UNIVERSITY OF PIRAEUS
SCHOOL OF FINANCE AND STATISTICS
DEPARTMENT OF BANKING AND FINANCIAL MANAGEMENT

MASTER IN BANKING AND FINANCE SPECIALIZING IN FINANCE AND
INVESTMENTS

A dissertation submitted for the degree of
Master of Science

MODERN INVESTMENT STRATEGIES OF HEDGE FUNDS

presented by

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Piraeus, September 2022

Contents

To my son Harry …

Acknowledgements

I would like to express my gratitude to my supervisor Assistant Professor Michail Anthropelos for his support and guidance throughout the dissertation project. Additionally, I would like to thank all the academic staff of the Department of Banking & Financial Management and specifically those who met throughout the master's degree programme.

Furthermore, I would like to thank mr Dimitris Manoussakis, Head of Office at Savills Hellas, for his immense support during my studies. Also I would like to thank all my friends for their unwavering support throughout the two-year period of my studies.Last but not least,it is impossible to extend enough thanks to my family, especially my wife Aspasia and my son Harry, who gave me the encouragement I needed during the last two years.

Abstract

The scope of this dissertation is to prepare a thorough analysis of the hedge funds industry in order to examine the size and the performance of the market. This analysis was conducted by both a literature review and an empirical analysis of publicly available data and more specifically from Hedge Funds Research database. Examination of the hedge fund industry was conducted by calculating Sharpe Ratio, Sortino Ratio, Value at Risk as well as by applying a linear regression using the Jensen model.

Our conclusions indicate that the aggregate performance of hedge funds within the period of 2010-2021 presented a notable decline, a fact which was observed in both literature review and the empirical analysis. The dissertation is divided into five chapters for better understanding. Initially, Chapter 1 is an introductory to the Hedge Funds, its characteristics, and their limitations as an asset class. Chapter 2 provides a thorough description of each hedge fund strategy. Chapter 3 indicates a literature review among the size and performance of hedge funds. Next comes Chapter 4 which presents the empirical analysis applied in order to determine the performance of hedge funds. Finally, Chapter 5 concludes the thesis and presents the main outcomes as well as its limitations and the suggestions for possible future research.

Keywords: Hedge funds, strategies, Arbitrage, Macro, Sharpe ratio, Sortino Ratio, Event Driven, Equity-Related

Περίληψη

Ο σκοπός της παρούσας μεταπτυχιακής εργασίας είναι η ανάλυση των Hedge Funds τόσο ως προς το μέγεθός τους σαν επενδυτικό προϊόν όσο και οι επιδόσεις τους. Για την ανάλυση λήφθηκε υπόψιν τόσο οι βιβλιογραφικές αναφορές, όσο και μια ανάλυση δεδομένων τα οποία προέκυψαν από την βάση δεδομένων Hedge Funds Research Database. Η εν λόγω ανάλυση βασίστηκε στον προσδιορισμό των Sharpe Ratio Sortino Ratio, Value at Risk, καθώς και της εφαρμογής μιας γραμμικής παλινδρόμησης βάσει του μοντέλου του Jensen.

Από την παρούσα έρευνα ως κύριο συμπέρασμα προέκυψε το γεγονός ότι τα hedge funds από το 2010 έως το 2021 παρουσιάζουν μια σημαντική πτώση ως προς την απόδοσή τους, γεγονός που αντικατοπτρίζεται τόσο στην βιβλιογραφική όσο και στην εμπειρική έρευνα.

Η παρούσα μελέτη χωρίζεται σε πέντε κεφάλαια με σκοπό την καλύτερη κατανόηση του αντικείμένου που πραγματεύεται.
Το πρώτο κεφάλαιο αποτελείται από μια εισαγωγή ως προς τα Hedge Funds, τα χαρακτηριστικά τους καθώς και τους περιορισμούς που τα διακατέχουν.
Το δεύτερο κεφάλαιο παρουσιάζει μια αναλυτική αναφορά ως προς τις κύριες στρατηγικές των Hedge Funds, για τις οποίες εφαρμόζεται και η εμπειρική ανάλυση.
Το τρίτο κεφάλαιο παραθέτει μια βιβλιογραφική ανασκόπηση ως προς την απόδοση και το μέγεθος των Hedge Funds. Επόμενο είναι το τέταρτο κεφάλαιο, στο οποίο γίνεται αναφορά στην ανάλυση δεδομένων για τον προσδιορισό των αποδόσεων των hedge funds.
Τέλος, το κεφάλαιο 5 ολοκληρώνει την παρούσα έρευνα και παρουσιάζει τα κύρια συμπεράσματα που προέκυψαν, τους περιορισμούς καθώς και ορισμένες προτάσεις του συγγραφέα για τυχόν μελλοντική έρευνα.

Λέξεις Κλειδιά:

Κεφάλαια Αντιστάθμισης Κινδύνου, στρατηγικές των Hedge Funds, Αντιστάθμιση Κινδύνου, Macro, Δείκτης Sharpe, Δείκτης Sortino, Event Driven, Equity-Related

Chapter 1

Introduction

1.1 What is a Hedge Fund?

As a hedge fund can be defined an investment vehicle which is actively managed and open to a limited group of investors, whose performance is measured in absolute return units. More specifically it is an actively traded portfolio of investments which engage in a wide range of activities related to investment and trade. In general term "hedge" means the mitigation of risk, which is targeted by a fund manager by applying several methods and strategies. Hedge funds are designed to generate high returns and are allowed to take both short and long positions, use leverage and derivatives, to invest in concentrated portfolios and to move quickly between various markets. Hedge funds frequently take large risks on speculative strategies such as arbitrage, swaps, and programme trading. In general hedge funds are limited to wealthy investors and institutions since they come with high fees required to be paid to their managers (Gad, 2022). Hedge funds are quite similar to pension funds since both are pools of underlying assets that cannot be offered as an investment product to the general public.

Hedge Funds may invest in a variety of assets with complex portfolio structures and risk management techniques. Although major differences exist between hedge funds and mutual funds. Compared to mutual funds, hedge funds are not regulated[1] and are allowed to invest in a wider range of products such as stocks, bonds, commodities and real estate or they are able to perform investments with higher level of risk with greater flexibility than mutual funds. A major difference can be considered the fact that hedge funds use long/short strategies in their investments. Additionally, hedge funds can employ leverage, which means that they can borrow and invest many times their capital. This strategy is a risk sophisticated that

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[1] In US regulation comes by Securities and Exchange Commission and in Europe by European Securities and Markets Authority

may increase returns significantly while on the contrary it can also lead to major losses.

Most hedge funds are established by a general partner while the group of investors that participate in the fund are limited partners who do not have active role in the decision-making process. Typically hedge fund managers invest a significant amount of capital (sometimes exceed 50% of the total assets in the fund) aligning their interests along with their investors. A typical hedge fund structure is presented on the above graph:
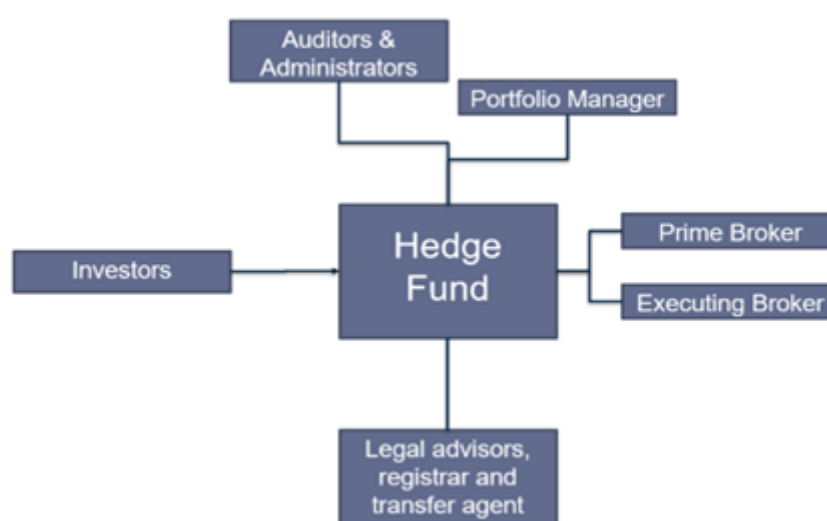
Figure 1.1. Typical structure of a US Hedge Fund. Source: (Hedgefundamentals.org, 2016)

Managers of hedge funds face fewer conflicts of interest compared with other institutional investors such as pension funds of mutual funds, who have different relations in business with the invested firms or other non-financial goals. Hedge funds managers have strong and independent motives to achieve positive returns due to their aim to reach opportunities on private capital markets. Several types of funds have similar characteristics with hedge funds, however with slight differences. In example private equities aim to the acquisition of high percentage of ownership stakes compared with hedge funds activists. Venture capitals target private companies since their goal is to force corporate governance actions within the firm such as merging, selling or initiating an initial public offering (IPO) and consequently they are acting earlier in contrast with private equity and hedge funds.

1.2   Historic Overview

The term Hedge Fund was introduced initially by Albert Jones in 1949 since he opened an equity fund that was organized as a general partnership to provide flexibility in constructing a portfolio. He took both short and long positions in securities to increase performance returns and at the same time reducing market exposure. Jones generated quite strong returns while he managed to avoid significant attention from the general community, until 1955 when an article in Fortune resulted the increased interest in hedge funds. Next came City Associates which was founded in 1964 by Carl Jones whereas in 1965 Fairfield Partners were formed by Dick Radcliffe and Barton Biggs. Within 60s his fund was performing well that resulted other hedge fund managers to copy his style. The boom of the stock market at late 1960s resulted a change in strategies where the long-short changed into long-bias for gaining the benefits investor reported that Julian Robertson's Tiger Fund six-year cumulative return was in the range of 43% after expenses and incentive fee. This incident was a major driver that reignited the interest in hedge funds with the formation of many new(Fung and Hsieh, 1999, p.4).

Following the strong performance observed through 1980s, a decrease in the industry were observed in 1990s. The major incidents that took place for 1990s decade were the Asian financial crisis in 1997 and the near collapse of Long Term Capital Management in 1998 while many other hedge funds suffered similar losses. According to Liang (2001, pp.11-12) within a 10-year period the average return of all hedge funds was 14.2% with 1993 being the best year where a 27.0% annual return observed. On the contrary, 1994 was the worst year in terms of performance since the annual return reached an annual figure of -0.6%. Additionally, the most volatile year was 1998 when many hedge funds showed evident signs of poor performance particularly due to the Russian Dept Crisis that followed shortly after the financial crisis of 1997 in Asia (Liang, 2001, pp. 11-12).

After the dotcom crisis in 2001, hedge fund industry grew rapidly with the number of funds being doubled in a five-year span. McCahery & DeRoode (2021, pp.18-19) measured the performance of hedge funds from 2000 to 2019, relying on a positive investment performance took place in the periods from 2000-2009 and 2010-2019. During 2000-2009 positive alphas indicated that hedge funds performed well. On the contrary, lower returns and negative alphas were observed in the period of 2010-2019 as indicated at the aforementioned study. More specifically, this

research found that the growth rate during 2010-2019 slowed down to 8.40% annually, compared with 20.30% between 2000 and 2010.

1.3 General Characteristics of Hedge Funds

This section attempts to provide an insight in the main characteristics of hedge fund investments. Hedge funds face limited regulatory requirements in respect to the use of short selling and leverage as well as their investments in iliquid securities and derivatives financial products. These characteristics are in contrast with the organizational structure of the more common pooled investment vehicles such as mutual funds. Furthermore, as common characteristics of the hedge funds are the absolute return targets of most managers and management fees (Jaeger and Pease, 2008, pp.9-12). The following figure summarizes the key characteristics of hedge funds against traditional investments:

Characteristic	Traditional Investment	Hedge Funds
Return	Relative returns in excess of defined benchmarks	Absolute returns
Risk	Risk is measured relative to a benchmark and it is quantified correspondingly by the so-called "tracking error"	Absolute risk
Regulation and Transparency	Highly regulated and high transparency	Exposed to few regulatory constraints. Limited transparency.
Fee Structure	Tied to assets under management and not to performance.	Average fee structure is c. 2% management fee plus a performance fee equals to 20%, often conditioned by a certain hurdle rate which must be exceeded before managers receive any performance fees.
Liquidity	Daily liquidity	Depending on the asset class, there can be limits on investment liquidity that require a minimum investment period of 6 months, one year or more.

Figure 1.2. Traditional vs Hedge Funds characteristics. Source:(Jaeger and Pease, 2008)

1.3.1 Absolute Return Target

The absolute return approach is significantly different from hedge fund managers compared with traditional relative approach in asset management. Typically a traditional fund manager seeks relative returns in excess of defined benchmarks. For instance a traditional fund manager will seek for opportunities in order to outperform stock indices such as S&P 500. If the manager achieves a 20% return over a year when a market index returns are 10% and the upcoming year loses are 10% when the index loses are 15%, she is said to have had two good years in terms of performance (Jaeger and Pease, 2008, pp. 7-8).

Hedge funds have absolute performance targets which are also referred

to as "skill-based investment strategies". Ibbotson et al. estimated a pre-fee return of a hedge fund within a period of 1995-2009 which equals to 11.13%. This return is decomposed into an alpha return of 3.00%, a beta return of 4.70% and fees equal to 3.43%. Positive returns are based on the skill of management team rather than on performance of the underlying asset.

1.3.2 Management Fees

Management fees for hedge funds are composed by a fixed part which is called asset management fee and a variable part which is called incentive fee that is based as a proportion of the fund's profits each year. A typical charge is in the norm of 2/20 which means 2% management fee and 20% of the fund's profit and income. Although the hedge funds apply also two other characteristics schemes in terms of compensation (Anson, 2002, pp.84-85).

Investor should also determine if there is a "high watermark" or a "clawback" in respect to the incentive fees, before they charge a performance fee to their investors. Under the typical high-watermark contract, hedge fund managers receive a fraction of the increase in fund value in excess of the last recorded maximum, provided that such an increase took place (Panageas and Westerfield, 2009).

During the recent years, average fees have shrunk. According to HFR, in Q4 2020, hedge funds charged 1.4% management fee and 16.4% performance fee. The abovementioned rates are lower than 1.6% and 19% respectively which were observed in 2010 (Picker, 2021). However a study by Ben-David et al. over a sample period between 1995 and 2016 showed that the aggregate effective incentive fee rate is 2.5 times the average contractual rate (i.e. around 50% compared with 20%).Ben-David et al. also found that investors collect 36 cents for every dollar earned on their invested capital (over a risk-free hurdle rate.

1.3.3 Leverage

The term "leverage" denotes a situation where either the economic exposure or the invested capital is higher than the available equity. It can be measured in a number of ways. Traditionally leverage is the ratio of the fund's balance sheet assets to equity. Despite the fact that it is widely used in the hedge fund world as a risk measure, it has several weaknesses since it fails to take into account market, credit and liquidity risks is a portfolio as

well as the use of off-balance sheet products (i.e. derivatives). Economic leverage is a better measure since it captures the degree of risks taken on by the fund and it is the ratio of potential gains and losses to net worth.

Hedge funds frequently borrow in order to increase the portfolio size and their returns. One form of leverage is through a margin loan where the fund seek to purchase for example securities which worth $400 million by borrowing $300 million loan and investing the remaining $100 million.

Another form of leverage is short selling. A hedge fund manager may take a short position on an undervalued price of a security with the expectation that this price will fall and the position will be purchased back at a lower price. In general short selling involves the sell of a security which is not currently owned by the seller due to take a directional bet on its anticipated price decline. Additionally the brokerage firm requires substantial collateral assets deposited in a margin account from the short seller. The short seller also pays the brokerage fee for borrowing security while at a later time borrowed shares are returned to the lender through buying replacement share in the open market.The short seller makes a profit when he/she buys the stock low enough in order to offset any costs associated with the borrowing of the security (Lhabitant, 2007, pp. 126 - 128).

Chapter 2

Description of Hedge Fund Strategies

This chapter presents a thorough analysis of each hedge fund strategy, their sub-strategies which have been applied and its characteristics. Furthermore, evident signs of how those strategies have been affected during turbulent economic times are presented, based on the recent bibliographic references, as analysed in the following sections of this chapter.

2.1 Investment Strategies

Hedge funds employ dynamic investment strategies which are designed to find opportunities in the market in order to trade their portfolio investments in an effort to maintain high and diversified absolute returns. The majority of mutual funds takes only positions in securities compared with hedge funds which are more active in the trading of portfolio investments to create returns which ideally outperform the market.Several hedge funds are looking to exploit anomalies related to pricing i.e., pricing mismatch between two related bonds. Regardless of their applicable strategy, most hedge funds are more active traders in contrast with mutual funds. Hedge funds strategies are divided into four broad groups, each of which has a number of subcategories:

1. Arbitrage

2. Event Driven

3. Equity-Related

4. Macro

The first two strategies aim to be market -neutral (aiming to achieve returns which are uncorrelated with the market movements), whereas strategies

with numbers (3) and (4) are strongly impacted by market movements (Stowell, 2017, pp265-267). The following table presents hedge funds strategies divided into subcategories:

	Subcategory	Description
Arbitrage	Fixed income - based arbitrage	Exploits pricing inefficiencies in fixed income markets, by combining long/short positions of various fixed income secutirites.
	Convertible arbitrage	Purchases convertible bonds and hedges equity risk by short selling the common stock.
	Relative value arbitrage	Exploits pricing inefficiencies across asset classes, i.e. dividend arbitrage, yield curve trades, pairs trading.
Event Driven	Distressed securities	Invests in companies in a distressed situation (i.e. bankruptcies, restructuring) and shorts companies expected to experience distress.
	Merger arbitrage	Generates returns by taking long position on the target and short position on the stock of the acquiring company.
	Activism	Looking to obtaining representation in companies board of directors for shaping company's policy and strategic direction.
Equity Based	Equity long/short	Consists of a core holding of particular equity securities , hedged with short sales of stock in minimizing overall market exposure.
	Equity non-hedge	Commonly known as stock-picking since the fund which follows this strategy takes long position in particular equity securities.
Macro	Global macro	Leveraged bets on anticipated price movements of stock markets, interest rates, foreign exchange and physical commodities.
	Emerging markets	Invests a major share of portfolio in securities of companies or the sovereign debt of "developing" or "emerging" markets.

Figure 2.1. Summarative table of Hedge Funds strategies. Source:(Farrell et al., 2007)

2.1.1   Arbitrage Strategies

With the term arbitrage is defined the ability to profit from price discrepancies in two products that will have the same value or a value that is different by a known amount. Arbitrage strategies seek to exploit observable discrepancies between closely – related investments by simultaneously purchasing and selling investments. Although hedge funds following this category of strategy should rely heavily on leverage to obtain significant returns since price inefficiencies usually are considered as slight. The heavy use of leverage lead for firms to suffering losses because of major shifts in unexpected pricing differences. A major example can be considered as the loss of Long-Term Capital Management.

According to Stowell (2017, p.272) arbitrage strategies require one of the following three conditions to be met:

- The same asset does not trade at the same price in all markets.

- Two assets with identical cash flows do not trade at the same price.

- An asset with a known price in the future does not trade today as its future price discounted by using the risk-free rate.

Fixed-Income Based Arbitrage
Fixed income strategies are among the most popular methods which are used to profit off from minor pricing differences in various asset classes. Funds which follow this strategy are trying to exploit pricing inefficiencies in fixed income markets by combining both short and long positions of various fixed income securities in order to earn profits. Portfolios are constructed in such a way as to have no correlation with interest rate

changes, trying to minimize portfolio's total duration. According to this strategy, a fund will take a long position on a security and at the same time will short the same security in order to capture the minor price difference.

As Duarte et al(2007) indicates the Fixed – Income Arbitrage strategy can be considered as a broader set of investment strategies that intends to exploit differences between various fixed-income securities. The most widely fixed income strategies are:

- Swap Spread (SS) Arbitrage

- Yield Curve (YC) Arbitrage

- Mortgage (MA) Arbitrage

- Volatility (VA) Arbitrage

- Capital Structure (CS) Arbitrage

Swap Spread (SS) Arbitrage

This strategy consists of two legs. Initially an arbitrageur enters into a par swap and receives a fixed coupon rate while pays a floating rate. Then the arbitrageur takes a short position in a par Treasury bond with the same as the swap maturity and invests the proceeds in a margin account. Cash Flows from the second leg pays the fixed coupon rate and receives the rate from the margin account. According to Duarte et al.(2007)this strategy is attractive to hedge funds since the floating spread has been stable during time with an average of 26.8 basis points and a 13.3 standard deviation between 1990 and 2006.

Yield Curve (YC) Arbitrage

YC takes both long and short positions at different points along the yield curve. According to this method, an analyst will identify points along the yield curve which are either "rich" or "cheap". In other words the hedge fund which applies this strategy, seeks profit from misprices along those different points, which leads to yield curve distortions. Furthermore, the investor will enter into a portfolio by taking a long and short positions in order to minimize the risk of the portfolio, which is held until the trade converges and the relative bond values come back to line (Duarte et al., 2007, pp.7-8).

YC arbitrage can be of two types according to Stefanini (Stefanini, 2006, p. 138):

- *Intra-Curve*:When the trading is related to securities of the same country, i.e. within one yield curve only.

- *Inter-Curve*:When the trading refers to securities issued by different countries, i.e. between two yield curves of different currencies.

Intra –Curve arbitrage can be classified in three additional strategies:

- <u>YC Flattener</u>: Shorting the bonds which are closer to expiration and taking a long position in bonds with longer expiration.

Figure 2.2. Yield-Curve flattener. <u>Source:</u>(Stefanini, 2006, p. 138)
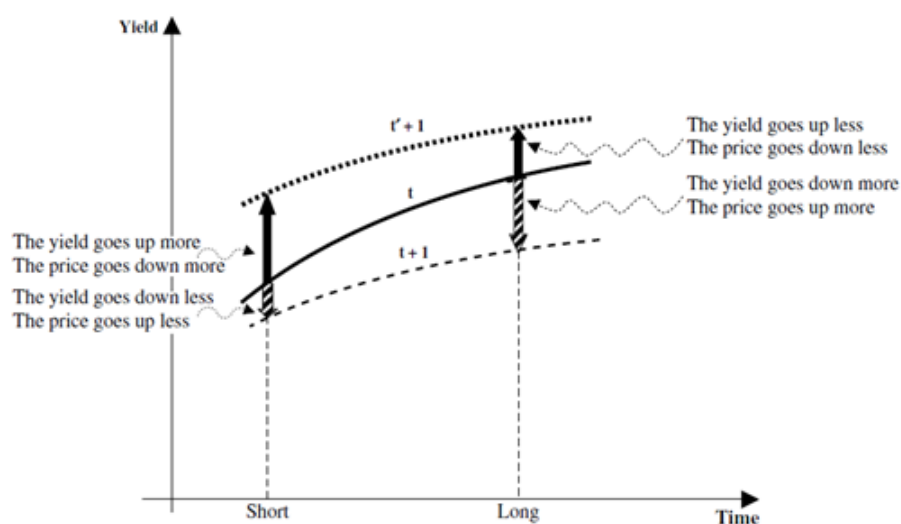
- <u>YC Steepener</u>: Taking long position for bonds which are closer to expiration date and shorting bonds with longer expiration.
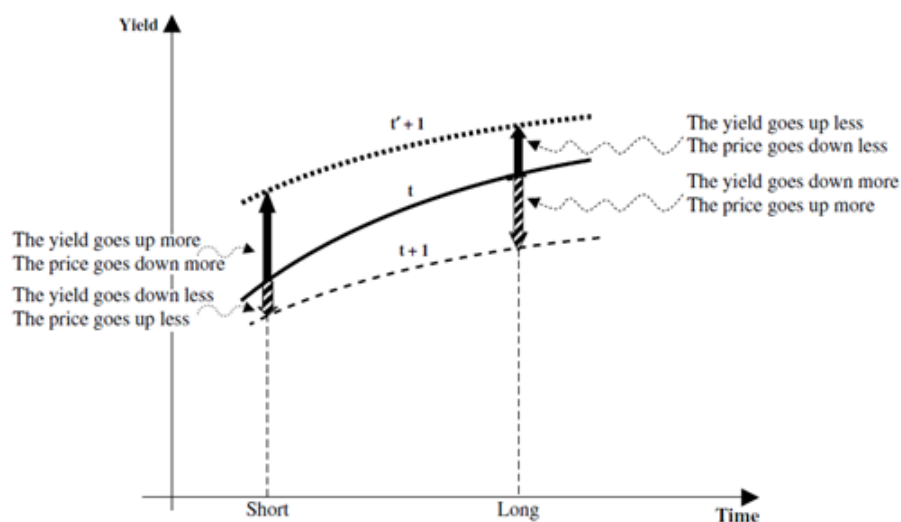

Figure 2.3. Yield-Curve Steepener. <u>Source:</u>(Stefanini, 2006, p. 139)

- <u>YC Butterfly</u>: It involves yields corresponding to three maturity dates. When YC displays a trough, arbitrage will require long position

for those bonds which expirations lie on the wings of the butterfly while short position will be applied for those bonds which are situated in the butterfly's body.
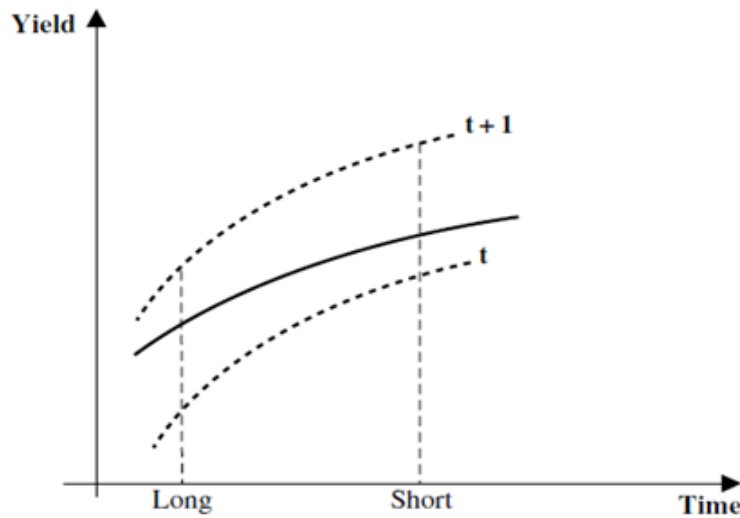

Figure 2.4. Yield-Curve Butterfly. Source:(Stefanini, 2006, p. 139)

Mortgage (MA) Arbitrage

MA strategy consists of acquiring mortgage-backed securities and hedging their interest rate exposure with swaps.

Volatility (VA) Arbitrage

Volatility arbitrage can be considered as a quite popular strategy since it is widely used among Wall Street firms as well as other major participants. VA is implemented by shorting options and then delta-hedging the exposure to the underlying asset. As a result, investors expect to profit from the tendency of implied volatility to exceed subsequent realized volatility (Duarte et al., 2007, pp.15-16).If the implied volatility is higher than the realized volatility, then selling options produces excess return proportional to the gamma of the option times the difference between the implied variance and the realized variance of the underlying asset.

Convertible Arbitrage

As convertible bonds can be characterized those bonds which provides to their holders the right to continue coupon payments, and the right of conversion into a fixed number of shares which takes place on a specified date. In case bondholder decides to exercise his right of conversion, he will receive a fixed number of shares in exchange. In other words, a convertible bond can be thought as a fixed income security which has an embedded equity call option. Since convertibles are traded along predictable ratios, any disparities would provide arbitrage opportunities, and consequently

this investment product is considered as ideal for arbitrage purposes (Stefanini, 2006, p.99).

A convertible bond consists of the bond and the call option of the underlying stock which is the right of converting the bond into a fixed number of shares. These types of assets are considered interesting for investment since buyers have the opportunity to participate in their growth if share price increases or limiting losses if share prices goes down. If the convertible bond includes a stock plus a put option with exercise price equals to the conversion price, it gives the guarantee of payment to its holder. Additionally, it provides exposure to a rise of the underlying stock, although the buyer should pay a premium on the stock's current price. As a result, the convertible has characteristics of both debt and equity, and consequently it provides any asymmetrical risk and return profile. Asset managers are seeking convertible bonds with specific characteristics which are:

- High volatility.

- Good liquidity of the convertible issue and the easily borrowable underlying stock.

- Low conversion premiums since convertibles are less sensitive to interest rate and credit risk.

- Stocks paying either no or low dividend.

- High convexity of convertibles.

- Low implied volatility.

This hedging strategy is considered as popular because of the relatively predictable hedge which can be established between the underlying stock and convertible. It is often considered a relative value strategy since funds often establish a market neutral profile with low correlation to the equity markets. Profit margin is a function of relative price inefficiencies between the convertible and common stock along with the series of cash flows derived from the hedge (Calamos, 2003, pp.6-7).

Arbitrage Techniques

A fund manager should assess the risk/return profile of each position individually and of the portfolio as a whole. The portfolio should be analysed regarding creditworthiness, and risks should be diversified per sector and by issuer market capitalization, in order to rely on an adequate

liquidity. There are various strategies which can be applied by a hedge fund manager, which are analyzed below.

According to cash-flow arbitrage strategy, the manager of a hedge fund sells the underlying stock and buys a convertible bond, where the proceeds are used for financing the acquisition process. It is widely used when there is no bond floor (i.e. in mandatory convertibles since they have higher coupon rate compared to a bond).

As a potential benefit can be considered the mitigation of the impact of equity market volatility. For example, the convertible bond declines in value as well as the common stock, which results in benefiting the manager who took a short position in the stock option. Additionally, hedge fund managers may generate returns from many sources such as income from coupons or dividends from convertible bonds, or potential income from the rebate of the portion of interest charged by the lender to the short seller (Stefanini, 2006, pp.111-113).

Another technique is the volatility trading, which is commonly attempted with convertible bonds that are "at-the-money" when the underlying stock price is close to the bond's conversion prices. where volatility is the major variable in option pricing. The majority of convertible bond arbitrages are constructed by taking a long position on the bond and a short position on the underlying share. Long position on the convertible bond captures the discount to the theoretical value while the short position on the stock reduces its exposure. According to this technique a bond can be traded close to its bond floor with the real gain coming from volatility(Stefanini, 2006, p.114).

Furthermore, gamma trading is another technique where the hedge fund manager seeks profit by trading the underlying stocks in response to delta[1].changes. Gamma factor depicts the convertible's delta sensitivity to changes in the stock price. Gamma is characterized by the convexity[2] of the curvature of the convertible price as a function of the underlying stock price, at a fixed price of the underlying share. Fund managers hedge to capture the profit of the underlying stock by taking either long or short positions for the underlying stock. In most cases the trading range is a multiplier which takes prices between 1 and 2 times the volatility of share on a daily basis. In case gamma is small, delta changes slowly and it is not necessary to carry out frequent adjustments to maintain the portfolio

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[1]Delta is the convertible price sensitivity to the underlying share price changes. It rises when stock prices increases and the stock prices decrease(Stefanini, 2006, pp.113-114)

[2]The price of some convertible issues is increased rapidly than they go down in response to changes in the underlying share price. This characteristic is known as convexity.(Stefanini, 2006, p.120)

delta natural[3].In case gamma provides small figure in absolute terms, delta changes slowly and it is not necessary to carry out frequent adjustments to keep the portfolio delta neutral. On the contrary, delta is highly sensitive to changes in the underlying stock price and requires adjustments to be made in keeping the portfolio delta neutral.

The greater the convexity the greater the hedge ratio error following share movements. As long as gamma increases, the potential profit for the hedge manager increases as well. Furthermore, it is noted that delta hedging and gamma trading generate profit in volatile markets whilst hedge fund manager suffer losses when the market volatility falls below a certain level. It is also noted that gamma trading activity reduces the volatility of the underlying share for companies whose convertible bond issues are significant in terms of size compared to the total shares outstanding since it usually acts against the direction of share price movements (Stefanini, 2006, pp.118-120).

It is noted that the most impactful risk for delta hedging and gamma trading can be considered the credit risk of the convertible issuer. The worst-case scenario for hedge funds which follow a convertible bond arbitrage strategy is the systematic grow of credit risk. For example, in 1994 and 198 the credit risk impacted significantly the hedge funds since credit spreads between corporate bonds and sovereign bonds widened. In order to hedge against credit risk, manager should acquire credit default swap. On the one hand the hedge fund manager is protected by paying a premium for the option while on the other hand the option writer receives a premium with certainty that the issuer's credit quality will improve in the future. Credit default swap is a contract between two parties in which the former acquires protection from another party against losses from the potential default of a borrower for a certain period of time. This type of derivatives offers fund managers the chance to buy or sell protection against a borrower default(Stefanini, 2006, p.121).

Finally, a carry trade is a technique based on the acquisition of bonds with higher yield than the borrowed money for buying them. In example, a carry trade strategy is based on the profit from short-term convertible bonds where the main assumption on the transaction is that the financial position of the issuer is enough to pay back the convertible bond(Stefanini, 2006, p.120-125).

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[3]Delta neutral position yields positive returns irrespective of whether stock price increases or decreases(Stefanini, 2006, pp.113-114)

Relative Value Arbitrage

The strategy of relative value is used to exploit price differences across asset classes such as pair trading which involves two competitive companies or peers in the same industry with common shares, with strong historic correlation in stock price movements. In other words, fund manager seeks to find prices of two stocks that have moved together historically. Once the spread between them widens, the fund manager will short the stock with the higher price and sell the latter (Gatev et al., 2006, pp.797-798).

Those funds which employ relative value strategy construct market neutral portfolios in order to eliminate systematic risks and to yield higher returns. Market neutral portfolios comprises both long and short positions which produces a beta close to zero. Additionally, risk is limited since a portion of portfolio always generate positive returns in a bull or bear market. Moreover, relative value strategy incorporates many sub-strategies such as convertible arbitrage, debt arbitrage and equity market neutral, each of which has different investment approaches. Despite the fact that all relative value strategies should seek to be market-neutral, some sub strategies cannot meet this criterion due to limitations on available securities to offset the long or short part of the strategy. For instance, since the securities traded may not have perfectly correlated hedges, it is possible to experience negative changes in asset prices of unanticipated magnitudes as a result of those risks (Dikanarov et al., 2017, pp.242-243).

According to this strategy, small profits are generated from individual trades in contrast with other strategies such as global macro strategy. To attract investors in using the relative value strategy, relative value funds may employ leverage to achieve return targets. Relative value funds are an uncorrelated investment vehicle with investments such as equities or bonds and attracts investors who seek to diversify their portfolio against the general market.

Gatev et al. (2006)examined the risk and return characteristics of pairs trading by using daily data from a period between 1962 and December 2002, where they found the existence of average annualized excess returns of c. 11% for top pairs portfolios. They also examined the robustness of their results in a variety of factors (such as risk factors, bankruptcy risk, microstructure factors) and they found that even though short-selling and transaction costs affects the magnitude of excess returns, pairs trading remains profitable throughout their period of analysis.

Hain et al.(2018) investigated the profits from relative value arbitrage strategies on energies commodities in Europe. Their study based on daily data for 85 futures contracts on coal, natural gas, crude oil, gasoil, emissions allowances, and electricity throughout a period from 2006 to 2013. Their results showed that trading suitably chosen pairs and trios of comoving commodity futures is highly profitable, robust to a conservative setting of transaction costs, and the strategies returns cannot be explained by systematic risk factors such as equity or commodity market returns or exchange rate risk.

2.1.2   Event Driven Strategies

An event-driven strategy is a type of investment strategy which attempts to take advantage of temporary mispricing in stocks, that takes place either before or after a corporate event takes place. The Event-Driven strategies focusses on transactions such as M&A, bankruptcy reorganizations,recapitalizations as well as other specific corporate events which create pricing inefficiencies. Therefore, event-driven strategies are linked to the level of corporate activity (Stowell, 2017, p.275).

As a result, a thorough research has been carried out on the operating and financial profiles of the companies by analysts. Investment decisions depend on a bottom-up analysis, that puts the burden of emphasis on fundamental analysis and a good knowledge of industrial sectors. The prediction of returns by hedge fund managers is considered as difficult due to the complexity of events. Positions can remain dormant, eroding the fund's global return when the expected events do not take place.

Event driven strategy entails in attempting to predict the result of a given deal and the right time to distribute capital in the investment. Investment opportunities rises by the uncertainty surrounding the final outcome of these events and for those fund managers who have assessed correctly the market with regards to the outcome and timing of these situations.

The performance of those hedge funds which pursue an event driven strategy does not depend on market direction. Although, some deals may fail or others may be redefined due to the weak equity markets, which affect negatively the strategy's performance. On the contrary, buoyant equity markets tend to act as catalysts by creating investments opportunities for the event-driven strategy (Stefanini, 2006, p.207). Event-driven strategy can be subdivided in several sub-strategies. According to Stowell (2017) these sub-strategies are:

- Activist

- Merger Arbitrage

- Distressed Securities

Activist

Activist shareholders try to take minority equity or equity derivative positions in a company and looking to influence the management of the company and its board to consider initiatives which the activist believe to be important to obtain certain actions. Usually, activist investors attempt to influence other major investors to support their recommendations to the company that sometimes leads to proxy solicitations designed to shift the management structure of the firm (Stowell, 2017, p.281).

Active investing focuses on a shareholder value and have an active role in corporate governance. Activists typically take an active role as a shareholder or bondholder to maximize shareholder value. Activists usually invest either in rich or undervalued companies, where they believe they can impact on decision making process to enhance shareholder value and generate larger returns on investments. In creating value, activists take the following actions as Stefaninni (2006):

- Reorganize companies and battle for strategic change.

- Dispose of non-core assets.

- Spin-off of business units.

- Distribute cash flows to shareholders through a share buy-back programme or with the payment of a special dividend.

Over the past three decades activist campaigns conducted by hedge funds have risen not only in size but in frequency as well. A major finding in the literature is the existence of short-term increases in share price following Schedule 13D fillings by hedge fund activists, which mandates that beneficial owners of more than 5% of publicly traded security intending to influence corporate control, disclose their ownership and intent within ten days of crossing the ownership threshold. Several studies indicated that short-term returns for this type of firms is in the region of 3-7%. To this end, corporate governance research turned to the connection between activism and subsequent changes in operating performance for targeting firms (Baker and Burke, 2021, pp.2-4).

Consequences of hedge funds activism have been examined in the literature throughout several studies. Clifford (2008)examined the effects of shareholder activism by hedge funds from 1998 to 2005, where the main finding was that firms which are targeted by hedge funds for active purposes earn larger excess of stock returns and improvements in operating performance (ROA) compared to a control group of firms which are targeted by the same hedge funds for passive purposes. Denes et al.(2017)examined the consequences of shareholder activism for targeted firms and draw two main conclusions. Firstly, activism is associated with improvements in share values and firm operations. Secondly activism disconnected from the formation of ownership blocks is associated with insignificant or very small changes in target value. Furthermore, shareholder activism has become more value increasing over time, with the effect in 1980s and 1990s being not significantly detectable in contrast with recent years. DeHaan et al (2019) examined the long-term effects of interventions by activist hedge funds. The outcome of their research presented positive equal-weighted long-term returns and operating performance improvements following activist interventions. Baker (2021) argued that significant reductions in the labor force at impacted businesses, and corporate tax avoidance increased within the subset of firms that do become more profitable following an event, results which will push institutional investors to reconsider their position on following this type of strategy.

Merger Arbitrage

Merger arbitrage strategy is probably the best-known arbitrage strategy among investors and hedge fund managers. This strategy involves the acquisition of the stock of the firm which is to be purchased and selling the stock of the firm that is to be the acquirer. Hedge fund managers who follow this strategy aim to capture the spread of the current market prices of the merger partners and the value of those companies upon the successful completion of the merger (Anson, 2002, p.26).

Particularly merger arbitrage strategy is an arbitrage strategy whose outcome purely depends on the risks associated with the finalization of the deal. Hedge Fund manager takes a directional position on the spread:

- Between the offered value for acquisition and the market value of the company to be acquired.

- In case of a merge, between the theoretical exchange ratio of stock of

the two entities involved in the merge and the current exchange ratio expressed by the market (Stefanini, 2006, p.75).

Hedge fund managers conduct significant research for those companies which involved in the merge, by reviewing their financial statements, proxy statements, management structures, cost savings from redundant operations, strategic reasons for the merger, regulatory issues, press releases and competitive position of the combined company within the industry it competes. Additionally, the rate of return which is implicit in the current spread will be calculated by the managers and will be compared with the event risk associated with the deal. In case the spread is sufficient to compensate the investor for the expected event risk, the arbitrage will be executed (Anson, 2002, p.26).

In the event of an acquisition, the company which will acquire the other pays a premium on the market value to take over the target company before the acquisition is announced. In other words, acquisition arbitrage exists by taking a long position on the stock of the target company and short position on the stock of acquiring company. However, there are circumstances which taking ca convergence position, that means doing the exact opposite (long position on the acquiring company and short on the company which will be acquired) (Stefanini, 2006, p.75).

Block(2006) examined the various forms of merger arbitrage based on cash and stock transactions. The particular study took into account 3064 mergers over a 20-year period of 1984 to 2003. Due to lack of adequate data or overly complicated tender offer 2997 mergers were eliminated by the study. By taking a long position in the target firm and short position in the acquiring firm, differences in prices can be potentially locked up by arbitrage. The outcome of this study is that the gap varies between 5% and 10% between the point of announcement and the final resolution. Consequently arbitrage is not perfect since merger can always be called off, thus creating losses which are impacted from the long position in the target company's stock. Although this study summarizes that the mergers arbitrage fund is normally able to earn strong returns in different types of market environments.

Liu and Wu (2014) examined the over-valuation hypothesis and merger arbitrage price pressure hypothesis as potential explanations for the observed negative returns to stock acquirers from a M&A. This study used daily data in order to study short selling price pressure around mergers. They found that prices around merger announcements are affected significantly by shorting pressure. Additionally, this study found

that merger arbitrage activity increases with estimated arbitrage spread on a daily basis, which shows that merger arbitrageurs play a pivotal role in stock mergers.

Another study by Rzakhanov and Jetley (2019) explores the impact of sector and individual fund's size on performance by taking into account supply and demand level for capital. They found that the greater the size of the sector is associated with significant dis-economies of scale, which are driven by price impact as investors tend to exert price pressure in the same direction and reduce arbitrage spread. An increase in merger arbitrage sector size impacts significantly the price as reflected in smaller merger arbitrage spreads, that drives down alpha. The greater the competition within the sector, the greater the prices which hinders the ability of a merger arbitrage hedge fund to deliver alpha.

It is noted that some managers who follow this strategy invest only in announced deals whereas others will invest on the basis of speculation. Deal risk is much greater with this type of strategy, although the return of this type of investment is high. To this end the term "arbitrage" is not appropriate, since there is plenty of risk associated with the merger announcement and consequently profits are not riskless. In managing risk associated with this strategy, the best way is diversification, which is applied in a mixed portfolio with several M&A along with single deals.

Distressed Securities

Investment strategies related to distressed securities are applicable for companies with distressed situation such as bankruptcy and restructuring, or companies which are expected to experience distress in the future. In other words the investment product is securities such as stocks, bonds, trade or financial claim of companies which will appear likely or will exit from financial distress or bankruptcy. When the holders of these securities choose to to sell and the demand is limited from buyer side, there is a anticipation of price drop. On the contrary, when a company is already distressed or appears to emerge from this situation, securities price may show a recovery trend.

An investor may purchase the securities of a company which will enter into a restructuring process until the company emerges from this and the value of security increase. When a distressed situation occurs, stronger securities should be more competitive in contrast with junior securities, which suggest that a hedge fund manager may short the latter and purchase the former. A successful investment strategy uses a process which focuses on fundamental analysis in order the manager to arrive at a decision whether

the underlying security is indeed underpriced (Stowell, 2017, pp.281-283).

Investment strategies related to distressed securities can be either active or passive. Active investors will seek to influence restructuring process by participating in a committee which will ensure the process is handled on a fair basis and its interests are protected. In other words, active investors will get involved in order to reorganize the company in the most beneficial way to its interests. On the contrary less proactive are passive investors, who look for less complicated situations(Stowell, 2017, p.283).

Long bias is shown on hedge funds which are managed along a distressed securities strategy with a long position. This characteristic enhances the risk of credit spread increase. Moreover, liquidity risk exists for distressed securities investments. Liquidity for distressed securities is quarterly, bi-annually or annually due to the illiquiditiy of securities and the long time horizons to finalize the manager's strategy (Stefanini, 2006, p.196).

Additionally there are risks associated with the complexity of bankruptcy laws and the intricacies of default situations such as claim priority, bankruptcy negotiation process et al. Leverage also is not used since distressed securities consists of high implied leverage because of the fact that trading usually takes place in a substantial discount of par value (Stefanini, 2006, p.196).

2.1.3 Equity Based Strategies

Equity based strategies takes long positions in undervalued stocks and short positions in overvalued stocks.

The correlation of equities with macroeconomic factors mean that they are riskier asset class for investment compared with cash or bonds.They are highly susceptible to systematic risk factors i.e. inflation which impacts negatively future cash flows. Hedge fund managers who apply equity based strategies are required to consider the risks associated with correlation to other investments held within their portfolio.

This category consists of two strategies; equity long/short and equity non-hedge which are analysed in the following paragraphs.

Equity Long/Short

Managers who apply equity long/short strategy, build their portfolio by combining a core group of long stock positions with short selling of stocks or stock index options/futures. In other words managers who apply this strategy are looking to set up an equity portfolio whose returns are not correlated to market performance, but rather to their stock selection skills.

Hedge fund manager who follow this strategy are looking to take long position for undervalued shares whereas they try to short sell overvalued shares. As a result the outcome of this strategy is positive when long positions go up and short positions go down (Stefanini, 2006, p.48).

In a long/short portfolio, short positions have double advantage: they provide a negative exposure to securities which are probably be overvalued and reduce the market exposure of the portfolio by hedging the systematic risk. Short positions must be developed in order to generate profit and not to hedge long positions. Adopting a strategy with both long and short position widens the span of available alternatives to the investor, which makes it possible to generate profit from the stock's performance (Stefanini, 2006, p.48).

The manager who apply this strategy may decide weather to hold a positive market exposure (net long bias) in order to take advantage of a generalized bullish period or to hold a negative market exposure (net short bias). In general the net market exposure is considered positive despite the fact that sometimes several funds driven by the manager's macro-economic view may have a net short exposure. Consequently a positive correlation is observed at the performance of long/short equity hedge funds, to the performance of the reference equity markets. In bearish markets these types of funds usually outperform the market and tend to be negatively correlated (Stefanini, 2006, pp.48-49).

Equity hedge fund managers maintain net market exposures as they have more flexible investment policy compared with managers who follow other strategies, as they adjust their net exposure to the equity market risk depending on the manager's preference and the market conditions. In a bull market hedge fund managers expect the value of their assets to increase and their short holdings to show a significant drop in their price. On the contrary, in a bear market managers expect their short holdings to drop more and their long holdings to fall less rapidly than the market. The main objective of these funds is to be anywhere between net long to net short.

Equity Non- Hedge

This category takes into account those hedge funds which seek returns based on trend-following trades or on market directional investments which may be either not hedged or limited hedged. This type of funds follow investment strategies with long or short bias positions having a dedicated exposure to one side of the equity market and they are therefore less flexible than general equity hedge funds.

According to this strategy managers seek to generate returns by selecting

a narrow portfolio of stocks, following a market-timing strategy and leverage is used to increase returns.More importantly, hedge funds which follow equity non-hedge strategy invest in less liquid asset. The main difference with those funds which apply equity long/short strategy is the exposure the former have and their portfolio construction, whereas the latter tend to be diversified by sector and by number of positions. Equity non-hedge funds are usually concentrate on a few sectors and they tend to invest in less liquid securities which cannot be hedged (Capocci, 2013, p.275).

2.1.4   Macro Strategies

Macro strategies typically involves the analysis of large quantities of macroeconomic data across markets and regions. Managers usually try to identify potential trends or imbalances in the risk premium relating to the main asset classes, such as currencies or equities. They take large positions depending upon the forecasts of changes in interest rates, currency movements, monetary policies and macroeconomic indicators, prepared by hedge fund managers (Stefanini, 2006, p.239).

Fund managers try to capture returns by trading the main world macro-economic indices by forming their own view as to the prevailing trends on the market. They usually trade all asset classes (i.e. treasuries, currencies, corporate bonds, precious metals, commodities), use all financial instruments (i.e. securities, indices, options, forward and futures contracts, swaps) and apply short selling and leverage. In general there are no geographical restrictions upon their operation and they can trade from G7 countries to emerging markets(Anson, 2002, p.18).

Global macro funds usually have large amount of capital investment, which is necessary to execute their strategies based on macroeconomic events. Additionally they may apply leverage in order to increase the size of their macro bets. As a result global macro hedge funds tend to receive the greatest attention and publicity in the financial markets (Stefanini, 2006, p.18).

Macro strategy is different compared with other strategies of investment applied by hedge fund managers, since it is considered as an overall approach than a strategy. Based on each opportunity set, managers arrive at an investment decision with the aim to profit from the inefficiencies of the markets. In order to gain expertise of the country or market they operate, hedge fund managers apply fundamental or technical analysis in order to gain a global overview of the country and in many cases they use

technical analysis for the verification of long term trends over a short term period. Whereas other hedge fund strategies require a particular economic environment to perform, the characteristics of their strategy enable macro managers to perform over time when an opportunity emerges (Capocci, 2013, p.321).

Types of Global Macro Strategy

Global macro strategy can be divided into discretionary, systematic, high frequency and commodity trading advisors (CTAs). Managers who apply discretionary strategy, they trade equity, fixed income, currency commodities, and futures markets primarily based on the managers' economic view of the market. Managers who apply systematic strategy, they trade equity, fixed income, currency commodities, and futures markets, by using systematic investment rules according to large volumes of market and economic data. Applicable rules by managers are determined by combination of insights and historical patterns in the data. The figure below classifies the discretionary and systematic sub-strategies according to their prime asset focus:

Primary Asset Class	Discretionary	Systematic
Equities	Global Long/Short	
Fixed Income	Fixed Income/Trading	
Currencies		FX Strategies
Commodities	Commodities	
Emerging Markets	Emerging Markets	
Volatility	Volatility	
	Discretionary Global mactro	Systematic Global Macro / CTAs
All	Multistrategy	

Figure 2.5. Clasification of discretionary and systematic strategies based on their prime asset class investments. Source:(Jaeger and Pease, 2008, p.74)

However, all global macro managers have in common the international scope of their strategies, the use of leverage and a main focus on structural macroeconomic imbalances and trends (Gurnani and Hentschel, 2021, p.2).

The discretionary investment process includes a broad range of investment strategies, focusing particularly to fixed income securities, emerging markets and volatility based ones. On the other hand, global macro managers who follow the systematic investment process are mainly active in currency markets.Additionally, there are managers following both sub-strategies who focus on the commodity industry sector.

At the same perspective, global macro trades are classified as either directional, where the manager bets on discrete price movements or as

relative value, where two similar assets are paired on a long and short sides to exploit a perceived relative mispricing. Directional macro trading involves either buying an asset or short selling it, according to expectations about the macroeconomic variables which influence the dynamics of the asset price. For example a manager who strongly believes that the value of Euro will rise compared with that of Dollar, he will sell Dollars and will buy Euros. In order to amplify the impact of market moves, managers who apply macro strategy often use leverage and derivatives. The greatest impact on macro funds, which causes high volatility and strong correlation of macro funds returns, is achieved by the use of leverage on directional bets (Gliner, 2014, pp. 30-32).

Relative value strategies are more heterogeneous than the directional ones, with the hedge funds which follow that strategy aiming to take advantage of mispricing between two similar financial products. For example, a hedge fund manager may look to profit from the yield spread between two similar securities with different maturities (i.e. 10th Year German Government Bund and the 20th Year German Government Bund), which constitutes an arbitrage opportunity. In this case the macro manager takes a long position in the product with the shorter maturity in order to capitalize on price increase and a short position in the longer maturity in order to capitalize on the drop of prices. If the spread was expected to decrease, the manager would be expected to take the opposing positions (Gliner, 2014, pp. 30-32).

Managers who apply the systematic global macro strategy, they seek to earn alpha by capturing the spread moves by relying on quantitative models and computerized algorithms. The process on these funds is considered as stringent,with the ability of operating solely on quantitative analysis and ensuring maximum returns with the main assumption that past risk adjusted returns are predictive. Over long periods of time (several years) systematic funds can produce more consistent returns compared to discretionary strategies. Although in periods of high volatility they tend to under-perform discretionary macro, as happened in 2008 (Gliner, 2014, pp. 30-32).

According to Gliner 2014, p.32 while systematic macro is scalable and can take large allocations, it is wise to allocate to both discretionary and systematic macro evenly. This allows for the manager not only to gain the advantages of both strategies, but also to hedge the disadvantages. In periods of stress, discretionary macro is negatively correlated and since discretionary traders can get short quickly, it can produce profit in

economic situations where the majority of people are losing money.On the contrary, systematic macro is allows safe allocations and predictability with more assurance.

Another type of global macro strategy is the high frequency trading, which is the process of using highly sophisticated technology in order to trade short-term spreads that may exist in the market. Holding periods range from milliseconds up to few hours depending on the applicable strategy. The utmost importance in this strategy is the frequency of trading which ensures the capture of spreads (Gliner, 2014, pp. 30-32).

Commodity Trading Advisors (CTAs) advises third parties about buying or selling futures contracts, options or retail off -exchange foreign exchange contracts. Based on the fact that futures are traded on the majority of global macro markets, CTAs can be considered a macro strategy. Many larger CTAs employ a model-driven approach which can be technical or fundamental. The majority of CTAs apply a highly automated trend following strategy, which is similar to systematic macro. CTAs are also required to be registered by the National Futures Association, the industry's independent, self-regulatory body.

Chapter 3

The performance of Hedge Funds

This chapter will analyse the most recent literature regarding the performance of hedge funds. Academic evidence is provided by several studies that reach on a conclusion that hedge funds showed a decline within the last decade (2010-2020) following the 2008 financial crisis. Additionally, a thorough market analysis which stems from various market sources will be presented.

## 3.1   The Size of the Hedge Fund Industry

Barth et al. (2020) indicated that the size of the hedge fund industry is the aggregate of net assets reported to the public databases plus net assets reported to the non-public database. The major difficulty is the capture of data which are listed in non-public databases, which include either small hedge funds that do not meet the minimum criteria for regulatory reporting, or large funds which are not required to register.

This type of AUM is considered as net, in contrast with Gross Assets Under Management which is the use of balance sheet leverage. Balance sheet leverage stems from the investment of borrowed funds, either through collateralised borrowing or through direct borrowing, and simultaneously increases both the assets and liabilities of the fund. Leverage increases the magnitude of both gains and losses of an investment strategy relative to the payoff of the strategy funded only by investor capital. Since hedge funds are funded by both investor capital and borrowing, gross assets of the fund are considered as a better KPI of fund's economic exposure and potential systematic risk to various sectors of financial markets than net assets, that represents the equity capital of the hedge fund (Barth et al., 2020, p.14). Edelman et al. (2013) showed that various commercial databases provide net AUM data.

While the estimates of the size of the industry were significantly large

particularly during the last years (2019-2021), a considerable threat of underestimating the industry exists. As of December 2016, the total assets of funds that do not report to any database measures $2.47tn, nearly the net assets reported in the publicly available databases (Barth et al., 2020, p.12). It is also considerable the fact that stressed by Barth et al. that from Q1 2013 to Q4 2016 public net assets have grown at c. 19% (from $2.1tn to $2.5tn) whereas a 51% increase (from $1.64tn to $2.47tn) was shown at non-public net assets. Finally the study conducted by Barth et al. (2020) addresses that the hedge fund industry is considerably largest than any existing estimate, with at least of total $5.0tn AUM as of 2016.

Barth et al. (2020) indicate that the total returns earned by funds that do not report to any public database are considerably higher in contrast with publicly reporting funds. The Hedge Fund industry has experienced explosive growth since the mid 1980s, and measured either by the number of funds or by the assets under management (AUM). Hedge fund industry is traditionally dominated by the US market, which is the home of the majority of all Hedge Funds with Europe being the second market in terms of AUM. As of September 2021, AUM grew substantially to $4.32tn with a notable y-o-y increase of 8.1% from 2020 where the total AUM amounted $3.99tn. It is also notable that the majority of hedge funds strategies experienced positive inflows in 2021, indicating that investors were happy with their hedge funds allocation overall(Preqin, 2022). The following figure presents the total size of hedge funds from 2010 until 2021 in terms of AUM:
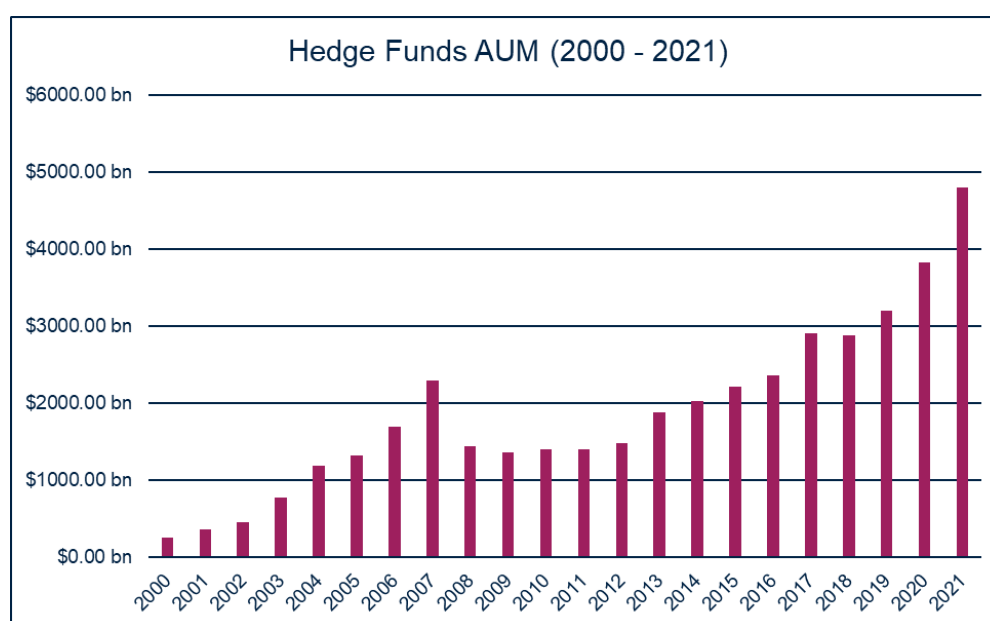
Figure 3.1. Hedge Funds AUM from 2000 to 2021. <u>Source:</u> BarclayHedge Database

Regarding North America region, hedge funds gained 13.67% as of September continuing their positive trend and outperforming European funds which exhibited a 8.65% increase and Asia Pacific with an annual increase of 9.16%. Definitely, the strong performance of North America's hedge funds resulted to positive cash flows that equals with $49bn, in contrast with Europe that follows by almost 50% lower ($20bn). The Asia -Pacific region also presented an increase of 11.9% throughout 2021 and compared with the year 2020. To this end, North America remained the most prominent investor based for hedge funds during 2021 (Preqin, 2022). This fact is also verified by Statista Research Department ((Statista Research Department, 2019)) as the following map indicates:
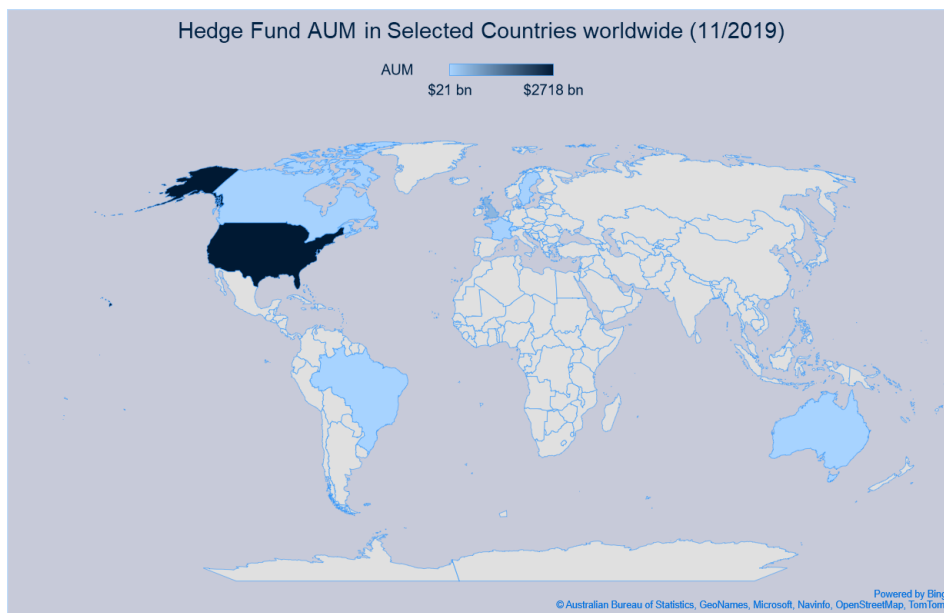
Figure 3.2. Hedge Funds AUM in selected countries worldwide. <u>Source:</u> Statista

Statista verifies as well the previous discussion based on data received by Preqin database, which indicates that the United States is the leading country in terms of hedge funds AUM, with the United Kingdom following second.

But which are the future expectations regarding the size of Hedge Funds during the next years ? According to Falcioni (2020) there is an expectation from the hedge funds to hold their positions as the second largest alternative asset class in 2025. Compounding Annual Growth Rate (CAGR) for AUM expected to be at a rate of 3.6% as Preqin forecasts.

3.1.1 Review of the Hedge Funds performance

Public and non-public disclosed data

Since the financial crisis of 2007-2009 the economic press and industry analysts stressed the relatively poor performance of hedge funds. Despite the fact that hedge funds presupposes that they should underperform a broad stock index during bull markets and outperform during bear markets, the extent of the underpeformance has received scrutiny. The majority of the studies conducted, rely solely on data contained in commercial databases without taking into account data from funds which do not report any database (Barth et al., 2020, p.18).

According to Barth et al. (2020) returns to both public and non-public funds move together, whereas the magnitude appear to differ, since public data presents larger downsides and small upsides compared with non-publicly reporting funds. These differences in monthly rates of return can reach to different conclusions in terms of total returns. Outperformance of non-public reported funds has been found in several hedge funds strategies as presented at the table below:

Strategy	Public reported database	Non-public reported database
Relative Value Strategies	9%	32%
Credit Strategies	5%	20%
Event Driven	19%	43%
Multi-Strategy	9%	26%
Other Strategies	10%	26%
Macro Strategies	3%	1%
Managed Futures	9%	4%

Figure 3.3. Comparison of returns between public and non-public reported funds. Source: (Barth et al., 2020)

From the above table it can be seen that the vast majority of hedge funds strategies that do not disclose their performance, exhibit higher returns compared with those which disclose their returns. On the contrary, only those hedge funds which follows Macro Strategies or Managed Futures present higher returns. As a result it can be seen that non-publicly reporting funds outperform than those reported in commercial databases, a fact that motivates the criticism of hedge funds by analysts and financial press. Throughout the period of 2013-2016 the net assets of funds which report publicly has grown by 20% whereas the growth of funds which do not disclose their returns is in the region of 50% in the same period (Barth et al., 2020).

3.1.2 Market Overview

The implications of financial crisis

The industry boomed in the 1990s and value of assets managed by hedge funds worldwide grew steadily until 2007. From 2008 and due to the financial crisis the market plummeted and did not showed recovery signs until 2013. Between 2007 and 2008 a growing uncertainty with regards to the stability of the global financial market, caused the reevaluation of terms of credit they extended to hedge funds,resulting reduction in leverage and subsequent liquidations of many portfolios. The year 2008 was the record low year with Credit Suisse / Tremont Hedge Fund index measuring losses of 19.1%. Throughout the Q4 2008, hedge funds suffered from significant net asset outflows as investors looked to raise cash from all possible sources. Consequently, even investors which exhibited strong performance saw significant losses such as Caxton Associates that measured a drop of 27% (Stowell, 2017, pp.255-256).

The hedge funds industry has struggled to recover from the financial crisis compared with other asset classes. Evident signs of recovery started to show from 2013-2014 and onwards while a growth of 6.3% was observed throughout the period of 2015-2019. From December 2008 to January 2013, a conservative investment style was adopted by hedge funds which was more costly and therefore has underperformed other investment choices. Within the period of financial crisis hedge funds have reached record low returns, with a rolling five-year return being 0.8% in October 2012 (Ineichen Research and Management, 2012).

The performance of hedge funds during 2019-2021 period

Throughout the year 2019-2021 hedge funds bounced back and seemed to be fully recovered by the implications of the financial crisis. More specifically, global hedge funds marked returns of 9.27%, 13.20% and 9.37% throughout the years 2019 to 2021. Respectively, the Covid-19 outbreak resulted in global economic shutdown as governments were forced to cease operations in order to contain the spread of the virus. With regards to support from this crisis, governments and central banks injected large amounts of economic stimulus in order to support the economies. The Covid-19 pandemic put hedge funds on the spotlight as an asset class which thrives on volatility and protects investors under market stress.

The performance of hedge funds bounced back through 2021 with returns equals to 13.56% for event-driven strategies and 13.14% for

distressed securities respectively. The following table presents the risk returns statistics of global hedge funds throughout a five-year period (2017-2021) (Eureka Hedge, 2022).

Indices Name	2021 Return	2020 Return	3Y Annualised Return	3Y Annualised Volatilities	3Y Sharpe Ratio (RFR = 1%)
Arbitrage	4.98%	12.01%	7.50%	2.57%	2.53
CTA/Managed Futures	6.66%	7.37%	6.62%	4.62%	1.22
Distressed Debt	13.14%	6.79%	7.98%	7.90%	0.88
Event Driven	13.56%	9.29%	10.06%	10.41%	0.87
Fixed Income	4.29%	5.31%	5.78%	6.42%	0.74
Long/Short Equities	10.80%	17.93%	13.55%	9.42%	1.33
Macro	3.97%	11.45%	8.09%	4.83%	1.47
Multi-Strategy	7.58%	8.70%	8.41%	6.26%	1.18
Relative Value	6.81%	9.40%	7.15%	5.92%	1.04
Global Hedge Fund	9.49%	12.91%	10.55%	6.69%	1.43

Figure 3.4. Performance in nubmers of global hedge funds breakdown into their main strategic mandate. Source: EurekaHedge

From the above table, it can be seen that long/short equities hedge funds were the most consistent among strategic mandates in delivering high returns to their investors. L/S Equities have the third best risk-adjusted return in 2021 over the last five years. Hedge funds which follow arbitrage strategies present a Sharpe Ratio of 2.53 due to low volatility of the strategy. It is also worth noting that only three strategies presented Sharpe Ratio less than 1, which are Distressed Securities, Event Driven and Fixed Income.

Overall Performance of Hedge Funds through the period 2010-2021

During the period of 2010-2021, hedge funds exhibited returns of 9.57% on an annual basis, which is slightly better than the 60/40 proxy portfolio's 9.1% return. Hedge funds during the aforementioned period had a standard deviation of 6.28%, which was significantly less than the 60/40 proxy portfolio's 8.20% as well as the MSCI World's Index return which showed return of 13.43% (Preqin, 2022).

3.2 Literature on Hedge Funds performance

Several studies have been conducted from the year of inception until today which try to measure the performance of hedge funds in several periods. Despite the limited available data, which sometimes are not adequate for the presentation of reliable results, the outcome coincides with the current market trends which stress the fact that a decline on the performance of hedge funds took place within a 10-year period after the global financial crisis.

Sullivan (2019) indicates that since the 2008 global financial crisis hedge funds exhibited poor performance. Post global financial crisis, and within the following decade, hedge funds shown a market decline in risk-adjusted alpha. Sullivan used a regression analysis in order to measure hedge fund alpha over a period from 1994 to 2019. Throughout the period between 1994 and 2008, hedge funds performance was quite strong whereas within the remaining period a deterioration in the risk adjusted returns was witnessed. Within the years following the global financial crisis, hedge fund managers, whatever active strategy they pursue, have maintained a relatively consistent exposure to market risks, reduced active risk exposures to many systematic research factors, and have added little to no idiosyncratic alpha (Sullivan, 2019).

Another study prepared by Metzger and Shenai (2019) used the Hedge Index database with over 9500 hedge funds in order to analyse the performance of ten major strategies during and post the financial crisis and more specifically throughout the period of June 2007- January 2017. The main finding was that some hedge fund strategies which have also persistent performances, are also able to outperform the benchmark in some periods. During the financial crisis period all strategies overperformed in contrast with S&P500. After the financial crisis and despite the fact that four strategies (Convertible Arbitrage, Fixed Income Arbitrage, Multi Strategy and Global Macro) were able to outperform the S&P500 in risk-adjusted terms, in absolute terms S&P500 was the best value performer.

Moreover, Bollen et al. (2021) verified a substantial drop in the performance of hedge funds by analyzing a broad sample from six commercial databases. In order to measure the performance , authors tested whether established models can successfully unerth subsets of hedge funds which consistently outperform. Decline in performance in the post financial crisis period is notable both in a value weighted index of all hedge funds each month, as well as in the cross-sectional distribution of individual funds. The proportion of hedge funds with significant alpha, dropped from approximately 20% before the financial crisis to just 10% after it, whereas the proportion with significantly negative alpha rose from 5% pre GFC to c.20% post GFC.

Chapter 4

Measuring Performance of Hedge Funds

This chapter presents an analysis of several data in order to measure the performance of each Hedge Fund Strategy.This is achieved throughout an analysis of time-series data along with the computation of several ratios and more specifically the Sharpe Ratio and Sortino Ratio. Analysis contains main statistics for each strategy along with the computation of ratios which indicates the performance of each strategy. Additionally, a linear regression analysis has been conducted by applying the Jensen's model in order to identify the performance of each strategy throughout the analysis period.

4.1 Data

In this study a dataset of hedge fund indices is employed to proxy hedge fund returns produced by different strategies. Dataset is compiled from the Hedge Fund Research (HFR) database. HFR produces over 300 indices that measures the performance of Hedge Funds, ranging from aggregate levels down to specific, niche areas of sub-strategy and focus on regional investment. In order to construct those indices HFR collects data from over 5,900 active hedge funds.The dataset includes the following investment strategies: Convertible Arbitrage (CA), Distressed Securities (DS), Fixed Income Arbitrage (FIA), Relative Value Arbitrage (RVA), Merger Arbitrage (MA), Equity Hedge (EH), Macro (M), and Emerging Markets (EM). The data used are collected from January 2010 until December 2021, although the analysis takes into account and shorter periods.

4.2   Limitations of Hedge Funds data

Hedge funds industry is neither regulated nor funds have to report performance measures in databases. Since measurement reporting takes place voluntarily, only a portion of the whole universe of Hedge Funds is reported in databases which have been set up in the mid-1990s.Databases which offer data for earlier periods, suffer from data misreporting, since the funds which seized to exist before the set up of database, are not included in those. It is also noted that each database have different reporting criteria regarding data collection and interpretation (Benedikt, 2009). All these facts lead to the existence of several biases which are the following:

- Survivorship Bias

- Selection Bias

4.2.1   Survivorship Bias

Survivorship bias is caused when a database excludes data of funds which have been disappeared over the years due the their poor performance. Therefore, historical return performance of the sample is biased upwards, whereas the risk is biased downwards.Malkiel (1995) measured the survivorship bias in mutual funds from 1971 to 1991. Unlike mutual funds, Survivorship bias in hedge funds cannot be measured directly due to the lack of observable data. More specifically, Survivorship bias can only be estimated by using hedge funds in a database (Fung and Hsieh, 2002).

A major issue concerns information of hedge funds which ceased to exist before the database become available. To this end hedge funds database are considered as vulnerable to survivorship bias, particularly prior to the mid-1990s. To this end, analysts cannot assess survivorship bias prior to the mid-1990s (Fung and Hsieh, 2002).

Secondly, another problem arises from the difference between the funds which just stopped data publication to a database ("defunct funds") and those funds which stopped operation ("dead funds"). It is obvious that a dead fund must also be a defunct fund. Furthermore, there is a type of fund which voluntarily stops reporting to a database since do not want to attract new investments (Fung and Hsieh, 2002).

Survivorship bias has been measured by Amin and Kat (2003) over the period of 1994 and 2001, at a rate of 2% per annum. Another study prepared by Aggarwal and Jorion (2010) measured Survivorship bias of over 5% for Hedge Funds in TASS database and throughout a period of 1994-2001.

4.2.2 Selection Bias

Selection bias derives from the voluntarily contribution of Hedge Funds to databases. Usually, hedge funds start-ups tent not to report their performance on the available databases at least in their beginning. Although, in case of positive performance, they might disclose the required by each database data after either 6 or 12 months after their commencing of operation (Stefanini, 2006, p.281).

An important issue which is strongly correlated with selection bias is the instant history bias. When a vendor imports a fund into database, the vendor often backfills the fund's historical returns in the database. For example, if the hedge fund is 2 years old, its record for the past two years will be included to the index and its values will be adjusted accordingly. When the performance of the fund is considered as satisfactory, the manager markets the funds to prospective investors, which often require the inclusion of the hedge fund within a database. Since the hedge fund manager may decide when to reveal the track record, returns from the incubation period will probably be high (Fung and Hsieh, 2002).

Fung and Hsieh (2000) considered selection bias and instant history bias to be spurious biases since both the causality and the magnitude of these biases are inherent in the data-collection process. Remediation can be achieved with careful manipulation: The elimination of selection bias may take place if hedge funds databases eventually converge to the universe of hedge funds. Instant history bias can be treated by dropping the returns of a fund prior to its entry into a database (Fung and Hsieh, 2002).

Backfill bias can be calculted by the following methods (Kaiser and Haberfelner, 2012):

1. Deduction of average returns of live funds with backfilling bias, from the average returns of live funds without it.

2. Deduction of the average return of live and dead funds with backfilling bias from the average return of live and dead funds without it.

According to Ibbotson et al. (2011) backfill bias was measured at c. 2.05% including only live funds, whereas the bias reaches the peak of 7.70%, including dead-fund data.

4.3 Descriptive statistics of the dataset

The following table presents the descriptive statistics of each strategy:

	CA	DS	FIA	RVA	MA	ACT	EH	EDT	M	EMA
Mean	0.47%	0.50%	0.47%	0.43%	0.36%	0.66%	0.54%	0.50%	0.18%	0.37%
Median	0.51%	0.67%	0.61%	0.54%	0.42%	0.75%	0.79%	0.57%	0.09%	0.55%
Max	3.56%	6.44%	3.41%	2.74%	4.84%	11.51%	8.28%	7.04%	3.99%	5.78%
Min	-7.52%	-11.05%	-11.01%	-9.77%	-9.58%	-20.33%	-10.89%	-12.40%	-3.70%	-12.81%
Std Dev	0.013	0.019	0.015	0.012	0.012	0.037	0.024	0.019	0.013	0.027
Skewness	-1.664	-1.581	-3.266	-4.032	-2.962	-1.036	-0.655	-1.989	0.205	-0.954
Kurtosis	8.575422	9.788421	25.11701	31.82287	30.15823	7.00322	3.718886	14.38946	0.160354	3.336072

Figure 4.1. Summarative table of Hedge Funds strategies. Source:Hedge Fund Research Database

From the table above it is noted that the mean value is positive for each strategy, while the highest mean return and standard deviation is observed at Activist strategy. On the contrary, the lowest mean value is indicated at Macro strategy, while the Relative Value Arbitrage includes the lowest standard deviation for the given sample data. With regards to standard deviation, the highest values are observed form Activist, Emerging Markets and Equity Hedge strategies, which means that the returns for those strategies are moved wildly and as an early outcome it can be seen that these are more risky compared with those strategies with lower values.

Other descriptive statistics are Skewness and Kurtosis. Skewness measures how much the probability distribution of a random variable deviates from the normal distribution. Skewness values are negative for the most strategies except Macro strategy which shows a positive value of 0.205.To this end, it seems that hedge fund return distributions are nonlinear and exhibit fat tails and extreme return values. Kurtosis measures the tailedness of a distribution. Tailedness is how often outlier occurs. In other words it measures the shape of a distribution's tails in relation to its overall shape. Kurtosis statistics encountered throughout the sample period are highly leptokurtic for the majority of strategies. Another early conclusion that derives from those statistics is the fact that the combination of high kurtosis and negative skewness are highly discouraging qualities for a risk - averse investors. As a result, hedge fund investors can potentially obtain attractive risk-return trade-offs however with higher kurtosis and negative skewness.These results correspond to past empirical findings where the existence of extreme returns is observed (Morton et al., 2006).

4.4   Data Analysis for each strategy

This section will present an analysis of the monthly data for each strategy throughout the period of January - 2010 to December - 2021. Analysis of returns for each strategy will be undertaken with graphs throughout the analysis period.

Convertible Arbitrage

According to the graph illustrated below it is noted that there are fluctuations throughout the analysis period. More specifically, in early 2010 there is an upward trend for returns while in early 2012 reaches the peak of over 3% returns. This volatility continues in the period of 2012-2018, where the volatility is at low levels, in the region of +2% / -2%. However volatility increases sharply in the period between 2019 to 2021, where returns for this strategy reaches the peak of c.4% while historic low figure of c. -7% is observed during the first half of 2020, probably as an aftermath of the COVID -19 pandemic.At the end of 2020, returns for Convertible Arbitrage strategy have been plummeted, with evident sign of a continuous trend in 2022.
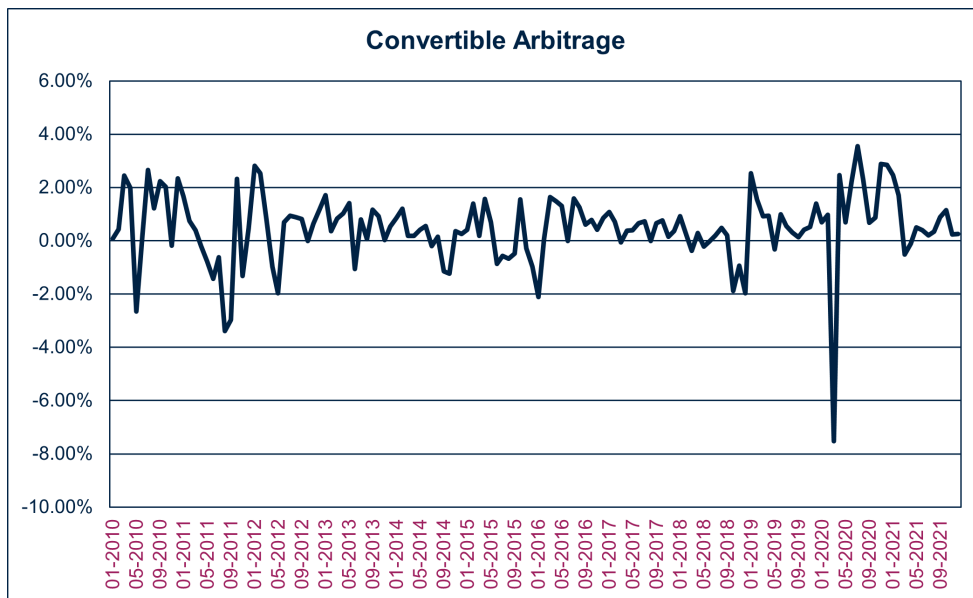
Figure 4.2. Returns of Convertible Arbitrage strategy. Source:Hedge Fund Research Database

Distressed Securities
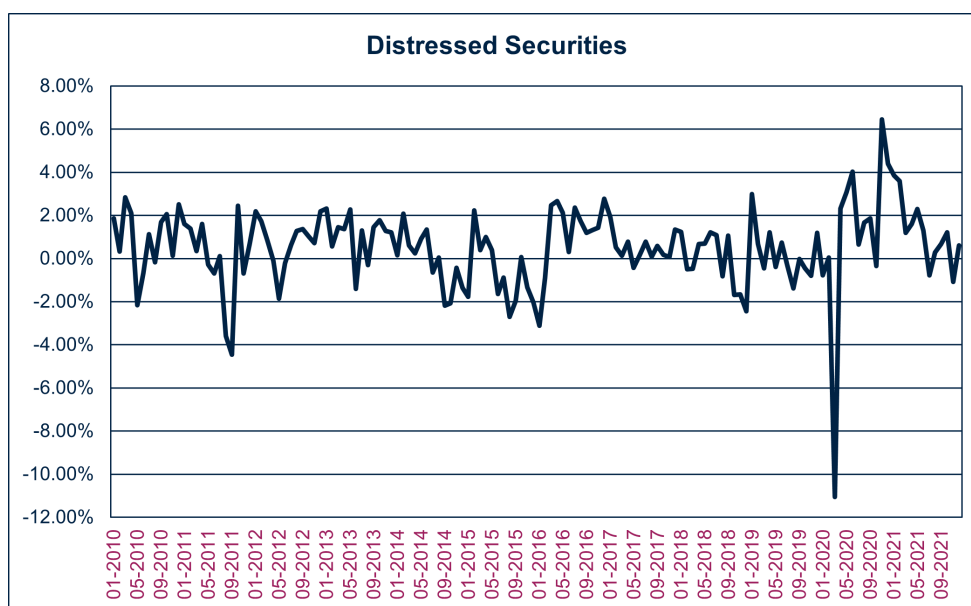
Figure 4.3. Returns of Distressed Securities strategy. <u>Source:</u>Hedge Fund Research Database

The graph above indicates the returns of Distressed Securities strategy in the period of 2010-2021. Return levels are in general in the region of +2% / -2%, while in some cases returns are either higher, with reaching the peak of over 6% in early 2021 whereas historic lows of over -10% is presented in early 2020. From 2020 and onward and after a sharp increase during early 2021, a major drop is presented, which however do not crosses the levels of early 2020.

Fixed Income Arbitrage
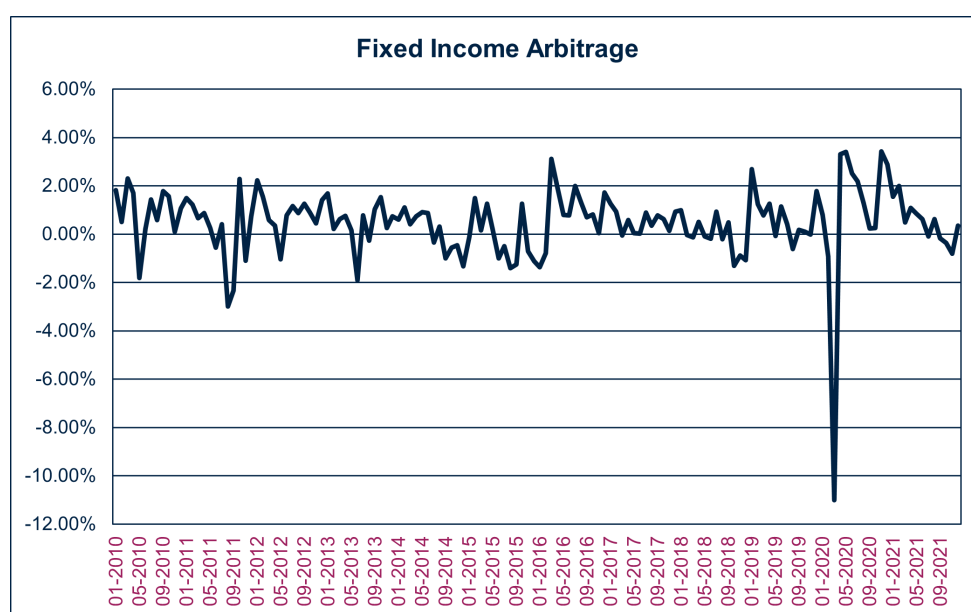
Figure 4.4. Returns of Fixed Income Arbitrage strategy. <u>Source:</u>Hedge Fund Research Database

This strategy shows low levels of volatilty throughout the analysis period. Following the sharp decreases in 2010 and the fluctuations between positive and negative returns throughout the period of 2011 to 2016, a stability in returns is observed until the end of 2019.

Relative Value Arbitrage

The following graph shows a relative stable fluctuation in levels of return throughout the period of 2010 to 2019, where values are in the range of +2% / -2%. The low level of standard deviation figure exhibits as well the subject trend. Again a sharp decrease is identified in early 2020 where the COVID-19 pandemic begun while it follows a year with mainly positive returns, with record high return value to be in the range of over 2%.
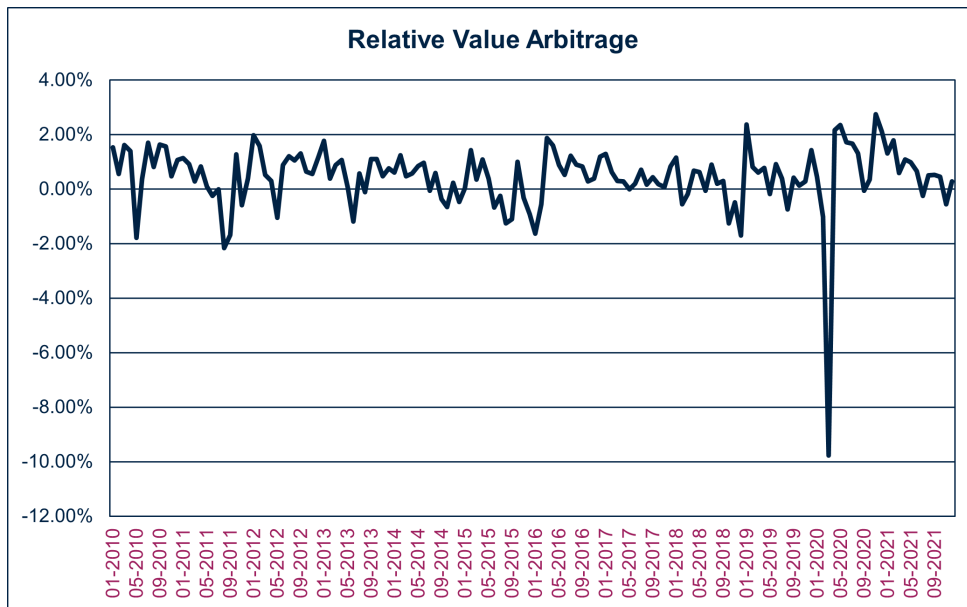
Figure 4.5. Returns of Relative Value Arbitrage strategy. Source:Hedge Fund Research Database

Merger Arbitrage

Merger Arbitrage strategy presents a stable pattern of fluctuation throughout the period of 2010 to 2019, with returns being in the range of +2% / -2%, without however reaching those figures. From 2020 and onwards the volatility is high both upwards and downwards, as an aftermath of the pandemic. In this case as well the end of 2021 presents mainly positive levels of return, however from Q3 2021 the trend is values to show a slight decrease.
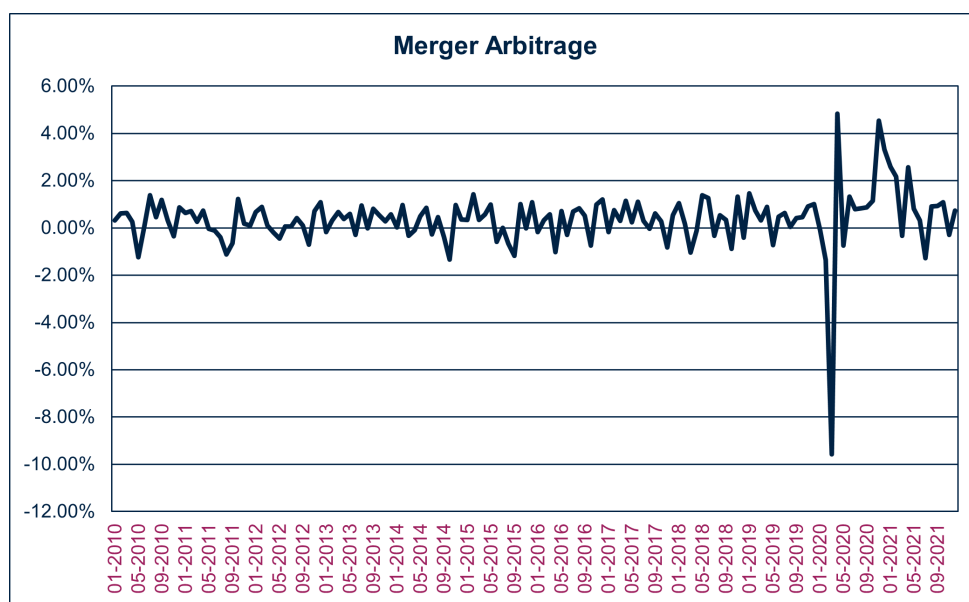
Figure 4.6. Returns of Merger Arbitrage strategy. Source:Hedge Fund Research Database

Activist

Next comes the Activist strategy. Overall this strategy remains with a stable pattern of volatility for the majority of the analysis period, with returns being particularly in the range of +5% / -5%. More specifically, a slightly upward trend is indicated from the end of 2021 until 2018. Record low figure is observed in the early 2020 while returns reach the peak in two times throughout this period, which are Q3 2013 and Q4 2020. Finally, the last quarter of the analysis period shows a positive trend which is expected to remain at the same levels.
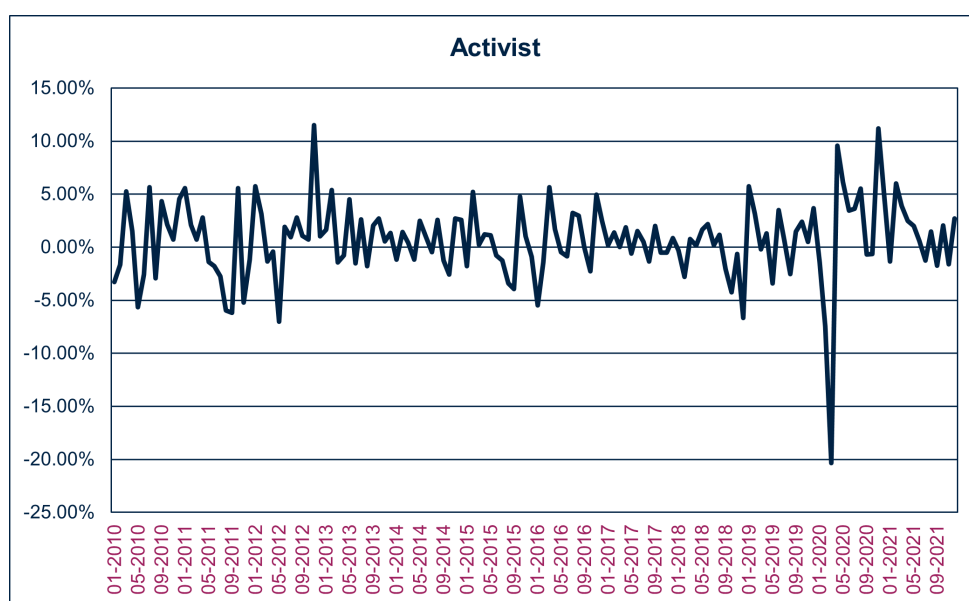

Figure 4.7. Returns of Activist strategy. Source:Hedge Fund Research Database

Equity Hedge

For Equity Hedge, a period of high volatility is observed throughout the period of 2010 to c. Q3 2014, while it follows with a period of relatively stable fluctuations. However negative values are also presented on the following graph, which exceeded -10% in Q1 2020 as an aftermath of the lockdown measures for COVID-19 pandemic.On the contrary, high returns were observed in early 2021 exceeding 5%. It is also noted that during 2021, fluctuations in returns either positive or negative were small. In general Equity Hedge strategy, presents high standard deviation (2.4%), which justifies the fluctuations throughout the analysis period in return levels.
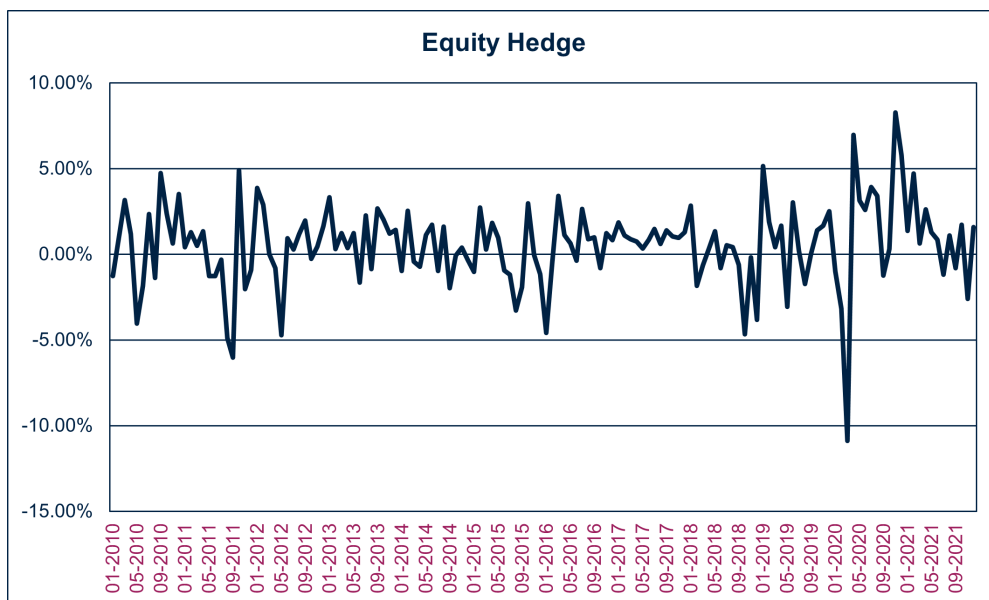
Figure 4.8. Returns of Equity Hedge strategy. Source:Hedge Fund Research Database

Event Driven

Next comes the Event Driven strategy. Again a fluctuation of returns is observed with prices range mainly between +3% and -3%. A period of positive only returns took place between 2016 and 2018, where the global economy in 2017 presented evident signs of strengthening with a moderate recovery in investment and trade.This sign of recovery is also portrayed in 2019 returns which were in higher levels compared with the period of 2016-2018. In 2020 a significant drop in returns was the outcome of the pandemic, while from Q3 2020 and until Q2 2021, return reached the peak by over 5%. The rest of the year showed a slowdown in return level, which was expected for 2022 as well.
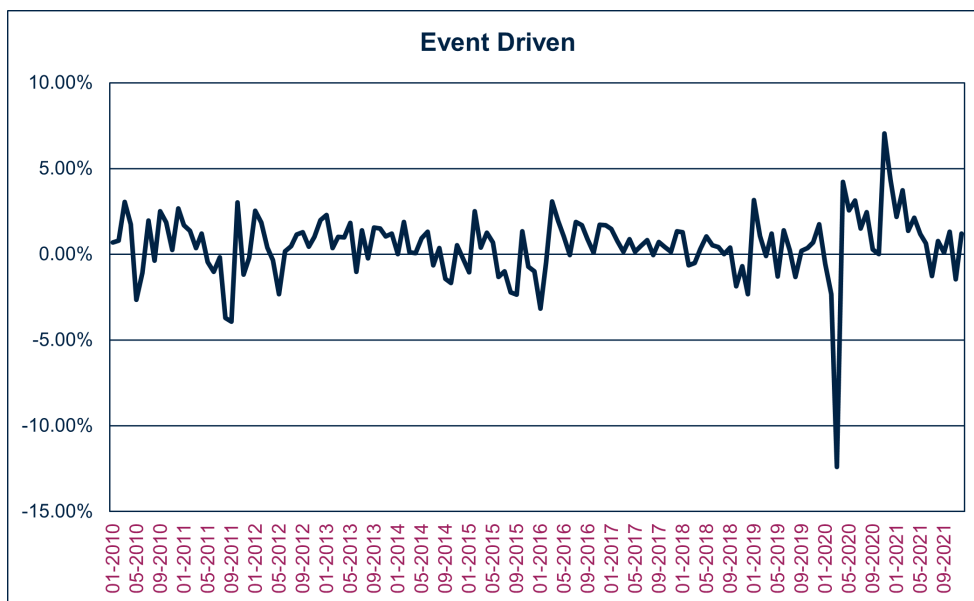
Figure 4.9. Returns of Event Driven strategy. Source:Hedge Fund Research Database
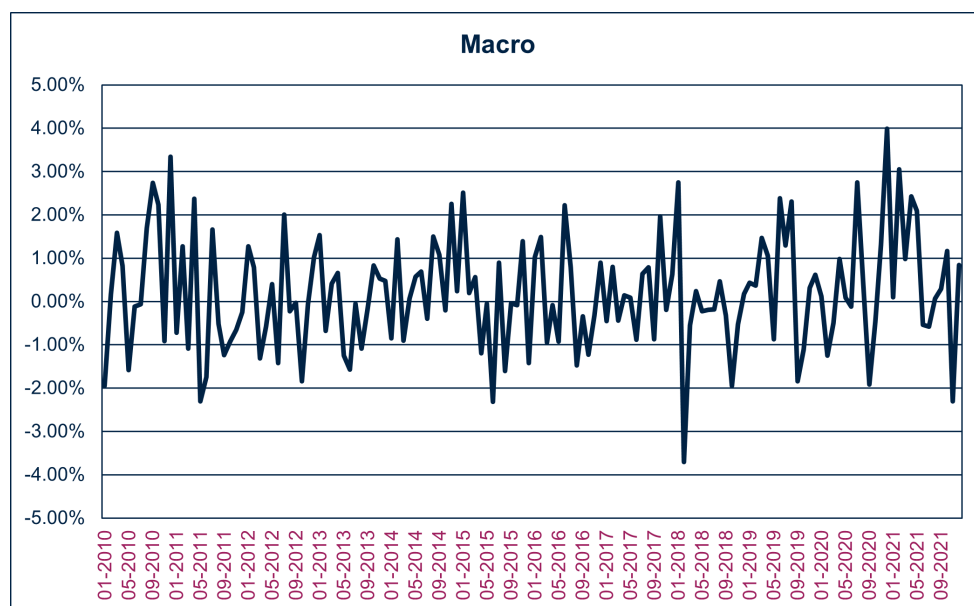
Macro

Figure 4.10. Returns of Macro strategy. Source:Hedge Fund Research Database

Macro strategy is the only one with positive skewness, which means that macro strategy demonstrate positive asymmetry and low figure of kurtosis. Additionally, standard deviation figure is one of the lowest compared with the rest of the strategies, which means that returns are in a narrow range, a factor which is mainly shown on the graph above. In general a fluctuation of the price levels is shown throughout the period of analysis without several returns to be above the buffer zone of +2% / -2%. Furthermore, the historic low levels of return in early 2020 is not observed in Macro

strategy. In 2021, level of returns are mainly at low levels, with signs of further drop in 2022.

Emerging Markets

The last strategy which is analysed is Emerging Markets.It is notable that the volatility is higher than the rest of the strategies, with exception of Activist strategy, which has the highest standard deviation. Again returns range between +5% / -5%. Nevertheless return reaches the peak of over 5% in 2015, 2016 and in Q2 of 2020, after the significant drop at levels lower than -10%. Furthermore, a positive performance with a decreasing trend, took place from Q3 2020 until the end of the analysis period.
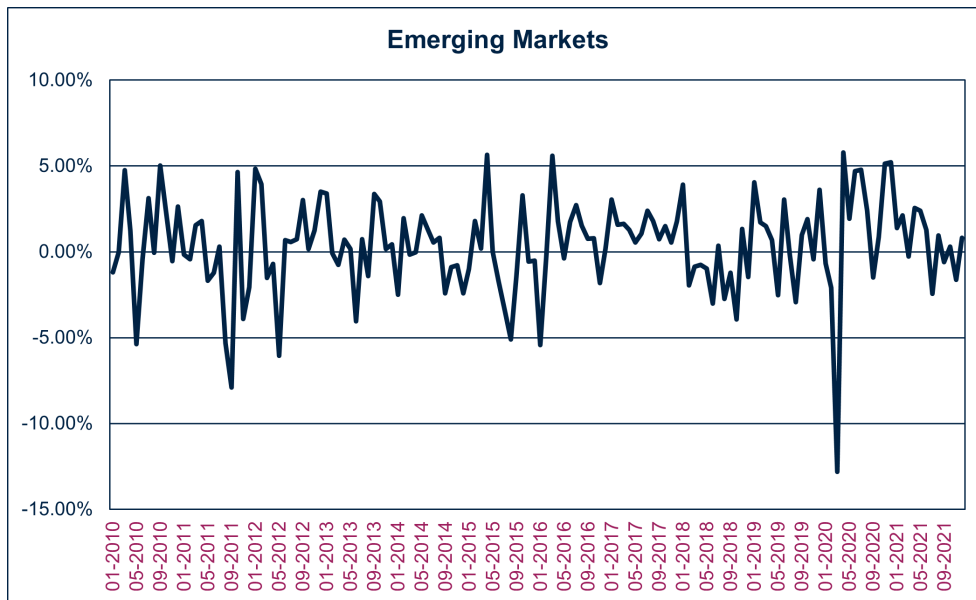
Figure 4.11. Returns of Emerging Markets strategy. Source:Hedge Fund Research Database

4.5   Performance Evaluation

In order to determine the performance of each strategy, several ratios have been calculated and more specifically the Sharpe Ratio, the Sortino Ratio and Value at Risk (VaR). Auer and Schuhmacher (2013)highlighted with their research that Sharpe ratio is considered as a prominent factor in measuring performance of hedge funds for two reasons: (a) because it produces a performance ranking virtually identical to the rankings derived from other frequently used performance measures and (b) since neither fat tails or asymmetry justifies a rejection of the measure.

4.5.1 The Sharpe Ratio

Sharpe ratio was introduced by William Sharpe (1966), who measured the predictive ability of 115 mutual funds in the period of 1945-1964. The Sharpe ratio measures the relationship between the mean and standard deviation of excess returns and it is used to measure investment performance. According to Bodie et al. Sharpe Ratio is defined as the portfolio's risk premium in excess of the risk free rate, divided by standard deviation.

According to William Sharpe1966, the measure of portfolio performance stems from a direct application of the theoretical results of the CAPM derived by three earlier studies of Sharpe (1964), Linter (1965a) and Traynor.The model is based on three major assumptions:

1. Investors are risk-averse.

2. Investors have identical decision horizons and expectations.

3. Investors are able to choose between portfolios solely on the basis of expected returns and variance of returns.

4. Transaction costs and related taxation is not taken into account in the model.

5. All assets are infinitely divisible.

The Sharpe ratio is simply the return per unit of risk (represented by variance). The higher the Sharpe ratio, the better the combined performance of "risk" and return. The Sharpe Ratio is calculated by using the following equation:

$$S_\alpha = \frac{R_p - R_f}{\sigma_p} \qquad (4.1)$$

where

$R_p = $ *Return of Portfolio*
$R_f = $ *Risk-free rate*
$\sigma_p = $ *Standard Deviation (of asset return)*

Sharpe ratio is considered one of the most widely used methods in measuring risk-adjusted returns. It compares historical returns of an asset compared with an investment benchmark. Risk-free rate represents the risk premium of an investment versus an asset without risk such as Treasury bill. The greater the Sharpe Ratio, the better its performance. Additionally, a negative value of Sharpe Ratio indicates that the risk-free rate is greater compared with the portfolio's historical return.

Limitations of Sharpe Ratio

It is noted that the major advantage of Sharpe Ratio is the simplicity of its formula and its ability to make a comparison across different type of investments. The major limitation of Sharpe ratio is the fact that is valid only for normally distributed returns. Consequently, Sharpe Ratio can lead to misleading conclusions in the existence of skewness and kurtosis. Fatter tails, higher peaks, skewness on the distribution are not taken into account by standard deviation (Mistry and Shah, 2013, p.1).

Another important drawback for Sharpe Ratio is the fact that it considered prone to manipulations. Despite the fact that the Net Asset Value do not suggest positive returns, the Sharpe Ratio can be positive, by manipulating the portfolio returns on portfolio and presenting it higher than the risk-free rate of return. To this end, Sharpe Ratio tend to be overstated in case of hedge funds with historic record which is considered a short.(Mistry and Shah, 2013, pp.1-2).

According to Mistry and Shah (2013), Sharpe Ratio can be manipulated through the information - free trading strategies, which are used in order to increase the fund's performance. This is appealing for managers whose bonuses are strongly related to Sharpe Ratio of the asset which they manage. Manipulation takes place by realizing a gain in an early stage of the evaluation period and investing afterwards the entire funds in a risk-free asset for the rest of the period. As the volatility of a risk-free rate is zero, Sharpe Ratio moves towards infinity. Finally, there is a difficulty in the interpretation of the Sharpe Ratio results when comparing different portfolios.

4.5.2 The Sortino Ratio

Sortino and Price Sortino and Price (1994) developed a ratio which divides the excess returns on a portfolio, with respect to the minimum acceptable return by the downside deviation. Downside deviation provides a better idea about the losses of an investment than standard deviation alone. More specifically, Sortino Ratio takes into account only those returns which fall below a specified by the user target. Sortino ratio is similar to Sharpe ratio with the main difference that takes into account the downside deviation instead of standard deviation. The equation which defines Sortino ratio is defined by the following equation:

$$Sortino\ Ratio = \frac{R_p - R_f}{\sigma_d} \qquad (4.2)$$

where

R_p = *Return of Portfolio*
R_f = *Risk-free rate*
σ_d = *The downside deviation*

Sortino ratio is an important ratio in measuring the performance of hedge funds strategies since it takes into account the tail risk, which can result in higher losses when the market underperforms Atilgan et al. (2013). This is presented in several studies which took place such as the one prepared by Fung and Hsieh (2004),where the main finding was the the significant positive relation between downside risk and the cross-section of expected returns on hedge funds.

4.5.3 Value at Risk (VaR)

Value at Risk (VaR) measures the riskiness of financial entities. It is defined as the maximum amount expected to be lost over a given period at a pre-defined confidence level, which usually is 1% or 5%. According to Bodie et al. (2018) VaR is the loss corresponding to a very low percentile of the entire return distribution, i.e. 5th, or 1st percentile return.

In the literature, there are several studies which conclude to the fact that VaR is suitable in measuring the the risk of hedge funds. Jorion (2000) analysed LTCM's failure by using a VaR apporach. The main finding from this study was the fact that LCTM understimated its risk profile due to reliance on short-term historic data. Gupta and Liang (2005) evaluated the risk in Hedge funds by comparing VaR and traditional risk measures. Gupta and Liang identified that VaR is a better measure in contrast with standard deviation due to negative skewness and substantial kurtosis in returns of hedge funds.

4.5.4 Analysis of Empirical Findings

The empirical findings cover the period from January 2010 to December 2021, however the analysis period was divided into four sub-periods, a fact that coincides with previous studies such as those prepared by Fung and Hsieh (2004), Naik et al., (2007). The applicable sub-periods are as follows:

- January 2010 to December 2021

- January 2010 to December 2013

- January 2014 to December 2016

- January 2017 to December 2019

- January 2020 to December 2021

The analysis of the empirical findings over four different periods allows to verify whether hedge funds generate returns under different market conditions. In determining the Sharpe Ratio, 3M T-bill were used as a risk-free rate since they are considered nearly free of default risk because they are fully backed by the U.S. government.

Sharpe Ratio results

The following figure presents the Sharpe Ratio as calculated for each strategy and for each analysis period.

Sharpe Ratios per Dataset

Analysis Period	Convertible Arbitrage	Distressed Securities	Fixed Income Arbitrage	Relative Value Arbitrage	Merger Arbitrage	Activist	Equity Hedge	Event Driven	Macro	Emerging Markets
2010-2021	-0.0310	-0.0054	-0.0292	-0.0635	-0.1210	0.0401	0.0109	-0.0088	-0.2511	-0.0518
2010-2013	0.3428	0.4384	0.5042	0.5773	0.2933	0.2180	0.1753	0.3798	0.0450	0.1071
2014-2016	0.1951	-0.0021	0.1414	0.2048	0.0304	0.1450	0.0280	0.0565	0.0120	-0.0351
2017-2019	-1.6023	-1.3558	-1.6111	-1.8229	-0.9074	-0.5794	-0.6191	-1.2765	-1.2286	-0.5742
2020-2021	0.3129	0.2954	0.1492	0.1211	0.3921	0.1707	0.2709	0.2096	0.2327	0.1777

Figure 4.12. Annualized Sharpe Ratios for each strategy. Source:Hedge Fund Research Database

In general Sharpe ratio indicates how well an investment performs compared with a risk-free investment. In this case each hedge fund strategy constitutes an investment which is compared with the T-bill.

From the following figure it can be seen that the Sharpe Ratio calculated for the total analysis period presents mainly negative values except Activist and Equity Hedge strategy. Negative Sharpe ratio means that the risk-free rate is greater than the portfolio's historical return. As indicated in Figure 19, the highest Sharpe Ratio within the period of 2010-2021 is for Activist strategy, measuring 0.0401.This means that Activist strategy generates almost 4 basis points of excess returns per unit of standard deviation on average. It is worth noting also that Activist strategy has the largest mean value between all strategies.

Sortino Ratio results

Sharpe ratio has been calculated for different time periods as analysed above. It can be seen that throughout the period of 2010-2013, Sharpe ratio is positive for each strategy, indicating the fact that Hedge Funds performed well. Additionally, within the period of 2014-2016, Sharpe Ratio for the majority of strategies is positive. At this stage it can be seen that hedge funds which followed Distressed Securities or Emerging Market strategy, underperformed since they indicate a negative rate. From this analysis is also highlighted the fact that throughout the period of 2017-2019, hedge

funds underperformed since Sharpe Ratio for all strategies is negative. Last but not least the period of 2020-2021 exhibits positive Sharpe Ratios for each strategy, a fact that indicates that Hedge Funds performed well throughout this period.

Moreover, Sortino ratio has been calculated for the same analysis periods and the results are presented on the table below. As stated earlier, Sortino Ratio does not consider the total volatility of the investment but only the downward deviation. In other words, Sortino Ratio assumes that investors are tolerant of volatile returns if gains are being made. From the table below it can be seen that there are no substantial differences in the results between these ratios. Results are presented on the table below:

Sortino Ratios per Dataset

Analysis Period	Convertible Arbitrage	Distressed Securities	Fixed Income Arbitrage	Relative Value Arbitrage	Merger Arbitrage	Activist	Equity Hedge	Event Driven	Macro	Emerging Markets
2010-2021	-0.0338	-0.0063	-0.0315	-0.0619	-0.1249	0.0533	0.0139	-0.0102	-0.2600	-0.0634
2010-2013	0.5695	0.6963	0.8544	1.0808	1.0825	0.3735	0.2624	0.6186	0.0712	0.1531
2014-2016	0.3044	-0.0030	0.2409	0.3244	0.2196	0.2398	0.0399	0.0828	0.0173	-0.0494
2017-2019	-0.7762	-0.7470	-0.7798	-0.8043	-0.8248	-0.5034	-0.5029	-0.7187	-0.7580	-0.4802
2020-2021	0.4139	0.3982	0.1788	0.1376	0.2300	0.2250	0.4038	0.2702	0.3920	0.2343

Figure 4.13. Sortino ratios for each strategy. Source:Hedge Fund Research Database

However, several differences were noticed between ratios which are summarized below:

- In the analysis period of 2010-2013, maximum value of Sharpe Ratio is 0.5773 for Relative Value Arbitrage strategy, whereas for Sortino Ratio the maximum value is 1.0825 for Merger Arbitrage strategy.

- In the analysis period of 2017-2019, minimum value of Sharpe Ratio is -1.8229 for Relative Value Arbitrage strategy, whereas for Sortino Ratio the minimum value is -0.8248 for Merger Arbitrage strategy.

- In the analysis period of 2020-2021, maximum value of Sharpe Ratio is 0.3921 for Merger Arbitrage strategy, whereas for Sortino Ratio the maximum value is 0.4139 for Convertible Arbitrage strategy.

- In each dataset the ranking order of Sharpe Ratios and Sortino Ratios deviates. In some cases indices differ by either one or two spots, however there are several cases where ranking differs completely in measuring the return by either Sharpe or Sortino ratio.

Value at Risk results

The following table indicates the VaR results, calculated for each analysis period:

Analysis Period	Convertible Arbitrage	Distressed Securities	Fixed Income Arbitrage	Relative Value Arbitrage	Merger Arbitrage	Activist	Equity Hedge	Event Driven	Macro	Emerging Markets
2010-2021	-0.0206	-0.0296	-0.0229	-0.0186	-0.0178	-0.0591	-0.0370	-0.0304	-0.0189	-0.0466
2010-2013	-0.0211	-0.0225	-0.0166	-0.0132	-0.0077	-0.0522	-0.0378	-0.0304	-0.0209	-0.0489
2014-2016	-0.0130	-0.0269	-0.0144	-0.0117	-0.0102	-0.0374	-0.0279	-0.0304	-0.0175	-0.0378
2017-2019	-0.0109	-0.0158	-0.0081	-0.0089	-0.0076	-0.0383	-0.0280	-0.0304	-0.0202	-0.0304
2020-2021	-0.0341	-0.0520	-0.0518	-0.0452	-0.0466	-0.1060	-0.0574	-0.0304	-0.0176	-0.0653

Figure 4.14. VaR results for each strategy. <u>Source:</u>Hedge Fund Research Database

VaR has been calculated at confidence interval of 95%. This means that the subject analysis can be 95% certain that VaR will fall within the confidence interval. From the table above, it can be seen that VaR rates ranges between -0.005 and -0.001 approximately. For all datasets the minimum value is observed for Activist strategy, except for the analysis period of 2014-2016, where the maximum value is for Emerging Markets strategy (-0.0378). On the contrary, maximum value is observed at Merger Arbitrage Strategy throughout all periods of analysis, apart from 2020-2021 where the VaR at Macro strategy is -0.0176. Finally, VaR means that for 95% confidence interval, losses will not exceed 1.76% in a month, for Macro strategy.

4.6   The Jensen Model

Jensen's model is a risk-adjusted performance measure which represents the average return on a portfolio which has been predicted by the CAPM, given the portfolio's beta and the average market return. Jensen's model is based on the following major assumptions:

1. All investors are risk averse, and are single period expected utility of terminal wealth maximizers.

2. All investors have identical decision horizons and homogeneous expectations with regards to investment opportunities.

3. All investors are able to choose among portfolios solely on the basis of expected returns and variance of returns.

4. Neither transaction costs, nor taxes are taken into account.

5. All assets are infinitely divisible.

$$E(R_j) = R_F + \beta_j * [E(R_M) - R_F] \qquad (4.3)$$

where

$E(R_j)$ = *The expected return of any asset.*

R_F = *The Risk-free rate.*

$E(R_M)$ = *The expected return on the market portfolio.*

β_j = *The measure of risk, which is the Asset Pricing Model.*

The equation above informs about the expectations of an asset class to earn given its level of systematic risk. In case a portfolio analyst is able to forecast the future prices of the asset class, he will be able to earn higher returns than those implied as per equation (3) (Jensen, 1968).

This analysis prepared by taking into account the whole period of data which is January 2010 - December 2021. Based on the data used a linear regression was conducted for each strategy in order to analyze the performance of each hedge fund strategy. The table below gathers the outcome of using the Jensen model for each strategy, depicting the alpha which signals whether the hedge funds under or over perform. Furthermore, p-value, R-squared and adjusted R-squared are presented as well.

Strategies	Regression Results				
Strategies	Alpha	p-value	R²	Adjusted R²	Standard Error
Convertible Arbitrage	-0.00198	0.0380	49.48%	49.12%	0.0112
Distressed Securities	-0.00211	*0.1070*	45.95%	45.56%	0.0150
Fixed Income Arbitrage	-0.00209	0.0416	48.79%	48.43%	0.0010
Relative Value Arbitrage	-0.00226	0.0132	48.97%	48.61%	0.000009
Merger Arbitrage	-0.00279	0.0041	39.63%	39.20%	0.0010
Activist	-0.00297	*0.1120*	67.25%	67.02%	0.0019
Equity Hedge	-0.00301	0.0023	80.30%	80.17%	0.0010
Event Driven	-0.00254	0.0201	63.29%	63.03%	0.0011
Macro	-0.00429	0.0003	21.35%	20.79%	0.0011
Emerging Markets	-0.00454	0.0044	58.57%	58.28%	0.0016

Figure 4.15. Linear regression results for each strategy.

The table above presents the alpha, p-value, R-squared, Adjusted R-Squared and Standard Errors for each strategy. Alpha indicates whether the hedge funds under or over perform regarding to the market conditions. R-squared provides a broad indication of the fit of the model to the data and it always increases as the number of effects are included in the model. Adjusted R-squared takes into account the loss of degrees of freedom associated with adding extra variables. A value of 1 for R-squared indicates

that the model perfectly predicts values in the target field whereas a value of 0 stipulates a model that has no predictive value. Standard error represents the average distance that the observed values fall from the regression line. More specifically, it analyzes how wrong the regression model is on average using the units of the response variable. The lower the values the better since it indicates that the observations are closer to the fitted line.

From the table above it is noted that the value of alpha for each hedge fund strategy is negative which indicates the underperformance compared with the risk-free rate. Additionally two strategies have a p-value higher than 5%, which are the Distressed Securities and the Activist. For those strategies, the null hypothesis fails to reject and consequently are not statistically significant. On the contrary, for the rest of the strategies, the null hypothesis is rejected since p-value is lower than 5% and consequently they are statistically significant.

As for the R-squared, their values indicates that each strategy has different explanatory power since values range between 20% to 81%. From the table above it can be stated that for Macro strategy the independent variable poorly explains the returns of the specific strategy.

As a consequence,from the model it can be seen that there is no linear relation between the market and each hedge fund strategy, a fact that is verified from the heteroscedasticity test which has been analysed according to the Breusch-Pagan test with the results being presented on the table below:

Strategies	Breusch - Pagan Test	
	Breusch - Pagan Test	p-value
Convertible Arbitrage	14.262	0.0001591
Distressed Securities	6.1947	0.01281
Fixed Income Arbitrage	11.23	0.0008049
Relative Value Arbitrage	13.025	0.0003073
Merger Arbitrage	7.6108	0.005802
Activist	2.2436	0.1342
Equity Hedge	1.9449	0.1631
Event Driven	7.0303	0.008014
Macro	0.71936	0.3964
Emerging Markets	5.9306	0.01488

Figure 4.16. Breusch - Pagan test.

From the table above it can be seen that each model violates the homoscedasticity assumption and consequently there is non -linearity between each hedge fund strategy and the risk free rate.

Chapter 5

Conclusion

The aim of this dissertation was to identify and evaluate the performance of the hedge funds for each strategy. The analysis was supported by an overview of the market along with a supportive empirical analysis by using publicly disclosed data which was taken by Hedge Funds Research database. The data used was for the period of January 2010 to December 2021 for the following strategies: Convertible Arbitrage, Distressed Securities, Fixed Income Arbitrage, Relative Value Arbitrage, Merger Arbitrage, Activist, Equity Hedge, Macro and Emerging Markets.

In general the market presents evident signs of growth throughout the period of 2010-2021. More specifically, from 2010 and onwards the market experienced a marginal increase of AUM, in contrast with 2021 where a sharp increase was noted not only throughout the ten-year period but also from 2020 to 2021. It is worth noting that AUM in 2010 was around $1,500 bn, AUM in 2021 reached the peak of near $5,000 bn.

Empirical analysis was undertaken by the calculation of the Sharpe Ratio, Sortino Ratio and Value at Risk (VaR). The above ratios were calculated for the whole period of the available data as well as for four sub-periods which allowed the examination of the market under different conditions. As regards the whole period, both Sharpe and Sortino Ratios derived similar results which indicated that all strategies where underperformed as an impact of the GFC. However, Activist and Equity Hedge strategies showed positive values, a fact that highlights an overall good performance for the subject strategies. The main reason behind the underperformance was the GFC which lead to severe losses for hedge funds portfolios. Moreover, the analysis of each sub-period reached to different outcomes.Overall and despite the Eurozone debt crisis in 2010 - 2012, some hedge funds performed well as Sortino Ratio and Sharpe Ratio portrayed. The main outcome that recovery of hedge funds started from 2010 and

onwards, for the majority of strategies. Although, during the period of 2017-2019, hedge funds performance slowed down in line with the global economies. Within this sub-period it was noted that the strategy with the highest Sharpe ratio was the Relative Value in contrast with Sortino Ratio which indicated that Merger Arbitrage strategy performed better.

During the sub-period of 2014-2016, Relative Value Strategy performed well as indicated by both Sharpe and Sortino ratio, whereas Emerging Markets and Distressed Securities indicated the lowest values. As regards the sub-period of 2017-2019 Sharpe Ratios and Sortino Ratios showed significant losses since currency - focused hedge funds suffered unprecedented losses in 2017 and 2018. Finally, and during 2020 - 2021 both ratios presented positive values with Merger Arbitrage strategy dominating in the Sharpe Ratio and Convertible Arbitrage in the Sortino Ratio. Within this period the main event which impacted severely the market was Covid-19, that increased the level of volatility. However, Hedge Funds performed well especially during 2021. Regarding VaR, Merger Arbitrage strategy presented the highest value except from 2020-2021 period where Macro Strategy showed the highest value.

The main outcome of this study was the fact that the hedge fund industry underperformed throughout the period between 2010 and 2021. This fact has also been verified by Jensen model since alpha values for each strategy exhibited negative rates. Additionally, the subject analysis indicated the non existance linearity between hedge funds indices and the risk free rate.

Additionally, the literature review of the market exhibited the an overall poor performance throughout the period post GFC and until 2021. However, Sharpe Ratios indicate higher rates than those computed in Chapter 4 mainly due to the fact that the analysis was conducted with different type of data and more specifically by using hedge funds returns. However, both literature review of the particular market as well as the empirical analysis reach to similar conclusions.

5.1 Limitations and Suggestions for Future Research

The main limitation of the current research was the lack of data. More specifically, the fact that hedge funds do not have to report their performance which lead to several types of bias could possibly impact severely the subject research. The use of hedge funds returns instead of indices is considered more proper since the results are considered more reliable. However the lack of access to those data will always be a major

issue for a future researcher who wants to analyze further this asset class. As a result the lack of data would be a major issue in any future research.

Assuming that data related to hedge funds returns are available, new dimensions and new opportunities can arise. An analysis of multivariate model which will be accompanied with time series of returns can possibly be taken into account in order to measure the performance of each strategy. As a result models such as the Fama - French three factor model as well as the Carhart four factor model can be implemented.Finally, a study which will analyse to what extent hedge funds portfolios incorporate corporate social considerations, ESG and their perfrormance, can also be implemented.

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