Risk and Return of different Hedge Fund Strategies during the Financial Crisis 2008

Bachelor Thesis

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Vienna, 13. 12. 2020

Affidavit

I hereby affirm that this Bachelor's Thesis represents my own written work and that I have used no sources and aids other than those indicated. All passages quoted from publications or paraphrased from these sources are properly cited and attributed.

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1 Background of the study

Hedge funds are private class investor options which are contributing a huge amount of capital to the investment sector through different trading options such as leveraging, long term equity holdings, derivatives and short selling (Ben-David, Franzoni, Moussawi 2011). They work closely towards an arbitrage resembling model which seems to stagnate due or in a financial crisis as a result of withdrawing capital from investors (Ben-David et al., 2011). Such a model describes the nature of a risk-free investment, which investors are seeking (Ben-David et al., 2011). In the market there is the assumption that everyone has the same information and that therefore such a model is not possible. Hedge Funds are trying to find the information which gives them the competitive edge compared to the typical investor. To achieve these returns they are following different strategies which can be based on discretionary investing or algorithms. With over 6000 existing funds which are managing assets over $400 billion, they have a large impact if affected by events, happening to the market (Capocci & Hübner, 2004). Besides Europe, which is represents only 9% of all existing hedge funds, and Asia with only 1%, in the US 90% of all hedge funds are based and, which also was the center of the financial meltdown in 2008 (Capocci & Hübner, 2004). Although hedge funds are growing in terms of assets under management, it appears that actual returns for investors are questioned due to currently stagnating returns (Aragon, 2007 cited in Dichev & Yu, 2011). A lot of funds are missing to generate alpha, which is the variable that represents the additional return achieved through the knowledge of the investors (Stefanini, 2012). Withdrawing capital from the market causes liquidity problems for such institutions which could lead to further losses of hedge funds (Ben-David et al., 2011). Due to their name, these institutions should be able to hedge the risk of the market and provide, through the options of taking long and short positions, a positive return for

their investors (Ackermann, McEnally, Ravenscraft, 1999). Hedge funds can have different focuses which might be on specific geographical regions, asset classes or investment strategies. These strategies are used to minimize risk and achieve higher returns. Risk and return are the metrics to measure the performance of hedge funds. Having the highest returns is not always the goal of an investor since the risk associated with it contributes to the decision-making process. The strategies of hedge funds often have a focus on different regions or can be differentiated by technical characteristics. Successful hedge funds often follow different strategies or a combination of it.

In the financial crisis 2008, a lot of hedge funds defaulted due to missing liquidity in the market and the withdrawal of capital allocations. There is missing research on the specific strategies and how they performed during the financial crisis. Investors often allocate capital to alternative investment classes such as hedge funds. If investors are seeking to hedge their capital from possible downturns, they can use such funds. This often is related to high fees and strict regulations. It is interesting to investigate which strategies would fit such an investors perspective and which strategies performed the best compared to their peers and a benchmark. This study will provide insides in the hedge funds industry as a whole and0^y0^0, analyze different strategies;bv

C≈¥bn m,./3421<23462341++´+/ on their risk and return performance during the financial crisis 2008.

2 Literature Review

2.1 Hedge Funds

Hedge funds started as limited partnerships which allowed them to represent an unregulated investment alternative for wealthy investors or institutions

(Ackermann et al, 1999). The main characteristics of hedge funds are their performance above typical market indices such as the S&P500 and to generate returns, even though the overall market is not performing positive (Ackermann et al., 1997). They operate by rewarding asset managers based on their absolute performance (Harmes, 2002). Due to their limited partnership structure, hedge funds do not have to register at the US.SEC (United States Securities and Exchange Commission) and therefore can disclose their asset holdings compared to mutual funds (Liang, 1999). Furthermore, they often require a minimum investment of $250.000 and are typically limited to a significant small number of wealthy investors (Liang, 1999). To motivate managers, these funds, have a complex fee structure such as management fees (2% of all assets under management) and incentive fees which are charged to increase the managers motivation (Liang, 1999). Large performance fees up to 60% could lead to excessive risk taking and therefore increase the overall risk of the fund (Ackermann et al., 1999). The Renaissance Technologies Medallion Fund, one of the most successful funds from James Simons, charged 5% of all assets under management and a 44% incentive fee (Lan, Wang & Yang, 2013). Additionally, they have introduced a specific lock-up time of approximately 1 year, to ensure investors are not able to withdraw their money and reduce the hedge fund's liquidity (Ackermann et al., 1999). To achieve higher returns, hedge funds are using credit (leverage) to finance their investments which helps them to scale their return on equity (ROE). With this method, also the overall risk of default is increased (Bessler et al., 2005). Although "hedge" funds could be related with the financial term hedging which means to protect financial products from price fluctuations, hedge funds are not following this principle, according to (Bessler et al., 2005). This would imply that these funds are taking more risk compared to the additional return generated. Hedge funds are denying these statements and according to past research from (Agarwal & Naik, 2003), they were able to achieve positive risk adjusted returns. The biggest risk of hedge funds is not lying in their typical risk profile, but rather in

their tails-risk which is associated as the risk in abnormal events such as a crisis. Unregulated market conditions before the 1980s enabled hedge funds to generate enormously returns which led to an explosive increase of funds. From 1980-1990, the number of registered funds increased from100 to 1000 (Liang, 1999).

2.1.1 The Return of Hedge Funds

The absolute returns of a hedge fund are the ultimate reason why investors are willing to pay high fees for the performance of the fund. When deriving the return of asset classes or individual investments, often the capital asset pricing model (CAPM) is used to measure the risk and the expected return (Fama & French, 2004). Further studies on the CAPM are implementing different variables to clarify variation, correlations and volatility. For simplifications the return of a hedge fund based on the CAPM can be derived including alpha and beta in a linear function (Stefanini, 2012). In this function beta is measuring the sensitivity of rates of return to market performances and alpha the additional return which cannot be linked to market trends (Stefanini, 2012). Table 1. from (Stefanini, 2012), shows a theoretical explanation for the performance of a hedge fund, whereas the return is categorized into two different betas (traditional and alternative) and alphas (structural and skill).

Figure 1: Simplified Return of Hedge Funds with Alpha and Beta

To identify traditional beta sources as credit spreads, bond durations and the general stock market are used even though it is hard to measure such risks (Stefanini, 2012). Liquidity, volatility, correlations and corporate events are referred to as alternative beta and product specific risk (Stefanini, 2012). Structured alpha is a measure for the advantages of hedge funds according to

their low regulations and flexibility (Stefanini, 2012). The skill alpha is linked to the portfolio managers ability to generate positive returns for the fund (Stefanini, 2012). A simpler and more quantified approach to this has been done by (Fama & French, 2004). Beta, representing the systematic risk and alpha, the ability to manage risk, are calculated based on their established capital asset pricing model which is used in universities and practice.

2.2 Traits of Hedge Funds

Hedge funds differentiate themselves to other investment options and asset classes such as stocks, bonds or managed funds in various fields. The following table provides a comparison between a traditional investment fund and a hedge fund (Eling, 2006):

Characteristics	Traditional Funds	Hedge Funds
Flexibility	Very low	Very high
Return profile	Relative return goal	Absolute return goal
Regulation	Very high	Very low
Remuneration	Weak results-driven	Strong results-driven

Table 1: Differences in Characteristics between Traditional and Hedge Funds

Flexibility in terms of the possibility to choose between different asset classes, markets and strategies is very high in hedge funds and in contrast limited in traditional funds (Eling, 2006).

A relative return goal targets to outperform a specific benchmark which could be a market index such as the S&P 500 or less common the Austrian ATX (Eling, 2006). Absolute performance, measures only the positivity of returns achieved from the hedge fund (Eling, 2006). To clarify this statement, if the market overall has a negative performance of in example: -7%, in a specific period and the traditional fund only makes a loss about: -4%, this is considered as a “good”

performance. On the other side, the performance of the hedge fund has to be positive to be considered as a “good” performance.

Traditional funds in the US as in Germany and other European countries, are underlying strict regulations such as the permission to go short in their positions or the use of derivatives (Eling, 2006). Through their limited partnership structure, hedge funds are less regulated (Ackermann et al, 1999). Outside of the US they are using offshore locations as the Cayman or Bermuda Islands, to safe taxes and increase flexibility (Eling, 2006). Investors of hedge funds are willing to take a risk of high losses and are not able to sue funds for weak performances or the loss of invested money.

2.3 The Structure and Strategies of Hedge Funds

In hedge funds, the relationship between managers and investors can be described with the principle-agent model, explaining the relationship between shareholders and corporate managers (Jensen & Meckling 1976, cited in Ackermann et al., 1999). By relating the goals of the investors to the managers, hedge funds try to engage them to achieve an outstanding return on investments (ROI) through two techniques: ownership structure and incentive contracts (Ackermann et al., 1999). There are different investment styles of hedge funds which are categorized in three major categories: 1. relative value, 2. event driven and 3. opportunistic strategies (table 3). Where relative value strategies have the least market-risk, the opportunistic strategies have a bigger exposure to market-risk (Bessler et al., 2005). In the next paragraph these strategies are going to be discussed and analyzed.

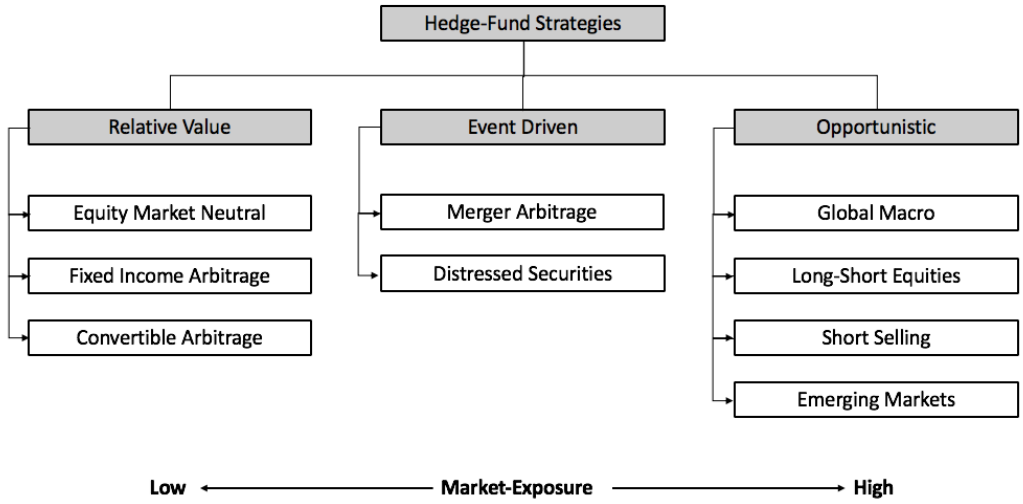

Figure 2: Strategies of the Hedge-Fund Industry

2.3.1 Relative value or market neutral strategies

The goal of relative value or market neutral strategies is to benefit from differences in price of the financial products (Bessler et al., 2005). Through the prediction of price differences and heavy leveraging, hedge funds are able to eliminate risks (market risk, interest risk or sector risk) to almost zero and increasing the ROE (return of the investment expressed as the return divided by the invested equity) (Bessler et al., 2005). Market risk is also often referred to as the systematic risk (beta) (Eling, 2006).

Equity market neutral strategies identify errors in the valuation of single stocks at the stock exchanges (Bessler et al., 2005). Furthermore, the strategy can be differentiated into fundamental arbitrage, where the portfolio manager decides when to invest. Arbitrage generally speaking is the ability to find price differences in the same product within different markets. Further, the asset is purchased at a discount and sold with a premium to different buyers (Eling, 2006). The age of computer systems and electronic trading has simply eliminated the concept of simple arbitrage, but it is possible to follow an arbitrage likewise strategy. Statistical arbitrage is based on algorithmic computer calculations (Eling, 2006). The returns with this strategy are positive

correlated to the volatility of the markets (Eling, 2006). This means that in times of high market volatility, which can be caused by macroeconomic events, investors are using the uncertainty in asset valuation to profit from (Eling, 2006).

Fixed income arbitrage is similar to equity arbnitrage. Fixed income products are government bonds, corporate bonds and swap products which are traded on the underlying assets (Duarte, 2006). Investors are looking on the type of bond, credit rating, interest rate and the duration of these assets (Eling, 2006). Within, there are 5 more strategies which can be used such as: swap spread arbitrage, yield curve arbitrage, mortgage arbitrage, volatility arbitrage and capital structure arbitrage (Duarte, 2006).

Convertible arbitrage is taking long positions in bonds and a short position in the underlying stock (Longcarski, 2009). Where the asset managers buy rising assets short and later sell them on a cheaper basis to create risk-free profits (Mitchell & Pulvino, 2012). Short selling is a high-risk investment, where the investor is speculating on a downward price movement of the asset (Stefanini, 2012). Taking a short position in a stock, the investor has to borrow the stock from a broker with the premise to give it back to him in the future and pay regular fees (Longcarski, 2009). Due to regulations from the Federal Reserve in the US, investors have to set up a cash deposit in their margin account of 100% in fully paid securities or 50% of the short sale value (Stefanini, 2012). This is due to the risk of making a huge loss and hurting the lenders of the stocks.

2.3.2 Event driven strategies

Hedge funds which invest their capial based on events related to companies such as restructurings, mergers & acquisitions, spin-offs, carve-outs or decisions on financing, are event driven (Eling, 2006). This strategy can be distinguished between mergers arbitrage, where fund managers try to

anticipate the outcome before such events happen and distressed securities which focuses on insolvent companies (Bessler et al., 2005).

Merger arbitrage or also called risk arbitrage, is the speculation on the stock price difference (spread) between two companies, when one acquires the other (Jetley & Ji, 2010). These speculations emerge from investors not seeing strategic gains or so-called "synergies" by these take-overs (Bessler et al., 2005). By capturing the arbitrage-spread, the fund typically buys the shares of the target company and shortens the shares of the acquire (Jetley & Ji, 2010). This strategy reported strong historical excess returns but is highly criticized due to the possibility that private information can be used well in such cases (Jetley & Ji, 2010).

In distressed securities, companies which are struggling with their financial or operational situation, are the target of hedge fund managers (Eling, 2006). When restructurings or bankruptcy proceedings are announced, the stock is going down due to the risk of default of the company (Eling, 2006). In this case, there is a huge possibility to gain from this price fluctuations where the managers bet on the recovery of the company (Eling, 2006). Managers can be passive and wait for the market to correct itself or actively by managing the restructuring (Bessler et al., 2005). With this proceeding, hedge funds are creating an actual value for society and the economy by saving companies and jobs (Lim, 2015).

2.3.3 Opportunistic strategies

Opportunistic strategies imply the manager to seek for a specific development of the market through better understanding of information (Eling, 2006). Forecasting trends or price-movements are the drivers of decisions and returns of this division (Eling, 2006). The subcategories: global macro, long-short equities, short selling and emerging markets are more heterogeneous to each

other than the different strategies in the market neutral or event driven divisions (Eling, 2006).

Global macro strategies are focusing on markets, currencies or policies which are influenced by different variables (Bessler et al., 2005). Compared to other portfolios, global macro-oriented ones are much simpler since managers are speculating on a whole industry or commodity rather than single titles (Eling, 2006). Speculating on trends and shifting high volumes in the market could lead to a movement caused by the speculation itself such as the bet on the British Pound by George Soros in 1992 (Bessler et al., 2005).

Long-short equity is the most common strategy of hedge funds where returns are generated from rising and falling stocks (Bessler et al., 2005). Hedge funds are analyzing these stocks and when they identify undervalued companies, they are taking a "long-position". On the other hand, when a company is identified to be overvalued, they are taking a "short-position" (Bessler et al., 2005). Managers in this division often have a quantitative background since statistical models are used or often constructed by the managers themselves to predict movements of stocks (Eling, 2006).

Short selling or sometimes also referred to as short dedicated bias are strategies whit a clear focus on shorting (Eling, 2006). It is important to mention that these managers are not constantly shorting the market (Eling, 2006). Especially during long periods of positive growth in the overall market, short selling is not effective (Eling, 2006).

The emerging markets strategy focuses their investments in non-developed countries such as Afrika, Asia or South Amerika. Portfolio managers try to identify information inefficiencies and benefit from it (Bessler et al., 2005). Investment assets from these countries are often facing huge growth potential but also a lot of risk due to political or economic reasons (Eling, 2006). Investors usually take long-positions and have got fundamental knowledge of the market

(Eling, 2006). A lot of money is flowing in regions such as Asia and Africa where investors are looking for higher growth rates than in Europe and North America (Ryback, 2007).

2.4 The Financial Crisis and Hedge Funds

Hedge funds are alternative investments which rely on the performance of the market, whether it be positive or negative. The strategies are implying to generate returns in both scenarios. Following the history of the financial markets, cyclical downturns or a big financial crisis happens once a decade. During a financial crisis, such as in 1998 or 2008, hedge funds are not able to completely outperform the market (Kelly & Jiang, 2012). These events are not predictable with strategies which would be shorting specific assets. Hedge funds are comparable to insurance companies in this case. They are earning attractive premiums in normal times but are struggling when unpredictable events happen (Kelly & Jiang, 2012). Investors are willing to pay high fees for states which have high marginal utility, which is represented by the outperformance of the market, but also demand high compensation to hold assets that suffer in times like a crash (Kelly & Jiang, 2012). One example was the collapse of the Long-Term Capital Management (LTCM) fund in 1998. LTCM was one of the most successful funds which faced big losses of 52% caused by the Asian currency crisis and the Russian bond default (Halstead et al., 2005).

If the market is facing a bear-period, people tend to liquidate assets to stop their loss. During the financial crisis 2007-2009, hedge funds had to liquidate a lot of their assets due to margin calls and the collapse of financial institutions (Ben-David et al., 2011). Stock ownership declined and stock trading decreased about 14% percent on average in the third and fourth quartile of 2008 (Ben-David et al., 2011). Volatility and high trading volumes are necessary for hedge funds to operate and generate returns, which gets difficult giving these

characteristics (Ben-David et al., 2011). Through over-leveraging to an extreme point, hedge funds could have a relevant impact on the market when losing money (Harmes, 2002). The liquidation of two Bear Stearns hedge funds in 2007 demonstrated that dramatic losses are having an impact on the stability of the financial system (Kelly & Jiang, 2012).

2.4.1 The Performance of Hedge Funds in the Financial Crisis

When looking at the performance of the hedge fund industry, we have to compare it to an index or a benchmark. These could be passive funds such as mutual funds or even a stock index such as the S&P 500. In recent years the trend for Long/Short funds has increased due to the characteristic to perform with positive returns even in a down market (Huang & Wang, 2013). There is empirical evidence that this is possible (Agarwal et al. 2009). A lot of mutual funds are now offering 130/30 funds which means in this case that the fund takes a 130% long position and 30% short position (Huang & Wang, 2003). This is in theory close to the hedge funds strategy but can differ from fund to fund since every fund is following their own strategy and not exposing the strategy to the public. We have to keep in mind that taking a short position is similar to buy an insurance on the specific stock, but this does not come without fees. Hedge fund are hedging the risk of a defaulting stock but is paying for it in form of the insurance from the short position (Huang & Wang, 2013). Based on statistical results from 2003-2009, the top 90% of all Long/Short equity funds were able to outperform the Vanguard S&P 500 Index, which is a long only fund (Huang & Wang, 2013). This shows that the ability to take short positions in such times as the financial crisis can add value to an investor.

Another indicator for the risk of hedge funds and mutual funds is their exposure to systematic tails risk. This occurs during periods of market downturns when investors marginal utility is said to be very high (Agarwal,

Ruenzi & Weigert, 2017). The Russian financial crisis in 1998 and the credit crisis in 2008 are examples (Agarwal, Ruenzi & Weigert, 2017). Furthermore, there is evidence that tail risk of such funds is predicting future returns (Agarwal, Ruenzi & Weigert, 2017). This implies that when measuring tail risk, funds which are improving this metric during a financial crisis are actually reducing risk in such a period (Agarwal, Ruenzi & Weigert, 2017).There is actual evidence that hedge funds are less exposed to tail risk during such a crisis (Agarwal, Ruenzi & Weigert, 2017). A metric to measure tail risk is value at risk (VaR) which is also used in this study.

3 Problem Definition

As presented in the background and the literature review, hedge funds follow a limited partnership structure and therefore are not easily accessible for the general public. A financial crisis is historically unavoidable and should be calculated into the considerations of investors when choosing hedge funds. Hedge funds are trying to grow their capital and returns also in times when the market is facing a regression (Ackermann et al., 1999). Through short selling and leveraging they should be able to outperform the market and generate positive returns (Ackermann et al., 1999). Not only the returns but also the risk is an important factor choosing a hedge fund strategy. Previous research showed that hedge funds liquidated their assets during the financial crisis 2007-2009 and stock trading decreased (Ben-David et al., 2001). When the investors withdrwal their assets and investments from funds, these are not able to continue operating and investing (Ben-David et al., 2001). This caused a lot of funds to shut down during the financial crisis in 2008 (Ben-David et al., 2001).

Through different strategies, hedge funds should be able to withstand these economic fluctuations and specific strategies related to short selling or arbitrage are specifically designed for these events. Although, hedge funds are able to apply these financial strategies, they are not able to outperform in events such as the financial crisis in 2008. Through this study the researcher is expecting to find the strategy that performed best during the financial crisis in terms of risk and return.

To measure the performance of the different strategies, specifically risk measures will be compared. The performance of hedge funds is often referred to as the change in net asset value during the month divided by the net asset value at the beginning of the month (Ackermann et al., 1999). These returns are net of incentive fees, management fees and other fund expenses (Ackermann et al., 1999).

Furthermore, the time period analyzed is crucial since it has a major influence on the returns. The reduction of the market capitalization of hedge funds is, according to (Ben-David et al., 2001), a great indicator and the two main events such as the Quant Meltdown and the Leman Brothers bankruptcy are defining the timeframe. The returns will be calculated on a monthly basis and will be provided from the Credit Suisse Hedge Index LLC.

4 Aim of the Research

Previous research was mainly focused on the differences of stock trading of hedge funds, the overall performance of the industry, risks and returns of hedge funds, and further research on the performance of different strategies of the hedge fund industry is needed.

4.1 Research Questions

This study examines the performance of hedge fund strategies during the financial crisis 2007-2008. In order to do so, the industry in terms of well

evaluated fund strategy indices has to be compared between themselves and further to alternative indices which are representing the market. Taking into account the knowledge gained from the literature the researcher aims to identify the best performing strategy in terms of risk and return during the financial crisis 2008 and over the whole reporting period from 1994-2020.

Through answering the mentioned question, the researcher expects to get an insight into the industry during the financial crisis and evaluate the results shown as the return and risk of the strategy. The outcome should provide a better understanding of the hedge fund performance and the correlation between risk and return. In order to compare these different performance periods, the researcher will make 2 observations. The first one will cover the financial crisis (2006-2011) and the second one, over the whole data reporting period (1994-2020).

5 Data

5.1 Data Collection

In previous academic research such as (Ben-David et al., 2001), (Ackermann et al., 1999), (Bessler et al., 2005) and many more, industry databases from private providers such as the Hedge Fund Research Inc., Eurekahedge Ltd. and the Credit Suisse Hedge Index LLC. are used. These providers offer a database consisting of up to 9000 different hedge funds and their performance (Hedge Funds, 2013). Since hedge funds are disclosed, due to their limited partnership structure, the specific positions of the funds and the strategies are not available to the public. In this study the researcher used the Credit Suisse Hedge Index database. Especially the Credit Suisse Hedge Fund Index which is an asset-weighted fund that tracks over 9000 funds with a minimum of USD 50 million assets under management (AUM) is used as a benchmark for the hedge fund industry.

5.1.1 Content of Data

The Hedge Fund Index is composed of 10 different strategies which are weighted in percent as of the volume of their current AUM. Event Driven has 3 sub – strategies such as distressed, multi-strategy and risk-arbitrage. The following picture from the Credit Suisse Hedge Index LLC. illustrates the change of the weights over time. In total 313 monthly observations from 31.03.1994 till 31.03.2020 have been used for comparison and statistical analysis.

Hedge Fund Strategies	Ticker	Nr. Observations	Observation period	Observation unit	Observation horizon
Hedge Fund Index	HEDGI	313	monthly	US dollar	1994-2020
Convertible Arbitrage	CVARB	313	monthly	US dollar	1994-2020
Emerging Markets	EMMKT	313	monthly	US dollar	1994-2020
Equity Market Neutral	EQNTR	313	monthly	US dollar	1994-2020
Event Driven	EVDRV	313	monthly	US dollar	1994-2020
Event Driven Distressed	DISTR	313	monthly	US dollar	1994-2020
Event Driven Multi-Strategy	MSEVD	313	monthly	US dollar	1994-2020
Event Driven Risk Arbitrage	MRARB	313	monthly	US dollar	1994-2020
Fixed Income Arbitrage	FIARB	313	monthly	US dollar	1994-2020
Global Macro	GLMAC	313	monthly	US dollar	1994-2020
Long/Short Equity	LOSHO	313	monthly	US dollar	1994-2020
Managed Futures	MGFUT	313	monthly	US dollar	1994-2020
Multi-Strategy	MULTI	313	monthly	US dollar	1994-2020

Table 2: Summarized strategies, their tickers, and observation characteristic

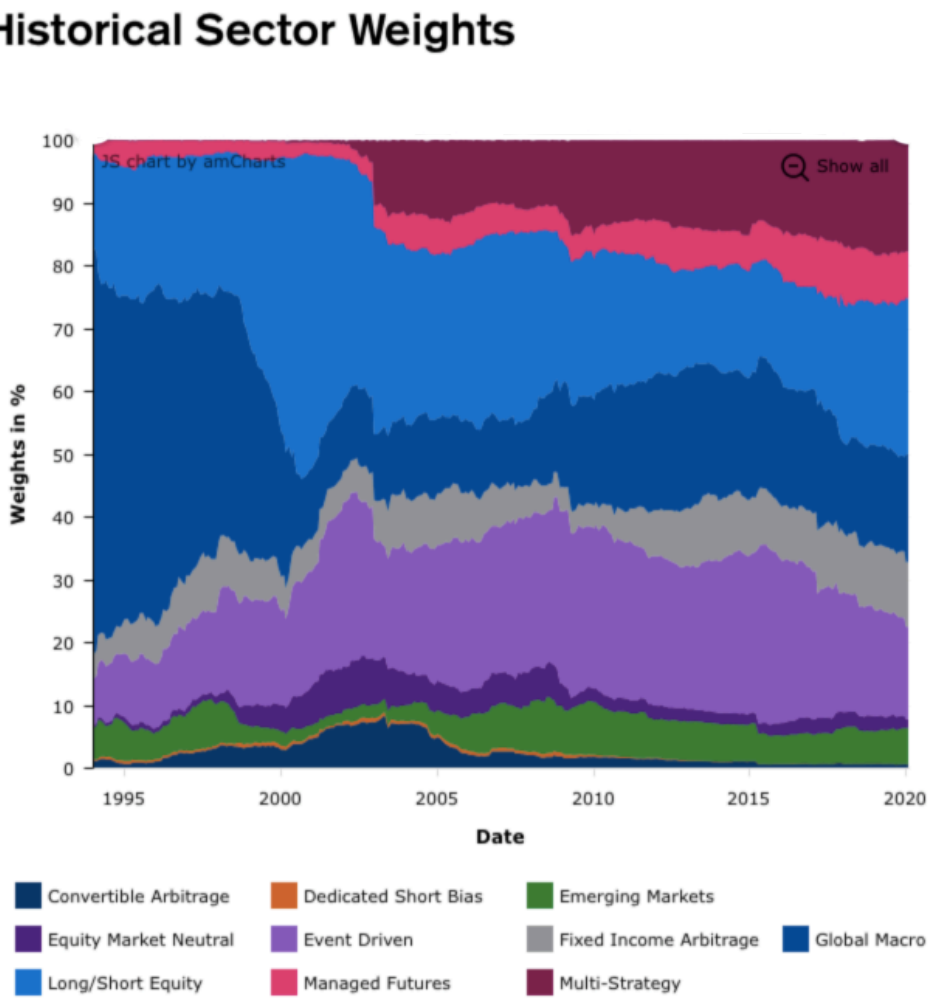

Figure 3: The change in the weights in percent of the volume of the strategies over the past 25 years

The Hedge Fund Index is the flagship index from the organization and is claimed to be one of the broadest and most accurate due to its weighted strategies (Hedge Funds, 2013). All recognized funds in this index are considered under the following three characteristics:

- A minimum of USD 50 million AUM,
- A minimum one-year track record, and
- Current audited financial statements.

The funds are subordinated to the specific categories and have to have a minimum of 85% of their assets to align with the strategy (Hedge Funds, 2013).

In order to have non-biased results and for indexes to be representative for a whole strategy, the Credit Suisse Hedge Fund Index as defined by the Credit Suisse Hedge Fund Indexes Rules Document (Hedge Funds, 2013) has certain points to fulfill. For indexes to be valuable the max volume contributed to the overall strategy is capped by 15% which is defined as "Fund Weight Cap". Which is calculated as follows: where "*c*" is the Fund Weight Cap and "*n*" the total number of member funds within each sector:

(1)

$$c = 15.0\%\ Max\left(1, \left(\frac{10}{n}\right)\right)$$

5.1.2 Benchmarks

To not only compare the Hedge Fund Index to all different strategies, other investment classes and indexes have to be used to create a spectrum of comparable outcomes. Since hedge funds are considered as an alternative investment, these returns will be compared to an index which represents the performance of the equity class. The comparison will be simple calculus of the key metrics used for explaining returns and risk such as: standard deviation, skewness, kurtosis, beta, alpha, sharpe ratio and value at risk. All calculations and graphs are built in Excel. The S&P 500 was chosen in previous research due to its representation for the whole economy since it covers and ranks the 500 biggest companies in terms of their market capitalization. The S&P 500 can be easily accessed and downloaded from Yahoo Finance. Monthly returns from 01.01.1994 till 01.05.2020 are used as benchmark since the data from the Credit Suisse Hedge Fund Index is covering the same timeline. Furthermore,

the risk-free rate represented by the returns from 4-week US treasury bills is downloaded from the official website of the American Federal Reserve.

6 Methodology

6.1 Operating Figures and Key Metrics

For the calculations in this thesis, several key metrics and figures are used to illustrate the performance of the hedge fund strategies. Not only the returns of the strategies are important to measure but also the risk associated with the returns. By considering risk with the achieved return, the overall performance can be evaluated. Risk management is an important aspect for every portfolio manager and risk is the most important variable to manage. There are different kinds of risk a firm has to manage such as: (1) Business risk, (2) Market risk, (3) Credit risk, (4) Liquidity risk, (5) Operational risk and (6) Legal risks (Dowed, 1998). To assess the risk which is associated with the returns of the strategies of the hedge funds, the following variables will be computed: value at risk (VaR), CAPM beta, skewness, kurtosis, sharp ratio, correlation and alpha to represent the performance of the different strategies.

6.1.1 Expected Return, Sample Return, Rolling Window Return and Wealth Development

Quantitative analysis will give insight to the overall performance of the strategies based on their means and statistical measures. Interesting is also to take a perspective on different windows of the period. By calculating a moving-average the researcher is able to present more normalized return characteristics which can be plotted in a graph. The period of 48 months was chosen to be able to capture different windows. Windows of normal market movements, the beginning of the crisis, the middle of the crisis and the outflow of the crisis. According to this strategy, a 48- months window was selected. The returns are always calculated as the average of the last 48 months returns. This

time series regression analysis style was used in several studies such as (Agarwal & Naik, 2003) to investigate in changing return exposure around the peak of the crisis.

6.1.2 Variance and Standard Deviation / Sample Variance and Standard Deviation

To calculate the risk for the hedge fund strategies the variance and the standard deviation are reliable measures used in statistics and corporate finance. To express it in terms, the variance of a risk is the expected squared deviation from the mean, and the standard deviation is then the square root of the variance (Berk & DeMarzo, 2014). The mathematical terms can be expressed as follows:

(2)

$$Var(R) = E[(R - E[R])^2] = \sum_R p_R \times (R - E[R])^2$$

$$SD(R) = \sqrt{Var(R)}$$

In this case *E[R]* is the expected return, where *R* is expressed in percent where historical monthly returns from the strategy will be used. *Var(R)* can also be expressed as the sum of all returns where *PR* is the probability of the return. The standard deviation, also called volatility in financial terms, is simply then the square root of the variance of the returns.

For our calculations we are determining two different methods. The computation of the overall period we are using all historical returns from 1994-2020 and dividing the total returns by the variance. For the period of the crisis 2006-2011 we are using the sample returns during this period. By comparing these two periods, we are trying to identify which strategies actually performed best overall. During the crisis and the deviation between these periods. The historical returns for the calculation of the variance are expressed

as the computation of the average squared deviation of the mean, and mathematically as follows:

(3)

$$Var(R) = \frac{1}{T-1}\sum_{t=1}^{T}(R_t - \bar{R})^2$$

In this case *T* is the total number of returns and *Rt* is the realized return for the year *t* and *R*, "overline" is the average annual return.

6.1.3 Correlation and Covariance

By using two statistical measures, covariance and correlation, the co-movement of different asset, fund or strategy returns can be described. The Covariance is the expected outcome between two different returns, expressed as *Ri* and *Rj* in the following mathematical term, of their deviations from the means (Berk & DeMarzo, 2014). For the use of historical data, the following formula is used:

(4)

$$Cov(R_i, R_j) = \frac{1}{T-1}\sum_{t}(R_{i,t} - \bar{R}_i)(R_{j,t} - \bar{R}_j)$$

The calculations of the covariance, enables to further calculate the correlation between two asset returns as the covariance of the returns divided by the standard deviation of the returns (*Ri* and *Rj*):

(5)

$$Corr(R_i, R_j) = \frac{Cov(R_i, R_j)}{SD(R_i)\ SD(R_j)}$$

For this computation we take the covariance from the two different returns and divide it by the product of the standard deviations from each return. Here again, the total number of observations is used and then compared to the period of the financial crisis.

6.1.4 Sharpe Ratio

The next important measure used by hedge funds is the sharpe ratio. Introduced in 1966 by William Sharpe, is was used to measure the performance of mutual funds (Berk & DeMarzo, 2014) and is used by hedge funds to indicate the additional amount of return of the strategy for each level of risk taken or also the ratio of reward-to-volatility provided by a portfolio:

(6)

$$\text{Sharpe Ratio} = \frac{\text{Portfolio Excess Return}}{\text{Portfolio Volatility}} = \frac{E[R_p] - r_f}{SD(R_p)}$$

In this research the portfolio-return and volatility are represented by a specific strategy. Generally speaking, the higher the sharpe ratio the better, giving the biggest return per unit of risk also referred to the efficient portfolio in theory (Berk & DeMarzo, 2014). The risk-free rate used to calculate the sharpe ratio will be the 1 months US treasury bill rate since the majority of the hedge funds are based in the US and this rate is considered as the risk-free investment in the US. The historical rates will be accessed from (US 3-Month Treasury Bill, 2020).

6.1.5 Value at Risk

In common portfolio theory, risk is described and interpreted as standard deviation of a specific return, whereas the *VaR* theories are describing the maximum likely loss a portfolio is facing over a specific time period at a given level of confidence (Dowed, 1998). Portfolio theory is limited to market price risks. *VaR* as is used to measure liquidity, credit and other risks of alternative

asset classes such as hedge funds. The *VaR* is computed over a specific time period for a distribution of returns with different confidence levels such as 99%, 95% or 90% (Dowed, 1998). By using a 95% confidence level to estimate losses, the VaR would cover all but the highest 5% of losses (Dowed, 1998) which will be used in this study given a limited amount of monthly return data. The VaR can be expressed in *absolute* and *relative* terms. The absolute term is the amount given, in example in dollars, for the specific time with a specific confidence level. The relative VaR is the absolute value added to the mean of the returns of a portfolio or strategy (Dowed, 1998), which is the average monthly return of the hedge fund strategy in this case.

To compute VaR, firstly we are simply ordering all our returns for the total and specific period from the smallest to the largest and numbering them from 1-313. There are 313 monthly observations for the total period, and we are looking for the highest possible loss with a 5% confidentiality. Therefore, we are multiplying 313 with 5% which equals 15,65 ~16. Now we take the 16th highest loss of all observations from the strategies to represent VaR. We are following the same method for the period 2006-2011, which only differentiates from the number of monthly observations.

6.1.6 Beta, Alpha and CAPM

There are 2 different events that can cause a stock price to fluctuate. Any firm specific news, whether they are announced by the company itself or from other parties, that are: announcements of changes in the company structure, ownership, or the performance of the company, are firm-specific and therefore represent independent risk (Berk & DeMarzo, 2014) and market wide news about the economy, which are affecting all stocks. These represent the common risk also referred to as: market-, undiversifiable- or systematic risk (Berk & DeMarzo, 2014). Hedge fund managers should be able to eliminate

firm-specific risk by diversification. The strategy index is representing several funds include each a large number of assets and therefore are considered to have eliminated firm-specific risk. Therefore, when calculating the risk and return of these strategies, it can be assumed that diversifiable risk is zero and the risk premium of the strategy is determined by the market risk (Berk & DeMarzo, 2014).

To measure systematic risk, the beta (β) of the strategy can be used to measure the sensitivity of the return compared to the performance of the market, represented by the returns of the S&P 500. Beta represents the % change of a strategy's return compared to a 1% change in the return of the market index (Berk & DeMarzo, 2014). The risk premium investors expect by holding a market risk can be expressed as follows:

(7)

$$\text{Market Risk Premium} = E[R_{Mkt}] - r_f$$

The market risk premium is the expected market return minus the risk-free interest rate (Berk & DeMarzo, 2014). To include beta into the calculation, the actual cost of capital can be calculated by:

(8)

$$\begin{aligned} r_I &= \text{Risk-Free Interest Rate} + \beta_I \times \text{Market Risk Premium} \\ &= r_f + \beta_I \times (E[R_{Mkt}] - r_f) \end{aligned}$$

The left side of the equation represents the cost of capital of the investment and on the right side the beta of the investment which leads to the well-known Capital Asset Pricing Model (CAPM).

The alpha (α) of a hedge fund strategy is representing the outperformance of the fund compared to the expected return based for the risk taken. The alpha can be calculated using the CAPM by plotting in the beta of the fund and the expected return. Alpha which is measuring the performance or skills of the manager can be represented as:

(9)

$$\alpha_i = \overline{r_i} - \beta_i \left(\overline{r_M} - r_f\right) - r_f$$

Where alpha of a specific fund or strategy can be estimated by a time series regression of a strategy's excess returns on the market excess return represented by the S&P 500 (Amnec & Martellini, 2003).

For the analysis of hedge fund strategies several performance measures are computed. For estimating returns the capital asset pricing model (CAPM), established by William Sharp (1964) and John Lintner (1965) (Fama & French, 2004) is applied. The CAPM is used to explore and test the relationship between expected return and market risk (Fama & French, 2004.

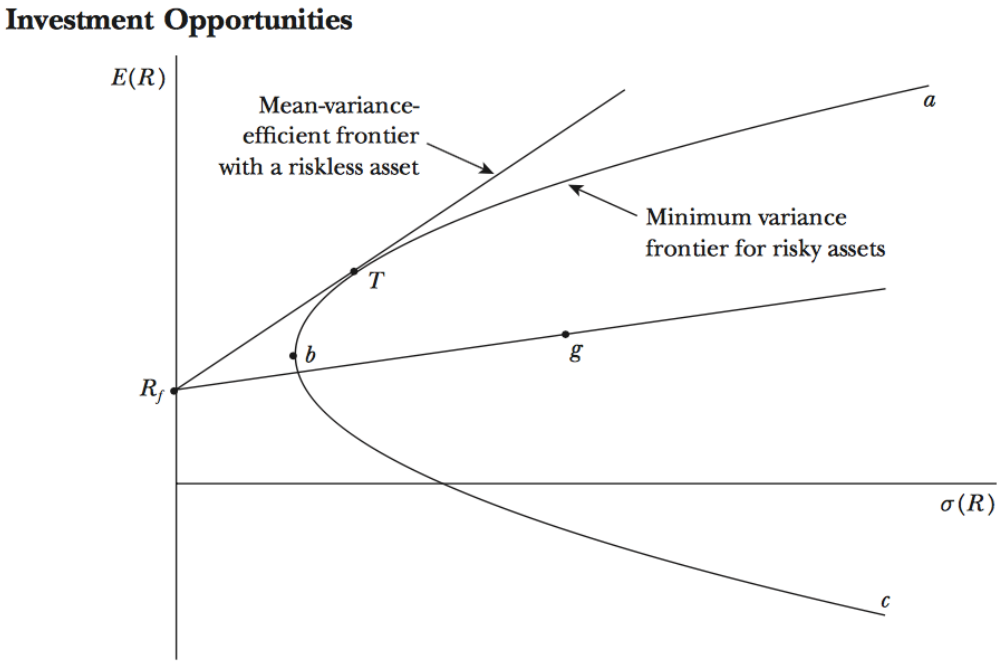

Figure 4: Investment opportunities within portfolios and the relationship between return and risk, accessed from (Fama & French, 2004)

As given in the graph the horizontal axis shows the risk of the portfolio measured by the standard deviation of the portfolio return and the vertical axis shows the expected return. The curve from the points *a,b,c* is called the minimum variance frontier (Fama & French, 2004) which visualizes the choices available to a portfolio manager. While following theory, *a* is able to generate the highest return but is exposed to higher risk. These investments are not including risk free investment and borrowing. If there is no risk-free borrowing then only portfolio combinations above point *b,* along *abc* are considered to be mean-variance-efficient. This is due to the maximization of returns by their return variances (Fama & French, 2004).

When a risk- free investment is added to the portfolio, the efficient is turned into a straight line, whereas the point *Rf* represents a 100% investment in the risk-free asset with a given expected return and 0 risk. When *x* is the proportion

of investment in a risk-free asset, then *1 - x* would be represented by point *g* in the graph above. To conclude the investment approach, portfolios which are diversified by risk and risk-free assets plot along the line between *Rf* and *g*.

The CAPM simplified states that all investors are aware of the perfect portfolio mix and all investors are seeing the same opportunities (Fama & French, 2004). Therefore, there should be no difference for a market portfolio *"M"* which is covering all available assets also known as our tangency portfolio.

By concluding the Sharpe-Lintner model only the assumption of the risk-free lending and borrowing is missing till now. In the market portfolio, an asset which average of the asset's covariances with the returns on other assets offsets the variance of the asset's return, is considered to be riskless. This means that this particular asset does not contribute anything to the variance of the market return. If risk-free lending and borrowing is considered in the model, the assets which are uncorrelated with the market return E(RZM), must equal the risk-free rate *Rf*, which gives us the following Sharpe-Lintner CAPM equation:

(10)

$$\text{(Sharpe-Lintner CAPM)} \quad E(R_i) = R_f + [E(R_M) - R_f)]\beta_{iM},\ i = 1, \ldots, N.$$

Expressed in words, the expected return on any asset *i*, is the risk-free rate *Rf* plus the assets market beta βiM times the beta per unit of beta risk, *E(RM) – Rf*.

Further academic work based on the Sharpe-Lintner CAPM was evaluated later on such as (Black, 1972) who assumed a flatter average return on market betas (Fama & French, 2004). Due to limited research on American securities which were concluded by building this model, (Friend & Blume, 1970) explored through empirical work the recommended Sharpe-Lintner model in financial books, does not always represent a legitim approach. Further developments of

the CAPM was done by (Jensen 1968) who set up the time-series regression model. Another model to mention is the (Fama & French, 2004) three-factor model to calculate expected returns.

6.1.7 Skewness and Kurtosis

There is evidence from previous statistical research, that skewness and kurtosis can be an indicator for the preference by investors of a specific portfolio combination (Aggarwal et al., 1989). These statistical measures are often used for monthly returns of stocks and can therefore easily applied this case of monthly returns of the hedge fund strategies. Skewness is measuring the asymmetry of the returns and can be positive or negative and is referred to as the third moment of a data or population (Aggarwal et al., 1989). Kurtosis is measuring the combined weight of the distributions tail, relative to the rest of the distribution and is referred to as the fourth moment of a distribution (Aggarwal et al., 1989). Skewness and kurtosis are computed as follows:

(11)

$$sk = [n/(n-1)(n-2)]\,\Sigma_i\,(x_i - x)^3/s^3$$
$$ku = [n(n+1)/(n-2)(n-3)]\,\Sigma_i\,(x_i - x)^4/s^4 - 3(n-1)(n-1)/(n-2)(n-3)$$

Where *sk* is the skewness of the timeline of returns, *n* is the number of the returns observed, x*i* is the *i*th monthly return where *i* ranges from *1 to n*, *x* is the average of the monthly returns, *s* is the standard deviation of the series of returns and *ku* is the kurtosis of the series of returns (Aggarwal et al., 1989). By a given skewness of 0 and kurtosis of 3, we could describe the data of the monthly returns to be normal distributed.

7 Results

In this section the results of the analysis will be explained into detail and presented in tables and graphs. The main purpose is to summarize all findings and guide the work to a conclusion for this thesis.

At first the results regarding the statistical return metrics of the strategies will be presented. Then the metrics covering the specific risk of each strategy will be discussed. The statistics are analyzed over the whole period from 31.03.1994 till 31.03.2020 and over the period of the financial crisis from 31.01.2006 till 31.01.2011. The first period is simply the total timeframe we had access on, and which is used to represent the strategies over a long time. This enables the author to follow the performance through economic cycles and different markets. The second timeframe for the crisis we chose 2 years before and after the global financial crisi.

7.1 Statistical Metrics for Return and Risk

The tables illustrate all metrics for risk and return. There were two analysis made, one for the overall period and one for the period for the financial crisis in 2008.

Index	Wealth Development	Mean	Standarddeviation	Skewness	Kurtosis
S&P 500	465%	0,64%	4,25%	-0,73	1,25
Hedge Fund Index	506%	0,59%	1,96%	-0,22	3,78
Convertible Arbitrage	360%	0,50%	1,80%	-2,61	17,45
Emerging Markets	332%	0,48%	1,45%	-1,83	11,01
Equity Market Neutral	478%	0,58%	1,74%	-1,85	8,57
Event Driven	596%	0,64%	1,91%	-2,71	15,95
Event Driven Distressed	398%	0,53%	1,92%	-1,83	8,18
Event Driven Multi-Strategy	223%	0,39%	1,51%	-4,30	41,39
Event Driven Risk Arbitrage	234%	0,39%	1,47%	-4,63	35,53
Fixed Income Arbitrage	976%	0,78%	2,44%	0,18	5,65
Global Macro	612%	0,65%	2,55%	0,04	4,29
Long/Short Equity	205%	0,41%	3,22%	0,01	0,07
Managed Futures	482%	0,58%	1,63%	-1,37	5,16
Multi-Strategy	474%	0,58%	1,43%	-1,76	6,96

Table 3: Statistical return and risk measures and key indicators for the whole period (1994-2020)

Covariance with S&P	Correlation with S&P	Beta	Alpha	Sharpe Ratio	Value at Risk (95%)
0	1	1	0%	0,10363	-8,007%
0,000494	0,60	0,274	0,273%	0,20085	-2,572%
0,000309	0,41	0,171	0,234%	0,17155	-1,92%
0,000302	0,49	0,167	0,212%	0,19632	-1,90%
0,000434	0,59	0,240	0,274%	0,21821	-2,93%
0,000513	0,63	0,284	0,317%	0,23104	-2,54%
0,000493	0,61	0,273	0,217%	0,17517	-2,94%
0,000339	0,53	0,188	0,115%	0,13101	-1,53%
0,000232	0,37	0,129	0,142%	0,13506	-1,32%
0,000266	0,26	0,147	0,521%	0,24009	-2,64%
0,000718	0,67	0,398	0,282%	0,17923	-3,80%
0,000002	0,00	0,001	0,219%	0,06821	-5,00%
0,000242	0,35	0,134	0,328%	0,23768	-2,47%
0,000257	0,42	0,142	0,318%	0,26608	-2,05%

Table 4: Statistical return and risk measures and key indicators for the whole period (1994-2020)

Index	Wealth Development	Mean	Standarddeviation	Skewness	Kurtosis
S&P 500	1%	0,15%	5,15%	-0,82	1,12
Hedge Fund Index	36%	0,54%	2,09%	-1,36	2,73
Convertible Arbitrage	34%	0,54%	3,13%	-2,35	8,87
Emerging Markets	20%	0,32%	1,56%	-1,43	4,05
Equity Market Neutral	46%	0,65%	2,02%	-1,05	1,37
Event Driven	33%	0,49%	1,97%	-1,24	1,94
Event Driven Distressed	56%	0,77%	2,18%	-0,86	1,16
Event Driven Multi-Strategy	31%	0,46%	1,20%	-0,67	2,20
Event Driven Risk Arbitrage	15%	0,27%	2,68%	-3,29	14,30
Fixed Income Arbitrage	61%	0,81%	1,94%	-1,29	3,77
Global Macro	36%	0,55%	2,64%	-0,95	1,31
Long/Short Equity	42%	0,64%	3,26%	-0,09	-1,24
Managed Futures	31%	0,48%	2,14%	-1,65	4,15
Multi-Strategy	31%	0,48%	2,14%	-1,65	4,13

Table 5: Statistical return and risk measures and key indicators for the whole period (2006-2011)

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Covariance with S&P	Correlation with S&P	Beta	Alpha	Sharpe Ratio	Value at Risk (95%)
0	1	1	0%	-0,00723	-10,993%
0,000780	0,73	0,294	0,368%	0,17043	-6,299%
0,000936	0,59	0,353	0,235%	0,11521	-12,26%
0,000492	0,62	0,185	0,068%	0,08627	-4,32%
0,000748	0,73	0,282	0,432%	0,23229	-5,09%
0,000728	0,73	0,274	0,180%	0,15663	-5,18%
0,000776	0,70	0,292	0,495%	0,26874	-4,77%
0,000353	0,58	0,133	0,202%	0,23400	-3,06%
0,000845	0,62	0,318	-0,001%	0,03291	-6,80%
0,000329	0,34	0,124	0,619%	$	-5,13%
0,001066	0,80	0,401	0,114%	0,13878	-7,13%
0,000044	0,03	0,017	0,449%	0,13983	-4,79%
0,000723	0,67	0,272	0,168%	0,13649	-6,94%
0,000724	0,67	0,273	0,217%	0,13818	-6,94%

Table 6: Statistical return and risk measures and key indicators for the whole period (2006-2011)

7.1.1 Wealth Development

Wealth development illustrates the comparable results of the gains an investor would have made if he had invested 100$ at in the beginning of the sample period and reinvested the gains every month. There are very unsimilar outcomes from the strategies and the overall market. The values are ranging between 205% for the Long/Short strategy and 976% for Fixed Income Arbitrage (table 9). The S&P 500 ranges approximately in the middle of all strategies with 465%. This illustrates that only the Hedge Fund Index, Event Driven, Fixed Income Arbitrage, Global Macro, Managed Futures and Multi Strategy where able to outperform the market. Figure 8 visualizes the wealth development with the assumption of having 100$ invested at the beginning:

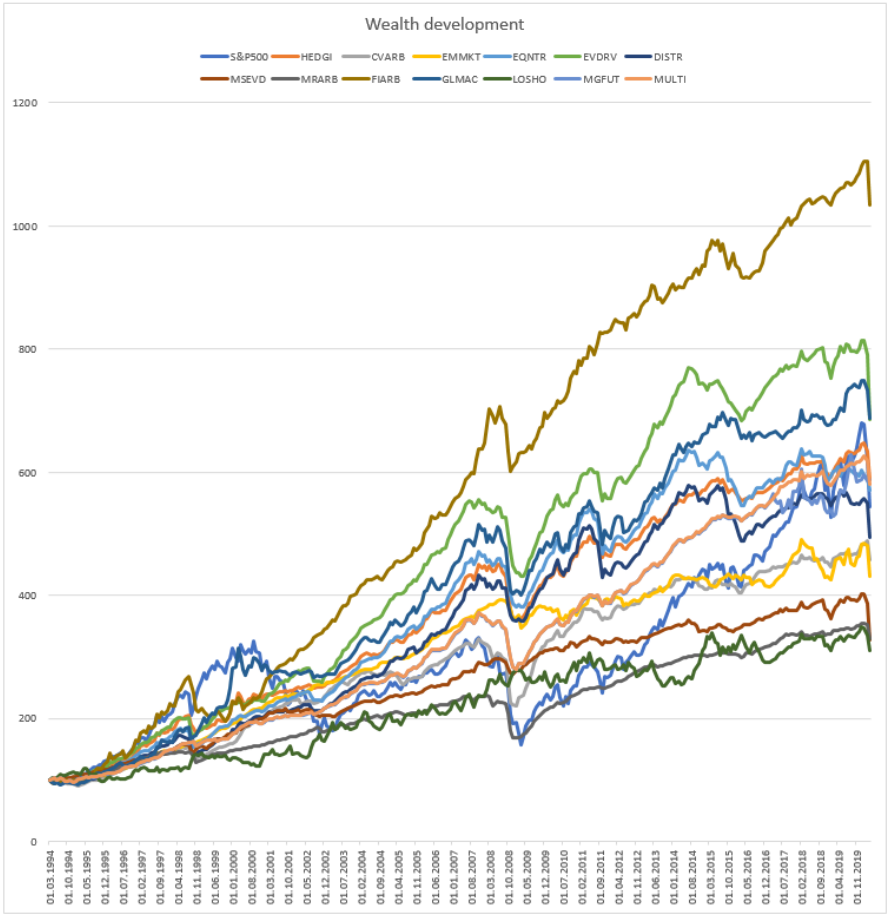

Figure 5: Wealth development of all strategies over the whole observation period

It can be observed that all but one strategy led to a loss of wealth in the period of 2008. The final result from this observation is that even though Long/Short was able to generate wealth during the crisis, the overall wealth development was also the lowest. This perfectly describes the relationship of risk and return, where a lower overall performance indicates the trade-off of being hedged during a crisis.

This has also to be compared with the wealth development during the financial crisis which will be made through two bar charts below. Figure 9 illustrates the wealth development in the percental change from the beginning 100$.

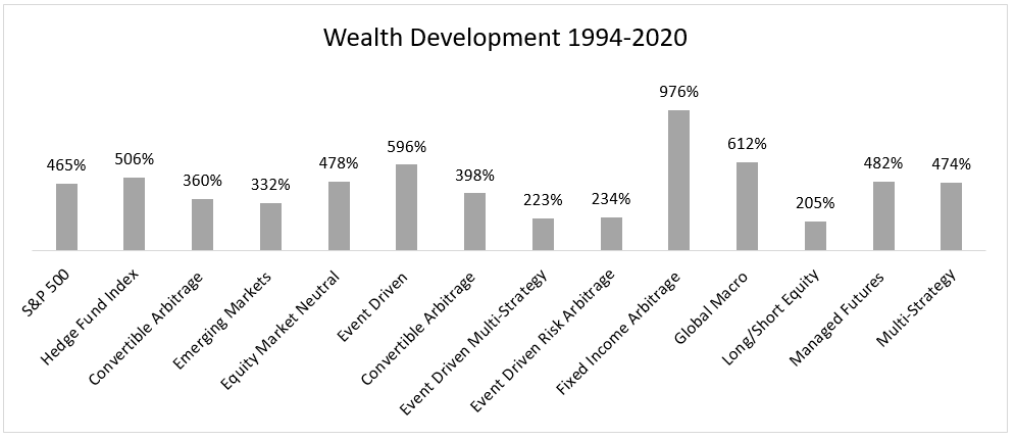

Figure 6: Wealth development from 1994-2020

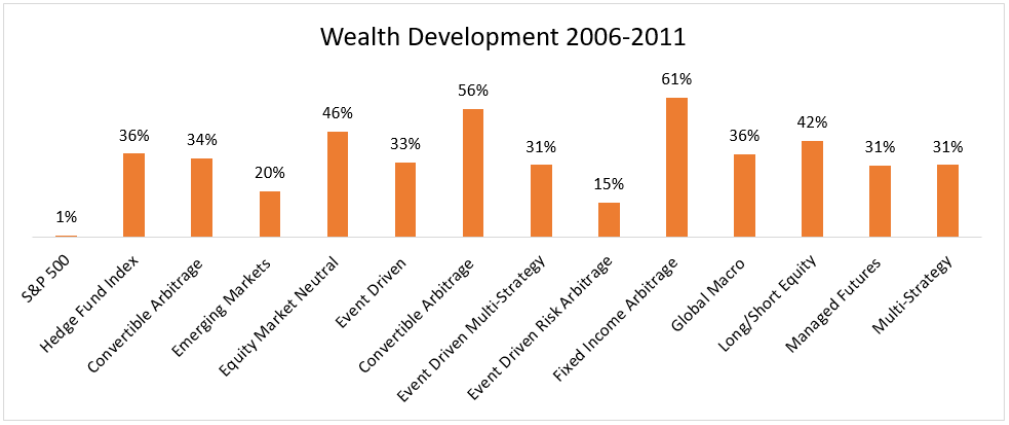

Figure 7: Wealth development from 2006-2011

Comparing the wealth development from the period of the crisis, all hedge fund strategies are exceeding the market. Strategies such as Fixed Income Arbitrage, Global Macro and Multi Strategy are performing well in both scenarios. Convertible Arbitrage and Long/Short with 56% and 42% are performing significant better during the crisis compared to the overall period. The results very much align with our literature. Short selling and the possibility of arbitrage in times of high volatility, are the strategies used in such circumstances (Longcarski, 2009).

7.1.2 Mean Return

The mean represents the average monthly return of the indices. This metric gives an appropriate value what return investors can expect on a monthly basis. The following table is comparing the whole performance period to the window from 2006-2001 representing the financial crisis.

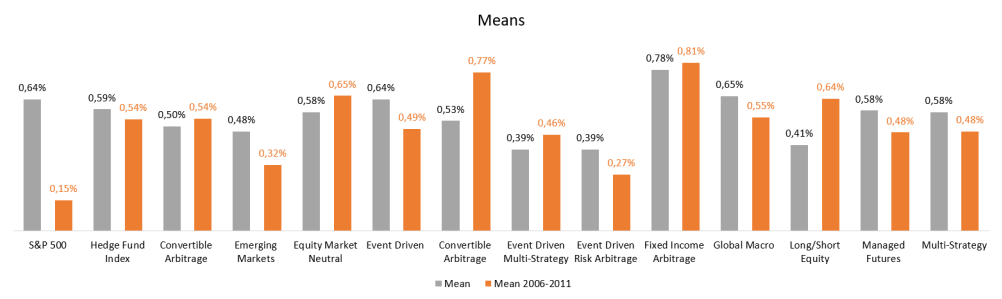

Figure 8: Mean return from 1994-2020 (grey) and 2006-2011 (orange)

For the whole reporting period, not a lot of strategies are having higher mean returns than the S&P 500 except Fixed Income Arbitrage (0,78%) and Global Macro (0,65%). This implies that ether the strategies are having very high and low returns or steady but small returns. For the period of the crisis all strategies are having higher mean returns that the S&P 500. This is due to the reason that hedge funds are aiming and claiming to have steady and positive (absolute) returns in times of a recession or bear market (Ackermann et al., 1997). The

strategies that had a better wealth development during the crisis also had higher means during the crisis.

7.1.3 Standard Deviations

The standard deviation is a measure of volatility of the strategies returns. Implying the aim of the portfolio managers to generate stable returns in every economic cycle, a low standard deviation is positive and a high is negative (Harmes, 2002). The following table compares again the two relevant periods.

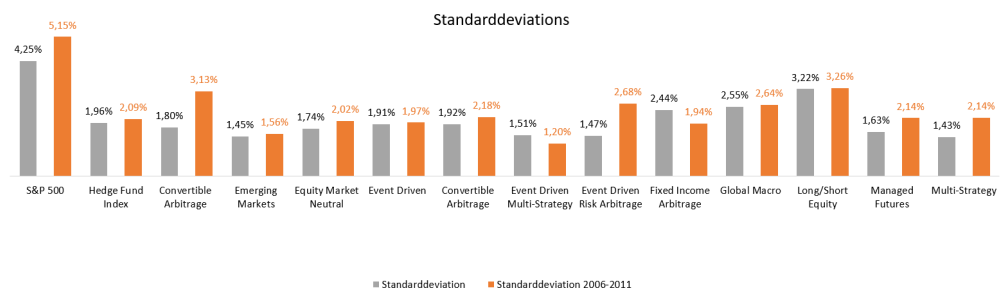

Figure 9: Standard deviations for 1994-2020 and 2006-2011

All strategies are showing a smaller standard deviation than the S&P 500 which amounts 4,25% in the overall period and 5,15% during the crisis. Investors who are seeking stability are aiming for the lowest possible standard deviation. High returns and low volatilities are especially performed by Fixed Income Arbitrage and Convertible Arbitrage. Although, Long/Short has stable returns, the strategy also has a high volatility which is the result from a negative kurtosis of the returns (-1,37).

7.1.4 Skewness and Kurtosis

Skewness is measuring the asymmetry of the returns and can be positive or negative. A positive skewness is referred to as right skewed and a negative to be left skewed. Right skewed asset return distributions have more frequent small returns and a few big losses whereas left skewed tend to have few high returns and more small losses. Portfolio managers tend to prefer stock or

assets that have consistent returns which implies a right (positive) skewness (Agarwal & Naik, 2003). The table below shows the skewness and kurtosis over the whole period and during the crisis.

Indieces	Skewness	Kurtosis	Skewness(Crisis)	Kurtosis(Crisis)
S&P 500	-0,73	1,25	-0,82	1,12
Hedge Fund Index	-0,22	3,78	-1,36	2,73
Convertible Arbitrage	-2,61	17,45	-2,35	8,87
Emerging Markets	-1,83	11,01	-1,43	4,05
Equity Market Neutral	-1,85	8,57	-1,05	1,37
Event Driven	-2,71	15,95	-1,24	1,94
Convertible Arbitrage	-1,83	8,18	-0,86	1,16
Event Driven Multi-Strategy	-4,30	41,39	-0,67	2,20
Event Driven Risk Arbitrage	-4,63	35,53	-3,29	14,30
Fixed Income Arbitrage	0,18	5,65	-1,29	3,77
Global Macro	0,04	4,29	-0,95	1,31
Long/Short Equity	0,01	0,07	-0,09	-1,24
Managed Futures	-1,37	5,16	-1,65	4,15
Multi-Strategy	-1,76	6,96	-1,65	4,13

Table 7: Skewness and kurtosis from 1994-2020 and 2006-2011 (crisis)

Over the whole period the majority of the indices are negative skewed except for Fixed Income Arbitrage, Long/Short and Global Macro. Multi Strategy Event Driven (-4,30) and Risk Arbitrage Event Driven (-4,63) have the most negative skewness which aligns with their purpose to achieve high returns on specific events, that incorporates a small number of high returns. Also, high kurtosis represents a small number of high returns. The S&P 500 has a negative skewed distribution of (-0,73) which is negative but not significant negative. Positive skewed strategies also performed the best in terms of mean and wealth development. Long/Short almost has a skewness and kurtosis of 0 which is in theory close to a normal distributed data. In the crisis the data moves respectively to more extreme events ore to fewer higher returns.

7.1.5 Covariance and Correlation with the S&P 500

According to modern portfolio theory, covariance is used to measure the direct relationship between two assets. By building a portfolio, managers seek to combine assets with low covariance which implies that these assets are not moving in the same direction (Berk & DeMarzo, 2014). Thus, a low correlation is favored by investors.

Indieces	Covariance	Correlation	Covariance (Crisis)	Correlation (Crisis)
S&P 500	0	1	0	1
Hedge Fund Index	0,000494	0,60	0,000780	0,73
Convertible Arbitrage	0,000309	0,41	0,000936	0,59
Emerging Markets	0,000302	0,49	0,000492	0,62
Equity Market Neutral	0,000434	0,59	0,000748	0,73
Event Driven	0,000513	0,63	0,000728	0,73
Convertible Arbitrage	0,000493	0,61	0,000776	0,70
Event Driven Multi-Strategy	0,000339	0,53	0,000353	0,58
Event Driven Risk Arbitrage	0,000232	0,37	0,000845	0,62
Fixed Income Arbitrage	0,000266	0,26	0,000329	0,34
Global Macro	0,000718	0,67	0,001066	0,80
Long/Short Equity	0,000002	0,00	0,000044	0,03
Managed Futures	0,000242	0,35	0,000723	0,67
Multi-Strategy	0,000257	0,42	0,000724	0,67

Table 8: Covariance and Correlation from the total period and the crisis

Between the whole period and the crisis are no remarkable differences. Long/Short has lowest covariance and correlation, which seems to have

completely uncorrelated returns. Fixed Income Arbitrage, Managed Futures, Multi Strategy are having the lowest covariance. For the correlation a correlation matrix illustrates the comparability of all the strategies. For simplification values over 0,6 are market yellow as normal correlation, over 0,7 market red as moderate correlation and over 0,8 blue as strong correlation.

	S&P500	HEDGI	CVARB	EMMKT	EQNTR	EVDRV	DISTR	MSEVD	MRARB	FIARB	GLMAC	LOSHO	MGFUT	MULTI
S&P500	1	0,60	0,41	0,49	0,59	0,63	0,61	0,53	0,37	0,26	0,67	0,00	0,35	0,42
HEDGI	0,60	1	0,58	0,48	0,74	0,72	0,78	0,54	0,57	0,80	0,84	0,25	0,48	0,56
CVARB	0,41	0,58	1	0,41	0,63	0,63	0,66	0,50	0,78	0,36	0,47	-0,03	0,57	0,69
EMMKT	0,49	0,48	0,41	1	0,44	0,55	0,50	0,57	0,36	0,25	0,45	0,20	0,31	0,47
EQNTR	0,59	0,74	0,63	0,44	1	0,85	0,90	0,56	0,52	0,41	0,72	0,01	0,49	0,57
EVDRV	0,63	0,72	0,63	0,55	0,85	1	0,83	0,71	0,56	0,39	0,66	0,05	0,41	0,56
DISTR	0,61	0,78	0,66	0,50	0,90	0,83	1	0,67	0,54	0,46	0,73	0,05	0,47	0,60
MSEVD	0,53	0,54	0,50	0,57	0,56	0,71	0,67	1	0,40	0,28	0,54	0,10	0,29	0,45
MRARB	0,37	0,57	0,78	0,36	0,52	0,56	0,54	0,40	1	0,41	0,40	0,00	0,51	0,64
FIARB	0,26	0,80	0,36	0,25	0,41	0,39	0,46	0,28	0,41	1	0,46	0,34	0,23	0,30
GLMAC	0,67	0,84	0,47	0,45	0,72	0,66	0,73	0,54	0,40	0,46	1	0,11	0,44	0,50
LOSHO	0,00	0,25	-0,03	0,20	0,01	0,05	0,05	0,10	0,00	0,34	0,11	1	0,10	0,14
MGFUT	0,35	0,48	0,57	0,31	0,49	0,41	0,47	0,29	0,51	0,23	0,44	0,10	1	0,86
MULTI	0,42	0,56	0,69	0,47	0,57	0,56	0,60	0,45	0,64	0,30	0,50	0,14	0,86	1

Table 9: Correlation matrix of all indices and strategies

Fixed Income Arbitrage and Long/Short are not strong correlated with the S&P 500 compared to the other strategies which might be the reason why these strategies are able to outperform the market during a downturn or recession. Higher correlated strategies are driven by events such as Event Driven, Multi Strategy Event Driven. Global Macro was able to outperform the market in terms of wealth development but also had a higher standard deviation compared to the other strategies.

7.1.6 Betas

Beta is a measure of the systematic risk and compares the performance of the strategy relative to the benchmark which is the S&P 500. The S&P 500 itself has a beta of 1 which implies that for every movement in the market it moves in the same direction. It also provides an overview of an investors perspective of how much exposure is wanted to a market benchmark. In this case a low beta with higher returns than the S&P 500 is desired compared to a high beta.

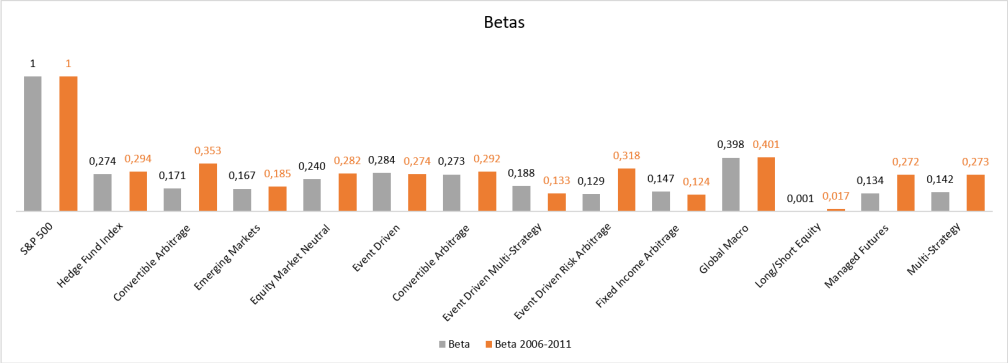

Figure 10: Betas from 1994-2020 (grey) and 2006-2011 (orange)

Observing the betas for all the periods, a statistical-significant low beta can be concluded for all strategies. Where Convertible Arbitrage, Event Driven Risk Arbitrage, Multi Strategy Event Driven, Fixed Income Arbitrage, Long/Short and Managed Futures are particular low. Even though Global Macro has a high wealth development and mean return the beta is very high (0,398). This implies that this strategy has a similar movement and is not as hedged during a crisis

as strategies with a lower beta. Multi Strategy Event Driven has a low beta but also a low wealth development of only 223% which is significantly lower than the S&P 500. Long/Short also has a low beta and wealth development. The numbers are minimal higher in the crisis than in the overall period and therefore there is no significant difference in these two periods.

7.1.7 Alphas

The alpha is calculated as the difference between the mean of the strategy and the mean of the benchmark multiplied by the systematic risk of the strategy, adjusted by the risk-free rate. Alpha shows the difference in the returns relative to the risk taken by the strategies. So, if the additional risk taken is higher than the additional return generated, the alpha would be negative. Alpha in literature is also considered to measure the portfolio managers abilities to generate a higher return than the market with the same risk (Stefanini, 2012). This implies that a higher alpha is desirable for all the strategies.

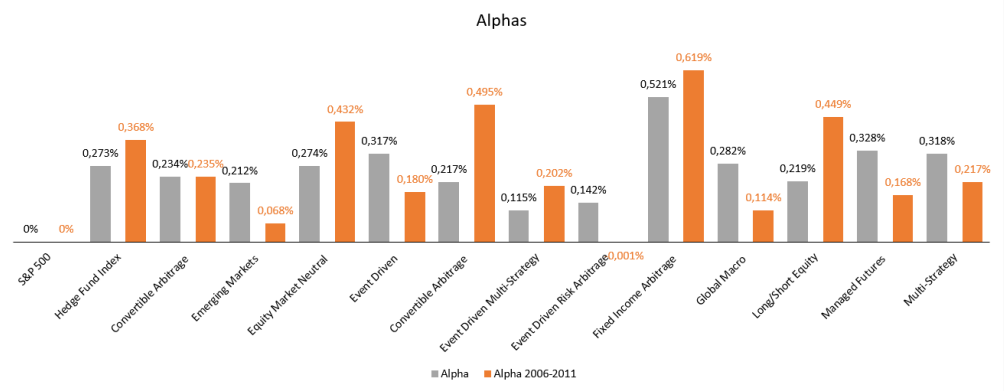

Figure 11 Alphas from 1994-20202 (grey) and 2006-2011 (orange)

Alphas are calculated on monthly mean values of each strategy which implies that an added alpha of 0,4% is high. For visual simplicity the alphas were also calculated on an annual average basis to show the exact average percentage the strategy generated compared to the S&P 500.

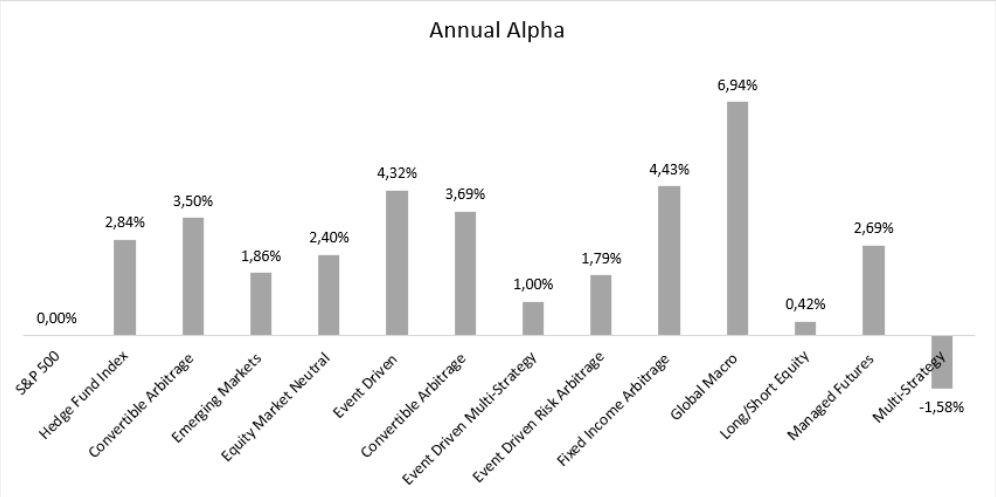

Figure 12: Annual alpha returns from 1994-2020 generated by each strategy

The ratio of the alphas is identical, the numbers differ due to the reason that the annual risk-free rate differs from the monthly. The strategies which generated the highest alphas are Global Macro, Fixed Income Arbitrage, Event Driven, Long/Short. Multi Strategy Event Driven are on the lower end of the performance and Multi Strategy is even negative which means this strategy's return compared to the additional risk taken was not positive. These numbers are the perfect representation why investors are willing to pay high performance and management fees for these hedge funds. Furthermore, they show the ability of risk managed with an according strategy. In table 16, the different periods are observed and the strategies alphas. A higher alpha in the period of the crisis compared to the normal crisis is a positive indicator for the performance of the strategy. This implies that during the crisis the strategy was even more able to generate returns and to hedge against negative losses. Long/Short, Convertible Arbitrage, Fixed Income Arbitrage and Equity Market Neutral were able to increase their alphas in the period of the crisis and can therefore be related to a statistical appropriate strategy for such an event.

7.1.8 Sharpe Ratio

The sharpe ratio is one of the most common methods to relate return with risk. It indicates the return achieved for one unit of risk taken (Berk & DeMarzo, 2014). This method is used to value mutual funds but is also established in the modern portfolio theory to assess hedge funds. Generally speaking, the higher the sharpe ration the better (Berk & DeMarzo, 2014). For the sake of this analysis the sharpe ratio of the strategies will be compared to the S&P 500 again. The calculation is based on the monthly means.

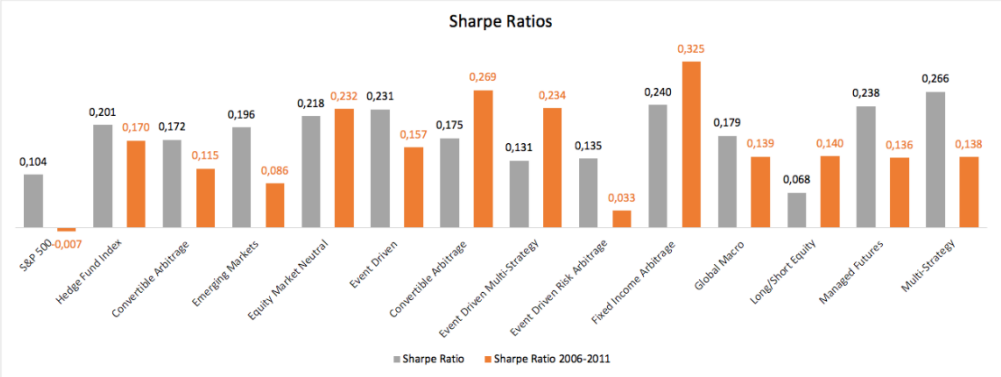

Figure 13: Sharpe ratios from 1994-2020 (grey) and 2006-2011 (orange)

For the period 1994-2020 almost all strategies are having a higher sharpe ratio than the S&P 500, despite Long/Short. This is related to its high standard deviation (3,22%) which was the highest from the strategies. Managed Futures and Multi Strategy have low standard deviations (1,63%) and (1,43%) and therefore are among the stronger performing strategies according to the sharpe ratio. A strategy that had a high standard deviation (2,44%) and still has one of the highest sharpe ratios is Fixed Income Arbitrage. Especially the "Relative Value" strategies (Fixed Income Arbitrage, Convertible Arbitrage and Equity Market Neutral) are having a higher score during the period of the crisis. This results from the nature of these strategies which are using differences in prices of financial products in the market (Bessler et al., 2005). High volatility is the main driver of these strategies. This represents a possible solution for

the best strategies in such events. In the event of a financial crisis the interest rates get reduced by central banks to promote economic activity. This also ramps up the sharpe ratio.

7.1.9 Values at Risk (95%)

Value at risk is a measure for the tail risk of the distribution what an investor can expect given a specific confidence ratio. For this study and the recurring nature of economic cycles a 95% probability is appropriate measure. Value at risk (95%) gives the maximum likely loss over a period with a 95% confidence (Dowed, 1998). For comparison the overall period and the crisis are analyzed.

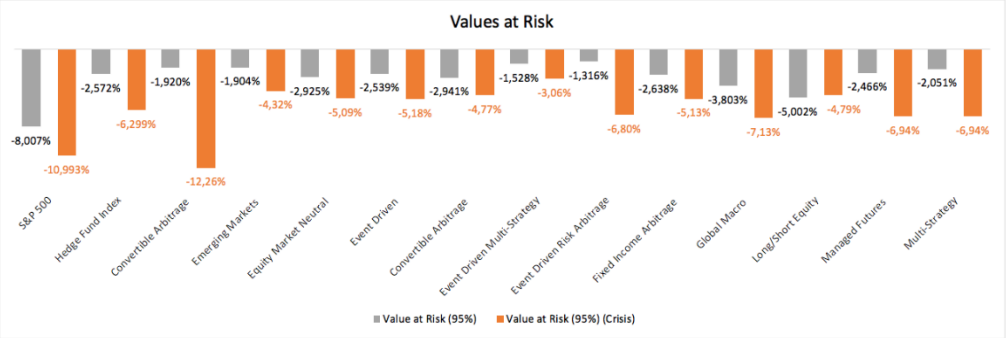

Figure 14: Values at risk from 1994-2020 (grey) and (2006-2011)

The VaR is higher for almost all strategies and the market in times of a crisis resulting from the enormous losses within this timeframe. Long/Short has one of the highest VaRs (-5.00%) over the total period, were the S&P 500 Index is the only one with a higher one of -8.007%. Long/Short has a high starting value which is due to the nature of their strategy in taking long and short positions in a stock (Huang & Wang, 2013). It is the only strategy which was able to improve this metric during the financial crisis and therefore the risk. All other strategies are having higher VaR in the period of the crisis. Since the VaR is a prediction for the returns or future returns during such a crisis (Agarwal, Ruenzi & Weigert, 2017), this outcome aligns with the results from the mean returns from the two periods. Long/Short was able to increase its mean returns during

the financial crisis and reduce its tail risk. Tail risk is a measure for the maximum losses that can be recorded.

These results are comparable to the given risk of the strategies defined by the beta and the standard deviation. Furthermore, the S&P 500 has by far the highest probable losses in the overall period which represents that the market is not hedged by a portfolio manager.

7.2 Rolling Window Returns

For the second part of the results section the researcher is diving deeper into the results if the strategies. The returns have been plotted as follows.

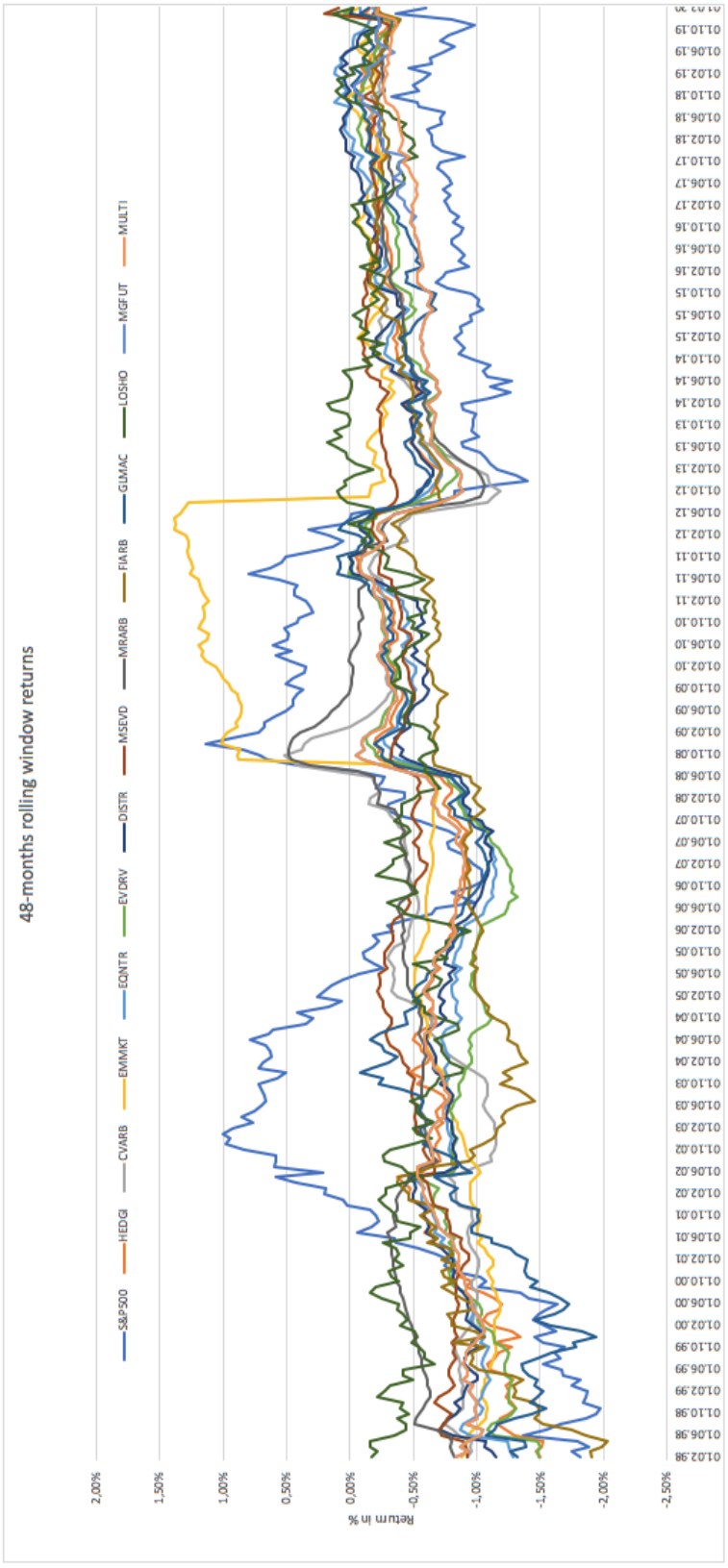

Figure 15: 48-months rolling window returns of all strategies

This analysis observes return development more clearly. The S&P 500 has by far the highest fluctuations. This is also confirmed by the highest volatility represented by the standard deviation. There is a strong upward trend visible around 2002, where the dotcom crisis was present. In the first period of the graph and almost the first ten years, a lot of strategies are having a consistent return performance until the years before the financial crisis in 2008. Almost all of the strategies are starting to increase in terms of their returns. Especially the emerging market strategy is having the highest returns, followed by the S&P 500, Event Driven Risk Arbitrage and Convertible Arbitrage. During the year 2008 the S&P 500 took a hit of -45,45% of annual losses. That is the biggest loss compared to the majority of the other strategies which ranged between -36,03% Convertible Arbitrage and -4,05% from Convertible Arbitrage and Fixed Income Arbitrage. The only strategy which was able to generate a positive result during this period was Long/Short with 17,59% which makes it the most successful strategy in the crisis.

7.3 Rolling Betas

Since betas have only be interpreted based on the full observed period, changes in market sensitivity due to the crisis period are not observable. Therefore, the betas have also been analyzed on a 48-month moving average. With this approach it is observable how the systematic risk changes over the whole period. Especially the movements and change during the financial crisis is relevant for this quantitative study. Figure 16 illustrates the movement of all strategies.

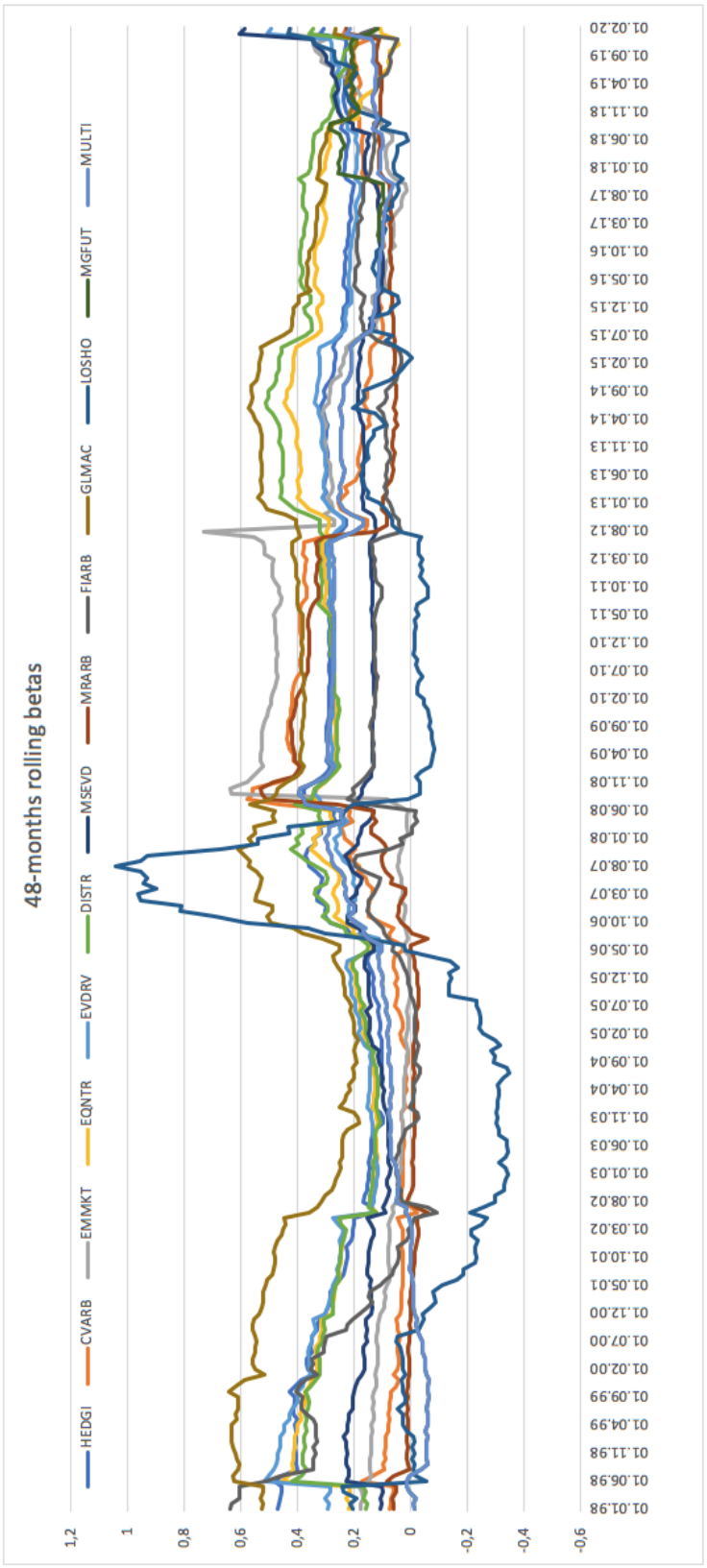

Figure 16: 48-months rolling betas

All strategies are following a consistent downward trend from 1998 and onward. The period from 2000 to 2004 is the time the dotcom bubble hit the financial markets. More interesting is the period after the dotcom crisis till the mortgage crisis in 2008. In the beginning of 2004, all strategy betas are starting to increase. The period before the crisis in 2008 is considered to be one of the most profitable on Wall Street. But with these enormously profits also the systematic risk (betas) of the strategies increased. The betas are compared to the performance of the S&P and therefore represent the betas in relationship to the performance of the market. The highest beta and also the highest volatility are observed for Long/Short. But what is a significant indicator, is that when the financial crisis hit the market, all betas decreased. This results in a lower systematic risk during the crisis than before in relationship to the S&P. This is due to the enormous loss that resulted from the financial crisis. This is also shown in the wealth development, were the S&P was the lowest performing strategy. Furthermore, the S&P had the highest standard deviation which is the volatility of the index. This shows that the S&P is much higher exposed to the systematic risk than all the other strategies. The lower the beta of the strategy is the better was the strategy hedge compared to the market. In figure 10, the lowest betas are illustrated through a bar chart which numbers are aligning with figure 16. What is clearly not visible is that the beta of Long/Short is not always low and very volatile. Fixed Income Arbitrage is again one of the strategies with a stable and low beta during the crisis.

8 Conclusion

We are able to conclude that the hedge fund industry is one of the questioned investment possibilities currently on the market. Since the financial crisis in 2008, a recognizable amount of these funds was not able to perform through and after the crisis which resulted in a reduction in the overall number of these funds. Even though this holds true hedge funds still represent a lucrative investment vehicle. After computing our risk and return related measures

there is a significant relationship between risk and return. Long/Short was the only strategy which was able to generate a positive wealth development during the financial crisis in 2008 but also had the lowest wealth development of 205% over the whole period. According to this outcome, we are able to state that Long/short is indeed a strategy which could be used to hedge the investor from negative returns during a crisis. Another indicator for the stronger performance during the financial crisis is the tail risk (VaR) of Long/Short. Also, here the strategy was the single one which was able to reduce VaR over the period of the crisis compared to the other strategies. Since a lower VaR implies a higher possibility for positive future returns (Agarwal, Ruenzi & Weigert, 2017), we can conclude that Long/Short also hedges the investor from risk during a down market. Fixed Income Arbitrage was also an outstanding strategy in terms of the highest possible wealth development and its low associated risk. We conclude that this might be due to the underlying asset class. Fixed Income Arbitrage is solely operating with bonds, rates and commodities and is compared to the S&P 500 which is a pure equity related index. Therefore, we can conclude that further research on this could reveal a better understanding of the hedge fund market compared to a fixed income index.

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