}

You can see very easily that the US Equity and Fixed Income follow a normal distribution with flat tails. Instead the HF graph shows a so-called leptokurtic distribution. This implies the obvious fat tail on the left and a higher (positive) kurtosis. The positive kurtosis is not only the reason for the fat tail but also for the peaky top of the curve around its mean. Moreover a slight negative skewness can be seen, even though she is not that huge as in Figure 3.6.

\textsuperscript{143} Kat (2003), p. 75.
\textsuperscript{144} UCLA Academic Technology Services.
\textsuperscript{145} Author not available.
Because of these kinds of distributions one has first of all to investigate, whether negative skewness and positive excess kurtosis are existent or not, before the correct performance measure can be chosen:

**Skewness**\(^{146}\)

\[
\text{Skewness} = \frac{1}{N-1} \sum_{j=1}^{N} \left( \frac{r_{j} - \bar{r}}{s} \right)^{3}
\]

Third Moment

**Kurtosis**\(^{147}\)

\[
\text{Kurtosis} = \left\{ \frac{1}{N-1} \sum_{j=1}^{N} \left( \frac{r_{j} - \bar{r}}{s} \right)^{4} \right\} - 3
\]

Forth Moment

In some literature the term -3 in the kurtosis formula is missing. In that case the kurtosis of a normal distribution is 3 instead of zero. Therefore including the -3 in the formula makes it easier to compare the kurtosis of the analyzed funds with that of a normal distributed return pattern. It shall already be mentioned that Excel is also subtracting the kurtosis by 3 when calculating it with the predefined formula.

The appropriate risk measure, when skewness and kurtosis are deviating from zero, is the so-called Modified-Value-at-Risk (MVaR) and the proper performance measurement tool the MSR. Before explaining what the MVaR is, one should be familiar with the simple Value-at-Risk (VaR). “Formally, VAR measures the worst expected loss over a given horizon under normal market conditions at a given confidence level”\(^{148}\). The authors will illustrate this formal definition step by step.

The VaR is a measurement of risk exposure for a certain security or portfolio according to market movements. Hence it measures the probability of a decreasing market value of a portfolio in a certain period of time. As known from hypothesis tests, confidence intervals are used to measure probability. Thus it represents a kind of worst-case scenario in a chosen confidence interval that shows the investor the maximum possible loss for a certain period under assumed normal market conditions.

For instance, a daily VaR of 50 million US dollars, assuming a confidence interval of 95%, means that only a 5% chance exists that the portfolio loss will exceed 50 million on a certain day. Therefore VaR provides a measurement tool, which demonstrates the risk exposure in a single absolute number of a particular currency. Remembering the previous explanation of fat tails, it seems logical that securities with fat tails will suffer higher possible losses than those without. Therefore such a risk measure is more appropriate than the normal standard deviation, which fails to illustrate those extreme values at the end of a distribution interval. Several different formulas exists in current literature. For this paper the author will use the formula Favre and Galeano started with to derive the MVaR:

**Value at Risk**\(^{149}\)

\[
\text{VaR} = W \ast (\mu \ast dt - n \sigma (dt)^{0.5})
\]

Based on this knowledge about the simple VaR, the MVaR can be introduced. The MVaR takes, besides the fat tails, also the skewness and kurtosis into account. Favre and Galeano managed to develop a quite simple formula that is able to adjust the VaR to the HF's specific skewness and kurtosis. Therefore they calculate a new critical value \(z_{CF} \) for a chosen confidence interval, which can be seen in the following two equations:

146 Lohninger (2006).
147 Lohninger (2006).
Modified Value at Risk\textsuperscript{150} 

\[ MVaR = W\left( \mu - z_{CF} \sigma \right) \]

\[ MVaR = W\left[ \mu - \left\{ z_{e} + \frac{1}{6} \left( z_{e}^2 - 1 \right) S + \frac{1}{24} \left( z_{e}^3 - 3 z_{e} \right) K - \frac{1}{36} \left( 2 z_{e}^3 - 5 z_{e} \right) S^2 \right\} \sigma \right. \]

New Critical Value\textsuperscript{151}

\[ z_{CF} = \left\{ z_{e} + \frac{1}{6} \left( z_{e}^2 - 1 \right) S + \frac{1}{24} \left( z_{e}^3 - 3 z_{e} \right) K - \frac{1}{36} \left( 2 z_{e}^3 - 5 z_{e} \right) S^2 \right\} \]

This is the new calculated critical value \( z_{CF} \) for a confidence interval of e.g. 95%.

Since negative skewness and positive kurtosis would result in a negative MVaR and this study deals only with time series of returns, the equation has to be slightly changed. The value of the wealth is standardized to 1 in order to get relative values and the minus sign helps to create positive MVaRs.

Modified Value at Risk for Portfolio\textsuperscript{152} 

\[ MVaR = -1\left( \mu - z_{CF} \sigma \right) \]

After deriving a new risk measure that takes all specific performance characteristics of HFs into account one can now apply a new performance measure like the Modified-Sharpe Ratio (MSR). As mentioned above, the SR is a performance measurement tool, which includes only the first two moments of a return distribution and serves very well for purposes of analysis of normal distributions. In order to apply it to the negative skewness and positive excess kurtosis as well as to fat tails of HFs, one has to exchange the standard deviation in the denominator with the above-explained MVaR\textsuperscript{153}. This simple adjustment will now provide a fairly powerful performance measurement tool. The following two formulas illustrate the SR and MSR:

Sharpe Ratio\textsuperscript{154} 

\[ SR = \frac{R_p - R_F}{\sigma} \]

Modified Sharpe Ratio\textsuperscript{155} 

\[ MSR = \frac{R_p - R_F}{MVaR} \]

For normal-distributed returns both measures display the same performance values. In the case of HFs, the MSR shows lower performance values, compared to usual SRs. Therefore traditional SRs overestimate the usefulness of HFs in efficient portfolios. In the later performed portfolio optimization process, the MSR will be applied for the comparison of HF indices to market benchmarks. A second optimization process based on the standard deviation will generate usual SRs to compare both results in order to get sound results.

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\textsuperscript{150} Favre/Galeano (2002), p. 8.
\textsuperscript{151} Favre/Galeano (2002), p. 9.
\textsuperscript{152} Favre/Galeano (2002), p. 9.
\textsuperscript{153} Gregoriou/Gueyie (2004), p. 4.
\textsuperscript{154} Gregoriou/Gueyie (2004), p. 4.
\textsuperscript{155} Gregoriou/Gueyie (2004), p. 4.
4 ECONOMETRIC THEORIES ABOUT TIME SERIES ANALYSIS

This chapter provides necessary knowledge about the analysis of time series that will be needed for understanding the data preparation, which is outlined in chapter six. These theories have been separated from the financial ones since they are unrelated to the content of the research questions and are not needed to interpret the results or to grasp the conclusions. However, they are crucial to prevent the production of spurious results and serve also for possible replications of the study. In this part the underlying theory is presented to ensure a succinct presentation of how the data has to be prepared in chapter six.

4.1 STATIONARITY OF TIME SERIES

Econometrics is defined as “the application of statistical and mathematical methods to the analysis of economic data, with a purpose of giving empirical content to economic theories and verifying them or refuting them”\textsuperscript{157}. In this case the data is represented by the HF and benchmark returns.

Since this study investigates the characteristics of time series it is reasonable to define that term as well. “A time series is a sequence of numerical data in which each item is associated with a particular instant in time”\textsuperscript{158}. This study deals with multivariate or multiple time-series analysis, since more than one set of data of the same time period is analyzed\textsuperscript{159}. Time series analysis investigates the temporal structure of the applied data.

The first thing one has to deal with is the stationarity or non-stationarity of time series. HF time series are a collection of discrete random variables with a sample size of 1, since every day, month or year only one observation can be done. This is called a single realization\textsuperscript{160}. If a time series is stationary, its probability distribution is stable over time and shifting the time series a certain number of time periods back or ahead, will not influence the distribution\textsuperscript{161}. It is important to test for stationarity since a stationary time series lacks a trend. Trends can be very problematic when correlation analysis is conducted. Therefore the absence of a trend is desired. Otherwise one has to eliminate the trend before conducting the correlation analysis.

The reason for this is that the existence of a trend causes the creation of spurious results. If two time series are completely uncorrelated but show a similar trend the correlation coefficient will be high, even though no relationship exists\textsuperscript{162}. A trend that is not recognized therefore ruins the accuracy of the results. There are two ways to reveal a trend. One way is to picture the time series. If the observations scatter around an imaginary line that is parallel to the x-axis, then the time series is stationary. If a trend is observed, then it is not stationary. The other method is to perform a unit-root test for stationarity. The complex theory behind this test is not relevant for this study. It suffices to mention that the most common tests are the Dickey Fuller (DF) and the Augmented Dickey Fuller (ADF) test. Both test stationarity, but the augmented test is more robust and reliable because it also adjusts for autocorrelation before performing the test. That is why this test is applied in the analysis of HF data in this study. The test is included in many statistical programs like EViews. It rejects the existence of a unit root if the test value is lower than the critical value. EViews calculates both, the test value and the critical value for different levels of significance, 1%, 5% and 10%. Usually all

\textsuperscript{157} Maddala (2002), p. 3.  
\textsuperscript{158} Maddala (2002), p. 513.  
\textsuperscript{159} Maddala (2002), p. 513.  
\textsuperscript{160} Maddala (2002), p. 515.  
\textsuperscript{161} Wooldridge (2003), p. 361.  
\textsuperscript{162} Noriega/Ventosa-Santa`laria (2007), p. 439.
values are negative. If the test finds a unit root (the test value exceeds the critical value of a certain significance level), the time series is non-stationary and therefore shows a stochastic trend\(^ {163}\). It also means that shocks affect the given time series permanently. Time series with stochastic trends are said to be integrated of order one or higher. A time series that is integrated of order one is symbolized by the following shortcut: I(1)\(^ {164}\).

If a trend is found, it has to be removed. Several methods are available. The most common ones are using the logarithm or differencing. E.g. a I(1) time series becomes stationary after the first difference was calculated. This is done by: \(\text{Value}_t - \text{Value}_{t-1}\). Unfortunately by doing this one observation gets lost for each time the difference is calculated. Still, it is necessary to get accurate results. If one is uncertain whether the time series are stationary or not, it is always safer to use differences, as long as the level of the time series is unimportant and only the relationship matters.

### 4.2 Autocorrelation

If the time series are stationary, there still remains the problem of possible autocorrelation that negatively affects the correlation analysis. Autocorrelation means a time series is cross-correlated with itself\(^ {165}\). To say it differently, a highly autocorrelated time series is strongly related to a time-shifted version of itself. The result is that the values of the time series affect each other, i.e. the next value depends on the prior one if there is a lag 1 or first order autocorrelation\(^ {166}\). There also might be higher lags of autocorrelation even though these are less common or are caused by the first lag autocorrelation\(^ {167}\). These correlations can be calculated by using the autocorrelation function (ACF) or the partial autocorrelation function (PACF). These calculate the correlations between the time series with itself at diverse points in time\(^ {168}\). When outputting the correlation coefficient at a specific lag, the latter additionally takes all inter-lags into account, in order to test if the correlation really comes from the particular time shift or if other correlations between these points in time, especially the first lag correlation, are the real reason for finding the observed higher order autocorrelation\(^ {169}\). To test if autocorrelation is statistically significant a Box-Ljung test can be executed. Most statistical programs, like SPSS, which is used to perform the test in this study, output the ACF, PACF and the Box-Ljung test statistic simultaneously. The null hypothesis of the test states: \(H(0)\): For each of \(x\) observed lags the first \(x\) autocorrelation coefficients are similar to zero\(^ {170}\). So accepting the \(H(0)\) means no autocorrelation is present. The program shows the test value without outputting the critical values of the test. Fortunately the probability values that are based on both figures are shown. A probability of less than 0.05\(^ {171}\) indicates undesired structures in the time series, and the \(H(0)\) has to be rejected. In that case the time series has to be adjusted to take the autocorrelation into account.

Autocorrelation is quite common among HFs. It is the consequence of marking to market problems, due to illiquid positions. For instance, marking to market problems can be caused by the non-existence of markets to trade securities in at a distinct time\(^ {172}\). Above all, fund managers that specialized in securities, which can only be traded at certain times like some convertibles, will face the problem to have a market value only at a specific point in the

\(171\) SPSS Inc. (2005), p. 115.  
\(172\) Eling (2006), p. 36.
future. In the case of missing current data, HF managers will report the return of the last month or try to estimate the market value\textsuperscript{173}. Thus returns are related to each other. As one can imagine, such assumptions of autocorrelated returns will result in a time series of less volatility and therefore will underestimate the true standard deviation and the risk associated with a particular investment. The smoothed time series also affects the correlation analysis. In order to prevent this underestimation of risk it is necessary to create a new, more volatile time series of returns. Following the approach of Brooks and Kat, which is also used by Kat and Lu, autocorrelation can be eliminated quite easily. According to this approach, the provided returns of the database are “unsmoothed”\textsuperscript{174}. This new set is believed to behave more volatile than the previous one and therefore to match the real features of the HF or HFI better. The observed/smoothed value can be expressed as:

\[
V_t^* = \alpha V_t + (1 - \alpha) V_{t-1}^*
\]

Where \(V_t^*\) is the observed or smoothed value of a HF at time \(t\). \(V_t\) stands for the true value at time \(t\) and \(\alpha\) is the autocorrelation coefficient. From above equation Brooks and Kat derive the following unsmoothed returns:

\[
r_t = \frac{r_t^* - \alpha r_{t-1}^*}{1 - \alpha}
\]

With this equation it is possible to calculate the “true” return \(r\) at time \(t\), through the observed returns, \(r_t^*\) and \(r_{t-1}^*\), as well as the autocorrelation coefficient \(\alpha\). Brooks and Kat argue that this autocorrelation coefficient for stock markets is close to zero. Therefore they suggest to set \(\alpha\) equal to the autocorrelation coefficient at lag 1\textsuperscript{177}. The autocorrelation coefficient at lag 1 describes the autocorrelation between the values \(V(t)\) and \(V(t-1)\). In most cases autocorrelations are significant for a large number of lags, but usually the autocorrelations at lag 2 and above are solely due to the propagation of the autocorrelation at lag 1. That means the lag 1 autocorrelation explains all higher order autocorrelations\textsuperscript{178}. One has to admit that such an adjustment will also shorten the time series by one value. Thus, above all, particularly short time series could suffer a significant loss of data. Since most time series last over more than one year, the authors believe that the problem of bias through autocorrelation is more important than loosing one return in the time series. The last concern of the adjustment of autocorrelation is the time series itself. Time series have to be stationary for processes of analysis. Therefore one can only use the \(\alpha\) of time series that are already stationary. If time series feature non-stationarity they have to be differenced as many times until stationarity can be verified. The problem of non-stationary time series is that they can show a trend, which will be interpreted as an autocorrelation by statistical programs. Therefore all trends have to be eliminated by differencing.

4.3 DATA BIASES

Several types of biases are known among researchers. This part will only deal with the most important ones, survivorship bias and backfilling bias, the so-called instant return history bias.

\textsuperscript{173} Brooks/Kat (2001), p. 34.
\textsuperscript{174} Brooks/Kat(2001),  p. 37.
\textsuperscript{175} Brooks/Kat(2001),  p. 37.
\textsuperscript{176} Brooks/Kat(2001),  p. 37.
\textsuperscript{177} Brooks/Kat(2001),  p. 37.
\textsuperscript{179} Nau (2005).
Due to the private nature of HFs, regular data reporting to public institutions is voluntarily. Hence serious problems in the consistence of data in HF databases can occur, so-called biases.

In current literature two definitions for survivorship bias exist. Ackermann et. al. defined it as “the effect of considering only the performance of funds that are alive and present in the database at the end of the sample period”\(^{179}\). Instead Liang defined it “as the performance difference between surviving funds and all funds”\(^{180}\). Thus there will be different results, because Ackermann et. al. took the difference between living and dissolved funds, while Liang took the difference of surviving and all funds. In this paper the authors will apply the definition of Ackermann et. al. Leaving out the return of dead funds will overestimate the average return of HFs and draw a diluted overall picture of the performance of HFs. This is above all the case of HF indices that replace closed funds by new ones. How distinctive the survivorship bias is, depends in general very much on the database and its will to collect, include and remain data of dead funds.

Several researchers investigated this problem and found different levels of bias, depending on the regarded database and on different HF classes\(^{181}\). The advantage of Eling’s study is that he calculated an average range for survivorship bias out of the 16 most important research papers that dealt with survivorship bias. He found a range from 0.01-0.36 percentage points per month, with an average of 0.18 percentage points\(^{182}\), which he calculated as the arithmetic mean out those 16 studies\(^{183}\). This means that reported returns are on average 0.18 percentage points too high, because of the bias.

The instant return history bias, or backfilling bias, occurs, when a HF that is already performing for some time decides to participate in a database. All previous returns will be backfilled. Of course this behavior itself will not cause any bias. However, only successful funds decide to provide their data to a database, in order to attract new investors and additional capital, while returns and the dissolution of unsuccessful funds will not be recognized in the database. Thus, like the survivorship bias, the backfilling bias causes a too positive picture of average HF returns\(^{184}\). Eling considered the problem of backfilling bias in the same way. Backfilling has an impact of 0.00 to 0.12 percentage points per month. The average is 0.08 percentage points per month\(^{185}\).

Thus for taking survivorship bias and backfilling bias into account, one has to adjust the time series of returns downwards, which will result in a more truthful picture of actual returns. In this study the average percentage points of Eling were applied for adjusting bias.

\(^{185}\) Eling (2006), p. 46.
5 SECONDARY DATA DESCRIPTION

This chapter has the objective to present the data that will be adjusted, processed and analyzed in the following progression. First, Barclays’ database is introduced. Secondly the Greenwich Alternative Investments Database is presented. This is of particular importance since the authors have no permission to provide the data to third persons. Additionally they confirmed to use the data for the purpose of this work only.

5.1 BARCLAYS’ HEDGE FUND DATABASE

Barclays\footnote{http://www.barclaygrp.com/products/databases/btg.html.} accepted to provide this study with HF performance data. The data has been transmitted via internet. It consists of one large Excel file. The Excel file itself consists of eight worksheets. The separate worksheets are labeled “Administration”, “Performance”, “Asset under Management” (AUM), “Holdings”, “Instruments”, “Track001”, “Track002” and “Track003”. The last three are useful for a detailed comparison of particular HFs. The sheet “Instruments” refers to the kind of assets used to execute the strategy. In combination with the strategy it would therefore be possible to identify the style of the HF. “Holdings” refers to the companies that run the fund and “Assets under Management” refers to the volume of each fund. However, the important worksheets are the first ones. The “Administration” sheet consists of a long range of information about each fund. First the domicile of the fund is listed. Next to the US, the domiciles of many funds are the Cayman Islands, Bermuda, the Bahamas, the British Virgin Islands and other offshore regions. Only few are located in Europe and if so, mostly in Switzerland or Liechtenstein. This has no doubt legal and taxation reasons. Further information includes whether the fund is listed or not, the currency and how fees are included in the calculation. All performances are calculated after fees and the level of basic management fees and additional performance fees are listed as well. Other information involves leverage, minimum investment requirements, the lockup period\footnote{Like mentioned earlier, this is the period the investors must hold their capital within the fund.} and the geographical focus. The most important information for this work is the information about the strategy.

Barclays provides three different classifications of HFs, the main strategy and two different additional strategies. This structure seems logical, since few HFs would follow solely one strategy for earning profits and hedging risk.

Barclays’ Hedge Fund Database consists of 3024 HFs and fund of funds (FoFs). 2405 can be identified as HFs and 619 as FoFs. Unfortunately 618 of the HFs did not supply the database with a strategy description. Deleting these 618 funds would have meant a loss of data of 20.5%. These funds can be seen as some kind of multi strategy. In the following theoretical and analytical part they are simply called blanks.

The remaining 1786 HFs are classified in 65 different kinds of strategies. FoFs are separated in 3 different strategies and also one group where a detailed strategy description is not available.

2655 living as well as 369 dead funds are included in the database. For later analysis this feature is of importance. Moreover 10 different kinds of currencies were used by those funds. The majority of HFs report in US-Dollars and 2956 also report at least monthly or even daily performance data. Finally the vast majority of funds are not listed on one of the stock exchanges in the world. This supports the picture drawn in the introduction. Only 23 were listed on the Irish or Luxembourg stock exchange.
The performance was measured in returns instead of prices over the time period from 1990-2006. This fits the purpose to test correlation market neutrality. Since it was important for the later analysis one should mention that the fund-IDs could be found on every worksheet to identify the funds conveniently. All HF names have been blanked. The data was provided only on that condition. This is not problematic since it has no impact on the study in any way.

5.2 THE GREENWICH ALTERNATIVE INVESTMENT HEDGE FUND INDEXES

Greenwich Alternative Investments\textsuperscript{188} has one of the largest databases for HFs and HFIs and plays a leading role in the indexation of HFs. The provided Excel spreadsheet consists of eleven different worksheets. The worksheets contain four of Greenwich’s most known index groups. For each index group, annually, quarterly and monthly data is listed in a separate worksheet, except for the investable indices. Regarding this index group the annually data is missing. Next to the investable indices there are US indices, international indices and global indices. International indices only contain non-US HFs and global indices contain all HFs. Hence, while the US and international index groups are defined by fund domicile, the global index group shall represent the whole HF universe. These HF indices are relevant for this study and are combined with other global benchmark indices, like the MSCI Global Index for stocks and the Lehman Aggregate Global Bond Index.

The global index group in the database consists of 25 global HFIs that cover several different strategies, which match quite well to the ones in Barclays’ database. Moreover, one global HFI, Greenwich’s composite index, is provided that covers all strategies and therefore reflects nearly the whole HF industry. The time period is a bit more limited and covers the years 1995-2006 only, but consists also of monthly return data. Therefore both databases fit quite well to each other and for the purpose of the analysis in this study. Like in the other database, the data is reported in terms of returns not prices.

\textsuperscript{188} http://www.greenwichai.com.
6 PRE-ANALYSIS – AN ANALYTICAL FRAMEWORK FOR DATA PREPARATION

Even though the first research question seems to be straightforward a lot of different and also complicated issues have to be considered before being able to analyze. This causes the analysis as a whole to become extremely complex. Therefore, this chapter creates an analytical framework, which shall serve as a guideline of data preparation for the reader. Figure 6.1 illustrates the framework, which will be explained step-by-step in the following.

The analytical framework of data preparation is structured into two parts, the process of filtering data and the process of adjusting data, which are building up on each other.

![Process of Data Preparation Diagram](image)

Figure 6.1 - Process of Data Analysis (self-made)
6.1 THE PROCESS OF FILTERING DATA

Since Barclays’ Hedge Fund Database is fairly extensive and complex a careful investigation is necessary in order to prevent as much bias as possible for later analysis.

6.1.1 SEPARATING HF'S AND FOFS

This study focuses solely on HF's and HFIs. Therefore any other funds have to be separated and excluded from the upcoming analysis. In this paper, the term FoFs refers to funds of HF's. These have two main purposes. On the one hand they want to diversify the risk by investing in large numbers of single HF's. On the other hand they serve as an investment alternative for small private investors, who are not allowed to invest directly into a HF, due to the accreditation problem. Those investment products are of no interest since they do not incorporate one of the theoretical HF strategies but consist of many of them. Furthermore, they are able to change their composition quite quickly. Thus they cannot reasonably be applied for market neutrality tests. Barclays’ Hedge Fund Database includes 2405 HF's and 619 FoFs.

6.1.2 ASSIGNING HF'S TO DIFFERENT CLASSES IN RESPECT OF THEORY

After the HF's were separated from the FoFs, they have to be assigned to the different types of strategies that were explained in the theoretical part. As mentioned before the main strategy is important to get a first classification. 65 different types of strategies can be found in Barclays’ database. Most of them are sub-strategies that focus on certain regions, sectors or on a certain aspect of the strategy itself. These sub-strategies have to be aggregated and put into the appropriate main-class, since 65 strategies are too much for an adequate analysis. After the aggregation process 2386 HF's could be classified. Table 6.1 illustrates the preliminary amount of the different samples of HF strategies.

<table>
<thead>
<tr>
<th>Relative Value/Arbitrage</th>
<th>Event Driven</th>
<th>Opportunistic</th>
<th>Special Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>amount</td>
<td>Name</td>
<td>amount</td>
</tr>
<tr>
<td>Equity Market Neutral</td>
<td>110</td>
<td>Event driven</td>
<td>78</td>
</tr>
<tr>
<td>Convertible Arbitrage</td>
<td>89</td>
<td>Distressed Securities</td>
<td>39</td>
</tr>
<tr>
<td>Fixed Income Arbitrage</td>
<td>150</td>
<td>Merger Arbitrage</td>
<td>51</td>
</tr>
<tr>
<td>Statistical Arbitrage</td>
<td>36</td>
<td></td>
<td>Emerging Markets</td>
</tr>
<tr>
<td>Multi Strategy Arbitrage</td>
<td>99</td>
<td>Global Macro</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 6.1 - Hedge Fund Samples (original)
6.1.3 Deleting Funds that Cannot be Assigned Properly

3 HFs had to be taken out of the sample since no performance chart could be found for them. 19 of the 2405 HFs were either option strategies or activist strategies and could not be assigned to any group appropriately. Therefore they were deleted for the further data preparation process. Finally the FoFs were deleted in order to keep the focus on the market neutrality of single HFs.

6.1.4 Choosing a Currency

The next problem that has to be taken into account is the currency. The performance of all HFs is measured in returns. This causes problems in the comparison of returns that are measured in different currencies. Returns in different currencies can only be compared, if the exchange rates of all currencies remain constant over time. This cannot be justified in a reasonable way. Regarding the movements of the last 12 years between Euro and US-Dollar, it becomes obvious that only one currency can be applied. Appendix 1 displays the movements of the exchange rate between the Euro and US Dollar. Therefore the authors decided to pick the currency that exhibits the highest amount of HFs. Fortunately the majority of HFs reports in US-Dollar, so that 2160 still remained for the further process of data preparation. Table 6.2 illustrates the new amounts for each sample of HF strategies. The careful reader may have noticed that the Euro is younger than 12 years. This chart is based on the ECU, which is the pre-currency of the Euro. The ECU helps analyst to compare the European Currency with other currencies before 2002.

<table>
<thead>
<tr>
<th>Relative Value/Arbitrage</th>
<th>Event Driven</th>
<th>Opportunistic</th>
<th>Special Strategies</th>
</tr>
</thead>
<tbody>
<tr>
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Table 6.2 - Filtered Hedge Fund Samples

These 2160 HFs, classified in different strategies, build the basis of the process of adjusting the data.
6.2 PROCESS OF ADJUSTING DATA

This process is by far more challenging than the previous ones and requires all the econometric knowledge explained before. It is outlined in Figure 6.2.

![Diagram of Adjusting Hedge Fund Data]

**Adjusting Hedge Fund Data**

- Autocorrelation
- Survivorship Bias
- Backfilling Bias

1. Applying a Test of Stationarity in order to test for Autocorrelation
2. Calculate Autocorrelation Coefficients and their Probabilities
3. Taking only Significant Autocorrelation Coefficients into Account
4. Adjusting Stationary Time Series for Autocorrelation

Adjusting for Survivorship Bias
Adjusting for Backfilling Bias

Calculating Unbiased Monthly Average Returns for each Hedge Fund Strategy

**Figure 6.2 - Process of Data Adjustment (self-made)**

6.2.1 TESTS FOR STATIONARITY

Before one is able to take the problem of autocorrelation and bias into account, one has to test, if the time series proves to be stationary and does not follow any trend. Only stationary time series can be adjusted for autocorrelation. Two problems occurred regarding the test. First, no available statistical program could perform a test for stationarity for a group of HFs and second, the amount of funds was too large to test every one separately. Two possible solutions existed. On the one hand, one could differentiate every time series once, which would have made almost all time series immediately stationary. This solution implicates two problems. First, one would loose data. Secondly, returns would not illustrate the real performance of
HF's anymore, since differencing eliminates the level of returns, thus making all of them close to zero. Such differentiated returns would only be useful for correlation analysis, but not for the comparison of absolute returns. On the other hand one could conduct a test of representative samples in order to know, whether differentiating is really necessary or not. If the sample would show a significant amount of non-stationary time-series regarding a certain HF class, differentiating would be in order. Since the authors were also interested in the real level of returns for a ranking and for portfolio considerations, they decided to conduct a test for stationarity. 10% of the funds in each subclass were tested. Since the funds in each class did not show a particular order, systematic samples have been drawn to ensure a random selection. EViews was used to apply the Augmented Dickey-Fuller test to every sample. Four lags were considered in every test. Surprisingly, the results showed that all tested HF's classes were stationary. Some single funds in some classes turned out to be non-stationary, but examining these funds made it clear that these showed very short time series with only few observations. Obviously this biases the test since the probability to find a trend, which occurred coincidentally, is higher in short time series. That is why the number of observations for non-stationary time series is listed as well. Overall the authors saw no need for differentiating and went on with the adjustment of data. Appendix 2 illustrates the results of the test for stationarity.

6.2.2 CALCULATING AUTOCORRELATION COEFFICIENTS AND RESPECTIVE PROBABILITIES

The next step that has to be executed is the adjustment for autocorrelation. This is justified by the fact that an adjustment for survivorship or backfilling bias, before taking autocorrelation into account, would give the time series a kind of trend that would be identified by statistical programs as autocorrelation as well. Thus all time series would show autocorrelated characteristics, whether they were autocorrelated before or not. After the adjustment for autocorrelation the adjustment for biases does not create a new autocorrelation, which was tested with EViews as well.

But before one is able to adjust for autocorrelation, the autocorrelation coefficient and its level of significance, which can be derived from the outputted probabilities, have to be calculated. Hence all time series are tested in SPSS for autocorrelation, with a level of significance of 0.05. The authors only used the autocorrelation display and not the partial autocorrelation function of SPSS. This is due to the fact that only the autocorrelation coefficient of lag 1 is of interest, which is calculated in the same way in both functions since there are no lags to be considered between lag 1 and itself. To be sure about the significance of the coefficient five lags were included in the test for autocorrelation.

6.2.3. ADJUSTING TIME SERIES FOR SIGNIFICANT AUTOCORRELATION

Only coefficients with probabilities of 0.05 or less are used for the procedure of adjusting the time series for autocorrelation. A value less or equal of 0.05 matches a confidence level of 95%. If the probability features a value of 0.05 or less, the respective autocorrelation coefficient value of lag 1 has to be inserted in the Formula 4.2 as the \( \alpha \)-term. According to this equation, a new time series is calculated that adjusts for autocorrelation and features one value less than the previous time series. After the application some sample tests have been conducted. The autocorrelation disappeared in all cases.

6.2.4. ADJUSTING FOR BIAS

The last issues that have to be regarded in order to have an unbiased time series for the analysis are problems like survivorship bias and backfilling bias. Survivorship bias is no
problem of the Barclay Hedge Fund Database, due to the persistence of dead funds in the database. The authors contacted a database manager of Barclays in order to discover, whether Barclays applies backfilling or not. He certified that backfilling is done for every new fund in the database. Therefore the authors took the calculated monthly average of Eling (2006), which was 0.08 percentage points, and subtracted each monthly return by this amount. Logically this procedure will decrease the monthly returns of each fund and each group of funds.

To sum it up, applying this procedure of data preparation for analysis, results in anti-autocorrelated and unbiased stationary time series of HF returns that focus on one currency and can be applied to all HF classes investigated in this paper.
7 ANALYSIS

This chapter describes the analysis process of the now prepared hedge fund data and of the hedge fund indexes. The analysis is conducted in order to gather the results that will be presented and interpreted in the following chapter. Decisions about the way the analysis was executed are outlined and justified.

7.1 ANALYSIS OF CORRELATION BASED MARKET NEUTRALITY

Analyzing correlation market neutrality in bull and bear markets requires several considerations to be executed before and during the actual analysis.

7.1.1 CHOICE OF TIME PERIOD

Before being able to analyze, one has to select an adequate time period. Here it is of importance to take the specific features of HF s and HF databases into account. HF databases are quite innovative, since the main development of this industry took place in the beginning of the 1990s. This is also the point in time most databases began to record. Of course, in the first years, every database has problems to gather its information. Therefore most researchers chose time periods beginning with 1994 or later. Low amounts of HFs in the time period between 1990 and 1994 can also be observed in the Barclays HF Database. Moreover the Greenwich HFI Database starts out in January 1995. Furthermore in approximately 1994 the overall market performance changed to a steady bull market, which enables a better classification in bull and bear markets. Hence the authors decided to investigate the time period that matches to both databases, the time period of 1995-2006.

7.1.2 IDENTIFICATION OF BULL AND BEAR MARKETS

Since the focus of this study is on HFs that are reporting in US Dollars and since the US has the largest financial markets, the S&P 500 will be applied for a proper assessment of different market types in the time between Jan-1995 and Dec-2006. Appendix 3 illustrates the performance of the S&P 500 during the last 12 years. According to this chart, the authors will assign the following time periods to the different market types:

- Bull 1: Jan-1995 to Aug-2000
- Bear: Sep-2000 to Feb-2003
- Bull 2: Mar-2003 to Dec-2006

7.1.3 RETURNS AND STANDARD DEVIATIONS OF HF SAMPLES

Analyzing correlation coefficients only is not an appropriate way of conducting an academic analysis. One has to keep in mind that correlation coefficients are based on the covariance, which is based on the standard deviation. The standard deviation is calculated out of the monthly or yearly returns. Thus analyzing correlation coefficients starts out with the analysis of returns. Therefore the authors calculated average annual returns for each HF strategy and ranked them separately for each year. This procedure is also executed for a market benchmark, which was in this case the S&P 500. The ranking can be seen in Appendix 4. This ranking also enables the authors to illustrate whether HFs managed to perform as it is stated in theory. Through comparing the HF performances with the one of the market proxy, the chart also provides a first sense, how the later correlation coefficients might look like. Finally, also the standard deviation and average return over the whole period for each strategy is provided in this appendix that gives some first information about risk-return relationships.
7.1.4 CORRELATION COEFFICIENT ANALYSIS OF HF SAMPLES

Analyzing the performance of HFs in bull and bear markets is conducted in several steps. First of all the market benchmarks have to be selected. The choice of the benchmarks has to be carefully done, since this will affect the outcome of correlation coefficients significantly. Since HFs are operating nationally as well as internationally and the US capital markets have huge influence on the global performance, the authors decided to choose four different benchmarks. Two indices are for the global performance, MSCI Global Index\(^{189}\) for stocks and the Lehman Aggregate Global Bond Index\(^{190}\) for bonds. For the US market the S&P 500\(^{191}\), which focuses on the largest 500 firms and the Wilshire 2500\(^{192}\), which tries to replicate the US market as a whole, are chosen. The choice of two US benchmarks stands in line with the focus on HFs that report in US currency. Of course several other indices can be selected, but this would make the analysis less comprehensible. Therefore the focus lies on the most important ones. The analysis itself is conducted in several steps.

7.1.4.1 CORRELATION COEFFICIENT ANALYSIS OF HF SAMPLES OVER THE WHOLE PERIOD

First of all a broader impression of HF correlation to the market proxies is of interest. Therefore the first analysis focuses on the whole time period from 1995-2006. In order to get an accurate picture, the correlation analysis is conducted on a monthly basis. An annual analysis would bias the coefficients, due to such a short time period of 12 years. Additionally an annual analysis would be too rough for the short-sighted correlation measure. Appendix 5 illustrates the correlation coefficient matrix, which is generated by a predefined function of Excel. All the correlation coefficient matrices display the correlation coefficients between the different HF strategies and the market benchmarks.

7.1.4.2 CORRELATION COEFFICIENT ANALYSIS OF HF SAMPLE OVER BULL AND BEAR MARKETS

The second step is to investigate the time series more deeply. Since the period of the bear market is quite short compared to the periods of the bull markets, its correlation coefficient could have less influence on the one of the whole time period. Thus considering correlation coefficients regarding the different types of markets illuminates, whether the correlation coefficient of the whole time series truly reflects all sub-periods. It also provides insights about a change in the correlation of HFs regarding bullish and bearish periods. As before, the correlation analysis is conducted on a monthly basis. Due to the fact that the time periods are shorter now, biases could occur that will be considered during the interpretation of the results. Comparisons will be conducted prudently. Appendixes 6 to 8 display the correlation coefficient matrices for the different types of markets.

7.1.4.3 CORRELATION COEFFICIENT ANALYSIS OF HFIS OVER THE WHOLE PERIOD

As mentioned before HFIs are used for the portfolio optimization process to answer the second research question. This reduces the risk of biases and helps to avoid some pitfalls. Moreover global HFIs are adequate to compare HFs as a whole with global and US benchmarks. Since the data is already present and consists partly of the same HF classes as Barclays database it can be used to confirm the results generated so far. Therefore another correlation matrix, based on the HFIs and the same benchmark indexes as before, is

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\(^{189}\) Data retrieved from Datastream Advanced 4.0.
\(^{190}\) Data retrieved from Lehmann Brothers directly.
\(^{191}\) Data retrieved from Yahoo-Finance.
\(^{192}\) Data retrieved from Datastream Advanced 4.0.
calculated. The whole time period from 1995 is taken into account and the analysis is again conducted for monthly returns. This step is of interest, since it is good to know, whether differences between correlation coefficients of single HFs and the market and HFI s and the market exist. If differences are found they have to be interpreted and have to be taken into account when answering the research question. Otherwise the results of the analysis so far are confirmed. In order to keep the red thread alive no separate investigation of bull and bear markets is conducted. Three more correlation coefficient matrices would simply go beyond the scope of the study and the appendix and would have added only few more insights, since the main focus for answering the first research question is still the investigation of the single HFs. Not all indices could be included in this attempt to compare the results received by looking at aggregated single HFs with HFIs. Some did not perform over the whole time period and some contained strategies, which were not included in the HF sample. Therefore only those are chosen that have an adequate length and match the definitions of different strategies in the theoretical part. In total, 19 HFIs are applied for this part of the analysis. 

Appendix 9 shows the matrix of the correlation coefficients, with the same benchmarks as above.

7.2 ANALYSIS OF THE HEDGE FUND PERFORMANCE BY USING PORTFOLIO OPTIMIZERS

This part describes the analysis of the HFI data. It is conducted to answer the second research question. Two optimizers are used to calculate optimal risky portfolios that include one HFI and two market indices. One optimizer calculates portfolios with optimal return-standard deviation relations, the other one portfolios with optimal return-MVaR combinations. As stated in the financial theory part, the MVaR is the more reasonable risk measure when investigating the role of HFs in optimal risky portfolios. Another optimal portfolio is calculated that does not include any class of HFs at all, but three market indexes. Finally the SR and the MSR are calculated for every optimal portfolio. Based on these two performance measures two rankings are generated. Each ranking also includes the optimal portfolio without HFs as a benchmark. It is of interest if the optimal portfolios that include HFs can outperform this benchmark portfolio in regards of both performance measures with particular focus on the MSR as the more suitable one.

7.2.1 CHOICE OF INPUT DATA

The choice of the input data is a difficult subject. It can greatly affect the outcome of the study and reduce its objectivity. As mentioned before, the authors have chosen indices, which provide broader results and reduce the risk of biases, due to a high amount of included HFs. This procedure is the most common one in similar research and guarantees objective outcomes. Moreover the selected indices are all global ones. This means they include nationally and internationally operating HFs. This makes a comparison and combination with the global MSCI and the global bond index easier and also more comprehensible and reasonable. The MSCI represents the global equity market and the Lehman Aggregate Global Bond Index represents the global bond market. All 19 global HFIs that were described in 7.1.4.3 are adopted. Selecting indices with shorter time series or ones that focus on certain regions could have affected the outcomes in an unwanted manner and could have prevented a generalisation of the results.

Finally, in the portfolio that does not include HFs at all, the MSCI and the Lehman Aggregate are combined with the already introduced S&P 500. This is reasonable since it is a widely accepted benchmark that is difficult to beat because it is well diversified. Additionally it represents the US equity market and the HFIs are mostly located in the US as well.
The next step is to select all other variables that are needed for the optimization process. First of all the risk-free rate is needed to calculate the tangency portfolio, i.e. the optimal risky portfolio that was described in the explanation of Markowitz portfolio selection theory. Moreover it is applied in the calculation of the MSR and SR. Both measures are needed for the final performance evaluation. One should mention that the risk-free rate is a theoretical construct, which is often assumed to be zero in financial literature. In general, it symbolizes the rate of return that can be achieved with zero risk exposure. Therefore treasury bills are often taken as a proxy for the risk free rate. Treasury bills are short-term debt issued by the US-government. Their maturity is at most one year and they only pay the principal without any interest in the meantime\(^{193}\). Since one assumes that the US-government is never “facing bankruptcy”, no risk is associated with this type of investment in theory.

For this paper, the authors used inflation adjusted treasury notes, instead of treasury bills. This decision has two reasons. First, treasury bills have been very volatile in the last years and varied from a range of 1% to 5\(^{194}\). Secondly, no adjustments for inflation are taken into account when choosing treasury bills. Therefore the authors chose 10 year inflation indexed TIPS\(^{195}\), which show a quite constant return around 2% in the last 3 years\(^{196}\). TIPS from the US treasury are also among the safest securities available. The applied value for the risk-free rate of approximately 2.3% p.a. represents the monthly average from 2006.

### 7.2.2 Neglection of Certain Factors and Limitations of the Optimizers

The first chapter already mentioned several limitations of this study that are caused by the portfolio optimizers, which were programmed in Excel. The reader should be aware of them in order to better understand the following explanations and the created results, which will be interpreted in the following chapter.

First of all the portfolio optimizers cannot take any transaction costs or taxes into account. This is a quite common assumption in theoretical models and eases the optimization process very much.

Moreover the optimizer can only be applied when inserting three time series. Therefore every optimal risky portfolio will contain three different assets or asset classes only. No more, no less can be inserted. This limitation is another reason why broad indices are applied instead of single securities or aggregated ones. Those indices already include lots of different securities or HFs so that markets, and whole asset classes, can be compared to get valuable results despite the limitation. The reader has to be aware that this optimal portfolio is only a hypothetical construct that cannot be achieved in reality, since no manager can replicate a whole index without a tracking error\(^{197}\). Transaction costs would reduce the overall performance of the portfolio too much. However for the theoretical issue, showing to what extent HFs should be included according to Modern Portfolio Theory and advanced performance measurement tools, these assumptions are adequate and necessary. The last limitation of the optimizer is that it works only with annual data. Therefore the time series have to be converted from monthly into yearly returns.

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\(^{193}\) Therefore they can be viewed as short term zero-coupon bonds.

\(^{194}\) Federal Reserve Government Release.

\(^{195}\) Treasury Inflation Protected Securities.

\(^{196}\) Federal Reserve Government Release.

\(^{197}\) See Glossary.
7.2.3 CALCULATION OF ANNUAL INPUT FACTORS

As mentioned before the optimizers are restricted to annual data. Therefore every time series of the different indices has to be converted from monthly returns into annual ones. A specific Excel spreadsheet was constructed, which was able to calculate the annual returns. Based on these annual returns of the MSCI and the bond index, as well as the HFI, the spreadsheet calculated the standard deviation, skewness, kurtosis and correlation coefficients of those variables. These variables were automatically inserted into the optimizer.

7.2.4 CALCULATION AND RANKING OF THE OPTIMAL RISKY PORTFOLIOS

With all information gathered it is possible to apply the optimizers to the indices. As already indicated, every optimization procedure involved the MSCI, the Lehman Aggregate and one particular HFI. The 19 considered indices have already been introduced. In order to compare these optimal portfolios with an optimal portfolio that does not include HFIs, another optimization had to be executed that involves the S&P 500 instead of a HFI. All in all 40 optimization processes have been executed, 20 for each optimization tool.

The whole optimization process was executed in three basic steps. First, the efficient frontier was calculated. After that, the CAL with the steepest slope was identified. This CAL is tangent to the efficient frontier. The last step was to calculate the exact return and risk values of this tangency point, which symbolizes the optimal risky portfolio.

In one optimizer the x-axis is labeled standard deviation, in the other one MVaR. A confidence interval coefficient of $z_{df} = 2.33$ was chosen for calculating the MVaR, which represents an often used 99% confidence level\(^{198}\).

After all optimal portfolios have been found the MSR and the SR can be calculated for every portfolio. This is done in a separate Excel spreadsheet. After that, the portfolios were ranked according to their performance. Both rankings are presented in the results and are of special importance for answering the research question.

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8 RESULTS

This chapter presents and interprets the different outcomes of the analysis for both research questions. In order to enable the reader to better understand the results and to make it easier to see the connections, this part is structured according to the research questions.

8.1 RESULTS REGARDING THE FIRST RESEARCH QUESTION

First the question “Are hedge funds performing market neutral in bull and bear markets?” shall be answered. For a better understanding a step-by-step approach is applied.

8.1.1 ASSESSMENT OF CORRELATION MARKET NEUTRALITY BASED ON A PERFORMANCE RANKING

First of all, it is of interest to investigate the annual returns of different HF strategies, in the time period of 1995-2006. This will support the upcoming results of the correlation analysis through the illustration of return fluctuations of the investigated HF classes compared to the S&P 500. This reveals the ability to HF managers to create stable returns over time and their ability to beat the market when looking at the returns.

Appendix 4.2 illustrates the matrix from which the results are derived. Of course this section is not discussing every HF strategy in detail, since this would be a kind of endless explanation. Only the most important issues are outlined. For criteria of understandability the argumentation follows the provided classification of HF strategies in Figure 3.2.

Remembering the theory, relative value strategies should feature lower returns than other strategies, due to their lower risk. In fact, equity market neutral is performing moderate or even below the average through all types of markets. Only in the bear market it seems to provide some advantages, when still providing quite good returns. Since this strategy is not very much affected by either bull or bear markets, an indication of market neutral performance is given.

Convertible arbitrage is a very interesting strategy regarding this result. It seems to be very volatile in its return distribution, but some pattern can be identified. According to the less than average returns in bull markets and the above than average returns in bear markets, one could assess them a slight negative correlation with the market. Such a return distribution seems logical. When markets are rising a conversion from bonds into stocks is more likely than in decreasing ones. Thus the bonds insure even in bear markets a satisfying profit.

A similar behavior shows the multi strategy arbitrage, which performs most of the time moderately in bull markets and can be found under the best fives in bear markets. In general those behaviors of return distributions can be seen for fixed income arbitrage and statistical arbitrage also. Thus, relative value strategies seem to fit to their theoretical characteristics. They show low returns, low volatility, a standard deviation of 7%-11% and a lower correlation with the market than other HFs.

Considering event driven strategies, one should keep in mind their higher riskiness, which can be seen in a standard deviation of approximately 7.5%-12.5%. The event driven strategy itself performs above average in most time periods in bull and bear markets. Therefore a statement about correlation coefficients based on annual returns cannot be made. Surprisingly merger and acquisitions feature a distribution with very low risk but also very low returns in respect to other strategies. Entirely different, the distressed securities show a very volatile distribution. It seems to be a superior strategy for bear markets, due to twice second places in
that time period. However in bull markets, especially in very fast increasing ones, it cannot achieve satisfying returns. In respect of the whole group one could conclude that it bears higher risk and some advantages in downward sloping markets.

The last group investigated, is the opportunistic strategies class. Here the standard deviations differ between 2.5%-20.5%. Taking the short strategy out of this calculation would change the standard deviation to a range of even 9.5%-20.5%. The small standard deviation of this particular class is quite uncommon for the opportunistic strategy group in general. Next to a financial reason, another one could be the small sample size of only 15 HFs. Therefore one should disregard the standard deviation of short selling, when considering the whole opportunistic group. Nevertheless the short selling strategy performs like it is stated in theory. In upward sloping markets, short positions are unlikely to generate high returns, while in downward sloping markets possibilities arise to gather profits. Therefore it verifies the expectations about being a bearish strategy, which is negatively correlated with the market. Contradictory, equity long clearly shows the performance one expects from a bullish strategy, which performs very well in bull markets, but cannot achieve this performance in bear markets.

Equity long/short, a mixture of those two previous strategies, performs better than the special strategy “equity long” in the first bull market and in the bear market. Surprisingly it also performed better than the short strategy in two out of three bearish years. Two explanations seem to be possible. The most obvious one is that the sample of the short selling strategies was rather small and in some years heavily biased, due to the fact that only some HFs were able to perform over a long time period. Therefore there could be monthly or annually returns, which are only constructed out of 2-3 HFs. This circumstance supports the decision to use HF indices in the portfolio analysis. Another argument could be the superior selection skill of equity long/short managers. This argument is not very powerful, since the equity long/short strategy performs worse than the equity long strategy in the second bull market.

The emerging market strategy can be used as a kind of proxy for the whole group. It offers huge returns, being 6 out of 12 times under the three best performing strategies, but also 4 times out of 12 under the three worst performing ones. Therefore it is associated with a very high volatility. In conclusion, the group of opportunistic strategies matches its expectations derived from theory. Generally higher returns are combined with higher levels of risk.

Another interesting strategy is the pipes strategy. Like the short strategy, this sample is rather small and therefore results should be handled with care. Nevertheless it exhibits similar features like the equity long and equity long/short strategy, but shows more volatility in its returns. As explained in chapter 4 this strategy puts companies under huge pressure, which enables the HF managers to earn tremendous profits. Evidence for that can be seen in the empirical findings, since pipes performed 8 times out of 12 under the two most successful strategies.

The last issue of this chapter is to compare HF returns to a market benchmark, which is, in this case, the S&P 500. It is difficult to make any comments about market neutrality by just comparing returns and one has to be very careful, when comparing samples of HFs with an index. An index is steadily readjusted in its weights and securities, which will result in an approximately optimal passive portfolio that reflects the underlying market. Even passive mutual funds cannot replicate an index without a tracking error, because the transaction costs that are necessary to adjust the portfolio would hurt the returns considerably. Therefore an index like the S&P 500 is a challenging benchmark. Nevertheless since HFs want to combine market neutrality with the idea of absolute return, i.e. a constantly high return despite market movements, some statements can be made. The S&P 500 outperforms the majority of the HF
strategies in bull markets. Only few HF strategies, like pipes and blanks manage to beat the S&P 500 in bull markets. The opposite is the case for bear markets. In all three years the benchmark ranks last and is outperformed considerably. This demonstrates the clear advantage of HFs to minimize losses or even generate profits through the use of short positions and derivatives. According to this result the superiority of HFs must be limited to bear markets, but it could be an indication for market neutrality.

8.1.2 ASSESSMENT OF CORRELATION MARKET NEUTRALITY BASED ON CORRELATION MATRICES

This section looks at the ability of HFs to perform market neutral in greater detail than the previous one. The previous section merely indicated the degree of market neutrality. Now the correlation coefficients regarding HF classes and the familiar market benchmarks are presented and interpreted in order to answer the first research question on the basis of hard numbers. This is done in two steps. First the correlation coefficients of the whole time series from 1995 to 2006 are investigated. After that, the time series are split up in order to investigate the correlation market neutrality for bull and bear markets. The correlation coefficients matrices can be found in Appendix 5 and Appendixes 6 to 8 respectively.

8.1.2.1 CORRELATION MATRIX REGARDING THE WHOLE TIME PERIOD FROM 1995-2006

Appendix 5 illustrates the correlation coefficients based on monthly average returns over the time period from 1995-2006. As mentioned before the focus lies primary on the stock markets, which are represented by the MSCI Global Index, the Wilshire 2500 and the S&P 500. It is not surprising that the correlation coefficients of S&P 500 and Wilshire 2500 differ not very much from each other, since both represent the American stock market, even though the Wilshire takes also smaller companies into account. But also the global index, the MSCI, shows a high correlation to both of them. This also reflects the importance of the American stock market for the global stock market. This discussion focuses on the correlations between the MSCI and the HFs, since even though the HFs are managed from the US most of them operate internationally.

The correlation coefficients illustrate very well that no strategy is able to perform market neutral regarding the assumption that market neutrality is evident if the coefficient lies in a range from -0.1 to 0.1. However, the equity market neutral (0.166) and convertible arbitrage strategy (0.212) are the ones that come close to this hurdle and therefore have diversification power if they are included in portfolios. Also the pipes strategy (approximately 0.29) still offers diversification potential. But the overall result seems to reject the common view of HFs being able to perform market neutral. Another interesting aspect that should be highlighted is the short strategy, which is the only one that exhibits a significant negative correlation. This is in line with theory and the investigation of the annual returns in the previous section. This already indicates that HFs that apply a short strategy have the potential to increase the performance of optimal portfolios, particularly in bull markets. This will be investigated when discussing the second research question. Finally the correlation coefficients regarding the bond index indicate market neutrality in regard to the bond market for all HF strategies, except equity market neutral (approx. 0.17) and emerging markets (approx. -0.13). Equity market neutral funds try to be market neutral in regard to the equity market, which is low correlated with the bond market. This might be the reason for the slight positive correlation. Emerging market strategies involve the purchase of government bonds that are issued by developing countries. Maybe these bonds behave differently than bonds issued from developed countries.
8.1.2.2 Correlation matrix regarding the first bull market (Jan-1995 to Sep 2000)

Further insights are necessary, since this study claims to investigate the relationships between the market and HF strategies separately for bull and bear markets. Therefore, correlation coefficients are calculated for the different types of markets. Due to the shorter time period, those series are more volatile and can be affected by extraordinary events. The assessment regarding the segregation of time periods was justified in the analysis. Appendix 6 illustrates the correlation coefficients regarding the first bull market. One can see a very similar matrix to the one in 8.1.2.1 regarding the stock benchmark as well as for the bond proxy. In general, the coefficients are higher, which supports the argument of no strategy being able to perform really correlation market neutral in regard to the stock market. Two divergences have to be highlighted. First, the pipes strategy performed market neutral in the first bull market (0.086). One has to remember that the sample here is relatively small, but the correlation coefficient indicates market neutrality quite strong. Secondly, the correlation coefficient of the merger arbitrage class is lower in regard to the first bull market (0.325) than in regard to the overall period (approx. 0.35). This has to be kept in mind when looking at the other time periods.

8.1.2.3 Correlation matrix regarding the bear market (Sep 2000 to Mar 2003)

Some surprising issues can be found in the bear market correlation matrix in Appendix 7. The equity market neutral strategy (-0.435) is the only one, besides the equity short strategy (-0.583), that shows an opposite market position. This does not indicate market neutrality as it was defined in the theory part, but they still offer diversification potential. The pipes class is now highly correlated with the market (0.61). Maybe this has practical reasons regarding the short selling component of the strategy. If these funds are not able to short sell the shares gained in the pipe, all they have are some illiquid securities that have a high probability to lose value.

A class where the correlation coefficient (0.244) decreased, compared to the whole period (0.424) and the first bull market (0.539), is the distressed security class. This makes sense, since in bearish markets more companies get into trouble. The strategy benefits from that and is therefore able to partly avoid negative influences on its performance. The emerging market strategy is again negatively correlated with the bond market. This time the correlation coefficient is even slightly lower (-0.34) than in the previous bull market (-0.3).

Comparing this correlation matrix with the annual return ranking, it becomes obvious that 9 out of 17 HF strategies show returns lower than 5% per year. Most of the time the bad performing ones are the same like, sector, macro, equity long, merger, statistical arbitrage, emerging markets and equity market neutral. Except the equity market neutral strategy, those strategies exhibit a highly positive correlation with the stock market. This questions the skills of HF managers, either not being able to use short positions of stocks and derivatives or not being able to forecast future market movements and to adjust their portfolio based on these forecasts. This might be a reason why they are not able to construct market neutral portfolios despite the available tools.

8.1.2.4 Correlation matrix regarding the second bull market (Mar 2003 to 2006)

The second bull market draws in most cases a similar picture as the first one as can be seen in Appendix 8. Most strategies show a slightly higher correlation coefficient for stocks as well as for bonds, compared to those ones of the whole time period. Furthermore bond and stock movements have now a slightly positive correlation, compared to previous results that show
no or even slightly negative correlations. However one strategy developed quite different. Now the fixed income strategy, that exhibited high positive correlation in the first bull (0.636) and bear (0.524) market, displays a market neutral position (0.094). To interpret this result one has to be aware of the composition of this class. It consists mainly of fixed income strategies that focus on arbitrage, high yield bonds, convertible bonds or on a large diversification of fixed income securities. One explanation could be a shift in the proportions of these classes in the later sample. Another reason could be a change in HF policy that took the focus more on bonds other than convertibles, as can be seen in the correlation coefficients. However this last result is more in line with the theory. Also the convertible arbitrage exhibits a lower coefficient now (0.21). The correlation of the pipes class is still one of the lowest (0.328) but clearly not market neutral anymore as in the first bull market. The merger arbitrage class shows the highest correlation coefficient (0.526) compared to all prior ones (0.349/0.325/0.264). This indicates a boom in the merger and acquisition field after the burst of the bubble was borne. During the bear market, the correlation was rather low. Afterwards it increased extremely. This could indicate the worth of this class in optimal portfolios.

8.1.2.5 CONFIRMATION OF THE GATHERED RESULTS

Like it was mentioned in the analysis chapter, the results have been tested by calculating another correlation matrix. This time, the available HF indices, that match the HF classes from the analysis before, have been used to investigate market neutrality, either to confirm the findings or to reveal discrepancies between the application of aggregated single HFs and HF indices.

Appendix 9 illustrates the correlation matrix of the Greenwich Global Hedge Fund Indices regarding the period from 1995 to 2006. It is also based on monthly data.

Some indices are named differently or are even missing compared to the samples from Barclays Hedge Fund Database. This is caused through the different classifications in current literature. But still, the most important ones are included and also a global HFI, which contains all strategies, is provided.

As in the correlation matrix of the sample, the stock benchmarks show similar directions of the coefficients and also the level is approximately the same. Therefore the MSCI can be regarded as the main benchmark again.

Another similarity can be seen in the equity market neutral index that exhibits a coefficient of 0.29 and is therefore not so much higher than the one found in 8.1.2.1 (0.166). The same similarity is the case for convertible arbitrage, where coefficients are around 0.25. Furthermore the short selling strategy demonstrates considerably negative correlations (-0.71) with the market benchmark. This fits also to our previous sample, even if the levels differ (range before: -0.35 to -0.58). Such aberrance can be assigned to the very small amount of the sample. Regarding the issue of market neutrality the only matching strategy is fixed income arbitrage (approx. 0.1). The correlation coefficient of fixed income arbitrage is very similar to the one that was calculated for the second bull market before (0.09). Thus the sample might be a biased in the first bull and bear market. The rest of the indices exhibit the same positive correlations as in the sample, with little differences in the absolute amount.

Finally it is very interesting that the overall HFI has a highly positive correlation with the stock benchmarks. Such a result seems logical, since most of our HF samples and indices showed highly positive coefficients. Hence an index consisting of all strategies should feature a similar high positive coefficient. This also indicates to absence of correlation market neutrality.

These results confirm the prior findings that the majority of HFs does not perform market neutral in regard to stock markets. But some strategies like equity market neutral, convertible
arbitrage, fixed income and short selling seem to back up the diversification of investors' portfolios, due to their lower or even considerably negative correlation coefficients. Regarding fixed income arbitrage, some results even suggest market neutrality. The rest of the strategies that have highly positive correlations are probably not very desirable considering also the former ranking. This will be investigated further in the following.

8.2 RESULTS REGARDING THE SECOND RESEARCH QUESTION

This section shall answer the question “To what extent should hedge funds be included in optimal risky portfolios according to Modern Portfolio Theory and advanced performance measurement tools, considering their degree of market neutrality.” As pointed out in the corresponding research objective the main goal is to support investors with guidance, how to improve the risk and return relationship of their optimal risky portfolios by using hedge funds. To assess and include diversification effects, correlation coefficients are needed again. But this time, since the indices are the relevant data, the correlation coefficients are solely taken from the index data. Performance measurement tools are needed, in order to illustrate to what extend the different HF strategies should be included in investors’ portfolios. In this case the MSR and normal SR help to investigate, whether HFs should be included in the portfolio or not. This will be executed by a comparison between SRs and MSRs of different optimal portfolios. One includes the S&P 500 and serves as a benchmark portfolio. The other ones include in each case a HFI, instead of the S&P 500. The detailed analysis process and the generation of the optimal portfolios have been outlined in the previous chapter.

8.2.1 PERFORMANCE MEASUREMENT BASED ON THE MODIFIED-SHARPE RATIO

Applying the MSR delivers some interesting and surprising results, as can be seen in Appendix 11. Only two strategies, short selling and convertible arbitrage managed to beat the benchmark portfolio. Thus only those two strategies are worth to be integrated in an investor’s portfolio, instead of the S&P 500. According to Appendix 12 short selling should be included with approximately 20% and convertible arbitrage with approximately 70%. This result is astonishing in two respects. First, more optimal portfolios that include HFs would have been expected to outperform the benchmark portfolio. Secondly, the weights of the HF indices in their portfolios, which outperform the benchmark portfolio, differ very much from each other. Both aspects have the same cause. It is due to the different diversification power of the fund classes. This is a complex issue and has to be explained step-by-step.

First of all, the focus lies on the result that only two portfolios of HF indices managed to outperform the benchmark portfolio. Therefore one has to regard the MSR that is responsible for this ranking. It consists of the return of the portfolio, of the risk-free rate and the MVaR of the portfolio, which consists then again of the standard deviation of the portfolio, the skewness and kurtosis. Since the risk-free rate is the same for all ratios, it can be neglected in the interpretation. Thus all other factors influence the ranking of portfolios and are of importance. Hence a high return of the portfolio and a low MVaR result in a high MSR. The most important factor in this equation is the correlation coefficient, since it reduces the standard deviation of the whole portfolio through diversification effects. The standard deviation is the main component of the MVaR. Thus a negative, market neutral or low positive correlation coefficient can reduce the whole MVaR. The skewness and kurtosis should be near to zero in order to achieve a low MVaR also. Last, the return of the HF should be quite high in order to ensure a high profit of the whole portfolio and to enable the new asset to “complete” the old securities in the portfolio during the optimization procedure. One comes to the conclusion that, in general, assets with low correlation coefficients, low standard
deviation, higher returns and normal (or even positive) skewness and normal (or even negative) kurtosis will have higher MSRs.

This perceived awareness is closely linked to the issue, to what extent HFs shall be included in optimal portfolios. An investor will extend the weight of a HFI as long as this additional extension will increase the MSR of the portfolio. Appendix 13 illustrates the explained issues.

This result can be illustrated further by some examples. The first one looks at the benchmark portfolio itself. The S&P 500 is highly positive correlated to the MSCI Index (0.92) and features almost the same average return, but more risk. Therefore it is likely to be replaced. Exactly this is executed in the optimal portfolio. Since short selling is not forbidden the optimal portfolio takes a short position in the S&P 500 and a long position in the MSCI and Bond Index.

The market neutral group (0.887), the equity market neutral group (0.914), the event driven (0.931) and the income strategies (0.963) achieve a MSR near to the one of the S&P 500. Moreover they feature higher (and positive) weights in the efficient portfolios. These results materialize mostly due to the low correlation coefficients of these fund indices with the market, or due to a better return risk-relationship. Once again, such results are in line with the previously drawn conclusion. It outlines that only those strategies manage to achieve a higher MSR and higher weights that are low correlated to the market and/or feature a better return-risk relation. The reason why they do not outperform the benchmark portfolio is because short selling is not restricted and, in some cases, because of their unfavorable skewness and kurtosis values. It can be observed that except the short strategy, all others have a higher MVaR than the S&P 500. That is why the short strategy is so valuable in the portfolio. It helps to decrease risk. The same is valid for the convertible arbitrage index. It combines a relatively low risk (7.7%) with a quite high return (11.52%)

This makes it possible to fully answer the second research question, to what extent HFs should be included in efficient portfolio according to Modern Portfolio Theory and advanced performance measurement tools, considering their degree of mark neutrality. The authors do this very abstract. All the more a hedge fund or hedge fund index performs market neutral all the more he is likely to be included in an investors portfolio.

But other factors have to be considered as well. The return of the fund directly affects the return of the portfolio. The standard deviation, the skewness and the kurtosis affect the MVaR and therefore the risk of the portfolio. Only if the low correlation is able to reduce the portfolio risk enough to compensate either for lower returns or for unfavorable skewness and kurtosis or for all three of them, the HF will actually be taken into account.

Due to the aggregation of monthly returns to annual ones, a slight downward bias in correlation coefficients has occurred to nearly all strategies. The most important ones for the portfolio analysis are listed in the following. Short selling has become even more negative, global income is now slightly negative correlated, fixed income arbitrage is now slightly positive correlated instead of market neutral and convertible arbitrage has become market neutral. Due to the limits of the optimization software those annual correlation coefficients have to be used for the portfolio optimization. Appendix 13 illustrates both correlation coefficients and Appendix 10 shows the whole matrix.

8.2.2 PERFORMANCE MEASUREMENT BASED ON THE SHARPE-RATIO

As stated before the normal SRs feature significant disadvantages regarding the topic of HFs. Since it does not take any skewness, kurtosis and fat tails into account one expects higher SRs than MSRs in general. Now most HFs should outperform the S&P 500, since the focus is
limited to the return-standard deviation relationship only. Results are illustrated in Appendix 11.

Four important facts are outlined in this chart. First of all, the results exceed all expectations, since every HF strategy is able to beat the benchmark portfolio. Some HFs even display SRs twice as high as the one of the benchmark. Therefore when limiting the performance measurement to return and standard deviation the common view of the superior role of HF strategies can be approved.

But comparing SRs and MSRs demonstrates clearly the overestimation of HF performance by the normal SR. Some differences are huge, like twice or three times the amount of the MSR. But there are also slighter differences, as can be seen for the macro strategy. These differences illustrate very well how negatively affected a rational investors’ portfolio will be, if taking skewness, kurtosis and fat tails into account.

The third fact is also derived from the comparison of those two performance measurement tools. The purpose of a performance measurement is to derive a kind of ranking of different securities. According to this ranking one can make decisions about the beneficaility of including a specific security into one’s portfolio. Appendix 14 displays the rankings of HF strategies and the S&P 500 according to the SRs and MSRs.

As can be seen quite clearly, the ranking is totally mixed up. Some strategies like macro, emerging markets and market timing perform poorly in both measures. But others are totally different in both rankings. The value strategy drops from first place to 12th, when taking the higher distribution moments into account. The short selling strategy behaves the other way around. It rises from the 15th place to the first place. But the largest movement is performed by the S&P 500 index that jumps from the last position to the third place. Thus an evaluation of the profitability of different securities is extensively affected by the choice of the correct performance measurement tool. An investor has to consider all possible risky factors that might influence the return of his portfolio, when adding a new security. Therefore more developed risk measures have to be applied. In case of HFs the MSR should be applied, which goes far beyond the normal standard deviation and takes all specific characteristics of HFs into consideration.

Finally one can compare the weights of the efficient portfolios, in order to see to what extend the normal SR recommends implementing the HF indices. Appendix 12 illustrates the weights of the HFI under the performance measurement of the SR and MSR. In all cases except of the event driven strategy, which had already a high weight, the weights increase significantly and build the lion’s share of the whole portfolio in the majority of cases. Thus the MSCI is replaced and sometimes even short sold in order to extend the share of the HFI. This is caused through the low standard deviation of most hedge funds, which fails to reflect all risk associated with hedge funds and sometimes due to their low correlation coefficients.

It became clear that applying a performance measurement tool that does not take the specific characteristics of the risk of HFs into account, results in a false structure of the final portfolio and a return-risk relationship that does not match rational investors’ preferences.
9 CONCLUSIONS

This chapter points out the most important findings of the results in a comprehensible way. Following the structure of the results part and of the overall study, the conclusions are separated into the two research questions.

9.1 CONCLUSIONS IN REGARD TO THE FIRST RESEARCH QUESTION

This part answers the question, if hedge funds perform market neutral in bull and bear markets. Several findings were gathered, which are presented below.

By looking at the ranking of HF classes based on returns, some indications for market neutrality could be found. But according to the correlation coefficients calculated from the samples from Barclays database for the time series as a whole and for the separation into different types of markets, market neutrality in regard to stock markets has to be rejected in general.

Regarding the assumption that market neutrality is evident if the coefficient lies in a range of -0.1 to 0.1, no market neutral fund class was found when considering the whole period from 1995 to 2006. Equity market neutral (0.166), convertible arbitrage (0.212) and Pipes (approximately 0.29) are the strategies that come closest to being market neutral. This makes sense from a theoretical perspective but the coefficients are still higher than expected. Other strategies like the event driven ones show even higher correlation coefficients although theory describes them as market neutral. Equity short is the only strategy that exhibits a negative correlation (-0.39). If the authors had chosen the other presented definition of market neutrality, then this strategy would have been the only one that features this ability.

When looking at the separate bull and bear markets some deviations occur. Fixed income arbitrage exhibits in the second bull market a correlation coefficient (0.09), which is low enough to justify market neutrality. The same is valid for the Pipes in the first bull market (0.086). In addition to the short strategy, equity market neutral shows a negative correlation (-0.435) with the MSCI during the bear market. Other strategies, like convertible arbitrage, display a low correlation with the stock market benchmarks again, but not low enough for a total market neutral position over time.

Comparing the correlation coefficients of a HF database to global HF indices, which are less biased, delivers similar results. This supports the work and analysis of the authors. Once again the fixed income arbitrage strategy is the only one, which manages to perform market neutral in regard to the stock market. Equity market neutral, market neutral arbitrage, convertible arbitrage and global income are lower correlated than the rest, but still too high. This confirms the result that even the strategies, which claim to perform market neutral, fail to achieve this. The remaining strategies feature a significant exposure to market movements. The correlation of the overall HFI with the stock market index confirms this result again.

As assumed, the relationship with the bond market can be regarded as being market neutral for most strategies. Only those, which have their main focus on bonds, feature a low, but also neglectable, correlation to bond markets.

Since correlation coefficients for both investigations are very similar, a main conclusion can be drawn. The assumption or common view of market neutrality has to be rejected for the majority of HFs. Only fixed income arbitrage, which focuses mainly on the bond market and
specializes in arbitrage, can justify being labeled market neutral when looking at the index or the second bull market. This finding is in line with theory, since relative value strategies are expected to be market neutral. But in case of fixed income arbitrage this is not even a major aim of the manager. It is more a by-product of the strategy instead of the result of the active attempt to create a market neutral position.

9.2 CONCLUSIONS IN REGARD TO THE SECOND RESEARCH QUESTION

This section provides the final conclusions regarding the question to what extend hedge funds should be included in optimal risky portfolios according to Modern Portfolio Theory and advanced performance measurement tools, considering their degree of market neutrality.

The study demonstrates clearly that the extent of including HFs in efficient portfolios is based on the correct choice of the performance measurement tool. Such tools that do not consider all performance characteristics of a specific asset will dilute the overall picture and give wrong advises to investors. As the reader could see advises change completely, regarding the choice of the correct HF strategy and the weight of the HF that should be included when based on another performance measure. The SR overestimates the favorability of hedge funds and is probably one important reason for the opinion that hedge funds are superior investment instruments. Therefore, in the case of HFs, the right performance measurement tool is the MSR. Based on the MSR, different alternatives of portfolio compositions can be evaluated. A rational investor will always pick the alternative, which shows the highest ratio, due to the fact that this will maximize the return-risk relationship. Thus only those HF's will be included into the portfolio, which manage to beat the MSR of the benchmark portfolio. The authors demonstrated that a high MSR is the starting point in determining the extent by which the HF will be included. The factors, which lead to a high MSR in general, are also responsible for the optimal weighting of the HF.

In brief, the following conclusion was drawn: A negative, market neutral or low positive correlation will cause a higher MSR that potentially enables the new portfolio to outperform the benchmark. But other factors have to be considered as well. The return of the fund directly affects the return of the portfolio. The standard deviation, the skewness and the kurtosis affect the MVaR and therefore the risk of the portfolio. Only if the low correlation is able to reduce the portfolio risk enough to compensate either for lower returns or for unfavorable skewness and kurtosis or for all three of them, the HF will actually be taken into account. Thus market neutrality supports the inclusion of HFs into investors’ portfolios but is not the only relevant factor, especially in the case of HFs.

In particular the study showed that only two HF strategies, convertible arbitrage (1.197) and short selling (1.276), managed to beat the benchmark portfolio (MSR of 1.072). Those were the ones, which featured a negative or a market neutral correlation coefficient in combination with a good return-risk relationship. Short selling had a MSR of 1.276 with a correlation coefficient of −0.86 to the MSCI and a weight of approximately 20% in the optimal portfolio. Convertible arbitrage had a MSR of 1.197 with a correlation coefficient of 0.016 and a weight of approximately 70%.

These findings are all based on the idea from Modern Portfolio Theory that diversification can improve the overall performance of portfolio, and that not only one particular factor e.g. correlation, return, risk, skewness or kurtosis, is responsible for the performance and for the

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199 Remember that this is a coefficient based on annual data. It has not been discussed in any part before.
200 Remember that this is a coefficient based on annual data. It has not been discussed in any part before.
optimal weight. It is rather the interaction between those variables that is important. Thus as can be seen above, even two efficient portfolios that feature approximately the same MSR, can display different amounts of weights, due to the differences in the amounts of the important factors.

As can be seen in Appendix 4, HFs offer huge returns and are able to outperform the market benchmark particularly in bear markets. Therefore the authors recommend especially in bear markets to evaluate an inclusion of HF strategies into one’s portfolio, in order to improve the risk-return relationship of the overall portfolio. This recommendation is confirmed through the empirical finding that only those two HFs were included, which displayed a favorable change in performance between the bull and the bear market. In longer bearish periods the inclusion of further HFs and higher weights might be advisable. Even if there is no strong evidence of market neutrality HFs seem to at least be able to prevent diversification meltdown, since the correlations did not increase considerably when the market became bearish.
A lot of facts argue for a further investigation of this industry. First of all the HF industry is still in its developing stages with huge growth rates every year. At the same time databases manage to gather more and more detailed information and are able to draw a better picture of HFs’ performance and characteristics. That is why it might be interesting to replicate this study after some time. Moreover new tools for time series analysis are developed and could cause quite different results to the common method of correlation analysis. One of those is the cointegration approach, which is very interesting, since it considers the whole process from a different angle. Unfortunately it is rarely applied in current HF literature.

This can be explained by several reasons. First of all cointegration is a quite new and demanding approach, which requires deeper knowledge of statistical relationships and methods. Secondly the application of cointegration makes only sense, if data was constantly collected over many years. Therefore it can be better applied when HF databases cover periods of at least 15-20 years and if HFs survive longer than they do now. Last, databases have to provide prices or values for each HF instead of returns, because the cointegration approach focuses on prices. This section shall give a short insight in this rather new approach and provide researchers with an incentive to apply it in their academic work.

Engle and Granger developed the cointegration approach in their paper “Co-integration and error-correction: Representation, estimation and testing”\(^{201}\), which demonstrated the basic idea of non-stationary time series. This basic idea behind cointegration is that an individual economic variable, viewed as a time series, can wander extensively and yet some pairs of series may be expected to move so that they do not drift too far apart\(^{202}\). Thus cointegration means simply the possibility to combine two or more non-stationary time-series, which are integrated of the same order \(n\), to a stationary linear combination that has an order less than \(n\)^{203}.

One has to keep in mind that correlation and cointegration are different approaches. The assumption that high correlations also imply cointegration and the other way round is wrong. Alexander, Giblin and Weddington use a quite demonstrative example, which describes the case of an investor holding a very large and diversified portfolio, which is compared with an equity index\(^{204}\).

The weights of the portfolio are matching the weights of the index, but the portfolio does not consist of all assets that are included in the index, i.e. a tracking error exists. This is quite realistic due to transaction costs. The portfolio and the index would show a correlation of almost one. They are nearly perfectly correlated. But in the long run, the assets, which are not included in the portfolio, but in the index, might develop in a way that is increasing the deviations between both. This could have been found out through the application of a test for cointegration.

This example shows quite clear the different assumptions of correlation and cointegration. Correlation focuses on the similarities in the movement of returns over time and is therefore very susceptible to instabilities in the long run. The reason for that is that correlation analysis is based on returns, which are short-term measurements and have limited memory. Therefore one has to rebalance passive portfolios in order to prevent the tracking error from behaving in

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\(^{201}\) Engel/Gragner (1987).


an unpredictable manner of a random walk. Due to the fact that most investors are interested in long-term performances of their portfolio, the correlation approach is not the appropriate approach for performance measurement and portfolio management. But the focus on long-term performance is exactly what cointegration does, through analyzing the change in prices.

Another interesting issue would be to compare different large HF databases with each other in order to investigate how specific biases can affect the outcomes. These differences in outcomes are of huge importance for portfolio considerations. Therefore it would also be of particular investors’ interest to use optimizing software, which can process a large variety of different securities and which focuses on advanced and adjusted risk/performance measurement tools. Such ones are provided by alternativesoft or laportesoft.

Of course, another recommendation is to apply the analytical framework in this thesis to HF classes that could not be considered in this study and to investigate the relationship of these classes to the ones investigated here. Another possibility is to investigate a specific class, e.g. equity market neutral or fixed income arbitrage in even greater depth.

Finally a study could be of interest that takes transaction costs and taxes into account or that focuses on the influence of different kinds and levels of fees.

11 CREDIBILITY CRITERIA

The purpose of this chapter is to evaluate the robustness and the accuracy of the analysis and its findings. It discusses credibility criteria that are relevant for quantitative studies.

11.1 RELIABILITY

The first criterion that is of interest is the reliability of the measurement. If a measurement is not reliable then it can never be valid. Reliability refers to the absence of statistical errors or random errors. It expresses the degree of accuracy of a particular reading. This implies the stability of the measurement. In other words, it states how well the construct that is measured is actually measured by using the chosen tool. Therefore, it is important to mention once again what kind of construct was measured with what kinds of tools.

Firstly correlation market neutrality was measured. Not the authors measured the returns of the HFs, but the HFs themselves. They reported these returns to the database, which provided the authors with the data. After that, statistical methods were applied to get reliable values of correlation market neutrality. Since the authors prepared the data prudently step by step and gathered extensive knowledge about the preparation of HF performance data, the occurrence of errors during the preparation of data and the analysis is highly unlikely. On the contrary, the analytical framework was created in order to avoid errors and to encourage and enable the reader to replicate this work.

Therefore the only source of distortion left is the utilized database. Since the used database, like probably all HF databases, usually sends information only to paying customers it is unlikely that the quality of the data is low, especially when considering the high level of fees. Therefore there is no evidence of lacking reliability regarding the measurement of correlation market neutrality. Testing the indices also confirmed the results gathered from testing the single funds. No result turned out to be contradictory or theoretically impossible.

Afterwards the advantageousness of HFs in optimal portfolios has been measured. Here the data comes from another database and represents indices. Indices can be calculated in many different ways by using many different specifications. Therefore the authors again have to rely on the quality of the provided data. The optimizers have been run on the same computers with the same settings as in the investments course of the master program to ensure the absence of software-hardware conflicts. The adjusted optimizer has been developed with the help of Sandra Eckel, who studies mathematics and computer science, and with the valuable advice from the Assistant Professor Rickard Olsson. The analysis was also conducted step by step and checked for inconsistencies a lot of times.

Reliability should also imply that the generated results are replicable. The authors believe they did everything to assure that by presenting the workflow of the research and particularly of the analysis and pre-analysis in great detail. But as mentioned in the introduction and indicated again in the future research suggestions the HF industry develops quite fast. Future developments could affect e.g. the general viability of some hedge fund strategies. This would make future studies less comparable to this one. Further the selection of the particular database certainly affects the outcomes of the investigation. Even though many HFs report to more than one database, there are deviations. Additionally some databases distinguish between more strategies than others do. All this might have an effect on the possibility to

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206 Bryman/Bell (2003), p. 76.
replicate the revealed results despite the authors attempt to be as sound and objective as possible.

11.2 VALIDITY

Validity is the most important criterion in quantitative research. It examines, if the measurement really measured the intended concepts. This kind of validity is also called measurement validity\textsuperscript{208}. This makes it clear why a non-reliable reading can never be valid. If one is not even able to measure something accurately one has no chance of measuring the particular concept that one intended to measure\textsuperscript{209}.

There are many kinds of validity. Since no specific statistical test was conducted only the weakest form of validity, so called face validity can be discussed. Face validity means that the readings are regarded as valid if they do not oppose the common sense of people who know the topic\textsuperscript{210}. This degree of validity is sufficient regarding the analysis conducted in this study, since in this study validity is less problematic than reliability.

In the present case one could even argue that if the readings are reliable they are also valid, since the probability that something else was measured, other than the intended concepts, should be neglectable.

This is the case because no social concept was measured, but a statistical relationship or a financial performance after an optimization procedure.

The extensive literature perusal and the knowledge of the authors themselves about this topic should have prevented them to confuse the approaches.

11.3 GENERALIZABILITY

Another important factor is the possibility to generalize the findings. Like most quantitative studies, this is also desirable regarding the present one. Generalization implies that findings are valid beyond the scope of the context in which the study was executed\textsuperscript{211}. This issue is tightly connected to the sampling method used to gather the data. As mentioned earlier in the paper and also in this chapter the possibilities for the authors to sample have been very limited. To gather the secondary data was quite demanding and time consuming.

Unfortunately the authors were not able to find out what factors motivate a certain HF to report to one database but not to another one. If there are some hidden patterns behind this decision process, then the choice of the database affects the generalizability of the work. On the other hand, a large amount of data has been processed and the applied database kept all dead funds in the records. These facts certainly improve the generalizability of the present study. Being aware of the fact that some sub-classes, which were applied to answer the first research question, turned out to be quite small, the authors were cautious in interpreting these findings. In these cases the generalizability is certainly limited. In other cases, hundreds of funds could be assigned to one particular class. Here the findings are of course sounder and probably generalizeable.

The shortcomings of too small samples were also compensated through the application of global HFIs, which give a broader view of HFIs in general. As can be seen in the results part, the outcomes do not differ very much from each other and go mainly in the same direction. Therefore a generalization for a broad variety of hedge funds can be justified.

\textsuperscript{208} Bryman/Bell (2003), p. 33.
\textsuperscript{209} Bryman/Bell (2003), p. 79.
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- Barclays Alternative Investment Database, retrieved 11/02/2007
  http://www.federalreserve.gov/releases/h15/data.htm
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  http://greenwichai.com/
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  http://www.investorwords.com/443/bear_market.html
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- Tracking Error, retrieved 20/04/2007
  http://www.investopedia.com/terms/t/trackingerror.asp

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  http://www.cnbc.com/id/17033360

For portfolio optimizer:
- Alternativesoft company, retrieved 16/04/2007
  http://www.alternativesoft.com/
- Laportesoft company, retrieved 16/04/2007
  http://www.laportesoft.com/
Appendix No. 1

Euro to US$ Exchange Rate Development
From 1/1/95 to 18/5/07 Monthly

Source: Thomson Datastream
## Appendix No. 2

### Stationarity Tests (Summary Overview)

no test = no test because of insufficient observations  
average observations = average numbers of observations in non-stationary time series

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Appendix No. 3

S&P 500 Composite-Price Index
From 1/1/95 to 21/5/07 Monthly

Source: Thomson Datastream
### Appendix No. 4

#### Ranking of Hedge Fund Strategies 1995-2006

1. Caption and standard deviation on the previous page

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### 2. Ranking of Hedge Fund Strategies

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### Appendix No. 5

**Correlation matrix of Hedge Fund Samples**

**1995-2006**

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<th>MAR</th>
<th>L/E</th>
<th>ELO</th>
<th>ESHO</th>
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<th>MAC</th>
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### Appendix No. 6

**Correlation matrix of Hedge Fund Samples of the first bull market**  
*January 1995 - August 2000*

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## Appendix No. 7

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**September 2000 - February 2003**

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### Appendix No. 8

Correlation matrix of Hedge Fund Samples of second bull market
March 2003 – December 2006

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## Appendix No. 9

### Correlation matrix of Global Hedge Fund Indices based on monthly returns

1995 - 2006

| NAME                                                                 | MNK | EMIN | MNAR | CAR  | FAR  | EDR  | DSEC | L/S/E | SHO  | EMA  | MAC  | MTIM | OPP  | HF   | SSIT | VAL  | SST  | INC  | MST  | MSCI | WIL | S&P | LeGBI |
|----------------------------------------------------------------------|-----|------|------|------|------|------|------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Global Market Neutral Index (MNK)                                    | 1.00|      |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Equity Market Neutral Index (EMIN)                            | 0.79| 1.00 |      |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Market Neutral Arbitrage Index (MNAR)                         | 0.84| 0.58 | 1.00 |      |      |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Convertible Arbitrage Index (CAR)                             | 0.65| 0.39 | 0.76 | 1.00 |      |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Fixed Income Arbitrage Index (FAR)                            | 0.38| 0.27 | 0.48 | 0.44 | 1.00 |      |      |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Event Driven Index (EDR)                                      | 0.93| 0.63 | 0.65 | 0.53 | 0.30 | 1.00 |      |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Distressed Securities Index (DSEC)                             | 0.75| 0.44 | 0.56 | 0.51 | 0.33 | 0.82 | 1.00 |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Long/Short Equity Group Index (L/SE)                           | 0.84| 0.64 | 0.61 | 0.43 | 0.21 | 0.86 | 0.53 | 1.00  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Short Selling Index (SHO)                                      | -0.60| -0.45| -0.41| -0.26| 0.02 | -0.74| -0.63| -0.85| 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Emerging Markets Index (EMA)                                  | 0.68| 0.48 | 0.52 | 0.32 | 0.19 | 0.58 | 0.58 | 0.72 | 0.62 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Macro Index (MAC)                                             | 0.57| 0.55 | 0.58 | 0.34 | 0.29 | 0.81 | 0.48 | 0.65 | -0.48| 0.64 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |      |
| Global Market Timing Index (MTIM)                                     | 0.58| 0.69 | 0.63 | 0.30 | 0.06 | 0.84 | 0.40 | 0.81 | -0.71| 0.59 | 0.56 | 1.00 |      |      |      |      |      |      |      |      |      |      |      |
| Global Opportunistic Index (OPP)                                     | 0.82| 0.70 | 0.59 | 0.42 | 0.23 | 0.83 | 0.61 | 0.94 | -0.78| 0.70 | 0.67 | 0.80 | 1.00 |      |      |      |      |      |      |      |      |      |      |
| Global Hedged Fund Index (HF)                                        | 0.89| 0.68 | 0.68 | 0.48 | 0.25 | 0.89 | 0.88 | 0.84 | -0.82| 0.84 | 0.72 | 0.81 | 0.92| 1.00 |      |      |      |      |      |      |      |      |
| Global Special Situation Index (SSIT)                                | 0.92| 0.64 | 0.64 | 0.50 | 0.27 | 0.99 | 0.72 | 0.88 | -0.75| 0.65 | 0.61 | 0.67 | 0.84 | 0.90 | 1.00 |      |      |      |      |      |      |      |
| Global Value Index (VAL)                                             | 0.80| 0.57 | 0.58 | 0.43 | 0.18 | 0.85 | 0.85 | 0.97 | -0.84| 0.74 | 0.60 | 0.72 | 0.86 | 0.95 | 0.85 | 1.00 |      |      |      |      |      |      |
| Global Special Strategic Index (SSS)                                 | 0.70| 0.49 | 0.54 | 0.36 | 0.21 | 0.72 | 0.81 | 0.75 | -0.65| 0.85 | 0.64 | 0.61 | 0.87 | 0.71 | 0.71 | 0.77 | 1.00 |      |      |      |      |
| Global Income Index (INIC)                                           | 0.63| 0.44 | 0.49 | 0.39 | 0.30 | 0.93 | 0.55 | 0.51 | -0.46| 0.59 | 0.40 | 0.42 | 0.47 | 0.61 | 0.69 | 0.54 | 0.86 | 1.00 |      |      |      |
| Global Multi Strategy Index (MST)                                    | 0.78| 0.64 | 0.58 | 0.44 | 0.24 | 0.81 | 0.61 | 0.91 | -0.70| 0.71 | 0.67 | 0.71 | 0.81 | 0.90 | 0.82 | 0.91 | 0.76 | 0.61 | 1.00 |      |      |
| MSCI World (MSCI)                                                    | 0.58| 0.29 | 0.45 | 0.24 | 0.10 | 0.63 | 0.46 | 0.73 | -0.71| 0.67 | 0.49 | 0.63 | 0.59 | 0.74 | 0.85 | 0.76 | 0.69 | 0.42 | 0.74 | 1.00 |      |
| Wilshire 2500 (WIL)                                                  | 0.56| 0.30 | 0.41 | 0.24 | 0.10 | 0.64 | 0.46 | 0.76 | -0.77| 0.61 | 0.44 | 0.68 | 0.60 | 0.75 | 0.69 | 0.80 | 0.65 | 0.42 | 0.77 | 0.94 | 1.00 |
| S&P 500 (S&P)                                                        | 0.49| 0.23 | 0.38 | 0.22 | 0.11 | 0.58 | 0.41 | 0.65 | -0.70| 0.57 | 0.39 | 0.60 | 0.53 | 0.68 | 0.59 | 0.74 | 0.61 | 0.38 | 0.75 | 0.93 | 1.00 |
| Lehman Aggregate Global Bond Index (LeGBI)                           | -0.06| 0.01 | -0.10| -0.02| -0.04| -0.03| -0.04| 0.00 | -0.11| 0.02 | 0.05 | -0.02 | -0.06 | -0.06 | -0.04| -0.09| 0.19 | -0.04| -0.14| 0.00 | 0.00 | 1.00 |
Appendix No. 10

Correlation matrix of Global Hedge Fund Indices - annual
1995 - 2006

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**Calculation of Modified Sharpe Ratio (MSR) and Sharpe Ratio (SR)**

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## Appendix No. 12

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## Appendix No. 13

All relevant data for the annual time series data of Global Hedge Fund Indices
Ranking according to MSR-Hedge Fund Weight of the efficient portfolio

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#### Ranking of efficient Portfolios

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