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İŞLETME ANABİLİM DALI
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HEDGE FUND STRATEGIES: PERFORMANCE, RISK AND DIVERSIFICATION OPPORTUNITIES

Doktora Tezi

HIND BENMAHI

İstanbul, 202X

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Danışman: PROF. DR. EMİN AVCI

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GENEL BİLGİLER

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ÖZET

Bu tezin amacı, son yirmi yılda farklı zaman dilimlerinde ve piyasa koşulları altında, serbest yatırım fonu stratejilerinin özelliklerini ve riske göre ayarlanmış performanslarını derinlemesine anlamak için serbest yatırım fonu (hedge fon) stratejilerini incelemektir. Bu tezde, serbest yatırım fonu stratejilerini, MSCI World Index tarafından temsil edilen, küresel hisse senedi piyasası ile karşılaştırmak için çoklu performans ölçümleri kullanılmıştır. Ayrıca, bu çalışmada daha iyi performans gösteren fon türünün belirlenmesi amacıyla serbest yatırım fon stratejileri ile yatırım fonlarının riske göre ayarlanmış performansları karşılaştırılmaktadır. Son olarak, bu tez çalışmasında, farklı serbest yatırım fonu stratejilerinin çeşitlendirme bağlamında sunduğu olanakları değerlendirmek için eş bütünleşme analizi kullanılmıştır.

Bu çalışmada, serbest yatırım fonu stratejilerinin performansları, varlık fiyatlama modelleri (Sermaye Varlıkları Fiyatlama Modeli, Fama-French 3 Faktör Modeli, Carhart 4 Faktör Modeli and Fama-French 5 Faktör Modeli), Sharpe rasyosu ve Sortino Rasyosu kullanılarak, 2001-2020 dönemi ile dört farklı ara dönemde (2001-2005, 2006-2010, 2011-2015 and 2016-2020) analiz edilmiştir. Ayrıca, yatırım fonlarının performansları da Sermaye Varlıkları Fiyatlama Modeli, Sharpe rasyosu ve Sortino Rasyosu kullanılarak 2008-2019 dönemi için incelenmiştir.

Bulgular, genellikle serbest yatırım fonu stratejilerinin, MSCI World'den daha iyi performans gösterdiğini ve yatırım fonlarından daha iyi risk ayarlı performans sağladığını göstermiştir. Ayrıca, en iyi performans gösteren stratejilerin genellikle Yönlü (Küresel Makro, Gelişmekte Olan Piyasalar) ve Olay Odaklı stratejiler (Sıkıntılı Borç, Çoklu strateji) olduğu, Göreceli Değer ve Uzun/Kısa Öz sermaye stratejilerinin ise en az performans gösteren stratejiler olduğu bulunmuştur.

Ara dönem analizi ise serbest yatırım fon stratejilerinin farklı özelliklerini ve farklı piyasa koşullarındaki performanslarını ortaya çıkarmıştır. Küresel Makro ve Gelişmekte Olan Piyasalar, farklı piyasa koşullarında iyi bir performansla öne çıkarken, diğer stratejiler, dalgalanan piyasalarda (Olay Odaklı, Yönetilen gelecekler) veya yükselen ve nötr piyasa koşullarında (Dönüştürülebilir Arbitraj) iyi performans göstermiştir. Son olarak, eş bütünleşme analizi, fon yöneticilerinin farklı fon yönetimi yaklaşımları olduğunu ortaya koymuştur.

GENERAL KNOWLEDGE

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ABSTRACT

The aim of this thesis is to examine individual hedge fund strategies in order to get a deep comprehension of their features and risk-adjusted performances in distinct time periods and market conditions over the last two decades. The paper encloses multiple performance measurement to compare hedge fund strategies with the global equity market which is represented by the MSCI World Index. It also compares hedge fund strategies with mutual funds to ascertain which fund type achieve a better risk-adjusted performance. Finally, this thesis study will use Cointegration analysis to evaluate the diversification opportunities by the use of distinct hedge fund strategies.

In this study, the hedge fund performances are analyzed for 2001-2020 period, and for four sub-periods (2001-2005, 2006-2010, 2011-2015 and 2016-2020) using asset-pricing models (Capital Asset Pricing Model, Fama-French Three Factor, Carhart Four Factor and Fama-French Five Factor Models), the Sharpe ratio and the Sortino ratio. Mutual fund strategies Indices are also analyzed for 2008-2019 using the Capital Asset Pricing Model, Sharpe ratio and Sortino ratio.

The findings demonstrated that the majority of hedge fund strategies indices performed better than the benchmark MSCI World and provide better risk-adjusted performance than mutual funds. Moreover, it is found that the best performing strategies are mostly Directional (Global Macro, Emerging Markets) and Event Driven strategies (Distressed Debt, Multi-strategy) while Relative Value and Long/Short Equity strategies are the least performing strategies.

The sub-period analysis revealed the distinct features of hedge fund strategies and their performance in different market circumstances. Global Macro and Emerging Markets stand out with a good performance in distinct market conditions while other strategies perform well in periods of fluctuating markets (Event Driven, Managed Futures), or rising and neutral market conditions (Convertible Arbitrage). Finally, the cointegration analysis demonstrated that managers do not adopt the same management styles.

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ABBREVATIONS

AIFMD: Alternative Investment Fund Manager Directive

AUM: Assets Under Management

ADF: Augmented Dicky-Fuller

CISDM: Center for International Securities and Derivatives Markets

CFO: Collateralized Fund Obligations (CFO)

CPPI: Constant Proportion Portfolio Insurance (CPPI)

CTA: Commodity Trading Advisor

ESMA: European Securities and Market Authority

FOF: Funds of funds

FSMA: Financial Services and Markets Act

ICA: Investment Company Act

ILS: Insurance-Linked Securities

GFC: Global Financial Crisis

LTCM: Long-Term Capital Management

MSCI: Morgan Stanley Capital International Index

POS: Public Offers of Securities

SA: The Securities Act SA

SEC: Securities and Exchange Commission

SFBC: Steinhardt, Fine, Berkowitz& Company

INTRODUCTION

Since Alfred W. Jones established the first modern hedge fund in 1949, there was no expectation that hedge funds will experience such a considerable growth in terms of capital allocation, number of funds and assets under management. Their popularity increased over the years as a result of their robust historical returns, being able to provide huge returns compared to other funds in their peer group. Hedge funds brought new insights to the world of alternative investments with their active management, flexibility and their sophisticated and performing strategies. Owing to their secretive and particular nature, no all-encompassing definition of hedge funds is existent in current literature. Yet, they can be described by their unique properties. Hedge funds are perceived as dynamically operated portfolios of investments that target absolute returns regardless of how the market is evolving (Fung and Hsieh, 1997; Liang, 1999). In order to achieve their aims, hedge fund managers adopt complex investment strategies using leverage, derivatives and switching between long and short positions domestically and globally (Asness et. Al, 2001). Moreover, hedge fund legal framework enables their growth and the evolution of their secretive structures, they are usually limited partnerships allowing access to a restricted number of investors (Liang,1999).

Since their creation, hedge funds have been considered as diversification instruments which are able to enhance the performance and the risk-return profile of their underlying portfolio (Amo et al., 2007; Amin and Kat, 2003; Staman and Scheid, 2008). In the past, numerous studies examined aggregate returns of hedge funds and compared them with mutual funds but few studies focalized on hedge fund strategies. Indeed, hedge fund strategies differ in terms of characteristics, risk exposure, market correlation and performance ability. Furthermore, their behavior relies on their investment style and the condition of their underlying market (Bali et. Al, 2012).

The aim of this thesis is to examine the risk-return profile of individual hedge fund strategies, ten major strategies classified under three categories in order to get a deep comprehension of hedge fund strategies features and risk-adjusted performances in distinct time periods and market conditions over the last two decades. The paper encloses multiple performance measurement tools to determine the most adequate risk framework for investors and to compare between hedge fund strategies and with the global equity market which is represented by the MSCI World Index. This thesis will further decrypt the long-term relationship between hedge fund strategies using Cointegration analysis to investigate

management styles analogies and asset similarities in term of risk exposure profiles between hedge fund strategies indices in order to evaluate the diversification opportunities of hedge fund strategies indices. Finally, this thesis will compare hedge funds strategies with mutual funds adopting similar strategies to ascertain which fund type achieve a better risk-adjusted performance and analyze their performances in comparison with the global equity market (MSCI World Index).

Among the main motivations for this study research is the huge interest in hedge funds either as a standalone investment or as a component of a portfolio, investors are no longer pleased with traditional investments. This study will shed light on the hedge fund industry and provide the fundamental knowledge about the industry's operations, components and performance evaluation. Despite the huge interest and academic attention for hedge funds, most of the academic papers cover aggregate returns of hedge funds and compare their performance with traditional funds and assets (Brown 1999; Ackermann et al., 1999; Brown et al., 1999; Liang 1999; Capocci and Hübner 2004). There are few studies on the performance of individual strategies and less comparative studies of these strategies which is mostly due to the restricted accessibility to individual funds data. This study attempts to contribute to the literature by analyzing individual hedge fund strategies performances. Furthermore, most of the studies in the literature investigate the performance of strategies using one database, three distinct hedge fund data providers were used to settle the possible divergence amid different databases and to offer a comprehensive image of the hedge fund industry. To the best of our knowledge, the present study is the first empirical research to apply the Fama-French five factor model to evaluate hedge fund strategies performance which will contribute to the literature of hedge fund strategies performance measurement. Moreover, a cointegration analysis of hedge fund strategies covering the last ten years has not been published. Due to the fact that most investors are more concerned in long-term performances of their portfolio, the correlation approach is not the adequate method for long-term performance evaluation and portfolio management. The long-term performance evaluation and the examination of diversification opportunities is what cointegration analyzes. This study is likely to contribute to this field.

In this thesis, the data from three hedge fund database providers (Eurekahedge, Credit Suisse, CISDM) are analyzed between 2001-2020 and then in four period samples namely 2001-2005, 2006-2010, 2011-2015 and 2016-2020 using alternative risk adjusted performance metrics, alpha based on four asset pricing models (Capital Asset Pricing Model, Fama-French Three Factor, Carhart Four Factor and Fama-French Five Factor Models), the traditional Sharpe

ratio and the Sortino ratio. Besides, statistical properties and cointegration analysis are elaborated for hedge fund strategies. Mutual fund indices are also analyzed between 2008-2019 using performance metrics: Alpha based on the CAPM, Sharpe ratio and Sortino ratio.

The findings demonstrated that the majority of hedge fund strategies indices performed better than the benchmark MSCI World and provide better risk-adjusted performance than mutual funds. Moreover, it is found that the best performing strategies are mostly Directional (Global Macro, Emerging Markets) and Event Driven strategies (Distressed Debt, Multi-strategy) while Relative Value and Long/Short Equity strategies are the least performing strategies. The sub-period analysis revealed the distinct features of hedge fund strategies and their performance in different market circumstances. Global Macro and Emerging Markets stand out with a good performance in distinct market conditions while other strategies appear to have advantages of a better performance in periods of fluctuating markets such as Event Driven and Managed Futures, or rising and neutral market conditions like Convertible Arbitrage. Overall, hedge fund strategies seem to outperform in times of crises and trend reversals and demonstrate a slight underperformance for some strategies in normal or rising market conditions. Finally, the cointegration analysis demonstrated that managers do not adopt the same management styles and there is an absence of overlapping in asset risk levels for CISDM and there may be a slight similar portfolio management approaches for Credit Suisse and Eurekahedge. Yet, there is still a scope for efficient portfolio diversification across the strategies.

This thesis will be useful for investors and portfolio constructors for further insights on hedge funds characteristics, their differences from traditional mutual funds, their risk-adjusted performance measures, their long-term performance and their strategies' features and performances. For hedge fund investment decision-making, it is fundamental to be acquainted with the hedge fund industry in order to select the most appropriate strategy or strategies for a determined period of time.

The study is organized as follows. In the first part, hedge fund industry is introduced and its differences with mutual funds are explained. In the second part, hedge fund strategies and their associated risks, managerial skills in hedge fund investments are mentioned in addition to a description of hedge fund strategies performances. In the third part, the theoretical framework, the research design and the methodology are clarified as the foundations of this study. In the fourth part, the empirical findings and discussions are reported. The study wraps up with a conclusion in the last section.

1. HEDGE FUNDS

This section introduces the essentials of hedge funds: their history and the evolution of hedge fund industry. Furthermore, a comprehension of hedge funds' characteristics is fundamental to understand this study's research questions and its results. A differentiation between hedge funds and their peer competitors which are mutual funds will be presented afterwards.

1.1. History

The history of hedge fund investments goes back to the 1940's when Alfred Winslow Jones, a former reporter for Fortune magazine, created the first modern hedge fund (Lhabitant,1996). Jones who had a sociological background started his investment partnership with only $100.000 and constructed his fund to avoid the Securities and Exchange Commission's regulations (Stefanini,2006). He intentionally did not disclose the fund to the general public in order to purchase any asset and to employ a broad array of investment techniques that he judged suitable to the market circumstances at any moment. Accordingly, Jones used a combination of short-selling and leverage to decrease the total risk of his portfolio and to build a conservative portfolio with a low exposure to the general market (Connor et al. 2004). He committed all his savings in the partnership and created a performance-based fees of %20 from the generated performance instead of a fixed percentage from assets under management (Mallaby,2010). This measure was aimed to attract investors and to align the interests of both managers and investors. Jones viewed himself as an excellent stock picker, therefore, he employed a market neutral strategy balancing his long positions in promising stocks with short positions in unfavorable stocks to minimize the exposure to market changes. He also utilized the resources gained from short-selling as leverage to increase the number of investments (Lhabitant, 1996). Jones hired other managers in 1952 and started to delegate the management of some parts of the portfolio and entrusted the managers with stock picking, thus, the first modern hedge fund is history became the first ever multi-manager fund (Stefanini, 2006).

During the 1960's, hedge funds aroused interest among other fund managers who started to imitate this investment approach. Furthermore, the stock market boost brought about changes in strategies (Liang, 1999). In the late of 1960's, new hedge funds saw the light among them: Steinhardt, Fine, Berkowitz& Company (SFBC) in 1967 and the Double Eagle in 1969.

Michael Steinhardt set up SFBC hedge fund with $7.7 million and adopted a multi-strategy approach after the expansion of his hedge fund with $5 billion assets under management in the eighties. The Double Eagle hedge fund was founded by George Soros which is the former name of the notorious Quantum Fund (Stefanini, 2006). Following the booming of the hedge fund industry, the Securities and Exchange Commission (SEC) started to keep a vigilant look on the growing industry and reported around 200 hedge funds with $1.5 billion assets under management in 1969 (Stefanini, 2006).

Throughout the 1970's, the hedge fund industry was affected badly by the recession of 1969-1970 and the bear market of 1972-74 (Ineichen, 2002). The S&P crashed by a third in the bear market of 1972-74 and funds with leveraged long only strategies were completely unhedged due to the lack of risk minimizing techniques, hence, numerous hedge funds closed and hedge funds dropped in popularity as an investment instrument with only 68 live hedge funds in that period (Lhabitant, 2002).

However, the industry was turned around in the 1980's with new hedge funds achieving an appreciated performance like the Tiger hedge fund. Julian Robertson and Thorpe Mackenzie founded Tiger hedge fund with a capital of $8.8 million and this fund had the best returns in the hedge fund industry (Fung et al., 1999). Tiger Hedge Fund followed a Global Macro strategy investing in securities and currencies using leverage and anticipating global macro-economic and political circumstances. In 1985, Robertson succeeded in his strategy through speculation in the non-US currency call options, anticipating the end of the appreciation of the US dollar opposed to Japanese and European currencies (Connor et al., 2004). Hence, the beginning of the 1990's was the blossom period of macro hedge funds. Soros, Steinhardt and Robertson operated macro funds accounted for billions of dollars investing in numerous securities, currencies and commodities all around the world in attempt to anticipate global macro-economic directions. In 1992, Quantum hedge fund managed by George Soros made massive gains by forecasting the depreciation of the British pound and the Italian lira during the Exchange Rate Mechanism crisis and by shorting the Thai baht during the Asian Contagion currency crisis (Fung et al., 2000). Following that, hedge funds drew more interest from the media and the financial world for their big profitability and contributions to extreme market events.

The successful performance of hedge funds in the beginning of the 90's was followed by a serious drop in performance and wide losses in the late 90's due to inaccurate speculations

in the time of the Russian debt crisis of 1998. George Soros's Quantum hedge fund suffered a loss of $2 billion during this crisis (Connor et al., 2004). In the same period, Robertson's Tiger fund lost above $2 billion dollar when the dollar depreciated against the Japanese yen, his long short strategy did not perform in a market directed by a modern economy (Stefanini, 2006). Still, the biggest event that has shaken the hedge fund industry in the late 90's was the debacle of Long-Term Capital Management (LTCM) hedge fund. LTCM, managed by John Meriwether and his partners coming from the best of wall street and academia including two Nobel winners in Economics Myron Scholes and Robert Merton, was the first hedge fund with a quantitative strategy (Connor et al.,2004). In 1998, LTCM incurred $4 billion loss upon its speculation on the convergence of European interest rates (Edwards, 1999). As an aftermath of the Russian debt crisis, an abnormal increase of spreads between government and private bonds occurred which triggered huge liquidity issues for LTCM and generated a big deficiency up to 90 per cent of LTCM's absolute value (Edwards, 1999).

The outcomes of the debt crisis in Russia and the LTCM collapse hindered the expansion of hedge fund industry and more hedge funds died than were launched, the number of assets under management decreased accordingly in 1998 till 1999 (Liang, 2001). Around 4000 hedge funds were reported in 2000 with assets under managements around $400 to $600 billion (Lhabitant,2002).

The beginning of the 21st century featured an extreme rise in equity markets as a result of the dotcom bubble. During this period, Quantum hedge fund incurred losses of $3 billion upon shorting high-tech stocks and then changing the strategy to buying near term stocks (Conner et al.,2004). In spite of the debacle of LTCM and the dotcom bubble crisis, hedge fund industry prospered during the following years and the number of hedge funds increased accordingly (Fung et al., 2004). Institutional investors like pension funds, insurance firms and sovereign funds started to invest in hedge funds and the number of funds reached almost 8000 in 2007 with aggregate assets under management around $2 trillion (Lo, 2007). Yet, the expansion of hedge fund industry during this period was stalled by a global financial crisis and the collapse of Bernard Madoff Ponzi scheme in 2008. Following the Global Financial Crisis (GFC), numerous hedge funds closed and many investors redeemed their assets which led to a decrease in the value of assets managed by hedge funds significantly. Moreover, the Ponzi scheme fraud brought about several changes for hedge funds in terms of monitoring and control. In 2010, the Dodd-Frank Wall Reform and Consumer Protection was introduced adding requirements for registration and disclosure to the Security Exchange Commission in the United

States (Preqin, 2020). Additionally, hedge funds were compelled to improve their operational structure and their conformity by the Alternative Investment Fund Manager Directive (AIFMD) in Europe (Preqin,2020). Consequently, hedge fund industry became more regulated alongside competition and barriers to entry's rise.

Regardless of the adverse market events and the increased inspection in the 21st century, hedge funds industry recovered growing up each year. The hedge fund sector reached $4 trillions in 2020 mainly driven by its growing performance Figure (1.1).

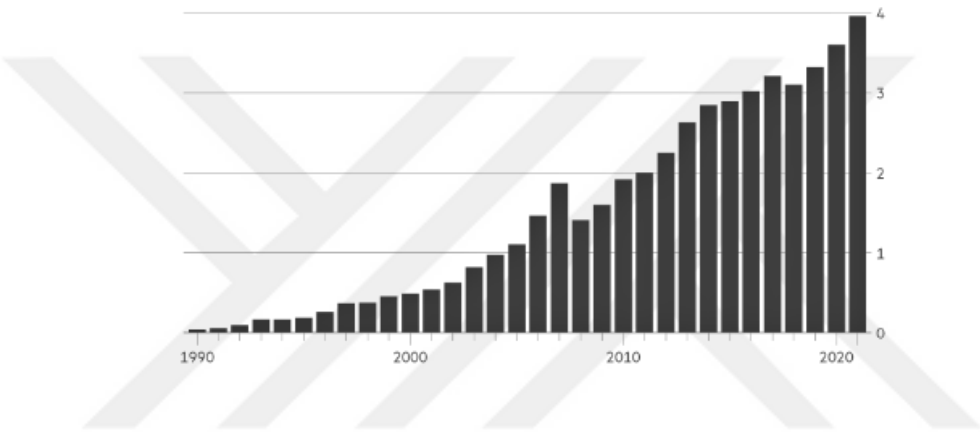


Figure 1.1: Historical Growth of Assets Under Management (AUM of hedge funds)

Source : https://www.ft.com/content/c87d52b2-d54e-4dae-9b50-98ca1e6c1d4c

Hedge funds' basics elaborated by Alfred Winslow Jones in 1949 represent the foundation of hedge funds, holding long and short positions in order to decrease the total risk. Over time, distinct strategies emerged from the basics of jones (Fung et al.,1999). Each strategy is distinct and involves dissimilar investment techniques and trading approaches with distinctive aims.

1.2. Hedge Fund Characteristics

Hedge funds are considered as a unique investment vehicle that display a number of distinct features when compared to other traditional investment tools. In this part, a thorough description of hedge funds and their characteristics will be elaborated.

1.2.1. Definition of 'Hedge Funds'

The verb 'hedge' expresses the way to decrease the overall risk in a security by holding a position that offsets an actual source of risk (Connor et al., 2004). There is no classic and broad definition of the term 'hedge fund' in current literate. The SEC defines hedge funds as "pooled investment vehicles that aim to achieve positive returns; hedge funds encompass flexible strategies that aim to take advantage in all types of markets by the use of leverage, short-selling and further speculative investment techniques that are not utilized by other funds. Hedge funds are accessible to accredited investors and they are not contingent upon regulations made to protect investors" (SEC Pub. No. 139 'Investor Bulletin Hedge Funds'; 2/13).

A common used definition of hedge funds is given by (Connor et al.,2004) who define hedge funds as an actively operated pooled investment vehicles which are closed to the general public and are only open to a restricted number of investors. Hedge funds are generally established as limited partnerships with the manager as the general partner and investors as the limited partners. Hedge funds can hold a mixture of positions in several distinct assets and their ultimate goal is to produce absolute returns in spite of the market condition.

Hedge fund management is based upon skills and experience since hedge funds aim to detect market inefficiencies to beat the market with well-designed investment strategies. (Edwards et al., 2001). Hedge funds are exempted from several restrictions and regulations, still, they are subject to constraints against frauds and managers are contracted by a legal duty to the funds they handle (SEC).

1.2.2. Characteristics of Hedge Funds

Hedge funds exhibit numerous structural and risk features that make them different from other investment funds and traditional assets. The main characteristics of hedge funds are highlighted below.

1.2.2.1 Active Management

Unlike other funds that exhibit a passive management, hedge funds are characterized by an active management where continual buying and selling occur with the intention of outperforming an underlying evolution of the market (Mallaby, 2010). While passive managers aim to match their performance to a certain index or benchmark, hedge fund managers seek additional value and strive for profit opportunities to take advantage of them (Ilmanen,2012).

1.2.2.2 Absolute Returns

The primary objective of hedge funds is to achieve absolute returns and hedge away market risk with their active management. Hedge funds are expected to provide absolute returns that differ from relative returns since they strive for positive returns in spite of any benchmark returns (Stefanini, 2006). Though, an absolute return method is not automatically applied to all hedge funds as not all hedge funds' positions can be hedged due to its large expenditure or simply because of its difficulty to be hedged (Stulz, 2007).

1.2.2.3 Low Barriers to Entry for Managers

Hedge funds represent good clients for investment banks due to the considerable brokerage fees they pay on the acquisition and sale of financial tools (Stefanini, 2006). Therefore, banks are delighted to welcome managers who want to set up a new hedge fund. Low barriers to entry for new managers are a characteristic of the hedge fund sector.

1.2.2.4 High Minimum Investments

Hedge funds are investment instruments aimed for qualified investors being able to invest huge amounts of money. Hedge funds investing restrictions qualify 'accredited investors' that have a minimum level of income or assets as being eligible to invest in the funds. Those investors include wealthy individuals, institutional investors, assurance companies, pension funds and investment professionals (Stulz, 2007). Furthermore, 'qualified purchasers' which means individuals or family-owned business that own a minimum level of investments, also can invest in hedge funds but the criterion to be a 'qualified purchaser' is more stringent than being an 'accredited investor' as the financial thresholds for an accredited investor are supposed to be lower in a significant degree than those of a qualified purchaser (Stulz, 2007). Overall, hedge funds necessitate high minimum investments and gives access to a restricted number of investors.

1.2.2.5 Limited Disclosure

In comparison to other funds, hedge funds have lighter requirements regarding reporting and disclosure. Indeed, hedge funds' disclosure of assets and investment strategies is limited and based on the number of assets in hedge funds, some managers may not be obliged to enroll or to file public reports with the Securities and Exchange Commission (SEC, 2020). Hedge funds incorporating assets more than $150 millions have to report leverage, brokers, trades, counter party disclosures and methods of evaluating illiquid assets to the SEC (Andrew

Ang,2011). Most of hedge funds should report to their clients in a regular way but it is not frequent that they disclose regularly.

1.2.2.6 Limited Capacity

There is a definite limit imposed to assets handled by hedge funds which is called capacity that a hedge fund cannot surpass otherwise it may alter its performance. Above the required limits, the added capital averts the duplication of relative value strategies and decreases returns which compel hedge funds to take additional risk in order to persist with their performance. Due to this limited capacity, assets handled by the biggest hedge funds are below those handled by the largest mutual funds (Stefanini, 2006).

1.2.2.7 Share Restrictions

There are certain constraints for investors when investing money in a hedge fund or withdrawing money from it. To invest money in a hedge fund for the first time, new investors should go through a subscription process to be eligible to invest their funds. Some hedge funds can be closed to new investors due to the limited capacity restriction and managers choose to close it to additional investors. To withdraw money from a hedge fund, there are restrictions imposed to investors. Unlike mutual funds that enable to withdraw money at a daily base, hedge funds are characterized by their long lock-up period (Andrew Ang,2011). A one-year lock-up period is required for new investments and new deposits where investors cannot pull out their funds. For overall withdrawals, hedge funds permit investors to withdraw their money on annually or quarterly bases. Withdrawals require an advance notice of 30 days or sometimes longer to one year and redemption periods are subject to a quarter or an annual advance notice (Jeager, 2008). These restrictions imposed by hedge funds are due to their important exposure against short positions and other liquidity positions (Andrew Ang, 2011). Furthermore, the restricted access to funds constitute like an option cost for investors because of the limited flexibility (Ilmanen, 2012). In extreme market circumstances like a financial crisis or an economic slowdown, managers of hedge funds enforce temporary restrictions defining the capital amount that can be pulled out in a certain period of time. These restrictions called ‘gates’ aim to prevent in case of fire-sale liquidations that cause severe losses for the other investors of the fund (Bollen et al., 2009). Gated funds may be traded in hedge funds’ second markets that offer considerable discounts at premiums in certain cases. These discounts and premiums are associated with the fund’s estimations of illiquidity and performance (Ramadorai,2012).

Finally, hedge funds that are held offshore present weaker share constraints that the ones held onshore because they are constituted of less liquid assets (Aragon et al., 2013).

1.2.2.8 Fees

Hedge funds charge their clients annually with two types of fees: management fees and performance fees. Management fee is a fixed percentage commonly 1% or 2% of assets under management and it is meant to defray the main operating expenses of a fund. Hedge funds assign a second type of fee related to performance called performance fees or incentive fees accounting around one fifth of the gains and sometimes it can be more reaching one fourth or even one third of the profit produced by the hedge fund (Stefanini, 2006). Commonly, its 20% of the hedge fund's annual net gains. Those gains are defined as the hedge fund's total earnings beyond a minimum level named the high-water mark which is the minimum return that should be attained for performance fees to be charged. The high-water mark is usually associated with an adjusting clause which gives the manager the ability to minimize it by a relative percentage in case of assets' removal by the investors (Lhabitant, 1996). Thus, the manager is rewarded if he can earn money for investors not only for the ongoing year but since the creation of the fund. Performance fees aligns the manager's interest with the performance part and motivate managers to reach the highest returns attainable. Usually, hedge funds with the highest high-water marks achieve better performance (Agarwal et al., 2009). To generate incentive fees, managers tend to increase the volatility of their assets and adopt higher risk investments (Brown et al., 2004).

Hedge funds are considered different from other investment funds since none of them charge a double layer of fees. The reason is hedge funds claim to be unique as they are able to offer alpha and beat the market and managers are eager to share their alpha with investors against a fee structure. The fee structure is required by hedge funds due to their limited capacity, hedge fund recent performance is not compensated with fees that are linear with assets under management (Goetzmann et al., 2003).

Hedge funds' remunerating system is asymmetric, managers gain in case of profits but don't share in case of losses. When facing a loss, managers tend to hold bigger risks to achieve profits again. This asymmetric system can be resolved when hedge fund managers invest their own savings in the fund and show a personal interest in the management of the fund which increase their motivation (Stefanini, 2006). By owning fund units and achieving a high performance, several hedge fund managers became billionaires (Ilmanen, 2012).

1.2.2.9 Leverage

Hedge funds often use leverage in their strategies to amplify their returns. Managers adopt several forms of leverage borrowing from brokers or banks to magnify their profits. They can leverage brokers' money by buying securities on margin to enhance their power in the market. Margin is utilized as well by trading in derivatives "contracts derived from underlying assets' prices" and they constitute a big part of hedge fund investment tools (Stefanini, 2006). Derivatives provide an asymmetric risk where the loss is considered less than the possible profit (Chen, 2011). Managers can borrow capital from banks to expand their hedge funds' and its strategies investments as they strive for returns exceeding the interest (Ang et al., 2011).

Leverage can increase returns and yet increase risks simultaneously; hedge funds can be faced with credit risk or may encounter margin calls by brokers in periods of losses (Stefanini, 2006). Furthermore, leverage boosts the expected return and the volatility of hedge fund strategies and it is more convenient to low volatility strategies that can manage to use leverage without significant effects on risk levels (Chen, 2011).

The percentage of leverage employed differs significantly among hedge funds and upon time. Margin calls are usual in times of financial distress where often managers close their funds due to big deficits coming from an extreme use of leverage (Stefanini, 2006). Still, hedge funds can adjust their leverage over time and depending on macro-economic factors leverage levels can variate. A drop in the fund's costs and volatilities as well as a rise in market prices can predict an increase of the leverage level of hedge funds, hedge fund leverage was at its minimum following the financial crisis (Ang et al., 2011). Moreover, hedge fund managers can adjust their funds' leverage level depending on the conditions of market liquidity (Cao et al., 2013).

Owing to their limited disclosure, the leverage ratio utilized by hedge funds is not officially revealed. Still, the hedge fund industry is appraised to carry on a leverage ratio beyond 3:1, as opposed to banks, hedge funds' leverage percentage is rather moderate (Ang et al., 2011). Unlike other investment vehicles, hedge funds are able to use different forms of leverage to induce an acceleration of profits despite of an increasing market risk. Without leverage, hedge fund managers won't be able to attract investors (Ang et al., 2011).

1.2.2.10 Legal structure

Hedge funds are renowned for their unregulated structure. Still, they are not completely unregulated, their structure allows them to benefit from some exemptions in regulation. Hedge funds are designed for wealthy, knowledgeable and private investors and not for the general population, thereby, some regulations are not relevant to hedge funds (Fung et al. 1999). Hedge funds' legal structure is inherent to its characteristics: flexible, uncertain with an incentive-based remuneration. These are the basic attributes of hedge fund strategies, though, they do not comply with a strong regulated system. Hedge funds are commonly formed as limited liability entities or limited partnerships to avoid tax payment. Taxes are not applicable on investment returns of the fund itself but taxed are applied when returns are delivered to single investors through their individual tax bills. If a hedge fund was formed as a corporation, taxes will be doubled (Connor et al, 2004). In the United States, the SEC exempt hedge funds from certain rules. Hedge funds can be exempted from the Securities Act of 1933 about registration and disclosure conditions. To be granted the dispensation, a hedge fund should consent to private placement which restrains a hedge fund from advertisement and public appeal and fixes the offer to 35 investors who do not comply with the minimum wealth restrictions ($1 million net worth and $200.000 annual income (Connor et al., 2004). This exemption is fundamental for hedge funds to avoid the divulgation of proprietary trading strategies and decrease disclosure' expenses and labor.

Furthermore, hedge funds can obtain exemption from The Investment Company Act (ICA) of 1940. This act was made originally for mutual funds and it incorporates registration conditions as well as restrictions on the practice of investment techniques, namely, leverage and diversification (Lhabitant, 2002). When first issued, funds with investors less than 100 were not subject to this regulation then the rule was modified in 1996 increasing the number of the contributing investors. According to the ICA of 1940, a "qualified purchaser "could be an individual with a minimum of $5 million assets or an institutional investor with a minimum of $25 million assets (Connor et al. ,2004). To be exempted from this regulation, hedge fund managers must enroll as investment advisers and the hedge fund can charge performance fees if the fund is restricted to high net worth people only. Hedge fund managers choose to register such as investment advisers to reassure investors and to be able to employ diverse investment techniques without constraint (Lhabitant, 2002).

In 2004, The Securities and Exchange Commission added a new requirement for hedge funds with a minimum of 15 investors and assets under management of $30 million. These hedge funds should abide by the rule and register. Consequently, they should report periodically their organizational structure and they will undergo conformity examinations of the SEC (Preqin,2020).

Hedge funds are secret investment instruments compared to other traditional tools, hedge fund managers hold their positions secretively without communication to not reveal their investment intentions. They avoid disclosing their trading models and systematic approach to other rivals and competitors. On the other hand, investors must grant privacy and flexibility to managers and trust their investment choices, asset allocation and risk management.

There is an important conflict of interest between a hedge fund's goal and a regulator's requirements. Hedge funds necessitate privacy, resilience and profits while regulators require full disclosure and a conservative management. Extracting hedge funds from the controlled investment vehicles and denying access to them for the general public appease this conflict of interest (Connor et al., 2004).

The US is the core place of hedge fund activities, still, the majority of hedge funds have a foreign domiciliation. Indeed, these off-shore hedge funds are founded in tax-shelter countries like the British Virgin Islands, Luxembourg, Cayman Islands, Ireland to reduce taxes for foreign investors. Usually, US hedge funds establish an offshore side by side fund to draw additional investors without surpassing the SEC restrictions (Brown et al., 1999). In the other countries, the conditions for hedge funds are broad ranging. In the United Kingdom, hedge funds are regulated by the Financial Services and Markets Act (FSMA) and the Public Offers of Securities Regulations (POS Regulations). The FSMA put restrictions on the publicity of hedge funds and the POS regulate their structure. In Switzerland, Hedge funds are barely regulated and they are open to advertising, the Federal Banking Commission approves their creation. In Luxembourg and Ireland, hedge funds are also permitted to list on the stock exchange. However, in other countries like France, the creation of hedge funds is prohibited and French jurisdiction ban offshore investments (Conner et. Al, 2004).

1.3. Hedge Fund Industry

1.3.1. General Outlook of the Industry

The alternative investment universe provides a wide array of distinct investable securities and products. Alternative investments cover different alternative asset classes and hedge funds represent an important component of the alternative investment universe. Hedge funds constitute one percent of the alternative investment industry according to the European Securities and Market Authority (ESMA). (Figure1.2) presents the percentage of alternative investment funds industry by type of funds.

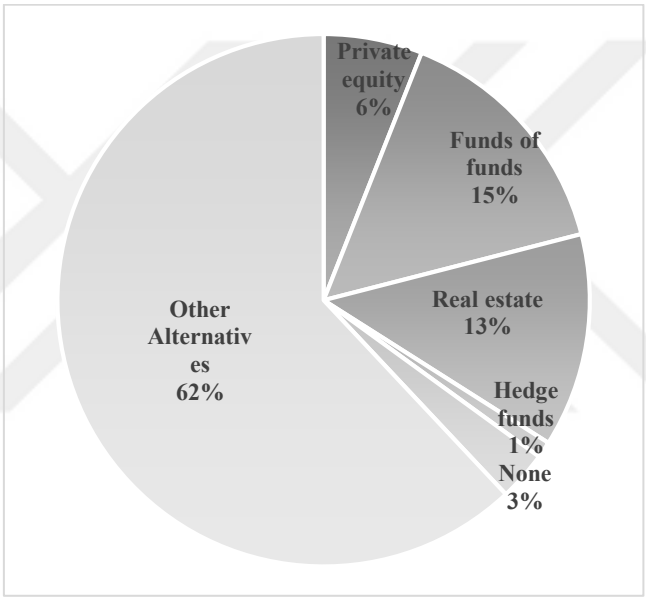


Figure 1.2: Alternative Investment Funds Industry by Type

Source: (*ESMA, Annual Statistical Report, 2022*)

The hedge fund sector was initiated by the private banking and family office business in 1970's when relative return outcomes were insufficient for investors which started to strive for absolute returns by hedging a portfolio asset with an index (Seco, 2005). The hedge fund sector aims to take advantage from market inefficiencies and mispriced securities to attain potential benefits with a minimized risk. It is an unregulated organizational structure restricted for public offering characterized by flexible investment strategies and appealing managerial fees geared towards experienced investors. Managers can have recourse to several techniques like switching between positions, employing leverage and arbitrage, buying or selling

mispriced assets and trading a wide range of instruments such as options, bonds and over the counter products (OTC) (Seco, 2005).

The hedge fund sector has been growing each year since its creation to become a $4trillion industry by 2020. Many reasons led to the expansion of this industry: unregulated companies started to operate the business that once was limited to banks, the foundation of brand-new capital markets (energy, leasing, insurance...etc.) and the possibility to achieve a positive return in both bull and bear markets. Therefore, hedge funds represent a long-term investment resolution. Furthermore, by including hedge funds to a portfolio of traditional assets, investors started to improve their risk-reward trade-off and create diversification opportunities (Asness et al., 2001).

Hedge fund industry did not grow only by increasing the number of funds and assets, an expansion of investors profiles occurred throughout the years. Insurance firms, private sector pension funds, banks and family offices started to invest in hedge funds to reduce portfolios' risk and amplify returns. (Figure 1.3) exhibits hedge fund investors profiles. Private funds, pension funds and non-profit organizations are the biggest investors in the hedge fund sector (as of 2021).

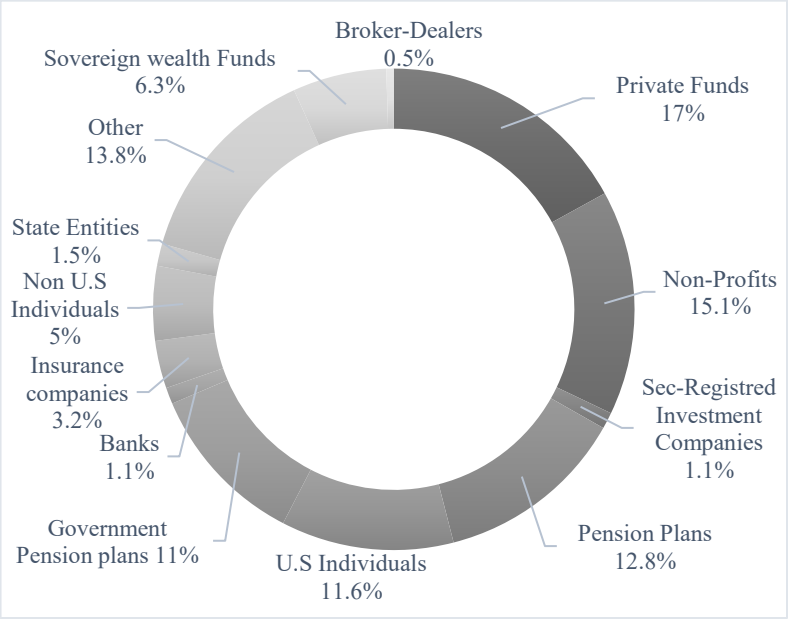
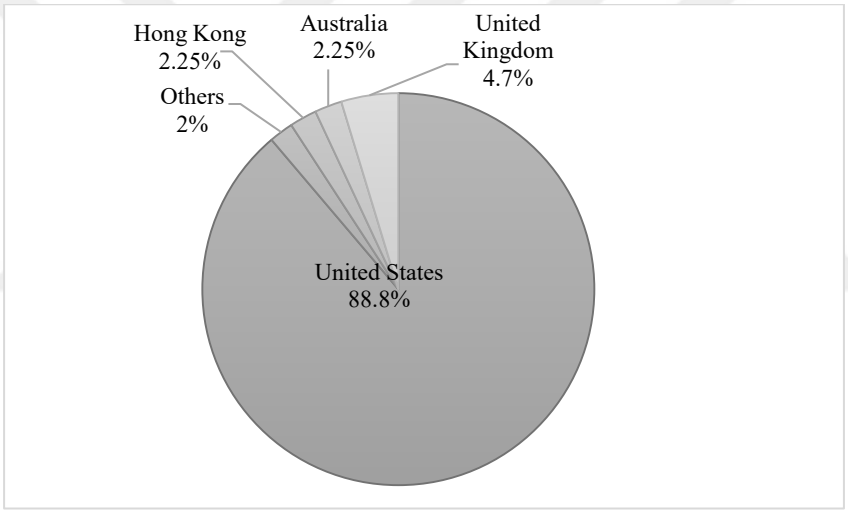


Figure 1.3: Hedge Fund Investors Profiles

Source: (SEC, Private Funds Statistics, 2021)

The majority of hedge funds are created such as limited partnerships with investors less than 500 and they are particularly controlled by the US industry. Hedge funds can be domiciled in off-shore institutions that are less subject to any regulatory oversight and be managed from their operation countries. As Panel A of (Figure 1.4) demonstrates that the majority of hedge funds are operating in USA and UK, reaching almost 94% of the hedge fund industry. On the other side, Panel B of (Figure 1.4) shows that the majority of hedge funds are domiciled in Cayman Islands with 53.4% of the industry while 34.1% of hedge funds have been domiciled in USA. The lack of regulation enables hedge funds to be flexible and use a wide range of different strategies like investing in the forecast of special events or distressed securities or using arbitrage strategies or strategies anticipating the macro-economic circumstances.

Panel A: Country of Operation



Panel B: Country of Domicile

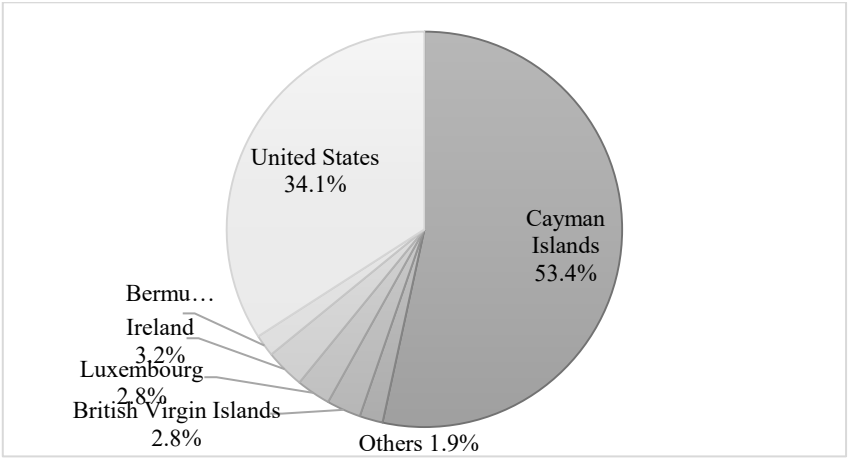


Figure 1.4: Hedge Funds by Country of Operation and Country of Domicile
Source: (SEC, Private Funds Statistics, 2021)

1.3.2. Hedge Fund Products

Investing in hedge funds is usually performed through distinct products namely: Hedge fund indices, hedge fund structured products and fund of hedge funds (Seco,2015).

1.3.2.1 Hedge Fund Indices

Hedge fund indices expanded rapidly after the burst in hedge fund allocations in the 2000's. There are two dissimilar types of indices: Industrial and Investable indices.

Industrial indices are weighted upon hedge fund returns and are employed to follow the performance of hedge fund industry. They are issued along sub-indices related to investment strategies and are generally helpful to study the development of hedge fund industry.

Investable indices were launched by companies promoting industrial indices and in opposition to industrial indices that are closed to new investors, investable indices may be opened to investments. Investable indices exhibit certain characteristics that belong more to equities than to hedge funds like liquidity, unlimited capacity for new investors or investment transparency (Seco, 2015).

1.3.2.2 Structured Products

Structured investment products penetrated the hedge fund sector and are used as an appropriate way to make secured investments in hedge funds. They are used to comply with some rules, to enhance returns, to protect the initial investment or to transfer risks to other parties (Seco,2015) among them:

- *Constant Proportion Portfolio Insurance* (CPPI) that aim to protect the initial capital and give access to the upside of hedge funds' return.
- *Leveraged investments* which magnify hedge funds' return through borrowing.
- *Collateralized Fund Obligations (CFO)* which convert the loan from a leverage structure into securities then sell it to bond investors.

1.3.2.3 Fund of Funds

Funds-of-funds are pooled investment funds where management companies invest in a portfolio of hedge funds instead of investing in single assets. The portfolio can include other underlying distinct funds like mutual funds. Funds of funds typically charge a double layer of

fees: the management and performance fees of the funds of funds in addition to the fees of the incorporated hedge funds (SEC).

1.3.3. Hedge Fund Structures

Hedge funds are structured in different sorts based on certain characteristics such as the fund's domicile country, the investors' location and the investment standard of the fund. There are typically three types of structures (Preqin,2020):

- *Master-feeder structure* is employed when hedge funds pool capital to one master fund from US and non-Us investors. The master fund company is generally located offshore in a tax neutral country and this company is in charge of investments' decision-making and the management of trading activity.

- *Side-by-side* is another structure where investors invest in domestic hedge funds and allocate trades parallelly to an offshore hedge fund that adopts a similar strategy. Managers of this structure seek to reach the same performance for both funds.

- *Standalone fund structure* is common for offshore managers without US attendance who invest without having access to a master feeder or investing in a parallel fund.

1.4. Hedge Funds vs Mutual Funds

Hedge funds and Mutual funds are both pools of investment capital that aim to outperform capital markets (Stowell, 2010a). Both funds hold money from a wide range of investors and aggregate it into one single fund. These funds are run by managers who invest in the name of their investors. Hedge funds and mutual funds adopt several investment strategies and are made of a large number of investment securities like stocks, bonds, money market instruments and comparable assets. Yet, in spite of these similitudes, hedge funds and mutual funds work in distinct regulatory and legal structures and exhibit numerous differences. Table 1.1 below will list and explain these differences.

Table 1.1: Hedge Funds and Mutual Funds differences

	Hedge Funds	Mutual Funds
Placement conditions	Free	Limited
Return target	Absolute	Relative
Number of owners	Few	Many
Type of investors	Pensions and endowment funds, wealthy individuals	Retail investors
Liquidity	Limited	High
Transparency	Disclosure for investors only	Reports disclosed annually
Fees	Performance and fixed based	Fixed

1.4.1. Fund Structure

Mutual funds are usually set up as corporations and are offered by numerous sponsors such as insurance firms, banks, brokerage houses and mutual fund complexes within the government rules and deploy various investment strategies (Chordia, 1996). Mutual funds are generally operated by independent directors which work as advisers and manage the fund's assets against fees. On the other hand, hedge funds are set up as limited partnerships between managers and investors and have more latitude to adopt high-risk investments (Stefanini,2006). Therefore, hedge funds display a tiered partnership structure with limited placement rules while placement rules for mutual funds are free.

1.4.2. Return Target

Mutual funds managers estimate any deviation or tracking error from a benchmark as risk, mutual funds' risk-reward tradeoff is evaluated in relation to the benchmark and not in an absolute way. Thus, mutual funds seek to secure a relative performance. Whereas, hedge funds aim to achieve absolute returns regardless of any condition even in falling market circumstances. Hedge funds do not relate to a benchmark but have instead distinct investment strategies. Moreover, hedge funds' future returns are slightly correlated with the direction of the markets while mutual funds' future returns rely on the direction of the financial markets (Stefanini,2006).

1.4.3. Liquidity

Mutual funds provide high amounts of liquidity and enable its investors to buy and sell on a daily basis. In contrast, hedge funds offer limited liquidity, they are characterized by lock up periods which limit investors to sell particular stocks or securities and withdraw their

investments (Liang, 1999). Hedge fund investors can withdraw their investments only quarterly and sometimes for an expanded period of time; lock-up periods are applied to conserve liquidity and preserve the stability of markets. Furthermore, it facilitates risk taking for hedge fund managers as they are aware of the time money will be possibly withdrawn from the hedge fund (Liang,1999).

1.4.4. Type of Investors

Mutual funds are open to all investors, they are accessible for buying and selling to the general public; nearly any investor can have access to mutual funds and invest in publicly traded securities (Ackermann,1999). Mutual funds usually do not utilize high-risk investment strategies; therefore, retail investors comprise a large portion of the mutual fund investor base. Moreover, mutual funds generally require a low minimum investment threshold (SEC, 2016). Mutual fund investors can buy them without any mediator distribution channel; they have the choice to invest in four distinct sorts of mutual funds: open-end, closed-end, unit investment trust and exchange traded funds (SEC,2016). Open-end funds are the most prominent type in the mutual fund industry and enclose most of the funds accessible to the general public. Closed-end funds provide shares to public by initial public offering only (Peavy,1990). Exchange traded funds are sold on an exchange during the day and investors prices that are near the net asset values (Hughen et al, 2009).

As for hedge funds, they are private investment businesses that deal with experienced investors with great assets net worth (Ackermann,1999). Hedge funds are particularly open for people with large income and savings amounts named Accredited Investors, or big institutions with a notable investment experience like: Pensions, Endowments, Insurance firms and foundations (Fung et al., 1999). Investors have an option to invest in four hedge fund alternative investments: Direct investing in a certain hedge fund, adjusting a portfolio from a number of hedge funds, investing in a hedge fund index and finally to invest in a fund of funds which can enclose mutual funds (Nicholas, 2004). Besides, hedge funds adopt much more riskier investment strategies than mutual funds and the minimum investments are generally very high, typically $1 million or more (Sec, Rule 501 of Regulation D).

1.4.5. Fee Structure

There is an important dissimilarity between hedge funds and mutual funds' fee structures. The fee structure of mutual funds depends mainly on the asset size of funds (Agarwal et al., 2000a); mutual funds charge generally a management fee which is a percentage of the

money handled by the fund, it is usually between 0.5% and 1% (Liang,1999). Management fees cover funds expenses like distribution fess, securities transaction fees, shareholder transaction charges and other expenses, it also includes the profit made by mutual fund managers. Conversely, hedge funds have a double layer fee structure with a bonus incentive (Ackermann et al.,1999). Hedge funds charge a fee based on performance where the potential payout that will be received by managers is superior to the fixed management fees (Fung et al.,1999). Performance fees are usually around 20% of the hedge fund profit, also called carried interest, throughout any year and they represent an incentive for managers to improve their performance; some of the largest hedge funds assign up to %30 or more. The second assigned fees are the management fees and they represent a percentage of the hedge fund asset value, management fees for hedge funds can differ from large to small funds and can range between %1 to %5 of the hedge fund net asset value (Stefanini, 2006). Management fees charged by hedge funds are significantly higher than those charged by mutual funds and they are supposed to cover the operating costs of managers. In the hedge fund industry, the standard structure of fees are generally 2% management fees and %20 performance fees, also named the 2-20 structure. Nevertheless, hedge funds employ high-water marks which is an instrument that keep managers from taking performance fees in the ongoing period when hedge funds achieve a bad performance over the previous periods, this mechanism protects investors from paying performance fees on the same profits more than one time and it motivates managers at the same time to make higher returns in order to diminish any accumulated loss (Stowell,2010a).

1.4.6. Strategies

Mutual funds' investments are restricted to publicly traded securities such as stocks and bonds. In contrast, hedge funds are allowed to invest in practically everything from stocks and derivatives, real estate, lands, public securities, life insurance to cryptocurrency. In bear markets, mutual funds are not able to protect portfolios while hedge funds can assure protection by adopting distinct hedging strategies and generating positive returns (Stefanini,2006). With their aggressive strategies, hedge funds seek profits despite the direction of the market whether it is going up or down. Furthermore, hedge funds have the ability to use a wide array of trading styles such as short selling, using leverage and using derivative securities (Stowell, 2010a). Short selling creates a lot of investment opportunities for hedge fund managers, the relative performance of stocks is more significant than the general market performance (Stefanini,2006). On the other hand, mutual funds are restricted to less flexibility in investments as they are not able to utilize short selling and other speculative techniques. Moreover, they

cannot make use of high leverage which limits their possible returns (Stefanini,2006). hedge fund managers hold short positions in order to decrease their investment portfolios' volatility with an intention to gain on both long and short investments. While mutual funds, by the use of a long only strategy approach, are sensitive to the fluctuations of the market. Hedge funds encounter less variation with their long and short approach. With their active management, hedge funds are operated to beat the market and their principal objective is to generate superior returns in spite of their investments' risk level (Stowell, 2010a).

1.4.7. Regulation

Mutual funds are highly regulated by regulatory authorities in comparison to hedge funds. They have to abide by certain regulations and they are controlled by the SEC in the US and by the European Commission in Europe; mutual funds are bound by restrictions limiting the instruments allowed and regulating the construction of their portfolio. These regulations aim to protect fund investors and reduce the flexibility of management in terms of business procedures, capital adequacy and structural organization (Stefanini,2006). Mutual funds are subject to two regulatory directives imposed by the SEC: The Securities Act of 1933 and the Investment Company Act of 1940. The SA of 1933 compels a documented outline for investors' transparency and education (SEC). The ICA of 1940 constrains mutual funds to disclose their performance track records on a current basis and inflicts penalties for nondisclosures or misrepresentations (SEC). Moreover, it enforces rules for the trading of mutual funds' shares to be at a fixed price depending on the fund's asset value (SEC). In addition to the SEC, mutual funds are monitored by the National Association of Security Dealers. These rules are aimed to provide guarantee to investors and make them trust the performances of mutual funds.

In opposition to mutual funds, hedge funds have the advantage to a very lacking trading regulation. Compared to mutual funds, there are no requirements for hedge fund managers and hedge funds are not subject to the ICA OF 1940 due to the secretive nature of their strategies and their distinct objectives. Their most important asset is their strategies; hence, hedge fund managers refrain to disclose their portfolios' positions and their secret trading styles. Hedge funds benefit from the lack of a strict regulatory system, which gives the hedge fund manager great latitude to raise a fund distinguished by unique traits in terms of the financial instruments used, the management style, the organizational structure and the legal form (Liang,1999).

2. HEDGE FUND STRATEGIES AND PERFORMANCE

In this section, the distinct hedge fund strategies and their investing styles will be described, because a proper understanding of hedge fund strategies' characteristics is necessary since the later analysis will study hedge funds' performance depending on the strategy followed. Moreover, a comprehension of the distinct hedge fund classes and their associated risks provide a perspective about the generation of returns and the risk-taking of the various hedge fund strategies. This knowledge is essential to justify the results of the analysis and to compare the assumptions with the actual findings. Therefore, hedge fund strategies, risks in hedge fund strategies investments, managerial skill in hedge funds, hedge fund strategies' historical performance will be introduced below as sub-sections.

2.1 Hedge Fund Strategies

The main features of hedge funds are their strategies. An investment strategy describes how the manager uses investment approaches and how asset classes are utilized to generate the desired returns. Strategies are essential for the expansion of funds and thereby they are crucial for investors (Connor et al.,2004). An investment strategy derives from managers' skills and creativity, there is no definite categorization of hedge fund strategies due to the mobile nature of the hedge fund universe. Hence, hedge fund strategies are always prone to continual development and change (Stefanini,2006). Various classifications are utilized in theory and distinct opinions about how to classify hedge fund strategies exist (Jeager, 2008). The selected classification for this study is the classification described by Stefanini (2006) and the different databases utilized for this analysis. Eurekahedge, Center for International Securities and Derivatives Markets (CISDM) and Credit Suisse are among the most prominent data suppliers of hedge funds and the ten hedge fund strategies introduced below correspond to their categorizations. The presented hedge fund strategies are divided into categories depending on their level of risk and their correlation with the market as presented in Figure 2.1).

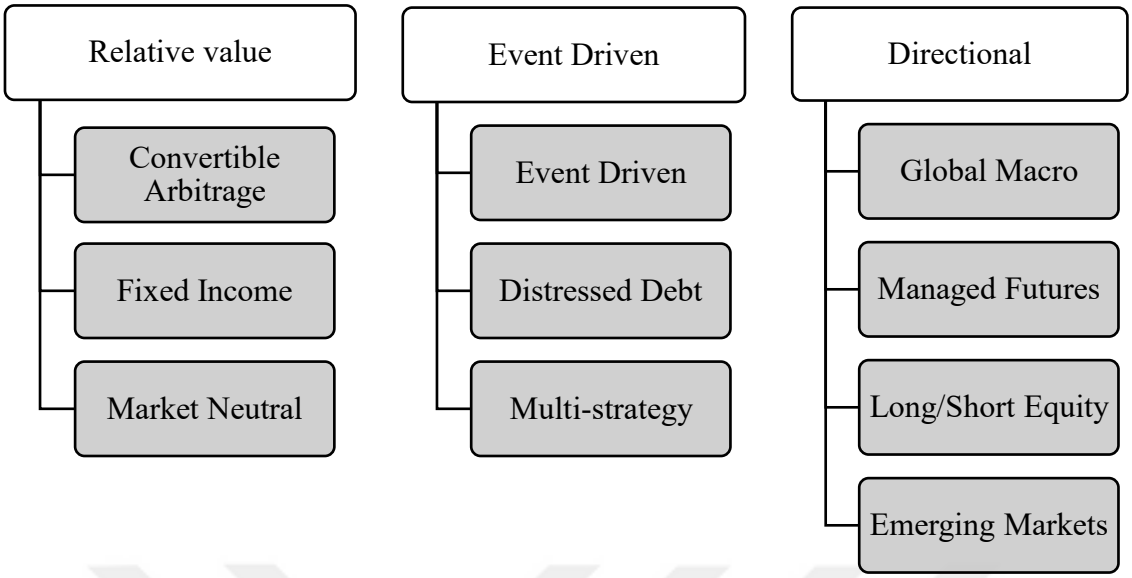


Figure 2. 1: Classification of Hedge Fund Strategies

Source: (Stefanini, 2006).

Three main hedge funds strategies can be identified, namely *Relative Value*, *Event Driven* and *Directional*; which can be classified further into 10 sub-strategies. These ten strategies are the most commonly employed in the hedge fund universe; The definition of each strategy will be given below based on hedge funds databases descriptions and on Stefanini' (2006).

2.1.1 Relative Value Strategies

Relative value strategies are arbitrage based strategies aiming to take advantage from price inefficiencies by the purchase of underpriced securities and short selling overprices securities (Stefanini,2006). Relative value strategies are seeking to profit from the spreads between securities (Eurekahedge,2020), these strategies intent to decrease market exposure in the inherent market and to focalize on market inefficiencies rather than taking advantage from market directions (Stefanini,2006). Relative value strategies include: Convertible Arbitrage, Fixed Income and Market Neutral strategies.

2.1.1.1 Convertible Arbitrage

Convertible arbitrage strategy is a relative value strategy whose returns are uncorrelated with capital markets but rather focuses on the profit generated from directional spreads. Managers adopting this strategy purchase and sell securities of a same issuer, they

usually hold long positions in convertibles and take short positions in the underlying common stock of the issuer (Credit Suisse,2020). Convertible securities encompass convertible bonds, warrants and convertible preferred stocks. Returns are created through the spread between long and short positions rather than from market movements. Convertible arbitrage funds exhibit a weak tandem movement with the market, still, market fluctuations affect this strategy and credit risk is involved in case of credit spreads widening. Interest rate exposure can also have an impact on this market uncorrelated strategy (Stefanini,2006). In a bearish market, the price of the convertible decreases slowly than the underlying stock. Whereas in a bullish market, the price of the convertible nearly matches the price of the underlying stock.

The objective of convertible arbitrage fund managers is to spot convertibles having a significant market price differentiation in comparison to the theoretical value and then perform transactions to capture that value while being hedged against market risks. Arbitrage possibilities are detected by the use of valuation models that identify investable convertible securities (Eurekahedge,2020).

Managers are looking for convertibles presenting the following features (Stefanini,2006):

- Increased volatility of the underlying stock
- Adequate liquidity of the convertible issue and quickly borrowable underlying stock
- Decreased conversion premium which implies less sensitivity to interest rate and credit risk.
- None or low dividend payments to prevent dividend payouts to shareholders from whom the stocks were borrowed.

Furthermore, managers evaluate the risk/return profiles of their positions and examine the issuer's market capitalization and reliability to ensure an adequate liquidity to their portfolios. They also keep track of their portfolios' sensitivity to interest rate fluctuations and their response to stock price changes. Managers following a convertible arbitrage strategy tend to diversify their portfolio and make use of leverage to amplify their returns (Stefanini,2006).

With the increase of the number of traders nowadays, a strong competition appeared among managers adopting the Convertible Arbitrage strategy. Nevertheless, the emergence of new financial instruments, like mandatory convertibles, represent an opportunity for these

managers to delve into new aspects of capital markets and to study new complicated structures in order to benefit from competitive advantages.

2.1.1.2 Fixed Income

Fixed Income is another relative value strategy that attempt to generate profits from inefficiencies and mispricing of fixed income assets and their derivatives in the general market. Hedge fund managers employing this strategy create their return by trading yield curves, besides, they can make investments in treasury curve related value, mortgage-backed securities, long/short credit, currency/yield and structured finance. They generally hold long and short positions (offsetting) to benefit from momentary misprices between related fixed income securities while making use of leverage. They build their portfolios in a way to nullify correlation with interest rate fluctuations and to diminish the portfolio's duration. Thus, Fixed Income strategy aims to take advantage from potential opportunities stemming from temporary mismatches while being protected against interest rate risk; after the creation of offsetting positions, the sensibility to interest rate change risk is neutralized (Credit Suisse,2020).

Fixed Income fund managers rely on mathematical models that are able to identify mispricing and handle positions. Managers take positions on assets whose prices are correlated historically or mathematically and assets that encounter mispricing due to external circumstances. Assets traded by these managers can be corporate bonds, treasuries, agency securities or municipal bonds (Stefanini,2006).

2.1.1.3 Market Neutral

Market Neutral strategy pursue a zero-net exposure to the market using a market neutral portfolio which performance is not related to market direction by holding long and short positions (offsetting) of equal amounts. Returns are generated through the associated mispricing of the traded securities. There are essentially two kind of style management for this hedge fund strategy. The first type of managers tries to benefit from investment possibilities specific to a group of stock while preserving a diversified exposure over a large variety of stocks defined by region, industry or sector. The second type of managers hold equity long and short positions and make use of derivatives, indices or options to hedge against market risk (Credit Suisse, 2020).

In bull markets, market neutral funds generate absolute returns when long positions rise more quickly than the fall in value sustained by short positions in a portfolio. Conversely,

in bear markets, they produce absolute returns when short positions climb faster than the drop-in value suffered by long positions. There is no guarantee that the Market Neutral strategy will work as expected, as it depends on the methods and the assets. Market neutral funds should be uncorrelated during rising and falling market conditions, however, during distress periods, correlation rely on managers' skills since some of Market Neutral fund managers offer a high diversification compared to their competitors during periods of market volatility. Indeed, a real Market Neutral portfolio should be diversified to maintain the different market exposures (Stefanini,2006).

2.1.2 Event Driven Strategies

Event driven strategies look for opportunities emerging throughout a company's life cycle caused by extraordinary corporate circumstances, like mergers, business combinations, acquisition, liquidation and restructuring. This group of strategies are defined by catalytic events which are circumstances that push the price towards a different value. Based on the chances present on the market, Event Driven fund managers actively allocate their capital over the distinct sub-strategies (CISDM,2020). The performance of this strategies doesn't rely on market movement. Nevertheless, weakened equity markets bring about failures that affect the strategy's performance. Among these strategies, there are Event Driven, Distressed Debt and Multi-strategy.

2.1.2.1 Event Driven

Event Driven strategy, also named special situations strategy, trades in various asset classes with the intention to make profits from potential mispriced securities associated with special corporate or market conditions that can cause large price fluctuations such as mergers, liquidations, bankruptcies, restructuring, spin-offs, acquisitions, recapitalizations, business consolidations, hostile takeover-bids, legal disputes, bond upgrades, sale or purchase of assets, stock buy-backs, discrepancies in the value of share classes, investments in real assets and also changes in benchmark or index composition (Eurekahedge,2020).

Event Driven strategy is an extremely speculative strategy which is based on managers' insight whom might feel that the market does not assess the current condition in a correct way. Event Driven strategy is not bounded to a certain investment style or class of assets, managers can utilize instruments such as long and short common and preferred stocks, options, bonds and credit default swaps. In addition to that, they can have recourse to excessive

amounts of leverage to magnify their returns. Managers try to anticipate the result of a certain deal or event and evaluate the best moment to allocate their capital, the uncertainty associated with the final aftermaths generate investment possibilities for managers who accurately predicted the results and the timing of these special situations beforehand (Stefanini, 2006).

2.1.2.2 Distressed Debt

Distressed Debt strategy is associated to distressed securities such as bonds, shares, financial loans or trade receivables of companies facing; emerging; or on the verge of financial distress (Credit Suisse, 2020). Distressed securities involve securities publicly traded at a high discount to their issue prices; and in case of the non-default of the issuer, these securities provide an important yield up to 10% over similar maturity US Treasury Bonds. Furthermore, distressed securities can incorporate bank loans and privately placed debt of entities with drastic operating and financial issue as stated in Chapter 7 or 11 of the US Bankruptcy Code (Stefanini, 2006). The important factor reflecting the performance of this strategy is the presence of distressed paper, which relies on the evolution of credit spreads and on the economic cycle.

Distressed Debt fund managers purchase those securities at a low price and generate gains if their anticipation of reorganization happen to be correct. Managers adopting this strategy investigate the industry and the issuer to see if there is any recent event or news that may impact the issuer or its debt security, they are always on the search for firms with possibilities of survival and whose securities have been extremely sanctioned by the market. Following that, they choose to invest in distressed securities or debt securities judged as Distressed Debt; they can also invest in orphan equity to offer companies emerging from bankruptcy with equity. Short selling is not operated on Distressed debt securities unlike other securities, the only technique to minimize the risk of these securities is diversification. Thus, managers invest in various regions, sectors and issuers to prevent the impacts of a big default (Stefanini, 2020).

2.1.2.3 Multi-strategy

Multi-strategy includes often more than a single strategy especially from the event driven strategies' family. Managers choose to allocate their capital among a number of hedge fund strategies in order to profit from the potential opportunities. They decide which portion of the capital to be distributed to the distinct strategies based on the opportunities provided by the markets. That way, managers can aim to seize diverse opportunities rather than to invest in a

certain strategy that may be unfavorable under particular market conditions (Credit Suisse, 2020).

Multi-strategy hedge funds managers are divided into groups, each trading group is specialized in an individual investment strategy. The hedge fund chief officer determines the capital allocation between the different groups and adjust his allocation continuously based on his predictions about the opportunities each individual strategy may arise in the future. Multi-strategy is categorized as an Event Driven strategy since it lacks of investment directionality; in spite of market direction for interest rates, equity markets or currencies, the strategy aim to preserve absolute returns by diversifying the capital. Hence, risk exposure is diminished and returns are smoothed for investors (Stefanini, 2006).

2.1.3 Directional Strategies

Directional strategies aim to seek advantage from major market trends in place of drawing their attention to analysis on single stocks (Hübner et al.,2011). Directional strategies are not overcrowded like other categories of strategies which are characterized by many traders who intend to take advantage from the same opportunities. In fact, markets are guided by macro-economic factors that have more strong impacts than other factors. If trends appear on markets, directional strategies fund managers are well experienced to seize them. Managed Futures, Global Macro, Long/Short Equity and Emerging Markets strategies are considered a part of this category (Stefanini, 2006).

2.1.3.1 Global Macro

Global Macro strategy has the widest investment mandate amid the distinct hedge fund strategies. Global Macro fund managers can invest in nearly any market employing any financial tool. Managers use a top-down technique to set up their portfolios and aim to create gains from the variations of asset classes and markets (Stefanini,2006). Global Macro fund managers attempt to predict price valuations on capital markets and set up directional portfolio positions (Credit Suisse,2020). To detect events that will engender price changes, they scrutinize global macro-economic, political, economic, financial and other external factors that affect the movement of financial instruments. In addition to that, they study capital markets and the risk-return prospects of investments. Managers monitor interest rates, inflation rates, government policies, currency and commodity prices to forecast eventual trends on those markets. Following that, speculations are done and positions are held on the expected changes

of these markets. Rather than hedging market risks, managers aim to profit from financial market directions following their perceptions and predictions about market direction. Global Macro strategies depend on managers' skills and experience as their performance relies on the timing and the quality of their managers' forecasts. Thus, managers should be well informed about almost all global security markets. Global Macro funds invest in well developed countries and emerging countries as well, they tend to go from one asset to another or one investing chance to another. Managers following the strategy utilize a large amount of leverage and derivatives and they operate in complicated and very volatile conditions (Stefanini,2006).

2.1.3.2 Managed Futures

Managed Futures is a directional strategy investing essentially in futures listed all over the world managed by professional hedge fund managers directly or through a Commodity Trading Advisor (CTA). A CTA can be an individual or a company that gives advises on opportunities to purchase or sell futures or options contracts against a profit or a remuneration (Stefanini,2006). Managers adopting Managed Futures strategies make their investments on a wide array of listed derivatives such as equity indices, bond indices, treasuries, currencies, commodities, interest rates, base and precious metals, energy and raw materials worldwide. It is achieved by the use of complex computerized models which takes long and short positions in future contracts automatically. Fund managers can readjust periodically the parameters of their trading models (Credit Suisse,2020). CTAs establish various models that are further processed by computers to detect a trend in various future markets and on distinct timespans. A performing trading model should decrease volatility and diminish slippage which restrain the profitability of Managed Futures strategies (Stefanini,2006). Managed Futures strategy can hold a limited or a diversified position on future markets (Credit Suisse,2006). Depending on the trading models, there are three different strategies in the Managed Futures universe (Seco, 2005):

- *Trend followers*: where trading transactions begin in the trend direction and close when it reverses, they display high returns associated with a high volatility and trend reversals can be very harmful to them.
- *Counter trend managers*: they hold positions counter to trends and attempt to predict reversals, they exhibit less volatility than trend followers and they achieve returns in various markets characterized by daily volatility and short trends.
- *Fundamental managers*: they have a similar approach to global macro hedge funds as

they are guided by their economic knowledge and opinions.

Managed Futures strategy is adopted on many markets to increase the number of investment possibilities and to reduce portfolios' risk by diversification in distinct sorts of asset classes and investments. Portfolio including Managed Futures decrease their risk because of their negative correlation with other traditional assets (Eurekahedge,2020).

2.1.3.3 Long/Short Equity

Long/Short Equity strategy is based on the hedging concept created by Albert Winslow Jones, the owner of the first hedge fund in history and his Long/Short strategy is still commonly used among hedge fund strategies. Long/Short Equity strategy is when a fund manager holds a long position on a stock he perceives as being underpriced by the market and short sells a stock he feels as being overpriced (Credit Suisse, 2020). Thereby, the manager can speculate in price falls and reduce market exposure caused by long positions. L/S Equity fund managers construct equity portfolios based on their stock selection skills instead of these portfolios' correlation with market performance. It is the most used hedge fund strategy with the highest volume (Eurekahedge, 2020). Indeed, hedge fund managers can invest in equity and equity derivatives across regions and industries.

Managers can choose to take a positive market exposure (long) investing in stocks to profit from a generalized bull market conditions or hold short positions in bearish markets to take advantage from decreasing prices. Hence, Long/Short Equity strategy is considered amid directional strategies. The performance of this strategy exhibits a positive correlation to the performance of the reference equity markets and in bearish markets funds following this strategy tend to present a negative correlation (Stefanini,2006).

Hedge fund managers can adopt distinct management styles. There are generally three management approaches (Stefanini, 2006):

- *Bottom-up*: when managers scrutinize the characteristics and principles of distinct companies and pick the companies they intent to buy or sell short, they are namely stock pickers.

- *Top-down*: when fund managers hold their positions upon a macro-economic study choosing the allocation sector and region first, then a stock selection further.
- *Stereoscopic*: when fund managers mix the above listed approaches.

There is no specific successful management, it depends on the fund managers to choose what favorable style to adopt; the possibility of achieving positive returns comes from independent analysis and studies of the hedge fund universe. It is important for managers to have an organized investment procedure able to continuously create trading ideas in order to achieve persistent performance (Stefanini,2006).

2.1.3.4 Emerging Markets

Emerging Markets strategy involves investments in equity or debt issued by governments or firms from less developed countries. Emerging countries are determined by their per capita Gross National Product and they are characterized by a strong volatility and a high inflation (Stefanini,2006). The most notable security issued by governments of emerging countries is the brandy bond, these countries are typically positioned in Asia, Latin America and the Middle East.

Emerging markets strategy takes directional positions on a large range of financial instruments to anticipate trends. Fund managers anticipate the macro-economic changes interfering on emerging markets (Credit Suisse, 2020). Emerging markets attract hedge fund managers due to the diversification and the opportunities they can provide and the possible growth they can achieve compared to developed countries. Their growth relies on several factors such as: public debt, political stability, taxes and interest rates, education levels, exchange rates and so on and so forth. Managers following this strategy tend utilize trading ideas to benefit from the durable development caused by the growth of middle classes (Stefanini,2006).

In this strategy, long positions are most common due to the regulations of some emerging countries, short selling may be forbidden and derivatives may be not evolved. Therefore, hedging may become a limited and a restricted process.

2.2 Risks in Hedge Fund Strategies Investments

Hedge funds seek absolute returns while taking different risks, therefore, studying hedge fund risks is the starting point of any investment process. Hedge fund industry encompass various funds with distinct trading strategies. These trading styles feature dissimilar risk characteristics. In this section, risk factors in hedge funds and their impacts will be discussed. Risk factors in hedge fund investments can arise from two essential origins: Hedge fund

industry's related risk factors and hedge fund strategies' specific risk factors. The industry specific risks stem from the features of the hedge fund industry while strategy's related risks are specific to a trading approach and its ensuing exposure. The fundamental risk sources are illustrated below Figure 2.2.

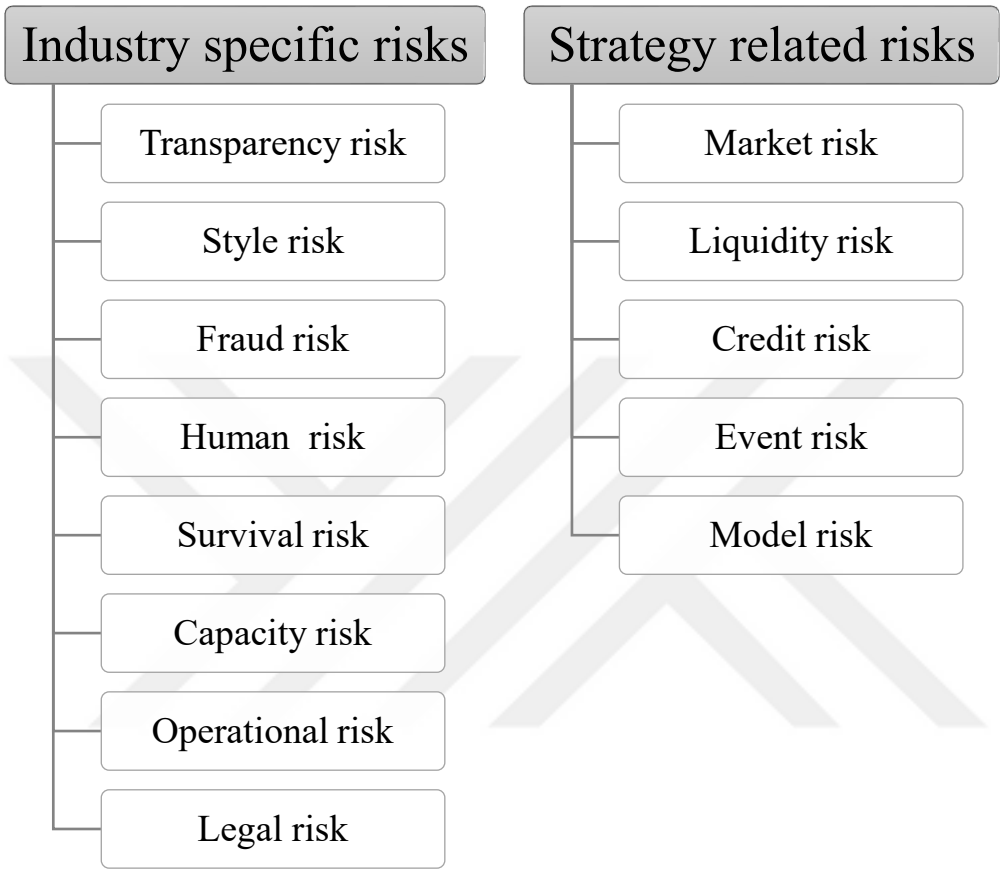


Figure 2. 2: Risks in Hedge Fund Investments

2.2.1 Industry Specific Risks

The industry's specific risks are not related to the strategies adopted by hedge fund managers but rather associated with the hedge fund industry. These risks can be diversifiable to some point in case of wide hedge fund portfolios, hence, these risks should be supervised and managed diligently in case of small portfolios with less hedge funds (Jeager, 2002). The most prominent hedge fund industry's specific risks will be mentioned in the following.

2.2.1.1 Transparency risk

Hedge funds adopt trading approaches to seek profits, thereby, they prefer not to divulge their most precious information which is their strategy. Hedge fund managers rarely disclose the current positions held in their investment portfolio (Stefanini,2006). The absence

of transparency is the principal source of uncertainty in hedge fund investments and it triggers other risk factors in investments like the style risk or the fraud risk as only a complete disclosure can protect against fraud or style drift risks (Jaeger,2002). Nevertheless, hedge funds provide a legal document which confine the manager to a specified number of actions and limit managers' activity to an extent. Furthermore, financial statements can be accessible to investors before any investment (Stefanini,2006).

2.2.1.2 Style risk

When a hedge fund's style happens to change, investors will encounter brand new sources of risk. A sample for a style change can be illustrated with a market neutral strategy fund becoming directional and advancing in new market sectors. Single hedge funds are chosen to be included in an investment portfolio for the trading style they adopt. A style drift can impact the portfolio's balance and a prolonged style change of funds can cause an unexpected risk concentration of the portfolio (Cottier, 1998). Style risk can also be manifested by the use of leverage by managers to follow their investment strategy. Managers tend to have recourse to leverage in periods of poor performances or fluctuating markets (Ang, 2011). However, Leverage use can open the door to the risk of an abrupt withdrawal of funds which push hedge fund managers to close their positions instantly and sometimes at most undesirable prices (Stefanini,2006).

2.2.1.3 Fraud risk

The lack in the regulatory system of hedge fund industry can ease fraudulent activities such as erroneous performance reports or illegal schemes. Yet, fraudulent acts seldom occurred in the hedge fund history as managers are engaged to stick to authorized activities. If managers do not respect their restricted set of activities, fraud may happen and managers may falsify their valuations (Jeager,2008). It is rather difficult for investors to identify fraud activities and for this reason they can call on a third party to audit and verify the reliability of the disclosed performance and facts (SEC Pub. No. 139 'Investor Bulletin Hedge Funds'; 2/13).

2.2.1.4 Human risk

Hedge funds are usually managed by a limited number of people; therefore, risk can arise from management and may depend on managers' skills; the first essential feature of human risk is the uncertainty about managers' potentials in achieving a persistent superior performance (Jaeger, 2008). A manager's record of performance is an important tool to evaluate

his skills and an appealing incentive structure can inspire managers to maximize their performance and prevent irrationality. Furthermore, a sudden departure of a key manager can be a source of risk that may affect the hedge fund's functionality and therefore its ability to follow a certain strategy, implementing a computerized trading operating system can be a rescue in this case (Patel et al.,2002).

2.2.1.5 Survival risk

A fund survival in hedge fund aggressive industry represent a source of risk in hedge fund investments. The creation of a new fund necessitates an important organizational expertise and skills and the success of the strategies implemented to new funds is primordial to the survival of these funds (Howell, 2001). There is a big probability that a young fund does not remain alive the first years of its creation as a result of structural and managerial issues (Patel et al., 2002). New funds have generally superior decreasing rates than old settled funds (Howell, 2001). Succeeding in the hedge fund industry requires high-risk strategies and an alluring incentive structure for newcomers.

2.2.1.6 Capacity risk

Hedge funds have a double layer of fees, yet, they are able to make profits with their specific performance fees which depend on absolute returns. When managers do not perceive more opportunities of return and think that maximum capacity is reached, they choose to close the funds to additional investments. If assets are raised above the natural capacity, expected returns are likely to decrease in the future (Stefanini,2006). Unrestricted fund-raising constitutes a risk in hedge fund investments, the bigger the number of assets is becoming, the lesser are the opportunities to attain favorable returns on the capital used. For some arbitrage strategies, investments in additional positions may decrease returns as the liquidity of the capital decreases with the unfavorable size impacts related to the market effect of big transactions (Tarrant, 1998). To prevent capacity issues, managers may send capital back to their investors or end their plan of action when a capacity limit of a specific strategy is attained. Some investors may sometimes find themselves unable to take part in superior hedge fund investments because of the capacity obstacle (Jeager,2008).

2.2.1.7 Operational risk

Operational risk stems from organizational and information systems' inefficiencies that can lead to incorrect operations. This type of risk involves all the damages that may be

caused by deficient internal processes, people, systems and also external events (Stefanni,2006). Since hedge funds have an elevated transaction turnover and a smaller number of people in comparison to traditional funds, operational complications are more likely to happen such as exceedance limitations and wrong implementations (Jeager,2008). Moreover, due to the complicated nature of hedge fund strategies, information systems and computerized models are very essential especially for offshore hedge funds which countries of domiciliation do not fulfill the infrastructure requisites all the time (Patel et al, 2002).

2.2.1.8 Legal risk

Regulatory and tax changes can impact all activities in the investment industry, especially for hedge fund investments as being more complicated and illiquid investments. The outcomes can be drastic for this type of alternative investment (Stefanini, 2006). Following the increased legal inspection imposed by the Securities of Exchange and Commission in 2004, resulting from the illegal activities performed by mutual funds and some small hedge funds in 2003, numerous investors redeemed their assets causing a dramatic decline in the number of assets left in hedge funds. For certain arbitrage strategies, legal changes can push managers to close their positions rashly and thereby incur losses. For example, the modification of the requirements regulating the short sale of securities can lead to a call in by owners or sometimes borrowed securities may require dividends which it will cost a significant price for managers, legal requirements can also make numerous institutional investors avoid investing in distressed securities (Stefanini, 2006).

2.2.2 Strategy Related Risks

The risks related to hedge fund strategies are more complicated to the risks encountered in traditional investment strategies. It is important for investors to evaluate the risk that may arise from the investment strategy and make a deep analysis of the features of the strategy and the risk management approaches followed by the hedge fund. The most fundamental sources of risk affecting hedge fund strategies' investments will be introduced in the following.

2.2.2.1 Market risk

Market risk is correlated with the performance of the variables having an impact on capital markets namely: the prices of financial instruments, interest rates, exchange rates, commodities…etc. Potential adverse movements of one of these variables can arise market risk

for hedge fund strategies' investments (Stefanini, 2006). Market risk sources can be separated into specific and systematic sources. Specific market risk results from changes in the price of single financial instruments while the systematic market risk stems from the general movements in market prices as hedge funds are able to hold net short positions in financial instruments and therefore can be exposed to several market prices (Duffie et al., 2003). The intense use of leverage amplifies market risk and increase hedge fund risk exposure. Based upon the trading strategy, managers employ leverage to magnify their returns and consequently increase the market risk exposure of the fund (Stefanini, 2006). The effects of market risk are more critical for hedge funds in comparison to traditional investment funds due to the intensive use of leverage (Cottier, 1998). Market risk alter the majority of hedge fund strategies' performance especially directional strategies which are correlated with markets such as Global Macro, Managed Futures, Emerging Markets and Long/Short Equity which performances are associated with equity markets and sometimes bond and currency markets. Arbitrage strategies can also be exposed to market fluctuations if not market neutral while Event Driven strategies can possibly be affected by equity market changes (Stefanini,2006).

2.2.2.2 Liquidity risk

Characterized by their illiquid nature, liquidity risk represents one of the main risk factors of hedge fund strategies' investments. Liquidity risk can emerge in hedge fund investing from three distinct sources: investors funding, market and redemption orders (Stefanini,2006). Liquidity risk associated with investors occur when they encounter difficulties to liquidate their assets and provide sufficient funds and consequently they fail to meet their obligations (Cottier,1998). Investors have an impact on hedge fund strategies liquidity and can be an origin of risk, short term investors who own a big part of the hedge fund can shatter long run strategies when they take back their capital. Hence, adequate lock up periods and a diversified customer base is essential for hedge funds (Chait, 2000). Liquidity risk is also linked to the liquidity of the financial instruments that fund managers invest in namely market liquidity risk. It happens when hedge fund strategies managers are forced to exit a position but are unable to adjust their position at favorable prices due to a liquidity squeeze on the market (Stefanini, 2006). Since illiquid positions are a central part of hedge fund portfolios, the ensuing risk is omnipresent in hedge fund strategies. Another crucial source of liquidity risk is linked to the specific features of hedge fund strategies which are the redemption orders. Hedge fund strategies are characterized by lock up periods which allow their subscribers to withdraw their money at pre-determined and fixed deadlines like monthly, quarterly or annually (Stefanini,2006). Yet, hedge

funds limit their liquidation orders to quarterly deadlines or more and generally with a preliminary notice and these orders take generally time to be put into action. Furthermore, managers can choose to put toff liquidation orders if they judge that these redemptions could be harmful for the rest of the investors of the hedge fund (Seco, 2005). Hedge fund strategies are widely exposed to liquidity risk due to the illiquid nature of their transactions. Long Short equity strategy can be a subject to short-squeeze risk when managers have short sold securities and brokers carry out an additional margin call in case of unfavorable market fluctuations inducing an extreme attrition of the position's value (Bali et al., 2012). Distressed securities funds generally carry illiquid securities which make them vulnerable to liquidity risk (Stefanini, 2006). For the simple nature of curve trading in Fixed Income funds, the notional controlled by positions is commonly very large which can arise liquidity difficulties since the related positions can difficult to unroll (Seco, 2015). Convertible Arbitrage strategies exhibit liquidity risk when there is a spread widening on the convertible bond and the stock of bids and the risk is particularly bigger for little convertible issues. It is difficult for managers to hedge away this risk. Activist managers adopting Event Driven strategies can encounter liquidity uncertainty when they are unable to undertake their transactions of buying or selling due to liquidity issues, Global Macro funds can encounter as well market liquidity problems (Stefanini,2006).

2.2.2.3 Credit risk

Credit risk depends upon the dependability of the organizational procedures and the operational structure of hedge fund strategies and their service brokers. Credit risk in hedge fund strategies investments arise from a financial counterparty's insolvency, called also counterparty or default risk, this type of risk originates when a counterparty to some of the financial transactions of the hedge fund strategy fail to meet their obligations engendering losses to the hedge fund (Stefanini,2006). Credit risk can also arise from the impairment of securities when a counterparty or an issuer, without default or liquidation, experiences a credit rating downgrade which consequently cause a negative impact on the market value of the assets inside the hedge fund (Duffie et al.,2003). Counterparties involve debt and equity owners; Hedge fund managers have to make sure that counterparties to the financial transactions will be able to honor their obligations and they should identify, capture and diversify credit risk of hedge fund strategies (Chait,2000). Country risk is another component of credit risk when a country or a government can default and fail to fulfill its obligations (sovereign debt). An important aspect of credit risk which affect hedge fund strategies investments is the widening of credit spreads, credit spreads are the differential between yields of distinct debt securities.

Credit oriented hedge fund strategies are all prone to credit risk and can be exposed to default risks and credit spread widening. Convertible Arbitrage is among the strategies subject to credit spread widening risk (Bali et al., 2012); the short position on the underlying shares decreases risk relatively, however when a credit spread widening occurs, stock prices decrease. Managers adopting this strategy can hedge away this risk by the use of credit default swaps (Stefanini, 2006). Fixed Income funds are likely to be exposed to the risk of credit spread widening; if fixed income funds operate high-yield arbitrage trades, they may handle low credit quality bonds or deficient collateral. Market Neutral funds can suffer similarly from credit spreads when using large/small capitalization spread transactions (Seco, 2005). Credit derivatives can help investors protect themselves from the widening of spreads, yet, they are more beneficial for hedge fund managers with little credit exposure (Stefanini, 2006). On the other hand, Distressed Securities strategy is sensitive to default risks because it retains securities in companies under extraordinary circumstances like mergers, liquidation or restructuring (Stefanini,2006). Finally, hedge funds pursuing an Emerging Markets strategy are subject to the country or the sovereign risk (Bali et al.,2012).

2.2.2.4 Event risk

The majority of hedge fund strategies are implemented in particular market sectors which make them vulnerable to special events in their market segment. External managerial decisions, exceptional economic and political events can affect hedge fund strategies investments (Jeager, 2008). The impacts on hedge fund strategies transactions vary according to the traded assets and the applied strategies. It is difficult for hedge fund managers to anticipate event risk with mathematical modeling as it is contingent on abnormal events (Bookstaber, 2003). Taking arbitrage strategies as an example, an unexpected dividend payout represents a special event where the manager who has short sold the company's share find himself forced to pay the dividend to the party from where he borrowed the share. Therefore, the hedge fund manager is unexpectedly exposed to a dividend payout risk (Stefanini,2006). Other special events, like pre-payments for mortgage backed securities or management decisions for merging companies or also political events like war, can affect hedge fund strategies investments (Stefanini, 2006).

2.2.2.5 Model risk

Many hedge fund strategies transactions are established employing models; hence, model risk constitute an essential risk factor in hedge fund strategies' risk profile. Model risk can arise when the assumptions of the model used are nonrealistic and when models are not developed upon practical estimations, it can also stem from quantitative models improperly adjusted to market circumstances. It is the risk resulting from inaccurate results generated by all the models used to assess risk, hedge and price (Allen, 2003). The causes behind this risk factor can be related to a wrong application of a model or the use of inadequate framework input to assess the model's prices or simply disregard the main origins of risk throughout the modeling procedures (Allen, 2003). Most of arbitrage strategies have recourse to quantitative models to detect and hedge arbitrage transactions and to forecast precisely pricing relations, thereby, these strategies investments can be subject to model risk. Hedge funds following a Fixed Income strategy can be affected by model risk since the fixed income sector requires the most sophisticated mathematical models for interest rates modeling (Seco, 2005). Managed Futures strategy is the hedge fund strategy that relies the most on modelization, Managed Futures fund managers deploy computerized models that effectuate trading decisions automatically (Stefanini,2006). Model risk is a crucial risk factor that can be detrimental for Managed Futures funds transactions.

All the risks associated with hedge funds strategies have to be evaluated and the investing ability of every hedge fund should be investigated before and during the lifespan of any investment. Risk management is a fundamental process for the prospering of hedge fund strategies. Hedge fund managers are no longer appreciated for their stock picking skills only, a rigorous risk management system and a due diligence process represent an important competitive advantage for hedge fund managers.

2.3 Managerial skill in Hedge Funds

Every single hedge fund has its particular organization, legal structure, business culture and most importantly its managerial characteristics. Hedge fund managers differs depending on professional experience, age and educational background. Sometimes, people having a very contrasting experience than most of the other managers can bring new sights and analyze the problems differently. Hedge fund managers have an unrestricted power and a wide flexibility to handle securities with the use of diverse strategies. In each hedge fund, it is the

manager who establish the plan of action: management style, targeted market, investment time horizon, returns and volatility goals, and the hedge fund's ideal capacity (Stefanini, 2006).

Managers have a full liberty to employ a wide array of financial instruments, to short sell and to use leverage to achieve their objectives. Besides, managers can also allocate their personal money in the hedge fund they are operating to get their investors' trust and to share their interests (Stefanini, 2006).

Managerial skills can have a considerable influence in hedge fund strategies performance. Generally, hedge funds' persistence performance is due to top performing managers rather than bottom performers (Jagannathan et al., 2010). Furthermore, talented managers tend to produce superior alphas in strong market circumstances than low skilled managers with their powerful and insightful asset selection, they have also the capability to hedge away risk exposures and amplify their returns (Titman et al., 2011). In comparison to mutual fund managers, hedge fund managers are renowned to be more skilled with their ability to achieve absolute returns (Liang, 1999). Hedge fund managers have to be shrewd, flexible and fast in their reactions to market events, they are constantly on the lookout for new opportunities to maintain the expansion in their assets under management (Stefanini,2006).

2.4 Performance of Hedge Fund Strategies

This sub-section will explore the performance of hedge fund strategies according to their historical returns and with the use of the maximum drawdowns which refers to the maximum fall in value that occurred for the distinct hedge fund strategies before an apical peal. Drawdowns can involve a market condition that can trigger the volatility of hedge fund strategies and subsequently cause a drop in their value.

In Figures 2.3 to 2.13, horizontal axis represents the years and vertical axis presents the monthly returns of hedge fund strategies for Eurekahedge, Credit Suisse and CISDM databases from 2001 to 2020.

2.4.1 Performance of Relative Value Strategies

Convertible Arbitrage strategy was stirred during the financial crisis period with negative returns as illustrated in (Figure 2.3), it reported drawdowns in November 2008 of -11.49% for Eurekahedge and -32.87% for Credit Suisse and a drawdown for CISDM in October 2008 of -52,5%. Other noticeable drawdowns happened in May 2010 (-15,4%) for CISDM and in September 2011 (-2,83%) for Eureka hedge as an aftermath of the credit spread widening triggered by the European debt crisis. Another significant drawdown happened in March 2020, -6.43% for Credit Suisse and -29.5% for CISDM arising from the credit spread widening brought about by the coronavirus associated economic recession.

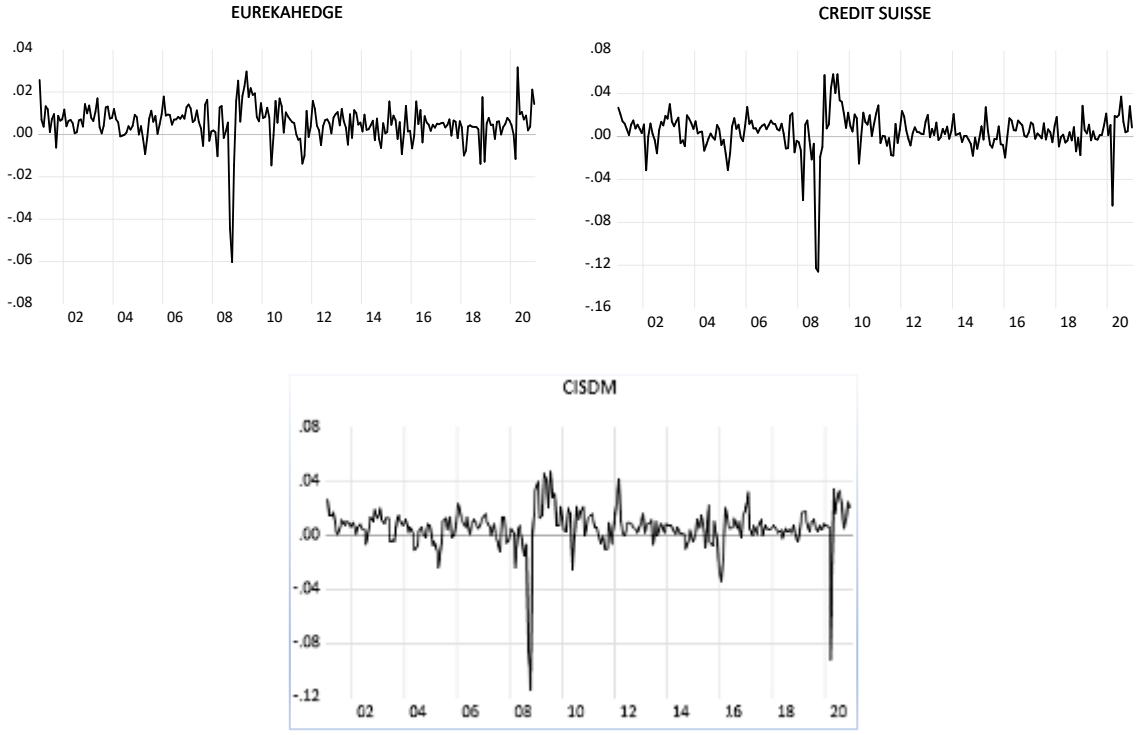


Figure 2.3: Performance Of Convertible Arbitrage Index

Fixed Income strategy registered negative returns for the periods of the Great Financial crisis in 2008 and of the Covid-19 lockdown in 2020 (see Figure 2.4 below). Throughout the GFC of 2008, these strategies recorded drawdowns of -12.01% for Eureka hedge, -29,01% for Credit Suisse and 41.2% for CISDM. In this period investors faced difficulties like high volatility in their equity portfolios and decreased fixed income yields. The second important

drawdown occurred in 2020 coinciding with the Covid-19 crisis that engendered a large widening in credit spreads and a related flight to quality, -9.41% for Eureka hedge, -6.51% for Credit Suisse and 43.9% for CISDM.

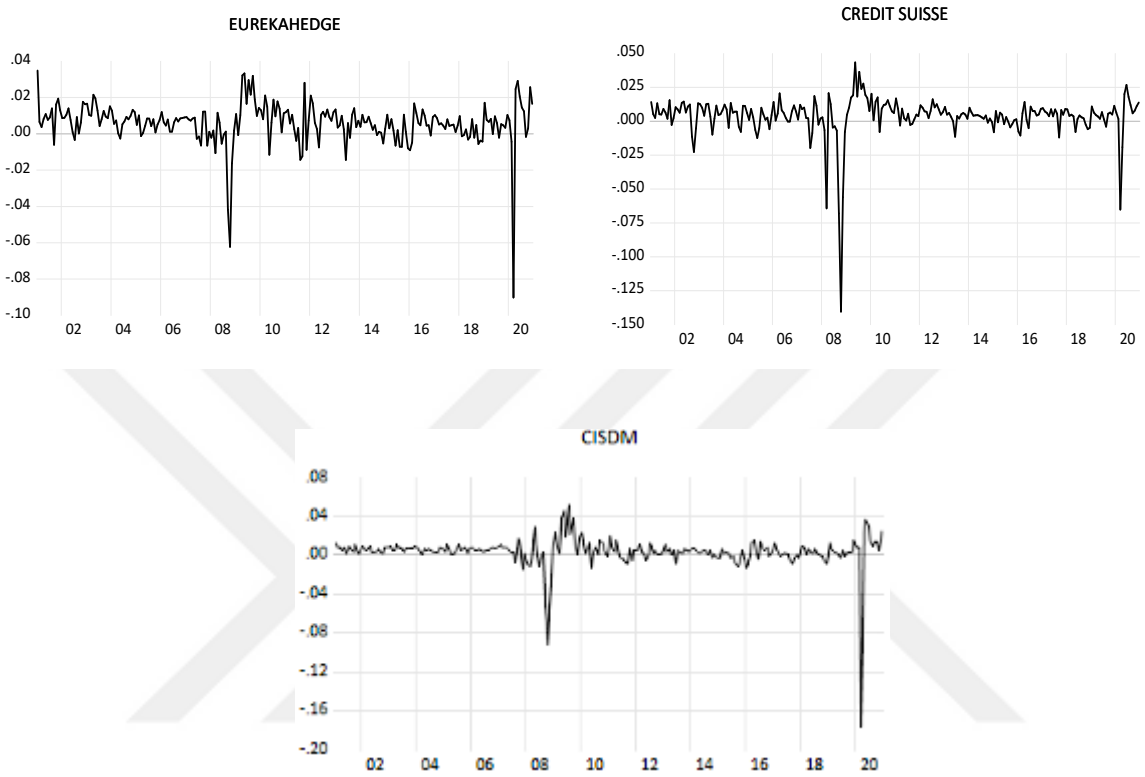


Figure 2. 3: Performance Of Fixed Income Index

The performance of Market Neutral strategy has been illustrated below in Figure 2.5. Market Neutral strategy experienced a negative historical performance in the time of the GFC 2008 with maximum drawdowns for Credit Suisse of -45.10%, CISDM of -20.04% and Eurekahedge with -0,042%. These strategies for the three databases reported negative performances during the crisis period. Another major drawdown took place in March 2020 of -35.06% for Credit Suisse, -15.77% for CISDM and -0.054% for Eurekahedge as a result of the coronavirus sanitary crisis (Covid-19).

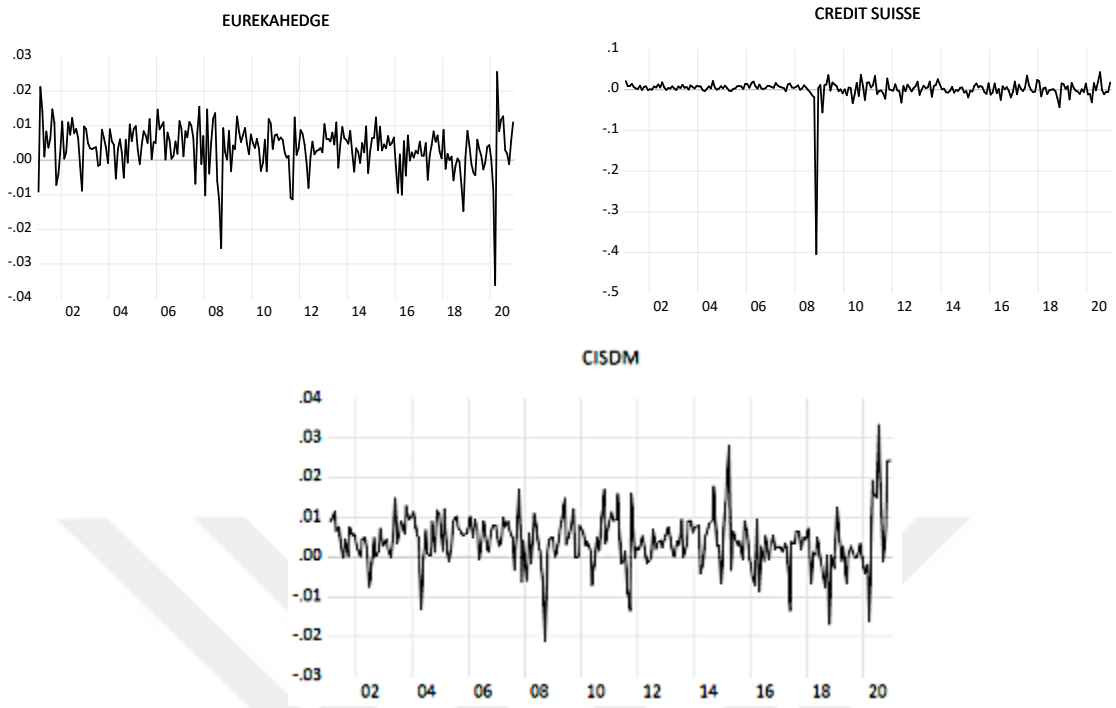


Figure 2. 4: Performance Of Market Neutral Index

2.4.2 Performance of Event Driven Strategies

The coronavirus related recession had significant repercussions on the strategies' historical performance, as exhibited in (Figure 2.6), for the three data bases. In March 2020, Event Driven strategy registered a drawdown of -15.92% for Eurekahedge, -15.51% for credit Suisse, and -29.24% for CISDM as result of the virus linked recession. Another considerable drawdown in February 2009 of -19.15% for Eureka hedge, in November 2008 of -23.23% for credit Suisse and in September 2008 of -15.41% for CISDM. This performance downturn is the outcome of the financial crisis when equity markets collapsed joined by an enlargement of credit spreads and an analogous flight to safety. The last significant drawdown occurred in February 2016 for Eureka hedge of -14.31% and in January 2016 with -7,89% for Credit Suisse and 29.59% for CISDM when per-barrel oil prices dropped and the average prices of energy bonds fell near to their bankruptcy recovery values with an ensuing credit spreads widening.

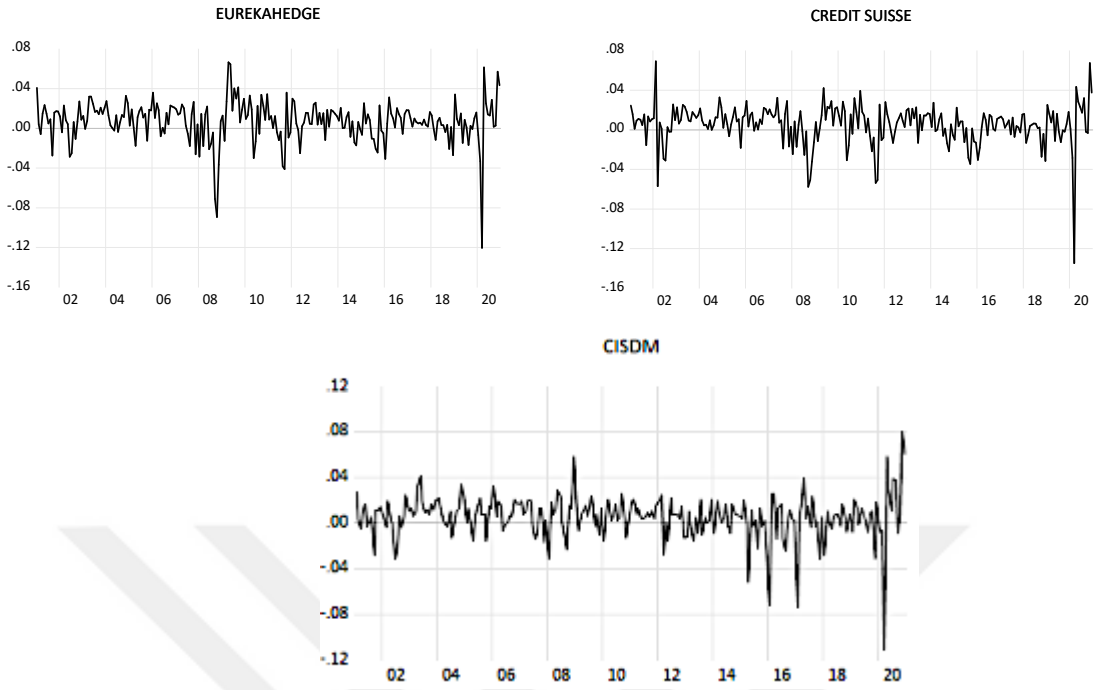


Figure 2. 5: Performance Of Event Driven Index

Alike other strategies, the historical performance of Distressed Debt was hit during the GFC 2008 and the coronavirus lockdown periods (see Figure 2.7). Three significant drawdowns occurred between 2001 and 2020. The first one happened in February 2009 with -28.24% for Eurekahedge and -22.45% for credit Suisse and in September 2008 for CISDM of -20.52% resulting from the flight to quality movement since many investors left mortgage-backed securities during the housing crisis as well as the broadening of credit spreads that took place in the time of the GFC. The second drawdown was in March 2020 of -9.72% for Eurekahedge, -13,32% for credit Suisse and -16.02% for CISDM arising from the pandemic crisis that affected credit spreads evolution and generated a flight to safety amid investors. The third drawdown came in 2016 of -9,68% for Eurekahedge, -11.03% for credit Suisse and 14.27% for CISDM indices subsequent to the widening of credit spreads caused by the decrease in energy bonds' average price.

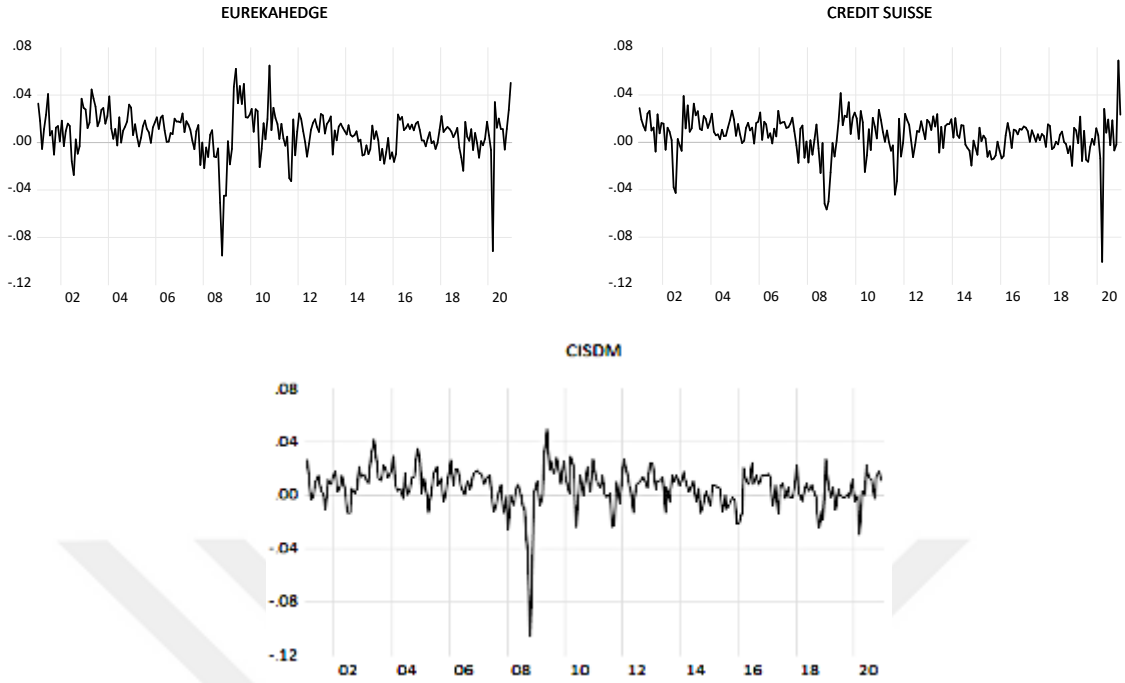
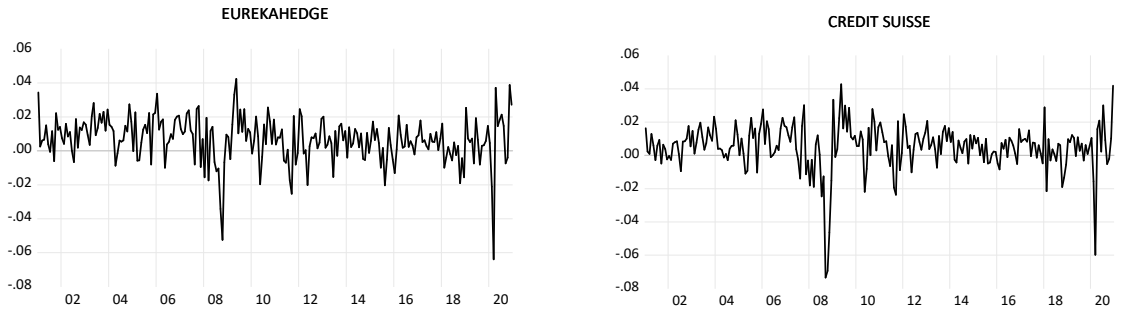


Figure 2.6: Performance Of Distressed Debt Index.

As illustrated in Figure 2.8, the historical performance of hedge funds following Multi-strategy faced declines during the period and reported a drawdown during the financial crisis in February 2009 of -11,71%; -45.10% for Eurekahedge and Credit Suisse and in September 2008 of -30% for CISDM. Other essential drawdowns happened in March 2020, -8.36% for Eureka hedge and -27.87% for CISDM during the early days of Coronavirus lockdown and in September 2011 of -39.43% for Credit Suisse triggered by the consequences of the European debt crisis.



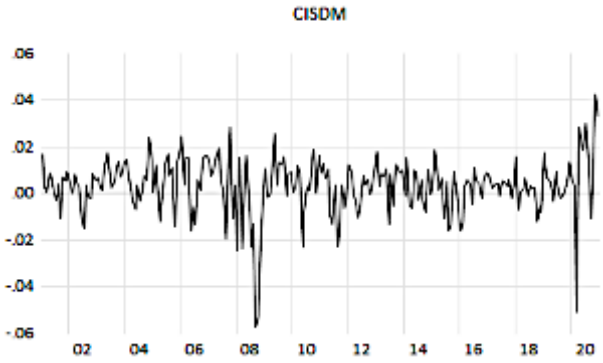
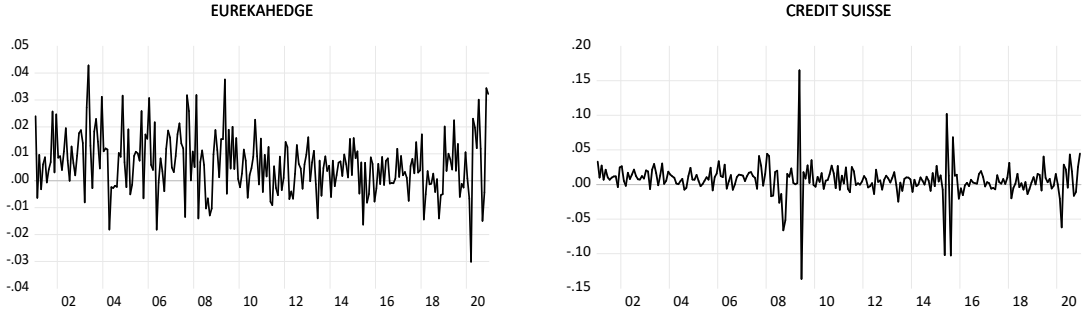


Figure 2.7: Performance Of Multi-strategy Index

2.4.3 Performance of Directional Strategies

Eurekahedge and CISDM indices' historical performances do not clearly display negative returns like Credit Suisse for the Global Macro strategy (see Figure 2.9) which relies essentially on managers' skills and forecasts. Yet, the databases encountered largest drawdowns from 2001 to 2020. The strategy's index performance has registered three major drawdowns related to some events taking place in the financial markets. The first drawdown took place in December 2018 of -4.31% for Eurekahedge index as an aftermath of the market's big decline and the raise of volatility triggered by the announcement of interest rate rise by the Federal Reserve, America's trade war with China and uncertainty in government policies, followed by a second drawdown in October 2008 of -3.95%. For Credit Suisse index, the largest drawdown occurred in October 2008 with -14.94% in the light of the financial crisis and the second in March 2020 of -8,09% resulting from the virus associated market turmoil and lastly in 2016 with -6.26% after the drop of oil price. For CISDM, an important drawdown occurred in 2016 of -13.32% reflecting the decline of energy bonds average price followed by a second drawdown in March 2020 of -11.01% stemming from the impacts of the coronavirus lockdown period.



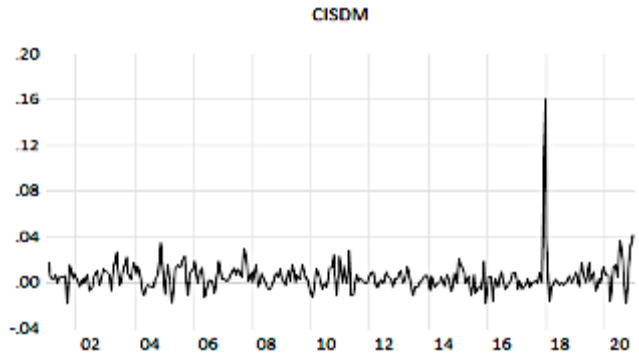


Figure 2.8: Performance Of Global Macro Index

Managed futures strategies exhibit extreme fluctuations in their historical performances (see Figure 2.10). For Eurekahedge, managed futures index faced the maximum drawdown in August 2004 of -6.29%. That year was a bad year for Managed Futures strategy as a result of the trend reversals that happened in all the sectors ensued by sideways markets. For Credit Suisse, Managed futures strategy experienced a trend reversal in January 2019 with the largest drawdown of -18.62% and for CISDM, the strategy encountered a maximum drawdown in November 2001 of -4.32% deriving from the repercussions of the horrendous New York attack in 2001. Managed futures strategy resisted the major market events that obstructed the other strategies which demonstrates its uncorrelation with the market.

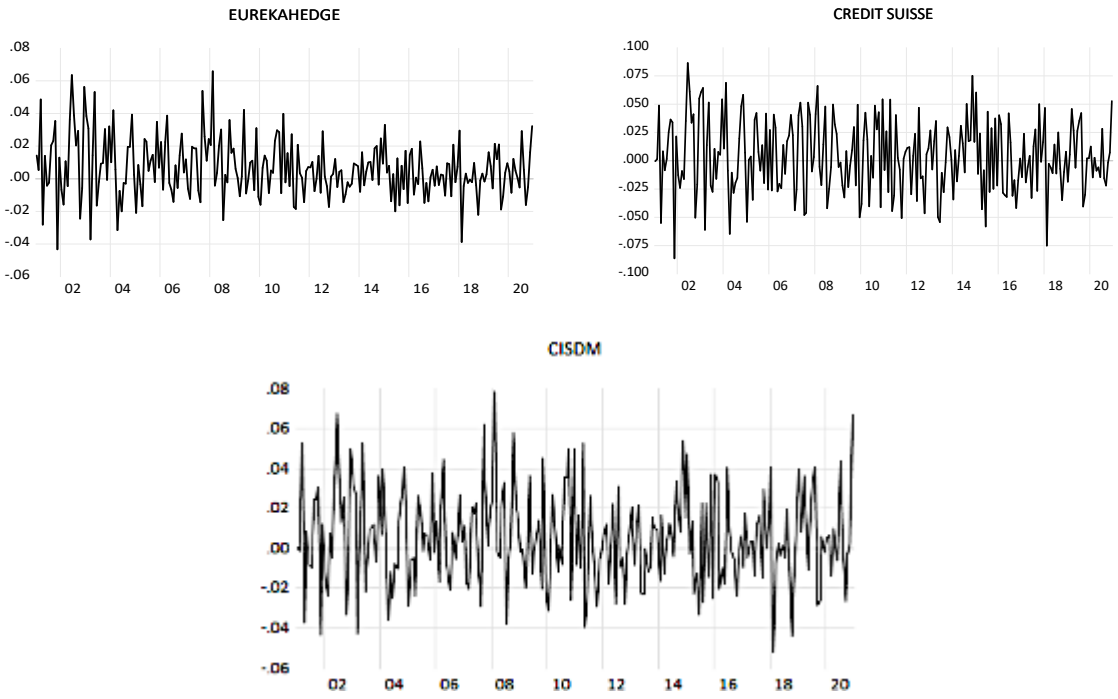


Figure 2. 9: Performance Of Managed Futures Index

Historical performance of Long/Short Equity strategies in Figure 2.11 reveals that the strategies were influenced by financial events during 2001-2020. There was a big drawdown in February 2009 of -21.79% for Eureka hedge index and -22% for Credit Suisse database. For CISDM, the largest drawdown occurred in October 2008 with -31.9%. Another noticeable drawdown took place in November 2008 of -21.19% for Eurekahedge and -21.63% for Credit Suisse. These drawdowns clearly reflect the impacts of the GFC (2007-2009). Market volatility brings about a flight to quality movement in investment allocations as investors switch their money into gold or riskless investments. Besides, the European sovereign debt crisis interfered with this strategy's performance during 2011 with drawdowns of -10,44% for Eurekahedge, -12,64% for Credit Suisse and -17.37% for CISDM as equity markets fluctuated subsequently after the European sovereign debt crisis.

Long Short/Equity strategies reported another considerable drawdown in March 2020 of -11.56%, -11,17% and -25.26% for the three strategy indices when investors engaged in a flight to cash and liquidity during an unexpected economic downturn caused by the (Covid-19) sanitary crisis. Investors were challenged with a high volatility in their equity portfolios.

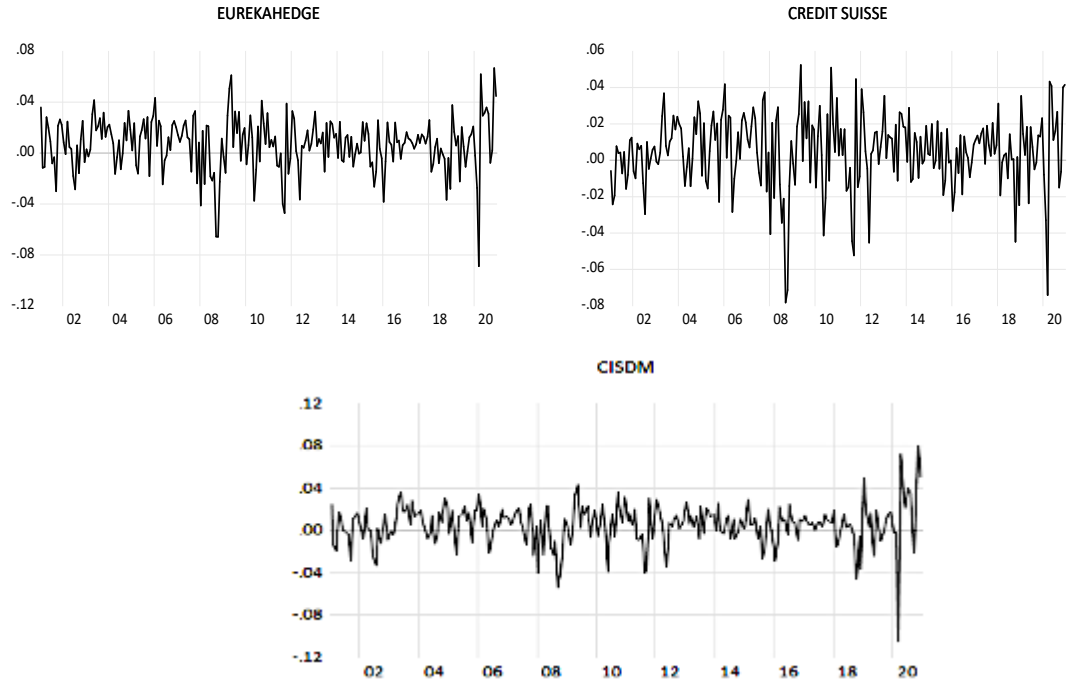


Figure 2.11: Performance Of Long Short Equity Index

Emerging markets strategies portray high fluctuations in this period (2001-2020) as illustrated in Figure 2.12. Over time, Emerging markets strategies historical performances experienced drawdowns as an aftermath of the intensive financial conditions the world has encountered.

In November 2008, the emerging markets index registered its maximum drawdown of -25.16% For Eurekahedge and its second largest drawdown of -30.95% after February 2009 of -32.34% for Credit Suisse. For CISDM, the strategy recorded a maximum drawdown in October 2008 with -23.19%. It is evident that the strategy was greatly stirred by the great financial crisis. Another relevant drawdown occurred in September 2011 of -10,48% for both databases and a -16.73% drawdown for CISDM when the sector was touched by the negative insight of performance fees. The third noticeable drawdown was an outcome of the coronavirus associated recession with -10,09%) for Eureka hedge, -11,95% for Credit Suisse and -14.92% for CISDM.

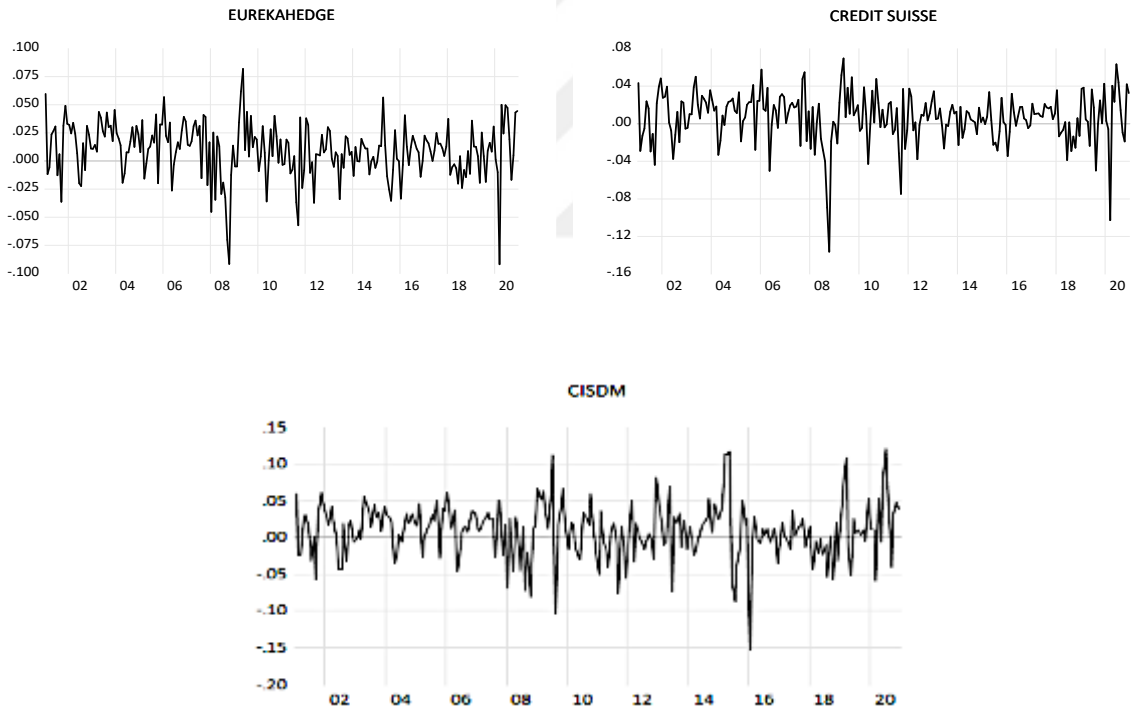


Figure 2. 10 : Performance Of Emerging Markets Index

2.4.4 MSCI World Index performance

Morgan Stanley Capital International Index (MSCI) illustrates international performance for several countries and regions focalizing on different geographic zones and stock types such as small, mid and large capitalizations. MSCI World is picked as a benchmark to hedge fund strategies' performance and as a proxy for market return because it represents international equity markets, it is rule-based, fully investable, transparent, diversified, liquid

and timely reported. The world equity index historical performance was impacted by the recent market events in the last two decades (see Figure 2.13).

MSCI World index registered a first drawdown in February 2009 of -55.36% when equity markets collapsed at the time of the great financial crisis. A flight to quality movement started when investors around the world left mortgage-backed securities ahead of the housing crisis and credit spreads widened following this financial crisis. The second important drawdown happened in June 2010 with -2,83% triggered by the European debt crisis and its resulting credit spreads evolution. Another relevant drawdown was in March 2020 of -9.72% reflecting the sanitary crisis that interfered with credit spreads and generated a flight to safety amid investors.

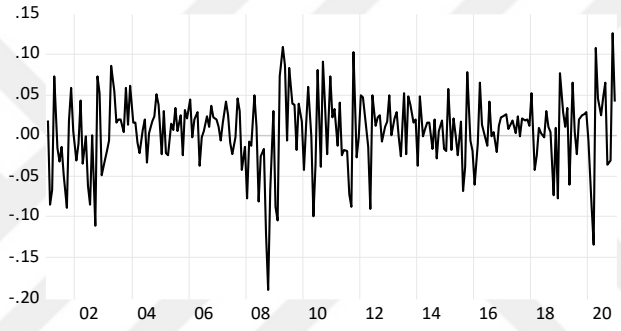


Figure 2.13: Performance of MSCI World Index

3. HEDGE FUND PERFORMANCE COMPARISON AND COINTEGRATION

The objective of this thesis is to provide a deep comprehension of hedge funds and its strategies' risk and performance components. For hedge fund investment decision-making, it is important to acquire knowledge of hedge fund industry in order to select the most appropriate strategy or strategies for a determined period of time. This thesis will be efficient for investors and portfolio constructors to make choices about performance measurement and portfolio allocation. Performance assessment will help mirroring hedge funds' performance and will enable investors to compare between the different investment strategies. This section starts with describing the theoretical framework behind this study research, it relates the essential financial and econometrical theories that will help analyze and evaluate hedge funds and their strategies performances in addition to the previous related literature. This section also covers the research design including methodological consideration, hypotheses, data and variables.

3.1 Theoretical Background

There is no doubt that a theoretical framework is needed to grasp the financial features of this thesis and the environment of our main subjects which are the hedge fund strategies and their performances. In order to understand the background of the research questions, it is important to mention the capital markets. This section will discuss the most employed financial theories: the efficient market hypothesis, modern portfolio theory and capital asset pricing models. It will also mention the performance related risk-adjusted measurements metrics. All these theories are relevant to the research questions and the objectives of this thesis.

3.1.1 Efficient market hypothesis

The efficient market hypothesis was introduced by Eugene Fama in 1965 in his article 'Random Walks in Stock market prices' which he developed with a new paper in 1970 named 'Efficient Capital Markets: A Review of Theory and Empirical Work'. It has been since its appearance the main theory describing security prices behavior in capital markets. The main presumption of the efficient market hypothesis is that security prices reflect the existing information (Fama, 1970) and that they pursue an unpredictable random walk (Fama1965). Investors can have access to information either given by companies in the form of reports or also provided by investors and daily news. This theory classifies market efficiency into: weak,

semi-strong and strong. In the weakly efficient markets, only historical data is included in the prices and consequently technical analysis will not succeed to provide excess returns. Yet, fundamental techniques can still generate abnormal returns. In a semi-strongly efficient market, historical data and current data also called publicly available data are accessible to investors and in this market form excess returns will still be generated by some forms of fundamental analysis. In the strong form of market efficiency, all information is available including insider information and therefore the only way to gain higher returns is to take higher risks or to have a good luck.

The efficient market hypothesis assumes that financial markets react to information quickly and are competitive. Thus, the market price will always reflect the true price of a security in circumstances of perfect information availability. It also suggests that market do not own a memory and thereby when a new information is available, the value of a security can go up or down approaching its fundamental value. Furthermore, the efficient market theory assumes that arbitrary gains are random and claims that arbitrageurs manage to create outperformance to the detriment of irrational investors. Indeed, deviations from fundamental value will offer outperformance to lucky investors while it will make other investors bear underperformance. Both aftermaths will compensate each other and in the end the market will still be efficient. The efficient market will be impossible to outperform without acquiring riskier assets (Fama, 1970). Still, the efficient market hypothesis is unable to explain the persistence and magnitude of excess returns gained by some managers regardless of arbitrage possibilities' limitation. These repeated returns imply other things than luck to be the cause of them.

Hedge funds' concept and objective do not fit with the strong market efficiency's assumption as they aim to outperform the market and generate alphas in exchange of performance and management fees for the service offered. Beating markets where prices pursue a random walk cannot be achieved consistently. Some hedge fund strategies target markets with less efficiency to generate returns like Emerging Markets strategies and therefore they are consistent with the claims of the efficient market hypothesis. Nevertheless, the majority of hedge funds today perform in mature and rather efficient markets. Moreover, the efficient market hypothesis mentions arbitrage gains and describes it as an outperformance of rational investors at the expense of irrational investors advancing that irrational decisions are exceptions and therefore arbitrage opportunities are limited. Among hedge fund strategies, a lot of strategies include arbitrage operations which aim to achieve gains through market misprices

and generate alphas. Thus, the efficient market hypothesis cannot give a proper explanation to the success of hedge fund industry.

3.1.2 Modern Portfolio Theory

It is necessary to be introduced to the Modern Portfolio theory to be able to estimate how to include hedge funds in optimal portfolios. The Modern portfolio theory was developed in 1952 by Harry Markowitz and became one of the fundamental economic theories in finance and investment fields which made him earn the Nobel Prize in Economics in 1990. Markowitz first introduced his Portfolio Selection Theory (1952) which gives assumptions about investors' investment decisions regarding their portfolio. The theory rejected former perceptions of maximizing portfolio value by randomly choosing an asset with the highest discounted anticipated return without considering risk. It argues that constructing efficient portfolios is not a matter of maximization but rather optimization. Modern portfolio theory (1952) is built on a mean-variance framework to assemble a portfolio of assets. Markowitz's theory advances that investors are risk-averse and that they can construct their portfolio to maximize expected returns for a given level of risk. A portfolio is called efficient when it manages to produce the highest return possible for the lowest risk or a given level of risk.

Expected return and standard deviation as the relevant risk measure are utilized as proxies for return and risk. As presented by equation 3.1, the expected return of a portfolio is the weighted average of returns of the individual assets in the portfolio, where r_n is individual asset returns and w_n is the weight of an asset in the portfolio. (Bodi, Marcus & Kane, 2005)

$$Expected\ return = (w_1 * r_1) + (w_2 * r_2) + \cdots \ldots . (w_n * r_n) \qquad (3.1)$$

In view of the huge number of assets available in practice, finding the optimal weights of assets in a portfolio is a complicated process which can be executed by portfolio optimization programs. All possible combinations of available assets included in a portfolio produce an investment opportunity set. As per the Modern portfolio theory, a matrix consisting of expected returns, variations and covariances between the assets is necessary to yield this set of efficient portfolios. All combinations can be plotted on a graph with portfolio expected return on the y-axis and portfolio standard deviation on the x-axis (as illustrated in Figure 3.1).

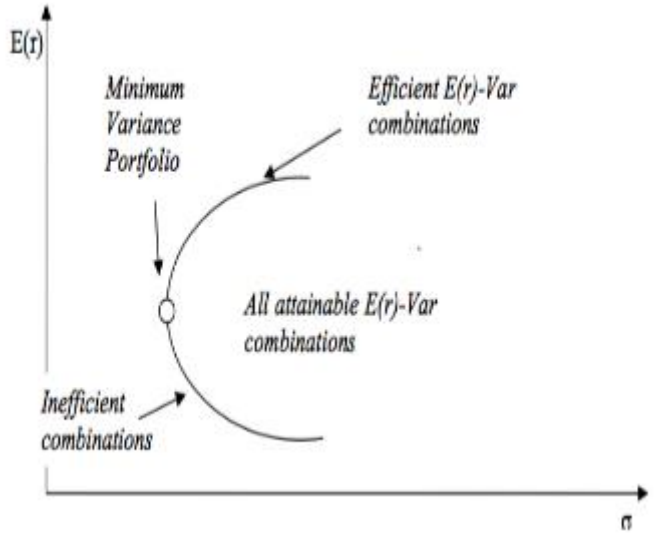


Figure 3.1 : The investment opportunity set

Source: (Andreas & Muske 2007)

Minimum variance portfolios describe portfolios belonging to the investment opportunity set and that have a 'minimum variance for given return or more' (Markowitz 1952). The connection between all the minimum variance portfolios is called the minimum variance frontier. Figure 3.2 exhibits the individual securities attainable and the minimum-variance frontier.

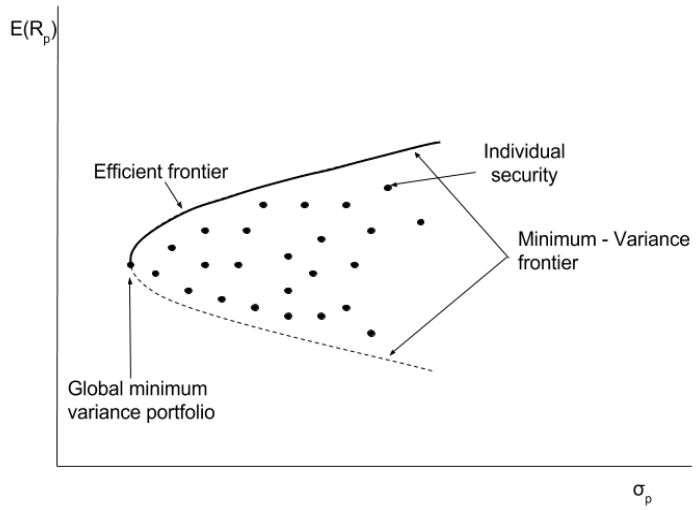


Figure 3.2: Minimum-Variance Frontier and Set of Risky Assets

Source: (*Bodi, Marcus & Kane, 2005*)

The minimum-variance frontier delivers the minimum variance attainable for a given expected return. The portfolio on the minimum-variance frontier that has the lowest risk in comparison to all attainable portfolios and is the closer to the axis-y is named the global minimum-variance portfolio. Investors cannot hold a portfolio with a risk lower than the global minimum-variance portfolio. The efficient frontier illustrates the optimal tradeoff between standard deviation and expected return through a curved line including all efficient portfolio compositions attainable for investors. These portfolios offer the best available risk-reward combinations. For the same return, no other portfolio provides a lower risk and for the same risk no other portfolio offer a higher return other than portfolios that lie on the efficient frontier. The efficient frontier can be extended over the maximum return portfolio by short sales. Yet, it is not always allowed to short sell for some institutions and for some type of funds like mutual funds. They restrict that every asset in the portfolio should be positive. For hedge funds, this restriction is ignored as hedge funds are allowed to exercise short-selling.

Modern Portfolio theory explains that in the absence of a risk-free rate, efficient portfolios can be built depending upon expected returns and standard deviations and optimal portfolios set on the efficient frontier's curve. Nevertheless, by including a risk-free security, we can get a higher risk return tradeoff that exceeds the one of the efficient frontier. A risk-free security permit investor to borrow and lend at a risk-free rate. A given mixture of risky assets located on the efficient frontier combined with a risk-free security which has a standard deviation of zero generate the capital allocation line. The capital allocation line displays the attainable portfolios from mixing the risky portfolio with the risk-free asset. The efficient risky portfolio is the tangency point of the capital allocation line and the efficient frontier. Figure 3.3 demonstrates the efficient frontier of risky assets, the capital allocation line and the efficient risky portfolio.

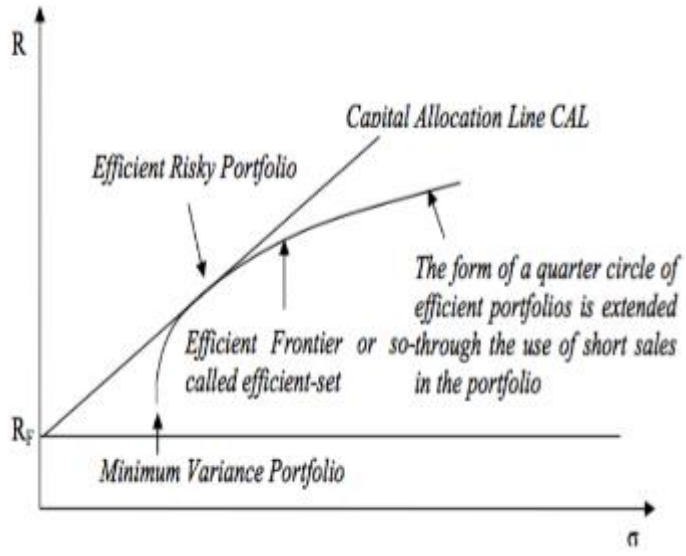


Figure 3.3: Efficient Frontier of Risky Assets with the Optimal CAL

Source: (Andreas & Musk, 2007)

The Capital allocation line starts at the risk-free return and is characterized by a slope which is an important performance measure known as the Sharpe ratio that will be introduced later among performance measurement tools. Investors can pick after combining the optimal risky portfolio with the risk-free security an own optimal portfolio that is located on the capital allocation line. Their decision making will depend on their risk aversion and utility. For our study, if hedge funds, bonds, stocks, treasury bills and treasury inflation-protected securities are accessible on the market, an optimal risky portfolio represents a portfolio that every rational investor would want to own.

Another major contribution of the Modern Portfolio Theory is introducing the diversification concept. The theory demonstrates that it is inefficient to focalize on the expected return and the risk of one given asset. Investors should rather invest in more than one asset to improve the risk-return relationship. Markowitz prompted investors 'to diversify among all those securities, which give maximum expected return' (Markowitz 1952). According to Markowitz, while constructing a portfolio, investors should diversify by investing in different assets to reduce the overall portfolio risk and maximize expected returns. Diversification is another key to manage portfolio risk by using the inter-correlation of more than one asset. When allocating the capital in different available securities, the overall portfolio's risk is reduced compared to the risk of any single security considered in isolation (Bodi, Marcus &Kane, 2005).

Yet, diversification benefits happen when securities do not exhibit a perfectly positive correlation. The Markowitz diversification strategy is essentially concerned with the degree of covariance between securities' return in a portfolio. An analysis of the covariance between securities' return is important to maintain expected return while lowering risk. In a scenario with two assets, the correlation coefficient between the two assets should be less than 1 to reduce the risk of the overall portfolio. The risk of the overall portfolio is completely eradicated If these assets display a perfectly negative correlation. Thus, the lower the correlation, the better the benefit (Bodi, Marcus & Kane, 2005). Still, diversification cannot dispose of all types of risk. Indeed, investors come across two types of risks, namely, diversifiable and non-diversifiable (See Figure 3.4). Diversifiable risk, named also unique, unsystematic or firm-specific risk is the part of the portfolio risk that can be get rid of by augmenting the portfolio size, this kind of risk is associated with business or financial risk and can be eliminated by building a well-diversified portfolio. Non-diversifiable risk or also called systematic risk is the kind of risk related with overall movements in the general market or economy and can be sometimes referred as market risk. Market risk is the constituent of the total risk that cannot be removed through portfolio diversification because market risk stems from market broad risk origins that alter all firms in the same manner (Bodi/Kane/Marcus 2005). As a sample, technologies' changes that bring about an overall industry downturn portray systematic risk.

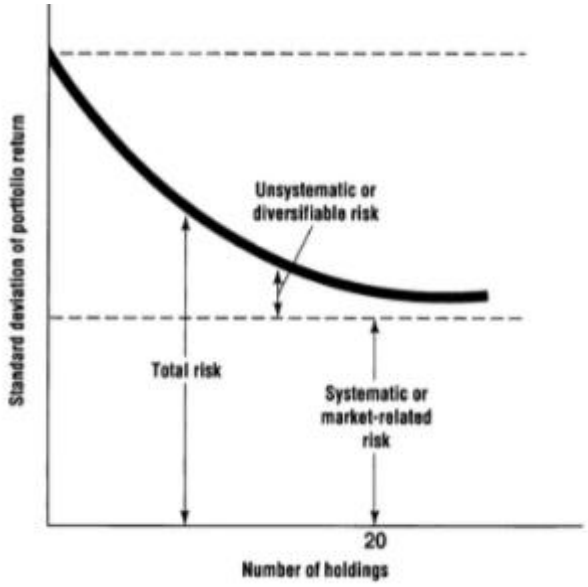


Figure 3.4: Systematic and Unsystematic Portfolio Risk

Source: (James L. Grant, 2001)

Hedge funds were developed to help diversify investment portfolios, manage the risk and achieve steady returns over time. Since hedge fund returns are known to be uncorrelated to the performance of the general market, using a hedge fund basket in a traditional portfolio composed of stocks and bonds can improve its efficiency (Amo et al., 2007; Amin and Kat, 2003; Statman and Scheid, 2007). According to Modern Portfolio Theory, hedge funds should be incorporated in an efficient portfolio to maximize the risk-return trade-off and create diversification opportunities. All in all, The Modern Portfolio Theory advanced by Markowitz (1952) delivered a fundamental framework in the evolution of the risk-return relationship of securities and was further employed for the creation of the Capital Asset Pricing Model (CAPM).

3.1.3 Asset-pricing Models

Asset pricing models evaluate securities' value with regard to the market risk or other exotic risks also named as factors. These models can be separated to single and multifactor models. The most acknowledged single factor model is the Capital Asset Pricing Model (CAPM) introduced by Sharpe (1964) and Lintner (1965). Multifactor models make use of diverse factors to estimate expected returns. The factors related beta coefficient symbolize the sensitivity to changes in every factor. Investors should pinpoint the factors that have an impact on the asset and determinate the factors' sensitivity and risk premium. Factors related beta coefficients that assess a security's sensitivity to the distinct risk premiums present on the financial markets are named alternative betas (Jaeger, 2008). Following the Capital Asset Pricing Model, several extensions have been developed to take on the factor specific beta coefficients aside from the equity world. Factor models will be presented here for a better comprehension of the words Alpha and Betta that will be analyzed for hedge fund strategies performance. The theoretical viewpoint of asset pricing models will also help to understand the following presentation of risk-adjusted performance measures.

3.1.3.1 Capital Asset Pricing Model (CAPM)

Sharpe (1964) and Lintner (1965) based on the idea of the Markowitz Portfolio Selection Theory (1952) developed the Capital Asset Pricing Model (CAPM), an equilibrium model that relates an asset's systematic risk with its expected return (Lintner 1965). According to the Modern Portfolio Theory, investors try to maximize returns avoiding unnecessary risk. The assumptions derived from this theory are that investors have access to the same free information, they share homogeneous expectations regarding expected returns and future

developments and they do not have enough power to influence market prices. Moreover, in this theory taxed and trading costs are not considered and investments are limited to publicly traded assets. Sharpe (1964) and Litner (1965) added two fundamental assumptions to the Markowitz model for a portfolio to be mean-variance efficient (Fama, French 2004). The first one is that investors who use the Markowitz portfolio selection model have the same investment horizon and are shortsighted in their investment intentions. Further, they assumed that all investors can borrow and lend at a risk-free rate and it doesn't depend on the amount borrowed or lent.

These assumptions imply that all investors are sharing the same efficient frontier by using the same approach and while having different combinations, they all own an optimal risky portfolio that is similar. Indeed, investors will hold the same market portfolio which sets on the efficient frontier and is the tangency point between the efficient frontier and optimal Capital Allocation line. The capital allocation line that passes through the market portfolio is named the Capital Market Line. Figure 3.5 exhibits the Capital Market line and the market portfolio.

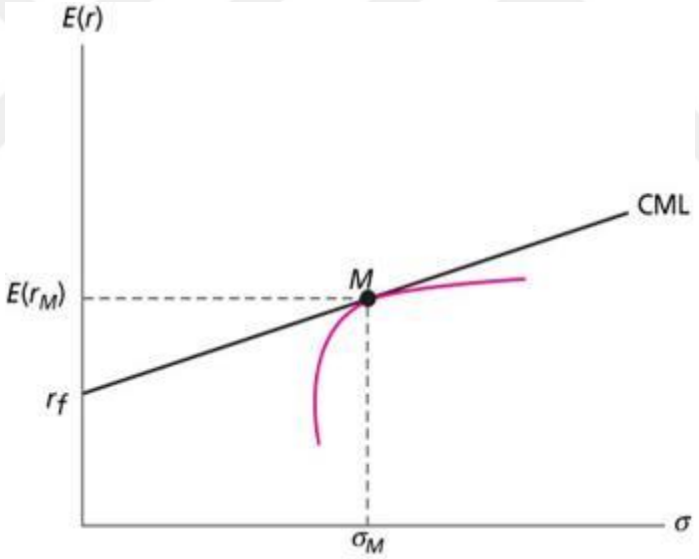


Figure 3.5: The Capital Market Line (CML)

Source: (Bodi, Marcus & Kane, 2005)

These assumptions bring in the so-called beta coefficient which is the sensitivity of a certain asset to the introduced market portfolio. The beta coefficient is the covariance of the asset with the market portfolio as a fraction of the variance of the market portfolio (Bodi, Marcus & Kane, 2005). A beta coefficient equals 1 implies that the asset has similar risk and expected return to the market. In practice, securities with a beta higher than 1 are considered

aggressive securities, since they on average move more than the market. Securities with a beta lower than 1 are called defensive securities, since they move less than the market.

$$\beta = \frac{\text{Covariance } (R_i, R_m)}{\text{Variance } (R_m)} \tag{3.2}$$

The beta of an asset estimates its contribution to the variance of the market portfolio and thereby the required risk premium is a function of beta. Risk premium of any individual asset or portfolio is the product of the risk premium on the market portfolio and the beta coefficient (Bodi, Marcus & Kane, 2005).

$$E(r_i) - r_f = \beta_i(E(r_m) - r_f) \tag{3.3}$$

where:

$E(rm)$- rf presents risk premium,

βi: is the market beta of an investment,

rf: is the risk-free rate

$E(rm)$: is an expected market return,

$E(ri)$: is an expected rate of return on investment

The expected return–beta relationship can be seen as a reward–risk equation. An asset beta is the relevant measure of its risk because beta is proportional to the risk the asset provides to the optimal risky portfolio. the expected return-beta relationship can be derived from the risk premium equation as:

$$E(r_i) = r_f + \beta_i(E(r_m) - r_f) \tag{3.4}$$

$E(rm)$- rf presents risk premium,

βi: is the market beta of an investment,

rf: is the risk-free rate

$E(rm)$: is an expected market return,

$E(ri)$: is an expected rate of return on investment

The Security Market Line (SML) illustrates the expected return–beta relationship. In comparison to the Capital Market line, the appropriate measure of risk for single securities incorporated as components of well-diversified portfolios is not the variance or the standard

deviation of the security but rather its input to the portfolio variance which is assessed by the security's beta (Bodi, Marcus & Kane, 2005). The Security Market Line is effective for single assets and efficient portfolios. Because the market's beta is supposed to be 1, the risk premium of the market portfolio is the slope and the discrepancy between the actual and the theoretically expected rates of return is named alpha (α) (See Figure 3.6).

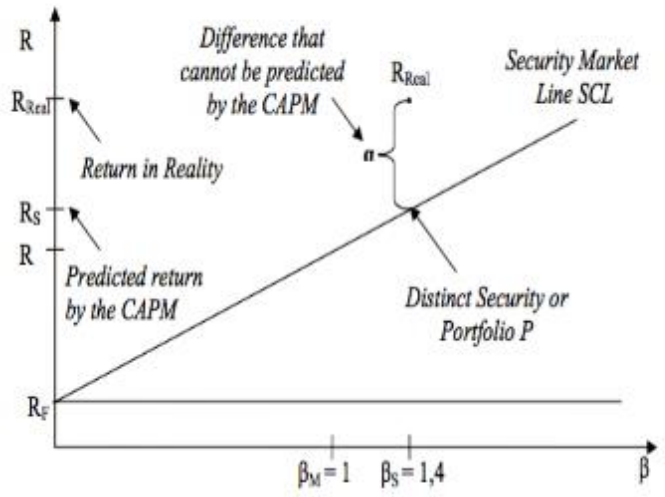


Figure: 3.6: Expected Return - Beta Relationship (SML)

Source: (Andreas & Musk, 2007)

The Security Market Line offers a benchmark for the appraisal of investments' performance. Taking into consideration an investment risk evaluated by its beta, the Security Market Line estimates the requisite rate of return to recompense investors for risk in addition to the time value of money. Beta represents an asset's volatility regarding market fluctuations and Alpha which can be positive or negative can be produced from investing in securities from a risky market like the stock market. It is the difference between the actual return and the expected return anticipated by an analysis model. A positive alpha displays an outperformance compared to the market and it is a scale that can only be explained in comparison to a benchmark that often portrays a certain market (Capocci, Hübner, 2004).

The Capital Asset Pricing Model received favorable opinions for its power to describe risk factors on the market. Yet, it also faced some critics concerning its limitations and unrealistic assumptions. Indeed, the CAPM depends on similar assumptions as the efficient market hypothesis such as efficient capital markets with rational investors and no arbitrage opportunities (Fama, 1970). Moreover, it was argued that the true market portfolio estimated by the market proxy is almost impossible to achieve and should rather incorporate everything

in the world that has value (Roll, 1977). It is only possible to build the true market portfolio by making qualified attempts (Ferson, Harvey 1991) and generally the market proxy works as a benchmark for systematic risk (Perold, 2004). Furthermore, some studies demonstrated that the Capital Asset pricing model did not succeed to explain market anomalies (Fama, French, 1993). Nevertheless, the CAPM is still utilized for many purposes such as the measurement of performance amid managed portfolios and in the calculation of the cost of capital of firms (Fama, French 2004). The whole concept is fundamental for this research study and the terms alpha and beta will be used in this research for the performance measurement of hedge fund strategies.

3.1.3.2 Fama French three-factor model

Fama and French (1992; 1993; 1996) suppose that the financial markets are in fact efficient, yet, they argue that the market factor does not explain all the risks alone. They designed a three-factor model by integrating two patterns in average returns left unexplainable by the Capital Asset Pricing Model of Sharpe (1964) and Lintner (1965). Fama and French (1993) assume that the size and the value are helpful factors to explain a cross-section of equity returns. They developed a three-factor model to apprehend the relationship between average return and size (Market capitalization, price times shares outstanding) and the relationship between average return and price ratios like B/M (Fama, French 1993). The model equation is presented as:

$$R_{it} - R_{ft} = \propto_{it} + \beta_1\left(R_{Mt} - R_{ft}\right) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it} \qquad (3.5)$$

In this equation:

R_{it}: is the return on asset or portfolio i for period t

R_{ft}: is the risk-free return

R_{Mt}: is the return on the value-weight market portfolio

SMB_t: is the difference between the return on a diversified portfolio of small stocks and the return on a diversified portfolio of big stocks.

HML_t: is the return on a diversified portfolio of high Book to Market stocks minus the return on a diversified portfolio of low Book to Market stocks.

ε_{it}: is a zero-mean residual.

Fama French model states that the expected return on a portfolio in excess of the risk-free rate is described by its return's sensitivity to three factors: Market (R_M- R_f), size (SMB) and value (HML) factors (Fama French 1996). The market factor is presumed to grab systematic risk coming from macro-economic sources. The size and value are firm-specific variables and were selected upon long lasting monitoring which showed that firm size (corporate capitalization) and book-to market ratio forecast divergences of average stock returns from levels in line with the Capital Asset Pricing Model (Bodi, Marcus& Kane, 2005). Fama and French (1993) built this model based on an empirical approach where they affirm that SMB and HML variables can proxy for still unknown more-important variables. They mentioned that companies with high book to market ratios are more expected to be in financial difficulties and that small stocks can be more triggered by transitions in business conditions (Fama, French 1995). Therefore, these two variables can be able to catch sensitivity to risk factors in the macro-economy.

Fama and French concluded that the choice of factors is not exceptional as they mentioned additional factors that may have an explaining ability, furthermore, they do not cleanly identify the variables given in the proposed models as hedging an important origin of uncertainty (Fama French, 1996). Fama French model gained a big popularity in modern finance and is widely used as an evaluation model. This model will be used in addition to the CAPM to evaluate our hedge fund strategies' performance.

3.1.3.3 The Carhart four factor model

The Carhart four factor model is a multi-factor model utilized to price assets. It was advanced by Mark Carhart in 1997 as an extension of the Fama French three factor model to enhance the explanatory power of Fama and French model (1993). His study was inspired by the three-factor model incapacity to describe cross-sectional deviation in momentum-sorted portfolio returns (Fama, French 1996) and previous studies on cross-sectional momentum factor.

The momentum effect was discovered by Jegadeesh and Titman in 1993. According to them, Momentum is a market anomaly that happens on stock returns and by employing momentum investment strategy, it is likely to achieve an abnormal return. The momentum strategy presumes buying stocks that achieved a good performance in the past months (winner) and selling stocks that performed poorly in the matching period (loser). Jegadeesh and Titman (1993) found in their research study that U.S stocks that had the best performance in a three to

twelve months period time persisted to show a good performance in the same subsequent period and on the other hand the least performing stocks continued to show a poor performance over the same period (3 to 12 months). They concluded that momentum effect is strong to time periods (Jegadeesh and Titman 1993). Following this study, Chan, Jegadeesh and Lokonishok (1996) argued that momentum anomaly is a market inefficiency that is caused by a slow reaction to information while Asness, Liew and Stevens (1997) added that momentum effect is robust to countries.

Motivated by these studies, Carhart incorporated a cross-sectional momentum factor to increase the explanatory power of the Fama French three factor model. Carhart (1997) noticed that the three-factor model performance estimations on mutual funds are more accurate but not economically distinct from the Capital Asset Pricing Model while the estimations of the four-factor model are continually different as a result of the important loadings on the one-year momentum factor (Carhart 1997). The model equation is presented as:

$$R_{it} - R_{ft} = \propto_{it} + \beta_1(R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it} \quad (3.6)$$

In this equation:

R_{it}: is the return on asset or portfolio i for period t

R_{ft}: is the risk-free return

R_{Mt}: is the return on the value-weight market portfolio

SMB_t: is the difference between the return on a diversified portfolio of small stocks and the return on a diversified portfolio of big stocks.

HML_t: is the return on a diversified portfolio of high Book to Market stocks minus the return on a diversified portfolio of low Book to Market stocks.

UMD_t: The difference between the returns of a portfolio of stocks with high prior returns and a portfolio of stocks with low prior returns.

ε_{it}: is a zero-mean residual.

Momentum strategies are still popular in financial markets, Carhart model is frequently utilized as an evaluation model of mutual and hedge funds.

3.1.3.4 Fama and French five factor model

Fama and French adjusted the outperformance propensity of the Capital Asset Pricing Model with their three-factor model (1993); adding the size and the value as explanatory factors made an important advancement over the CAPM. Yet, several studies (Titman et. Al, 2004;

Novy-Marx, 2013) criticized the three-factor model being incomplete and unable to explain anomalies related to profitability and investment for cross-sectional variations in average returns. Motivated by these studies, Fama and French extended their three factor-model to a five-factor model by including profitability and investment factors. Their study is based on the dividend discount model which asserts that the present value of stocks relies on future dividends; with the use of the discount model, they obtained two additional factors: investment and profitability (Fama and French, 2015).

Fama and French five-factor model describes the expected return on a portfolio in excess of the risk-free rate by its return's sensitivity to five factors: Market, size, value, profitability and investment factors, the five-factor model's regression has the equation below:

$$R_{it} - R_{ft} = \propto_{it} + \beta_1(R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \varepsilon_{it} \quad (3.7)$$

In this equation:

R_{it}: is the return on asset or portfolio i for period t

R_{ft}: is the risk-free return

R_{Mt}: is the return on the value-weight market portfolio

SMB_t: is the difference between the return on a diversified portfolio of small stocks and the return on a diversified portfolio of big stocks.

HML_t: is the return on a diversified portfolio of high Book to Market stocks minus the return on a diversified portfolio of low Book to Market stocks.

RMW_t: is the spread between the return on a diversified portfolio of stocks with robust profitability and the return on a diversified portfolio of stocks with weak profitability.

CMA_t: is the spread between the return on a diversified portfolio of stocks of low investment companies and the return on a diversified portfolio of stocks of high investment companies.

ε_{it}: is a zero-mean residual.

In their research paper, the regression was performed on portfolios constructed on size (SMB), value (HML), profitability (RMW) and investment (CMA). Thereafter, the performance results of the five-factor model were compared with the three factor model's performance results to observe if their three-factor model doesn't target considerable anomalies describing average stock returns (Fama and French, 2015). The main objective of this regression is to see if the five-factor model explains stock average returns and to examine how the distinct factors are related and how they affect average stock returns. Their results revealed

that the value factor becomes disposable for explaining average returns when investment and profitability are incorporated into the regression. Yet, they argued that a four or a five-factor model will be more convenient for investors seeking absolute returns while a five-factor model can be applied for a factor tilt approach and absolute returns objectives. Fama and French (2015) assume that the five-factor model is superior than the three-factor model in reducing the average stock returns' anomalies that remained unexplained by their previous model. They concluded that small, profitable and value firms with no considerable growth expectations generate higher expected returns (Fama and French, 2015).

3.1.4 Risk-adjusted Performance Measures

In the past, hedge funds performance measurement was not always based on historical returns of portfolio and investors and returns were not always associated with risk. However, due to various circumstances, some hedge funds started to achieve terrible performances and investors started to lose faith in hedge fund managers. Therefore, more adequate performance measurement tools were required to evaluate hedge fund performances (Bodi, Marcus &Kane, 2005).

The most basic measure of hedge fund performance considers the return (Rp) of the portfolios and it is calculated with the following equation (Bodi, Marcus &Kane, 2005):

$$Rp = \frac{Ve - Vb}{Vb} \tag{3.8}$$

Where:

R_p: The portfolio's return

V_e: The value of the portfolio at the beginning

V_b: The value of the portfolio at the end

This formula is applied for funds not experiencing any deposit or redemption during the calculation period. Overtime, risk started to be associated with returns and a two-dimensional performance measurement were created. It is not sufficient to evaluate the returns without considering the risk levels of portfolios (Sharpe,1964; Litner,1965). There are two types of risk-adjusted performance measures: A relative measure that estimate risk-adjusted returns in comparison to a proxy and an absolute measure that appraise the performance without using a benchmark (Hubner, 2009). In this study, both of these measures will be utilized to

evaluate and compare hedge fund strategies performances. Alpha is one of the most prevailing relative measure and Sharpe ratio and Sortino ratio are one of the most employed absolute measures in hedge fund performance analysis. The introduction of these three measures is essential to understand their applications in this research and to comprehend the interpretations of the actual findings.

3.1.4.1 Alpha

Alpha (α) is a risk-adjusted measure of active return on investment; it represents the return of an asset above what it is expected considering the asset's risk exposures. Alpha is also called excess return or abnormal return which relates to the efficiency market hypothesis in which it is impossible to systematically generate positive returns that beat the market. A positive Alpha (α) demonstrates that an asset or a portfolio, given the exposure to the different risk factors, abnormally achieved a superior performance (Bodi, Marcus& Kane, 2005). In the alternative investment world, Alpha is utilized as a performance measurement tool to determine if an investment strategy is able to outperform the market or its edge and if a trader or a manager has succeeded to beat the market return in a certain period of time (Kowoski,2007). It is a relative performance measure that evaluates the performance of an investment in comparison to a proxy that often represents a specific market (Jensen, 1968).

The most basic calculation of Alpha(α) is based on the Capital Asset Pricing Model (Sharpe 1964, Lintner 1965) and is often referred as the Jensen's Alpha (1968) where:

$$\propto_{it} = R_{it} - \left(R_{ft} + \beta_i\left(R_{Mt} - R_{ft}\right)\right) \tag{3.9}$$

where R_{it} is the return of an investment i at time t, R_{ft} is the risk-free return at time t, Rmt the market portfolio's return at time. The αi represent the intercept of the regression (Patro, 2001). Alpha is usually utilized in combination with Beta (β) which stands for the sensitivity of an asset or a portfolio the market portfolio, it is used as a measure of the market volatility also named as market systematic risk (Bodi, Marcus & Kane, 2005).

$$\beta_{it} = \frac{Covariance(R_{it}, R_{mt})}{Variance(R_{mt})} \tag{3.10}$$

where R_{it} is the return of an investment at time t and R_{mt} is the market portfolio's return at time t. A beta equals 1 shows that the asset or the portfolio has the same risk and volatility as the market (Bodi, Marcus & Kane, 2005).

Following the extensions of Capital Asset Pricing Model to multi-factor models, new relative performance measures were not created and researches commonly made use of the portfolio abnormal return known as Alpha that involves systematic risk and which is calculated similarly to the Jensen's Alpha (1968). Alpha (α) is the preeminent performance measurement tool for multi-factor models where the model determines the factors driving the expected returns and alpha represents the intercept of the linear regression (Ilmanen, 2012). It is computed such as:

$$\alpha_{it} = R_{it} - \beta_{i1}Factor1_t + \cdots + \beta_{i5}Factor5_t \quad (3.11)$$

Where R_{it} is total return of an investment i at time t and the betas namely factor loadings ($\beta_{i1}, \ldots \beta_{i5}$) design the sensitivity of the fund to each factor (Bodi, Marcus & Kane, 2005).

Alpha (α) is strongly established as a prevailing performance measurement metric in the investment lexicon and all investors and fund managers are seeking positive and significant alpha (Fung et al.,2008).

3.1.4.2 Sharpe Ratio

William F. Sharpe introduced the Sharpe ratio in 1966 following his contribution to theoretical finance with the CAPM. The Sharpe ratio is among the most employed performance measurement metrics and it is built on the beliefs of the mean-variance framework in which returns have normal distributions and investors are characterized by a quadratic utility function (Sharpe,1966). The Sharpe ratio estimates the risk premium in comparison to the overall risk of a portfolio, the overall risk includes systematic and unsystematic risk and is referred as the standard deviation of a portfolio (Bodi, Marcus & Kane, 2005). This ratio indicates the excess returns to be received given an additional risk taken for an asset or a portfolio, it is defined as

$$Sharpe\ Ratio = \frac{(r_i - r_f)}{\sigma_i} \quad (3.12)$$

Where $(r_i - r_f)$ is the excess return of the investment over the risk-free rate and σ_i is the standard deviation of the investment returns.

The Sharpe ratio is widely used in the academia and the industry as a significant performance measurement metric (Eling et al., 2007; Ackerman et al., 1999; Liang and Kat, 2001), it was initially developed to appraise the performance of mutual fund managers and its

use extended further to the hedge fund universe. Since the ratio relies on the overall risk of an investment, it is more adequate for investors allocating their capital in an individual fund and focusing on the total risk of their portfolio. The higher the ratio, the more appealing and worthier the investments are; taking into consideration the same level of risk, the returns of higher Sharpe ratio investments will be superior than those of investments having inferior Sharpe ratios (Sharpe,1994). The wide use of the Sharpe ratio in performance measurement is due to its simple formula that incorporates standard deviation. Therefore, it is unnecessary to compare with a benchmark and to examine the sensitivity of a fund to the benchmark and the distinct loading factors. It is more convenient to use when comparing different investment strategies. However, the Sharpe ratio is often criticized as an inappropriate measurement for particular investments like hedge funds as it demonstrates certain drawbacks (Capocci 2002; Brooks and Kat 2002; Amine and Kat 2003; Eling and Schuhmacher 2007).

The Sharpe ratio is based upon the assumption that returns have a normal distribution; still, in real market circumstances and for some hedge funds, the distribution can be negatively skewed and exhibit a high kurtosis which reduces the reliability of the Sharpe ratio. Furthermore, the Standard deviation incorporated for Sharpe ratio's estimation considers positive and negative deviations in returns from the average. Thus, the downside volatility is not precisely assessed in the Sharpe ratio's calculation (Mazhar, 2018). To reduce the limitations of Sharpe, other measures were developed like the Sortino ratio that takes heed of negative deviations and downside volatility.

3.1.4.3 Sortino Ratio

When Harry Markowitz introduced the Modern Portfolio theory (1952), he assumed that downside deviation would be more useful to investors than standard deviation. Yet, he applied standard deviation in his theory as optimizations were not mathematically practical at that time (Rollinger et. al, 2013). In the eighties, Frank Sortino began his research to develop an ameliorated risk-adjusted returns measure. The Sortino ratio (1994) is a modification of the Sharpe ratio and has been introduced to consider the asymmetricities in returns' distributions. In place of standard deviation, the Sortino ratio employs downside deviation as a measure of risk. The downside deviation accounts for only returns falling below a minimum acceptable return (MAR) or a desired target return, the minimum acceptable return can represent a long-

term Treasury bond, short-term Treasury bill, average return, zero or any desired target return. The Sortino ratio of an investment can be computed as:

$$Sortino\ Ratio = \frac{E(R_{it} - MAR)}{\sqrt{E(Min(R_{it} - MAR), 0)^2)}} \quad (3.13)$$

Where R_{it} is total return of an investment i at time t, MAR is the minimum acceptable return, and $\sqrt{E(Min(R_{it} - MAR), 0)^2)}$ is the downside deviation.

While evaluating and comparing the performance of funds displaying skew in their return distributions, the Sortino ratio was found to be more adequate (Chaudhary et. Al, 2008). The only difference between Sharpe and Sortino ratios is the downside volatility rather than the overall volatility. The reasons behind this modification is that positive volatility is beneficial for investors, thereby, it should not be considered in the calculation of risk. Accordingly, Sortino ratio includes only downside volatility and excludes upside volatility in the estimation of the ratio (Sortino, 1995). Financial Analysts and investors opt for the Sortino ratio to assess high volatility investments and Sharpe ratio to assess low volatility investments.

Owing to the dynamic trading strategies characterizing the hedge fund industry, the Sortino ratio can be a significant performance measurement tool for hedge fund performance analysis since it takes into consideration some hedge funds' features such as distributions asymmetricities (Amin and Kat, 2003).

3.2 Related Literature

This section relates previous researches on various aspects of hedge funds such as the evolution of measures of hedge funds' performance, the evaluation of hedge funds' and their strategies performance, hedge funds' correlation with other traditional indices and the continuity of hedge funds' performance. Before mentioning the previous studies in the literature concerning hedge funds and their performances, it is important to mention the evolution of performance measures of risk-adjusted returns in previous researches.

In the past, hedge funds' performance measurement was based on the Capital Asset Pricing Model (Sharpe 1964; Litner 1965) and its extensions such as the Jensen's alpha (1968). Over the years, multi factor models were introduced to evaluate hedge fund performance

considering distinct features. Sharpe (1992) first put in place the asset class factor model that incorporated twelve asset classes and described the fluctuation of their returns in a definite time using their level of exposure. Yet, the model was only suitable for long-only strategies and hedge funds employ strategies holding short positions and using leverage. Following that, there has been a significant number of studies on multi-factor models especially with the increased literature on cross-sectional variations in stock returns. Many researches showed that the cross-section of average returns on common stocks in the U.S were slightly related to the Capital Asset Pricing Model's betas and detected additional factors like the company's size (Banz, 1981; Fama and French, 1992), dividend yield (Litzenberger et al. ,1982), book-to-market (Fama and French, 1992), leverage (Bhandari,1988) and the momentum factor (Jegadeesh et al. ,1993; Carhart, 1997). They assume that these factors have an explanatory power of the cross-sectional variations in stock returns. Fama and French (1992) constructed a three-factor model extending the CAPM and adding the size and the value as explanatory factors while Carhart (1997) expanded Fama French three-factor including an additional component which is the momentum effect. These models are the most utilized to assess hedge fund performance, they were applied in distinct studies in the hedge fund literature like Schneeweis et al. (1998), Capocci and Hubner (2004), Jordao and De moura (2011), Nicola and Vijay (2017).

The Sharpe's reward to variability ration (1966) is the most notable and the broadly utilized performance measurement tool which assesses the excess return over the risk-free rate is association to the overall risk. It was frequently employed in the theory to evaluate hedge fund performance (Ackermann et al.,1999; Liang and Kat, 2001; Amin and Kat, 2003). However, numerous studies demonstrated its limitations as a performance measurement tool due to its reliability on the mean-variance framework and its possible inadequacy for hedge fund returns' that tend to exhibit asymmetricities in their return' distributions (Capocci, 2002; Brooks and Kat 2002; Eling et. Al, 2007). In a response to this problematic, Sortino and Price (1994) established the Sortino ratio which separates the bad deviation from the total risk and divides the excess return of an investment by the downside deviation. The downside deviation is the deviation of returns under a minimum acceptable target. This ratio helped reduce the limitations of Sharpe ratio in the performance measurement of asymmetric return distributions (Rosenberg et. Al, 2004; Scherer 2002; Chaudary et. Al, 2008).

There are multiple significant researches that have been made on hedge funds performance in the hedge fund literature. Many studies compared hedge funds performance with other benchmark indexes such (S&P500); Ackermann et al. (1999), Liang (1999), Brown

et al. (1999) and Cappoci and Hübner (2004) concluded that hedge funds perform better than traditional benchmark indices. For Turkish hedge funds, Çağıl and Hosseini (2011) came with the result that Turkish hedge funds are not able to outperform the benchmark ISE-100 index.

Besides, hedge funds returns' correlation with the performance of capital markets was also studied in hedge fund literature. Fung, et al. (1997); Schneeweis, et al. (1998); Agarwal, et al. (1999) and Liang (1999) documented that hedge funds display a low correlation with other financial assets which can enhance the risk-return tradeoffs if hedge funds are incorporated in a portfolio with other traditional assets. For Turkish hedge funds, Kamışlı (2020) reported that Turkish hedge funds exhibit an asymmetric causality with exchange rate, gold and bond indices' returns. Thus, Asness et al. (2001) and Amin and Kat (2003) argue that diversification benefits arise when hedge funds are inserted in a portfolio of stocks and bonds.

Hedge funds have been drawing a lot of academic attention, still, few studies were concluded on how hedge fund strategies perform and which strategy is superior in term of performance. This is essentially due to the restricted access to individual funds database. Among the researches covering hedge fund strategies performance; Fung, et al. (2011) investigated Long/Short strategies performances and they discovered that less than 20% of the studied funds could beat the market and more than 80% didn't succeed to generate positive alphas. Capocci and Hubner (2004) examined hedge funds investment behavior using various asset pricing models. Their findings showed that up to 25% of single hedge funds could achieve significant returns and most of them prefer trading in small stocks and emerging markets. Also, in their study on hedge fund strategies performances for the period between 1994 and 2011; Bali, et al. (2013) found out that Long/Short Equity and Emerging Markets strategies indices performed better than the S&P 500. In addition to that, they concluded that the majority of hedge fund strategies outperform the U.S treasury market.

Several authors evaluated hedge fund during financial crises; Liang, et al. (2001) documented that hedge funds incurred losses as an aftermath of the economic crisis of 1998. Schaub and Schmid (2013) examined hedge fund performance in the financial crisis of 2007 and they demonstrated that illiquid hedge funds were affected more than liquid hedge funds by the financial crisis. In accordance to these studies, Capocci and Hubner (2004) and Stoforos, et al. (2016) showed that hedge funds were not able to achieve superior returns over traditional assets in period of crises. Unlike previous studies, Nikola and Vijay (2019) argued that hedge fund strategies could beat the market during the crisis periods in their study for the period

between (2007-2017) and they concluded that Global Macro, Emerging Markets and Multi-strategy were leading in terms of performance.

Hedge fund managers play a big part in hedge fund and their strategies performance, they hold a discretionary power and they can handle actively distinct asset classes employing a wide array of strategies. A few studies scrutinized managers' skills and its impacts on the performance of hedge funds. Jagannathan, et al. stated that hedge fund managers adopting a top-down management approach achieve a more persistent performance than managers following a bottom-up style underlying the significance of managerial talent, they also concluded that talented managers produce superior alpha than low skill managers in strong market situations with their improved asset selection ability. Consistent with these conclusions, Titman and Tiu (2011) assert that talented managers are able to hedge away systematic risk exposure and accordingly exhibit reduced R2 in multi-factor regressions.

Risk management in the hedge fund industry is fundamental. Indeed, risks associated with hedge fund strategies and their performances are manifold and they can bring about various impacts depending on the strategy applied by the hedge fund. (Bali et al., 2012) revealed that some specific strategies can be affected by some specific types of risk: Long/Short Equity are exposed to the short-squeeze risk stemming from their brokers, Fixed Income strategy is subject to the credit spread widening risk, Distressed Securities can face an exposure to liquidity and credit risks and Emerging Markets can face sovereign risk. Furthermore, they argued that hedge funds that are highly exposed to systematic risk deliver superior risk-adjusted returns. (Bali et al., 2011) also assumed that relative value strategies had lower variations and spread in their beta factors than directional strategies. With the use of asset pricing models, (Fung et al.,2011) assumed that Long/Short Equity strategies demonstrated significant alphas to traditional as well as exotic risk factors. Also, Agarwal and Naik (2004) indicated that hedge funds illustrate significant exposures to Fama French (1993) three-factor model and to Carhart (1997) momentum factor.

A diversified portfolio of hedge funds with a global perspective is the ultimate goal of investors (Fothergill et al, 2001). Cointegration and factor analysis can be adopted to examine the diversification possibilities of distinct hedge fund strategies. it is also used to prevent the incorporation of two or more managers with the same investment approaches in the same portfolio oh hedge funds, (Alexander et. al 2001). The cointegration approach has rarely been used in the comparison of the long-term performance of the different hedge fund strategies. It

is an approach that has been developed in the recent years and should applied to compare the performance of hedge fund strategies since hedge fund databases offer today a bigger horizon that it provided before. Gregoriou and Rouah (2001) explored the long-term relationships between ten hedge funds and stock market indices for a period of ten years. They came with the result that three of the hedge funds were cointegrated while the others were not cointegrated.

In the literature, many studies made a comparison between hedge funds and mutual funds analyzing the similarities and the discrepancies of these two funds' risk-adjusted performances and risk exposures (Ackermann et al., Liang 1999; Brown et al., 1999; Capocci and Hübner, 2004).

Ackermann et al. (1999), Liang (1999) examined the dissimilarities between hedge funds and mutual funds and various market indices and they argue that hedge funds constantly beat mutual funds but not always market indices. They further advance that hedge funds' outperformance is mostly due to flexible nature of hedge funds investments and their motivating incentives and also due to the increased legal restrictions that obstruct mutual funds' performance. Moreover, Ackermann et al. (1999), and Liang (1999) revealed that the returns of hedge funds display a higher volatility than the returns of mutual funds and market indices. Brown et al. (1999), Capocci and Hübner (2004) investigated the risk-adjusted performance differences between hedge funds and mutual funds and studied their performance persistence. They came with a result that hedge funds continuously outperform mutual funds and proved that hedge fund performance persists at annual horizons and it is due to their investment flexibility rather than pure chance as indicated by Kosowski et al. (2007). For Turkish hedge funds, Çağıl and Hosseini (2011) analyzed the performance of Turkish hedge funds and mutual funds and they concluded that Turkish hedge funds are unable to surpass mutual funds. In his paper, Stulz (2007) compiled the literature differentiating hedge funds and mutual funds performances, he assumed that hedge fund industry's expansion is mostly related to its superiority to the mutual fund industry and its power to provide complicated investment strategies that mutual funds fail to provide.

Later researches attempted to seek for the reasons behind hedge funds' superior performance. Agarwal et al. (2009) scrutinized hedge funds, mutual funds and hedge mutual funds (HMF) performances. HMF's are mutual funds that adopt similar strategies to hedge funds but do not profit from the fee structure and the lack of regulation that are specific to hedge funds. Agarwal et al. (2009) determined that despite using the same investment strategies,

hedged mutual funds failed to outperform hedge funds however they could surpass traditional mutual funds which the authors ascribed to their use of flexible investment strategies and the experience of managers adopting similar hedge fund strategies. The authors deduced that the lack of regulation, investment selection flexibility and managerial experience are the key factors behind hedge funds outperformance. In the same direction, Eling and Faust (2010) tried to explain hedge fund superior performance employing emerging markets data since these markets are characterized by limitations on short selling and the use of derivatives, they were looking forward to disclosing additional factors explaining hedge funds' performance. Based on their findings, they stated that hedge funds superior performance in emerging markets is associated with their ability to alter actively their asset distribution. Overall, the majority of the existent literature advance that hedge funds surpass mutual funds and other traditional assets in terms of performance.

3.3 Research Design

In this section, the hypotheses of this thesis are explicated. Thereafter and a description and a justification of the data utilized in this empirical research is provided.

3.3.1 Hypoteses Development

As related in the existing literature of hedge fund strategies performance, there are more studies confirming hedge fund strategies outperformance in comparison with benchmark indexes (Ackermann et al.,1999; Liang, 1999; Brown et al., 1999; Capocci and Hubner, 2004; Bali et Al., 2013; Nikola and Vijay, 2019). Hence, this study is likely to be in accordance with their results. The first hypothesis is:

Hypothesis 1: Hedge fund strategies indices outperform the market benchmark (MSCI World) index.

Some authors examined hedge fund strategies performance in divided periods to analyze hedge fund strategies behavior in reaction to market situations and trend reversals. (Liang,2002; Capocci and Hubner, 2004; Schmid, 2013; Stoforos et al., 2016) demonstrated that hedge fund strategies are affected by extreme market events and underperform the market in period of crises. Yet, few authors demonstrated that hedge fund strategies could beat the market during crisis periods (Nikola and Vijay). Therefore, the second hypothesis is:

Hypothesis 2: Hedge fund strategies outperform the market benchmark (MSCI World) index in period of crisis and trend reversals.

Several authors compared the performance of hedge funds and mutual funds (Ackermann et. Al, 1999; Liang, 1999; Brown, 1999; Schneeweis & Martin, 1998; Liang and Kat, 2001; Capocci & Hübner, 2004; Stulz, 2007; Eling and Faust, 2010) and confirmed hedge funds prevailing over mutual funds. Furthermore, few studies compared mutual funds following hedge fund strategies (Agarwal, 2009) and affirmed hedge funds outperformance over mutual funds. Yet for Turkish hedge funds, (Çağıl and Hosseini, 2011) demonstrated that Turkish hedge funds are unable to beat mutual funds. Thus, the third hypothesis will be:

Hypothesis 3: Hedge fund strategies indices outperform Mutual fund strategies indices.

Cointegration approach is used to prevent the incorporation of two or more managers with the same investment approaches in the same portfolio of hedge funds which eliminates the opportunities of diversification and therefore deteriorate the performance (Alexander et. al 2001). The cointegration approach has rarely been used in the literate since hedge fund databases used to be very limited. Gregoriou and Rouah (2001) explored the long-term relationships between distinct hedge funds and found that three of the hedge funds were cointegrated, while the others were not cointegrated. So that, the fourth hypothesis will be:

Hypothesis 4: Hedge funds strategies are strongly cointegrated and there is a probability of management style or asset risks similitudes preventing any diversification opportunities.

3.3.2 Data Selection and Description

The aim of this study is to present a thorough comparative analysis of the most significant and important hedge fund strategies for the full period study and for divided sub periods as well as to compare hedge fund strategies performance with mutual funds adopting similar strategies. Furthermore, the study examines the long-term relationship between hedge fund strategies. Therefore, the research adopts a time-series and a comparative research design.

To cover the general performance of hedge funds and compare hedge fund strategies, hedge fund strategies indices are selected for this purpose. Hedge fund indices shed light on hedge fund strategies and their related risk and return properties and increase the transparency and the accuracy of the hedge fund industry (Credit Suisse, 2020). Hedge fund strategies' indices are collected and studied for the period of January 2001 to December 2020. For the sub-

periods study, the time span is divided to four periods (2001-2005), (2006-2010), (2011-2015) and (2016-2020) which provides a large sample of returns and prices.

Three databases are being exploited to sort out the possible divergence among distinct databases and to offer a broad sample that is representative of the hedge fund industry. Eurekahedge, Credit Suisse and the center of international securities and derivatives markets (CISDM) are being used which are the most all-encompassing on the market.

The Eurekahedge Global Hedge Fund Database is Eurekahedge's main database with 25,877 hedge funds as of 2020 with 11563 active hedge funds involving Funds of funds (FOF) that are not included in this research. The database covers various regional and specialized hedge funds including Asia (AHF), Emerging Markets (EMHF), Frontier Markets (FMHF), Latin America (LAHF), Insurance-Linked Securities (ILS), Commodity Trading Advisors and Managed Futures (CTA), Long Only Absolute Return Funds (LOARF), Obsolete Funds (OHF) and many others (Eurekahedge, 2020). Eurekahedge includes 2530 funds in its index assessing only the largest funds which exclude a large number of funds tracked by the database. To be incorporated in their index, funds should be operating for at least a year and should have $50 millions Assets Under Management (AUM). Moreover, there are no twin funds in the database indices, funds that have a distinct share class or are the same but in a different currency are eliminated (Eurekahedge, 2020).

The Credit Suisse Hedge Fund Database tracks nearly 9,000 funds restricted to a minimum of US$50 million value. Credit Suisse carries 284 funds in its index culled from a database of about 9000 funds. It takes in only funds that features a minimum investment of $50 millions and, audited financial statements and a one-year track record and eliminate duplicate funds. Furthermore, Credit Suisse database adopts a rules-based methodology to reduce subjectivity in the selection process and to bring off a maximum depiction of the index world. Credit Suisse doesn't restrict its indices to a certain region and may incorporate funds operated in several countries worldwide (Credit Suisse, 2020).

The Morningstar CISDM Database (formerly the MAR Database) is the senior Hedge Fund and CTA database in the market. CISDM Database keep tabs on the performance of hedge funds, commodity trading advisors, and managed futures funds. It is composed of more than 6000 hedge funds including funds of funds and CTAs. CISDM Database is highly acknowledged as a research tool by academics in their researches and in articles related to hedge

funds. Hedge fund indices are calculated by the Center for International Securities and Derivatives Markets (CISDM) at the University of Massachusetts. CISDM incorporates 3770 funds in its index cut out from the large number of funds tracked. Audited financial statements and minimum asset conditions are not compulsory for funds to be admitted however twin funds are removed in the index calculations (CISDM, 2020).

Table 3.1: Number Of Funds In Hedge Fund Strategies Indices

	Eurekahedge	Credit Suisse	CISDM
Convertible Arbitrage	78	11	86
Fixed Income	310	26	73
Market Neutral	54	16	112
Event Driven	110	31	110
Distressed Debt	19	9	82
Multi-Strategy	242	20	322
Global Macro	181	23	203
Managed Futures	358	34	460
Long/Short Equity	900	70	2052
Emerging Markets	278	44	270
TOTAL Funds	2,530	284	3770

The number of possible overlapping funds in these databases is usually very small because databases generally have different clients and only a very small number may report to more than one database. Table 3.1 exhibits the number of individual hedge funds in each of Eurekahedge, Credit Suisse and CISDM strategies indices. There are 10 strategy indices in total. The global hedge fund indices which are the Eurekahedge Hedge Fund Index, the Credit Suisse Hedge Fund Index and the CISDM index consists of all the funds in this table.

Table 3.2: Mutual Fund Strategies' Indices

MUTUAL FUND	STRATEGY	INDEX
VANGUARD 500	GLOBAL	VFINX
BOSTON PARTNERS LONG SHORT EQUITY	LONG SHORT EQUITY	BPLEX
THE ARBITRAGE FUND	ARBITRAGE	ARBNX
DWS GLOBAL MACRO	GLOBAL MACRO	DBISX
GUGGEINHEIM SERIESTRUST MANAGED FUTURES STRATEGY	MANAGED FUTURES	RYMTX
BLACKROCK EVENT DRIVEN STRATEGY	EVENT DRIVEN	BALPX
SA GLOBAL FIXED INCOME	FIXED INCOME	SAXIX
ABERDEEN DIVERSIFIED ALTERNATIVES	MULTI-STRATEGY	GASIX
CALAMOS MARKET NEUTRAL FUND	MARKET NEUTRAL	CVSIX
ICON EMERGING MARKETS	EMERGING MARKETS	ICARX

To compare hedge fund strategies performance with mutual funds applying similar strategies, data for mutual fund indices are collected and analyzed from (Yahoo finance, 2020) for the period starting from January 2008 until December 2019. Hedge fund indices were analyzed and compared to mutual funds for the same timespan (2008-2019). The different mutual funds' indices were selected for their similarities with hedge fund strategies and Vanguard 500 index was selected as a global proxy since it tracks the Standard & Poor's 500 index, one of the most widely used benchmarks for U.S. stocks. Table 3.2 illustrates the mutual fund indices selected for the comparative analysis.

To appraise the performance of the various hedge fund strategies indices and to compare them with mutual funds indices, a benchmark is necessary. Benchmarking with an index is consistent when the benchmark index is comprehensive, rule-based, investable, transparent, diversified, timely reported and liquid (Stefanini, 2006). In this research, Morgan Stanley Capital International (MSCI) World is picked as our benchmark and proxy for market return. Data is collected from Morgan Stanley site (2020). Finally, the data for the variables used in asset- pricing factor models for comparison purposes of hedge fund strategies have been downloaded from Kenneth French Data Library from Tuch School of Business.

3.3.2.1 Data Biases

Data reporting is voluntary in hedge fund industry due to the secretive nature of hedge funds. Therefore, data inconsistencies may take place in hedge fund databases and they can subsequently display biases at performance data level. The main potential biases that are likely to appear in hedge fund databases are:

3.3.2.1.1 Survivorship bias

The survivorship bias happens when a fund ceases reporting to databases providers which can be due to its weak or because of its termination (Ackermann et. Al, 1999). Funds are regarded as dead or closed when they halt reporting and these funds can be excluded from databases following their disappearance (Fung et al., 2000). Consequently, databases may exhibit biased historical returns (Fung et.al, 2001). Hedge that ceased reporting are denoted defunct funds in contradiction to alive funds that continue to report to database providers. Survivorship bias appears once a fund's securities involves only profitable investments in the preceding periods (Fung et al., 2000). Our databases attempt to prevent the survivorship bias to occur by including the past performance of defunct and closed funds in their indices until they are totally liquidated or incapable to fulfill the financial reporting conditions. In such manner,

the effect of the survivorship bias will not be of a big concern in this research (Eling et. Al, 2010).

3.3.2.1.2 Self-selection bias

The self-selection bias refers to the voluntary disclosing of hedge funds returns to databases, hedge fund managers are compelled to report to their investors but have the choice to disclose or not to database providers (Liang, 2000). Considering reporting as an option, managers with a good performance record will be eager to report in order to draw additional investors using the database as an advertising instrument. In the other direction, managers with a bad performance track will be more conservative to report to avoid the comparison with other successful funds (Eling et al., 2010). Some well performing managers may refuse to report their numbers if they are not seeking for additional investors because increasing the capital may reduce hedge funds' returns (Fung et al., 1997). Thus, database providers may not illustrate the full hedge fund universe (Fung et al., 2001). Yet, the selection bias represents a small concern since the managers' reasons for not disclosing offset each other which reduces its extent (Fung et. Al, 1997). Moreover, the presence of this bias relies on the hedge fund group overperforming which makes its clear impacts vaguer (Lhabitant, 2002).

3.3.2.1.3 Black-filling bias

Black-filling bias arises when a hedge fund operating in the past resolves to be a part of a database provider. To be included in a database, hedge fund managers are asked to deliver historical performance. For these situations, funds with good performance tracks are willing to provide their accumulated returns while funds with a weak performance history may decline to disclose (Ilmanen, 2012). Hence, only profitable funds agree to deliver their historical performance to engage new capital while an unprofitable performance history will not be perceived in the database (Eling et al., 2010). Therefore, this bias may adorn the general image of hedge fund returns (Capocci& Hubner, 2004). Nevertheless, Black-filling bias can be remediated by removing the past 12-24 monthly returns of the new added funds (Fung et., al, 2000; Capocci & Hubner, 2004).

3.4 Methodology

The distinct empirical measurements and the models and variables used to compare hedge fund strategies performances with the benchmark and with mutual funds and to analyze the long-term relationship between hedge fund strategies in this thesis are described below:

3.4.1 Performance Measurements

Three measures have been computed to compare the distinct hedge fund strategies indices with the benchmark (MSCI World) and with mutual fund indices: Alpha, the Sharpe ratio and the Sortino ratio.

- Alpha as a risk-adjusted measure of active return on investment is calculated with the use of four asset pricing models namely the Capital Asset Pricing Model (CAPM), Fama-French Three Factor Model (FF-3), Carhart Four Factor Model (Carhart 4) and Fama-French Five Factor Model (FF-5) to compare hedge funds strategies performances and evaluate their performance. Besides, Alpha is computed for mutual funds indices using the CAPM to compare with hedge fund strategies indices' performances.

For comparison purposes, hedge fund strategies indices were tested through four models to determine the explanatory factors for the performance of the distinct hedge fund strategies and the degree to which the strategies involve market risk. In addition to that, mutual funds following the same strategies were tested through one model (CAPM) for a comparison analysis with hedge fund strategies. These models are the most prevailing in the hedge funds performance literature[1].

CAPM is widely utilized in finance to price risky securities and produce expected returns for assets considering their risk (Litner,1965; Perold ,2004). CAPM is estimated with the following regression:

$$R_{it} - R_{ft} = \propto_{it} + \beta_i \left(R_{Mt} - R_{ft}\right) \qquad (3.14)$$

Where, R_{it} is total return of the hedge fund or mutual fund i at time t; R_{ft} is risk free rate of return (one-month US T-Bills) at time t; R_{Mt} is market portfolio (MSCI world) return at time t. The intercept of this equation $\propto_{it}$ will be used for our hedge fund strategies performances comparison and for our outperformance or underperformance measure relative the market benchmark (MSCI World).

[1] The data used in factor models is downloaded from Kenneth French Data Library from Tuch School of Business. Further information about the data and variables refer: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

With the addition of two factors to the original CAPM that are the size premium (small minus big; SMB) and value premium (high minus low; HML). The Fama French – 3 factor model (1993) is estimated with the following regression:

$$R_{it} - R_{ft} = \propto_{it} + \beta_1(R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it} \qquad (3.15)$$

Where, R_{it} is total return of a hedge fund i at time t; R_{ft} is risk free rate of return (one-month US T-Bills) at time t; R_{Mt} is market portfolio (MSCI world) return at time t; SMB_t is the size premium (small minus big) and HML_t is the value premium (high minus low).

The factors SMB (Size), HML (Value) were created from six size/book-to-market portfolios (French,2020). These portfolios do not include hold ranges or transaction costs. The portfolios are the convergences of 2 portfolios formed on size (market equity, ME) and 3 portfolios built on the ratio of book equity to market equity (BE/ME). (SMB) is measured from the average return on three big portfolios minus the average return on three small portfolios. The variable HML (high minus low) is assessed from the subtraction of the average return on the two growth portfolios, from the average return on the two value portfolios (small and big). The intercept of this equation $\propto_{it}$ will be used for our hedge fund strategies performances comparison and for our outperformance or underperformance measure relative the market benchmark (MSCI World).

Carhart model (1997) is a refinement of the three-factor model and incorporates a fourth factor. It considers size (SMB), value (HML) and an additional factor which is the momentum factor (UMD). The model is estimated with the following regression:

$$R_{it} - R_{ft} = \propto_{it} + \beta_1(R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{it} \quad (3.16)$$

Where, R_{it} is total return of a hedge fund i at time t; R_{ft} is risk free rate of return (one-month US T-Bills) at time t; RM_t is market portfolio (MSCI world) return at time t; SMB_t is the size premium (small minus big); HML_t is the value premium (high minus low) and UMD_t is the momentum factor premium.

For the Carhart four-factor model, the factors SMB (Size), HML (Value) and are calculated as explained above. UMD (Momentum) is built from six size/book-to-market portfolios (French,2020). The portfolios are the crossings of 2 portfolios based on size (market equity, ME) and 3 portfolios formed on prior (2-12) return. UMD variable is the spread between the returns of a portfolio of stocks with high prior returns and a portfolio of stocks with low prior returns.

The five-factor model was built by Fama and French (2015) as an extension of their FF-3 factor model. In addition to size (SMB) and value (HML), the five-factor model includes profitability (RMA) and investment (CMA) as explanatory variables. The model is estimated with the regression:

$$R_{it} - R_{ft} = \propto_{it} + \beta_1 (R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \varepsilon_{it} \qquad (3.17)$$

Where, R_{it} is total return of a hedge fund i at time t; R_{ft} is risk free rate of return (one-month US T-Bills) at time t; RM_t is market portfolio (MSCI world) return at time t; SMB_t is the size premium (small minus big); HML_t is the value premium (high minus low); RMW_t is the profitability premium and CMA_t is the investment premium.

The Fama/French 5 factors (2x3) are elaborated using 6 value-weight portfolios formed on size and book-to-market, 6 value-weight portfolios formed on size and operating profitability, and 6 value-weight portfolios formed on size and investment (French,2020). SMB and HML factors are calculated as explained above. RMW (Robust Minus Weak) variable is the spread of the average return on the two robust operating profitability portfolios and the average return on the two weak operating profitability portfolios while the fifth variable CMA (Conservative Minus Aggressive) is the difference between the average return on the two conservative investment portfolios and the average return on the two aggressive investment portfolios.

- The Sharpe ratio (1966) is computed by measuring the spread between hedge fund or mutual fund return (ri) and risk-free rate (rf), then dividing the difference by the fund's volatility which is measured by the standard deviation (σi). The formula applied for each fund index is:

$$Sharpe\ Ratio = \frac{(r_i - r_f)}{\sigma_i} \qquad (3.18)$$

• The Sortino ratio (1994) is calculated by measuring the difference between hedge fund or mutual fund return (r_i) and the minimum accepted return (MAR) which is the one-month T-bill, then dividing the excess return (if any) by the fund's downside deviation ($\sqrt{E(Min(r_{it} - MAR), 0)^2}$). Sortino ratio is calculated for each fund index using the following formula:

$$Sortino\ Ratio = \frac{E(r_{it} - MAR)}{\sqrt{E(Min(r_{it} - MAR), 0)^2)}} \tag{3.19}$$

3.4.2 Cointegration Analysis

Eagle and Granger (1987) developed the co-integration model in their paper "Co-integration and error-correction: Representation, estimation and testing" which showed the basic idea of non-stationary time series. This basic idea behind cointegration is that "an individual economic variable, viewed as a time series, can wander extensively and yet some pairs of series may be expected to move so that they do not drift too far apart" (Eagle and Granger,1987). It means simply the possibility to combine two or more non-stationary time-series, which are integrated of the same order n, to a stationary linear combination that has an order less than n. Non cointegrated variables will progress separately and will not be drawn to their long-tern relationship.

Unlike the Engle-Granger test, Johansen's test is used to test cointegrating relationships between several non-stationary time series data, it allows for more than one cointegrating relationship. As such, the test can detect multiple cointegrating vectors (Johansen, 1988). Johansen's approach identifies the number of cointegrating vectors between the dependent and the independent variables, all the variables should be at order I (1). The fundamental equation that represent Johansen's cointegration test is given by (Johansen,1988):

$$Z_t = AZ_t + \cdots + A_n Z_{t-n} + Bx_t + \epsilon_t \tag{3.20}$$

Where Z_t is the vector for the I (1) independent and dependent variables, x_t is the vector of the non-random variable and ϵ_t is the error term.

In this research, the presence of a long- run relationship will be investigated to determine if hedge fund strategies are managed in similar management styles that make them

meet in the long term which eliminates the opportunities of diversification and therefore an appealing performance.

3.4.3 Hedge Funds Comparative Analysis Of Performance

To evaluate the performances of hedge fund strategies for the full period (2001-2020), alphas are estimated for each hedge fund strategy's index through asset pricing models' equations. OLS Regressions were run for the ten strategies' indices. Subsequently, we investigate the exposure to systematic risk by estimating the betas statistics from the different asset pricing models' equations. Accordingly, MSCI World index monthly returns were calculated for our period (2001-2020) as our market benchmark. The average monthly returns of a U.S 30 days treasury bill is used as the risk-free rate. The dataset for every strategy's index encompasses 240 months, the null hypothesis H_0 for all the regressions is alpha equivalent to zero. The study's regressions are conducted with significance levels of 1%,5% and 10%.

To compare between hedge fund strategies performance and to get further results about the strategies that provide more value to investors, risk-reward measures are assessed to rank the different strategies: the traditional Sharpe ratio and the Sortino ratio considering the asymmetric distribution of hedge fund strategies' return. One-month US treasury bill return is considered as the minimum acceptable return in the estimations. Sharpe ratio and Sortino ratio are calculated for all the strategies and then classified according to the results.

The full period was also divided in four sub-periods (2001-2005), (2006-2010), (2011-2015) and (2016-2020) to analyze hedge fund strategies characteristics in times of crisis and trend reversals which enlarged the number of outcomes to analyze. Regressions were rolled for each hedge fund strategy's index for each period to estimate alphas from the four asset pricing models' equations. The dataset for each period consists of 60 observations for each strategy, the null hypothesis H_0 for all the regressions is alpha equivalent to zero. The study's regressions are conducted with significance levels of 1%,5% and 10%.

To have further insights about hedge fund strategies behavior in period times, risk-adjusted metrics, the traditional Sharpe ratio and Sortino ratio are calculated for each strategy and each period. One month US treasury bill return is considered as the minimum acceptable return in the estimations.

3.4.4 Hedge Funds and Mutual funds Comparative Analysis Of Performance

To compare hedge fund strategies performance with mutual funds and the benchmark for the period (2008-2019), regression analysis is conducted with monthly returns of hedge funds and mutual funds indices following similar strategies as dependent variables and the monthly returns of MSCI World index as the independent variable for this period using the Capital Asset Pricing Model equation. Alphas are assessed for each hedge fund and mutual fund indexes following the same strategy. OLS Regressions were run for the ten strategies indices for both hedge funds and mutual funds.

The average monthly returns of a U.S 30 days treasury bill is used as the risk-free rate. The dataset for every strategy's index for both funds encompasses 144 months, the null hypothesis H_0 for all the regressions is alpha equivalent to zero. The study's regressions are conducted with significance levels of 1%,5% and 10%.

To obtain further results about the fund type that provide more value to investors, Sharpe ratio and the Sortino ratio measurement tools are computed to compare the distinct funds according to the strategy applied.

One-month US treasury bill return is taken as the minimum acceptable return in the computations. Sharpe ratio and Sortino ratio are calculated for all the strategies for both funds.

3.4.5 Cointegration Analysis Of Hedge Fund Strategies

This study adopts the co-integration approach which has rarely been used in the hedge fund literature which investigates the long-term performance through the change in prices. Before applying the Johansen's cointegration test, the stationarity of hedge fund strategies' time series is inspected with the use of the Phillips-Peron (PP) and the Augmented Dicky-Fuller unit root tests based on model with constant and trend, the number of lags was selected according to the minimum Akaike Information Criterion (AIC). Thereafter, Cointegration is verified through critical trace statistics and maximum Eigen values.

4. EMPIRICAL FINDINGS AND DISCUSSIONS

In this section, the comparative analysis of hedge fund strategies for the full period and for the sub-periods, the comparative analysis between hedge funds and mutual funds and the cointegration analysis empirical results are examined and interpreted respectively.

4.1 Comparative Analysis Of Hedge Fund Strategies' Performance

This part of the study aims to investigate hedge funds and its strategies performances in comparison with the market and determine which strategy taking risk into account is superior in terms of performance. To achieve that, performance measurement tools will be applied to hedge funds for the three studied databases for the whole timespan and for different sub-periods. First, Alpha is calculated as a performance metric through multiple asset pricing models: CAPM, FF-3, CARHART and FF-5 models. Then, Sharpe ratio and Sortino ratio are used as risk-adjusted performance metrics to evaluate and compare hedge fund strategies performance. The results are given for the entire observation period as well as for divided sub-periods to interpret hedge fund strategies performance and to analyze how their performance changed during the time interval.

4.1.1 Descriptive Statistics

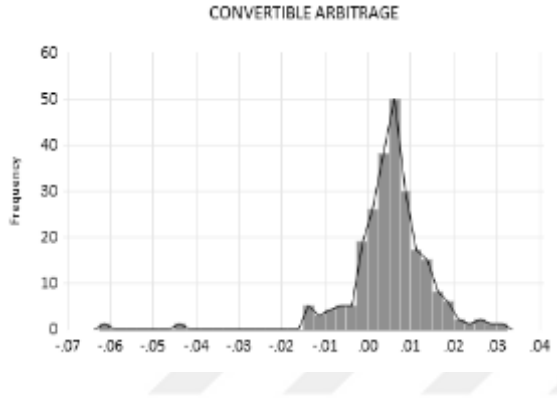
Tables. 4.1-4.2-4.3 report the descriptive statistics of the group strategies indices' returns for Eurekahedge, Credit Suisse and CISDM over the period time.

Table 4.1: Descriptive Statistics for Eurekahedge and MSCI World Index

Indices	Mean	Median	Sd	Skewness	Kurtosis	Jacues-Bera	Largest Drawdown
Eurekahegde Hedge Fund Index	0.0065	0.0075	0.0143	-0,6487	2,9144	27.6881	
Relative Value Strategies							
Convertible Arbitrage	0.0052	0.0057	0.0090	-2.1809	14.785	1073.96	-11.49%
Fixed Income	0.0059	0.0071	0.0117	-3.1430	23.051	621.101	-12.01%
Market Neutral	0.0035	0.0043	0.0066	-1.3207	6.3730	93.0463	-0.054%
Event Driven Strategies							
Event Driven	0.0070	0.0090	0.0208	-1.4972	7.7939	112.327	-19.15%
Distressed Debt	0.0080	0.0098	0.0187	-1.3154	7.0626	174.520	-28-24%
Multi-Strategy	0.0067	0.0072	0.0133	-1.0438	4.2782	56.1935	-11.71%
Directional Strategies							
Global Macro	0.0061	0.0060	0.0109	0.3271	0.7273	10.5445	-4.31%
Managed Futures	0.0064	0.0047	0.0177	0.4542	0.7688	24.7198	-6.29%
Long/Short Equity	0.0068	0.0085	0.0209	-0.7497	2.3655	26.1489	-21.79%
Emerging Markets	0.0098	0.0110	0.0241	-0.7566	2.2628	42.5417	-25.16%
Benchmark							
MSCI World	0.0043	0.0104	0.0450	-0.6552	1.6414	36.1315	

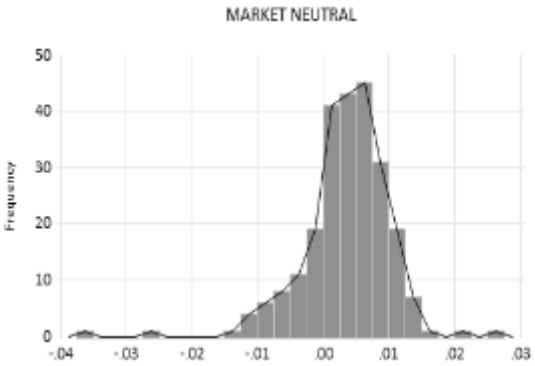
As exhibited in Table 4.1, the average rate of returns of the global hedge fund and the hedge fund strategies (except Market Neutral strategy) exceed the MSCI World. Hedge fund strategies have lower standard deviations than the MSCI World. It demonstrates that hedge fund strategies have a better risk/return profiles comparing to the MSCI world. Amid the distinct strategies, Emerging Markets strategy have the highest average return and the highest volatility. It has the highest standard deviation along with Long Short Equity and Event Driven strategies. Market Neutral and Convertible Arbitrage, have the lowest standard deviations amid all the strategies. Convertible Arbitrage and Global Macro strategies have the best risk/return profiles. Figures 4.1 plot the distributions of each hedge fund strategy for Eurekahedge indices.

Convertible Arbitrage Distribution

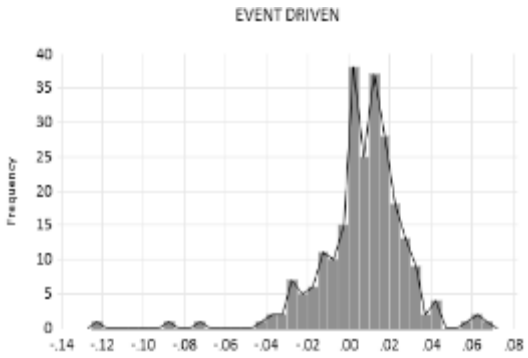


Fixed Income Distribution

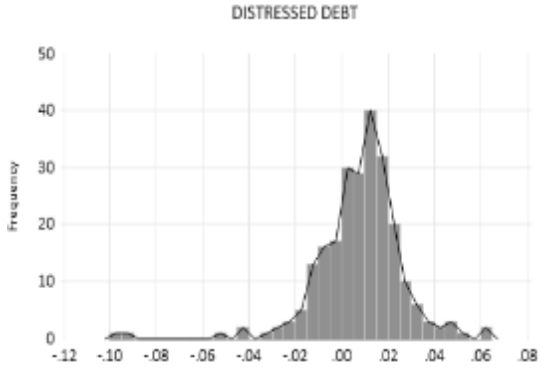
Market Neutral Distribution



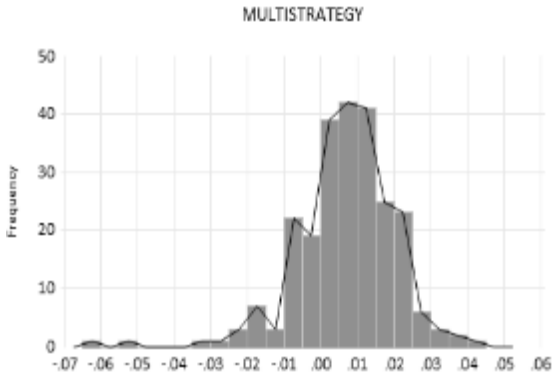
Event Driven Distribution



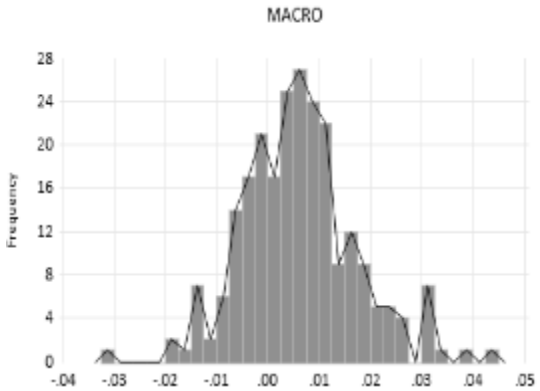
Distressed Debt Distribution



Multi-Strategy Distribution

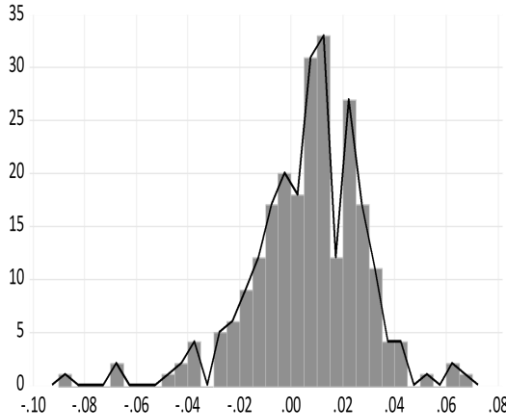


Global Macro Distribution



Managed Futures Distribution

Long/Short Equity Distribution



Emerging Markets Distribution

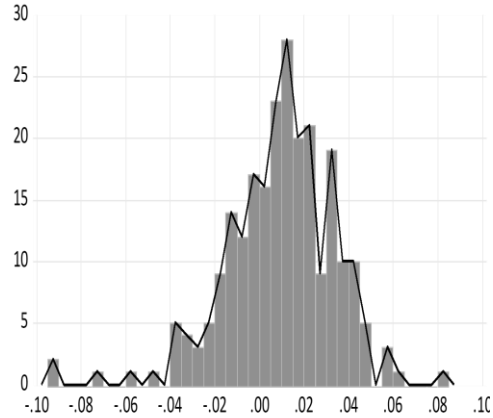


Figure 4.1: The Distributions Of Each Hedge Fund Strategy for Eurekahedge Indices

The figures 4.1 demonstrate that the majority of hedge fund strategies are not symmetric and have mainly returns expanding toward the left side except Managed Futures and Global Macro strategies. For Eurekahedge indices, Relative Value and Event Driven strategies have a kurtosis more than 3 which implies extreme fluctuations because of the fatter tailed distribution. Directional strategies report a Kurtosis below 3 (platykurtic) reflecting minor fluctuations. Most of hedge fund strategies indices register a negative skewness implying extreme negative returns. The Managed Futures and Macro strategies are the only strategies with positive skewness illustrated by the tails toward the right making it desirable amongst investors. The normality of the returns data is tested using a Jarque-Bera normality test (1987). The critical value (5.99) is exceeded for all the hedge fund indices entailing that hedge fund indices are not normally distributed.

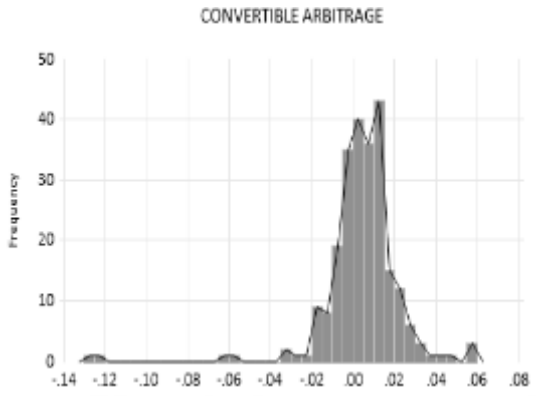
Table 4.2: Descriptive Statistics Of CREDIT SUISSE Strategies' Indices

Indices	Mean	Median	Sd	Skewness	Kurtosis	Jacues-Bera	Largest Drawdown
Credit Suisse Hedge Fund Index	0.0045	0.0059	0.0151	-1.4089	5.3636	151.919	
Relative Value Strategies							
Convertible Arbitrage	0.0043	0.0052	0.0188	-2.6961	18.474	1753.75	-32.87%
Fixed Income	0.0037	0.0052	0.0152	-4.8268	37.801	7242.92	-29.01%
Market Neutral	0.0014	0.0040	0.0290	-11.493	159.97	62189.4	-45.10%
Event Driven Strategies							
Event Driven	0.0051	0.0052	0.0200	-1.7975	10.529	30.877	-23.23%
Distressed Debt	0.0055	0.0083	0.0170	-1.5608	7.7694	58.1198	-22.45%
Multi-Strategy	0.0052	0.0064	0.0140	-1.8517	8.790	501.314	-45.10%
Directional Strategies							
Global Macro	0.0066	0.0071	0.0236	-0.3425	17.588	1170.79	-14.94%
Managed Futures	0.0037	0.0025	0.0320	-0.0135	-0.514	2.9262	-18.62%
Long/Short Equity	0.0048	0.0056	0.0205	-0.8497	2.0511	41.60	-22%
Emerging Markets	0.0066	0.0098	0.0263	-1.2541	4.5563	151.919	-32.34%
Benchmark							
MSCI World	0.0043	0.0104	0.0450	-0.6552	1.6414	36.1315	

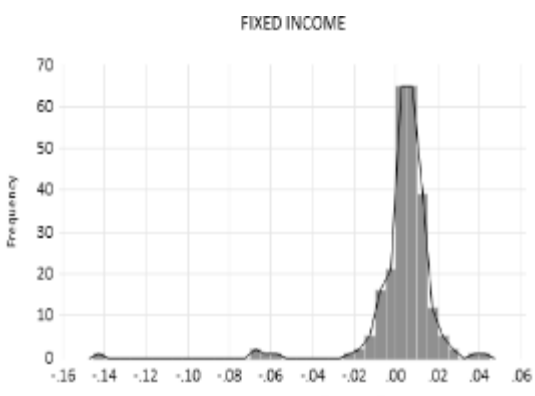
Table 4.2 reveals that Credit Suisse hedge fund index and the hedge fund strategies' indices with the exception of Market Neutral, Managed Futures and Fixed Income strategies report a higher average return (mean) than the MSCI World with lower volatilities (SD). Emerging Markets, Managed Futures and Market Neutral strategies have the highest standard deviations between the strategies. Emerging Markets strategy record the highest average return while Market Neutral strategy report the lowest rate of return. Multi-Strategy and Distressed Debt strategy appear to provide the best risk/return profile while Market Neutral is revealed to have least desirable risk/ratio among the strategies.

Figures 4.2 illustrate the distributions of each hedge fund strategy for Credit Suisse indices.

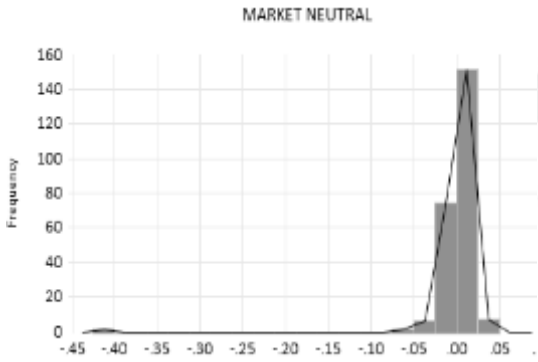
Convertible Arbitrage Distribution



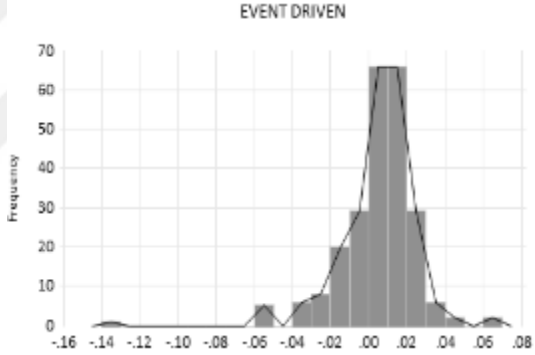
Fixed Income Distribution



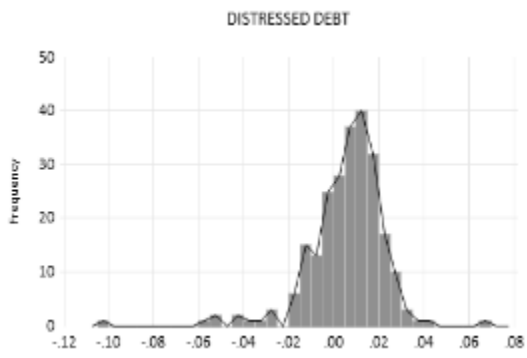
Market Neutral Distribution



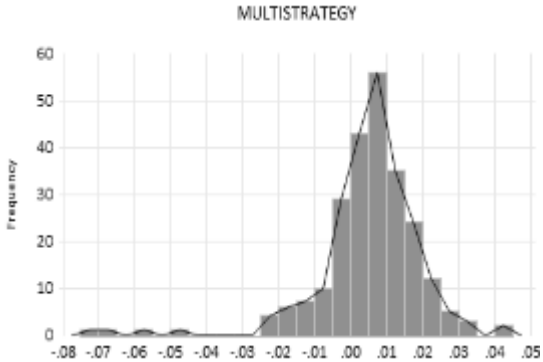
Event Driven Distribution



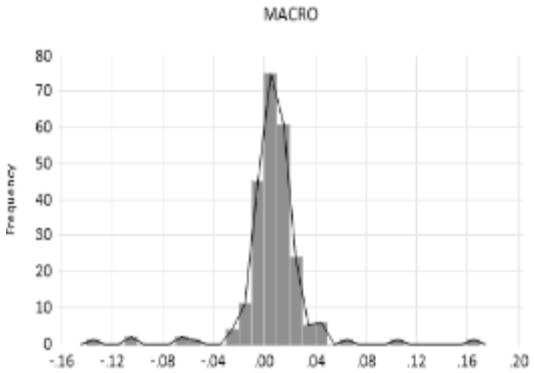
Distressed Debt Distribution



Multi-strategy Distribution

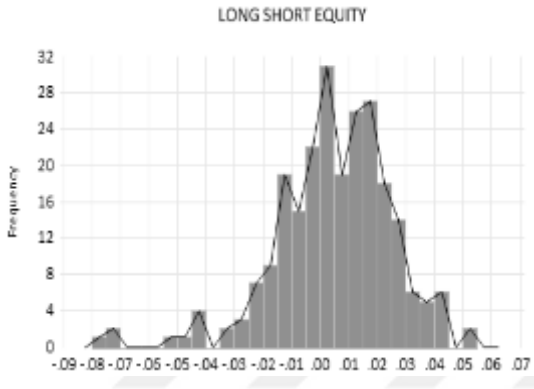


Global Macro Distribution



Managed Futures Distribution

Long/Short Equity Distribution



Emerging Markets Distribution

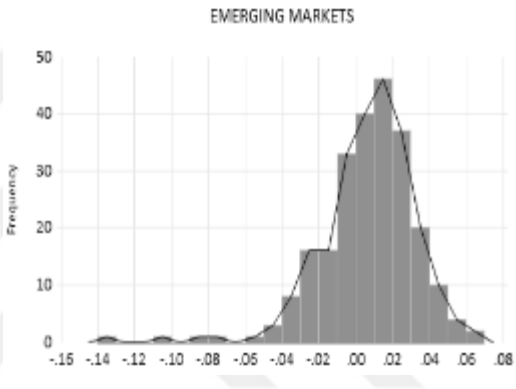


Figure 4.1: The Distributions of Each Hedge Fund Strategy for Credit Suisse Indices

Figures 4.2 show that hedge fund strategies indices are asymmetric and have returns leaning toward the left side of the distribution. Managed Futures and Long/Short Equity strategies are the only strategies with a kurtosis more than 3 (leptokurtic) implying small fluctuations in comparison to the other strategies. All hedge fund strategies indices are negatively skewed underpinning the probability of extreme negative returns. Jacque Bera's critical value (5.99) is overpassed for all the hedge funds indices except from managed futures. It is the only strategy with a normal distribution.

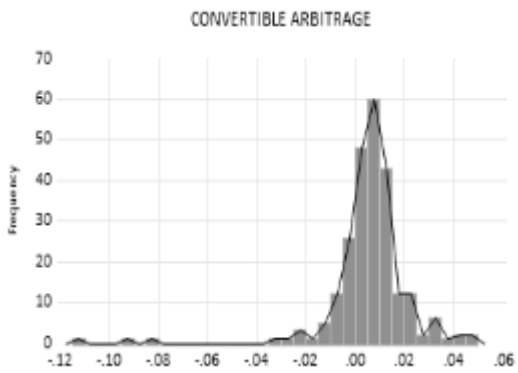
Table 4.3: Descriptive Statistics of CISDM Strategies' Indices

Indices	Mean	Median	Sd	Skewness	Kurtosis	Jacues-Bera	Largest Drawdown
CISDM Hedge Fund Index	0.0055	0.0076	0.0191	-1.0216	4.9945	117.29	
Relative Value Strategies							
Convertible Arbitrage	0.0055	0.0063	0.0161	-3.1214	21.082	2240.53	-52.5%
Fixed Income	0.0038	0.0046	0.0167	-6.1007	61.939	1769.9	-41.2%
Market Neutral	0.0041	0.0040	0.0068	0.1415	2.953	41.526	-20.04%
Event Driven Strategies							
Event Driven	0.0057	0.0071	0.0191	-1.2688	8.596	205.886	-29.59%
Distressed Debt	0.0057	0.007	0.0147	-2.0011	13.6743	1220.39	-20.52%
Multi-Strategy	0.0032	0.0034	0.0121	-1.2489	5.332	424.885	-27.87%
Directional Strategies							
Global Macro	0.0047	0.0033	0.0141	5.756	60.557	26408.33	-13.32%
Managed Futures	0.0052	0.0029	0.0236	0.0352	-0.0364	2.0834	-18.62%
Long/Short Equity	0.0051	0.0068	0.0195	-0.7697	5.142	24.522	-31.9%
Emerging Markets	0.0077	0.0105	0.0423	-0.12	1.744	21.253	-23.19%
Benchmark							
MSCI World	0.0043	0.0104	0.0450	-0.6552	1.6414	36.1315	

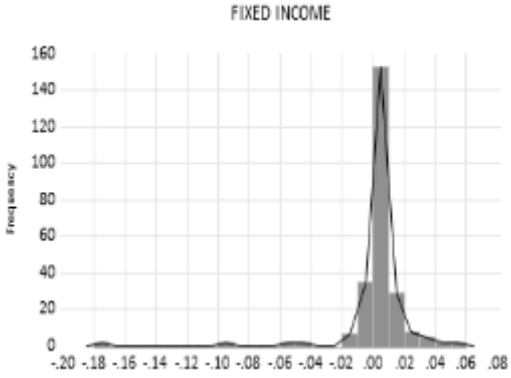
The results in Table 4.3 demonstrate that the majority of hedge fund strategies' indices and the CISDM global hedge fund have higher means than the MSCI World Index with lower standard deviations. Market Neutral, Fixed Income and Multi-Strategy are the only strategies with lower average returns than the market. The strategies differ in term of returns, Emerging markets strategy produces the highest return on average (mean) with the highest volatility (SD) among hedge fund strategies. Event Driven and Convertible Arbitrage strategies generate as well high average returns with a lower volatility. Market Neutral and Distressed Debt strategies have the best risk/return ratios among hedge fund strategies.

Figures 4.3 illustrate the distributions of each hedge fund strategy for CISDM indices.

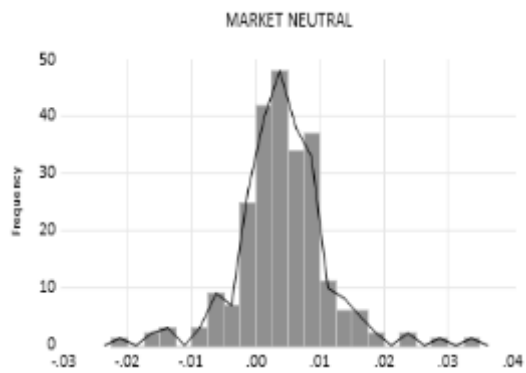
Convertible Arbitrage Distribution



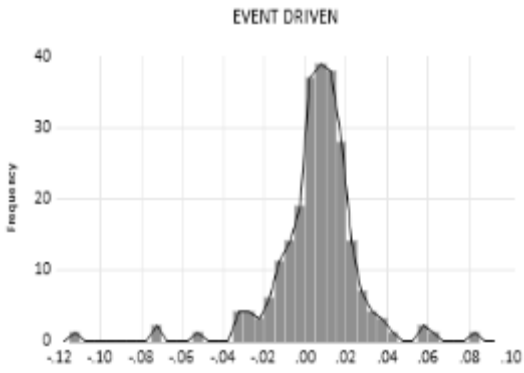
Fixed Income Distribution



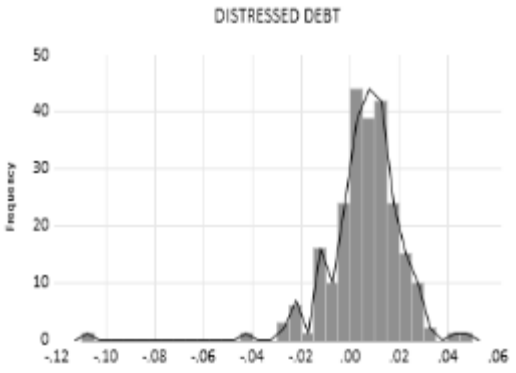
Market Neutral Distribution



Event Driven Distribution

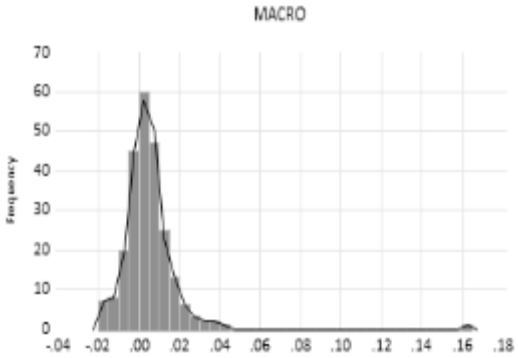


Distressed Debt Distribution



Multi-Strategy Distribution

Global Macro Distribution



Managed Futures Distribution

L/S Equity Distribution

Emerging Markets Distribution

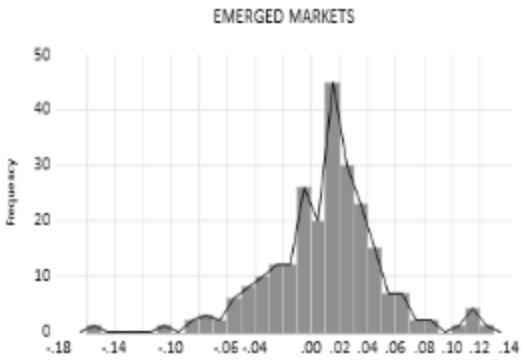


Figure 4.2: The Distributions of Each Hedge Fund Strategy for CISDM Indices

Figures 4.3 unveil the asymmetricities of most of hedge fund strategies indices with returns expanding to the right for some strategies and to the left for others. Managed Futures, Emerging Markets and Market neutral are the only strategies with a kurtosis more than 3 (leptokurtic), which discloses small fluctuations in comparison to the other strategies. Managed futures, Global Macro and Market Neutral strategies display a positive skewness with longer tails towards the right, making them favorable for investors. Jacque Bera's critical value (5.99) is exceeded for all hedge funds indices except Managed Futures. It is the only strategy with a normal distribution.

To analyze the degree to which hedge fund strategies move in relation to each other. Tables. 4.4, 4.5 and 4.6 exhibit correlation matrices between the distinct strategies' indices for the studied timespan (2001-2020).

Table 4.4: Correlation Matrix of Eurekahedge

Correlation matrix of Hedge Fund Strategies for Eurekahedge and MSCI World Index												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1											
2	0.8182	1										
3	0.8862	0.9623	1									
4	0.6825	0.7794	0.7687	1								
5	0.5390	0.8320	0.7069	0.5392	1							
6	0.0324	0.3992	0.1694	0.1330	0.6358	1						
7	0.6630	0.7692	0.7664	0.7239	0.4889	0.0535	1					
8	0.8293	0.9151	0.9358	0.8208	0.6167	0.0921	0.8688	1				
9	0.7056	0.8149	0.7976	0.7864	0.5883	0.0653	0.8454	0.8847	1			
10	0.7969	0.9690	0.9351	0.7932	0.8011	0.3149	0.7806	0.9108	0.8487	1		
11	0.3029	0.5712	0.5326	0.4093	0.4719	0.2915	0.4365	0.5053	0.4802	0.5624	1	
12	0.7735	0.8969	0.9145	0.7278	0.7121	0.1445	0.7369	0.8525	0.7987	0.9249	0.4563	1

1-MSCI World; 2-Eurekahedge Hedge Fund Index; 3-Long/Short Equity; 4-Convertible Arbitrage; 5-Global Macro; 6-Managed Futures; 7-Distressed Debt; 8-Event Driven; 9-Fixed Income; 10-Multi-Strategy; 11-Market Neutral; 12-Emerging Markets

Table 4.5: Correlation Matrix of Credit Suisse

Correlation matrix of Hedge Fund Strategies for Credit Suisse and MSCI World Index												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1											
2	0.7617	1										
3	0.8483	0.9097	1									
4	0.5390	0.7273	0.6286	1								
5	0.3024	0.5053	0.4000	0.3525	1							
6	-0.0090	0.2958	0.1989	0.0051	0.3105	1						
7	0.6748	0.8176	0.7394	0.6788	0.3474	0.0227	1					
8	0.6899	0.8350	0.7843	0.6287	0.3756	0.0708	0.8793	1				
9	0.4735	0.6695	0.5251	0.7946	0.3406	0.0054	0.6076	0.5557	1			
10	0.6691	0.9083	0.8209	0.8009	0.4326	0.1824	0.7662	0.7575	0.7189	1		
11	0.2812	0.3963	0.2713	0.2273	0.1158	0.0009	0.3524	0.2839	0.3617	0.4293	1	
12	0.7660	0.8343	0.8163	0.6506	0.4320	0.0780	0.7126	0.7133	0.5866	0.7401	0.2629	1

1-MSCI World; 2-Credit Suisse Hedge Fund Index; 3-Long/Short Equity; 4-Convertible Arbitrage; 5-Global Macro; 6-Managed Futures; 7-Distressed Debt; 8-Event Driven; 9-Fixed Income; 10-Multi-Strategy; 11-Market Neutral; 12-Emerging Markets

Table 4.6: Correlation Matrix of CISDM

Correlation matrix of Hedge Fund Strategies for CISDM and MSCI World Index												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1											
2	0.8694	1										
3	0.8607	0.9494	1									
4	0.5843	0.7422	0.6413	1								
5	0.2875	0.3859	0.3786	0.2085	1							
6	0.0380	0.1800	0.1815	0.0520	0.4491	1						
7	0.6724	0.7907	0.7038	0.7319	0.2464	0.0562	1					
8	0.4394	0.5512	0.5850	0.3880	0.3051	0.1357	0.3405	1				
9	0.4986	0.6783	0.5998	0.7782	0.1343	-0.0152	0.6110	0.4000	1			
10	0.7230	0.9071	0.8828	0.7302	0.4242	0.2731	0.7718	0.5186	0.6390	1		
11	0.5312	0.6899	0.7162	0.4422	0.3629	0.2605	0.4901	0.4794	0.4082	0.6894	1	
12	0.3651	0.5095	0.4413	0.4185	0.1809	0.1190	0.3772	0.2395	0.3021	0.4594	0.4463	1

1-MSCI World; 2-CISDM Hedge Fund Index; 3-Long/Short Equity; 4-Convertible Arbitrage; 5-Global Macro; 6-Managed Futures; 7-Distressed Debt; 8-Event Driven; 9-Fixed Income; 10-Multi-Strategy; 11-Market Neutral; 12-Emerging Markets

The correlation matrices in Tables (4.4, 4.5 and 4.6) demonstrate that Managed Futures strategy shows a low correlation with all the other strategies for Eurekahedge, Credit Suisse and CISDM. The Managed Futures strategy have the lowest correlation to the MSCI World with Market Neutral and Global Macro strategies for Eurekahedge. For Credit Suisse, it portrays a negative correlation with The MSCI world index, with Market Neutral and Global Macro strategies that exhibit the lower correlation with the benchmark. For CISDM, Managed Futures strategy displays a negative correlation with Fixed Income strategy and a low correlation with the MSCI world index compared to other strategies. In addition to that, Directional Strategies like Emerging Markets and Global Macro exhibit a low correlation with other strategies and with the MSCI world index.

Managed futures appear to be the least correlated with other investment strategies. When there are trends to be followed on the futures market, the strategy achieves a good performance. On the contrary, when the market moves sideways, there are wrong signals and the mathematical models will switch among buy and sell decisions when prices find no direction. Volatility is an undesirable scenario for this strategy. Overall, hedge fund strategies indices portray low to negative correlations with the global equity index.

4.1.2 Comparative Performance Analysis Of Hedge Fund Strategies

The performances of hedge fund strategies for the full period 2001-2020 and the four sub-periods (2001-2005, 2006-2010, 2011-2015, 2016-2020) have been explored under this section.

4.1.2.1 Performance Comparison: Whole Period 2001-2020.

Tables 4.7-4.11 report the findings for Eurekahedge, Credit Suisse and CISDM hedge fund strategies' indices performance results using asset-based measures as risk adjusted performance alpha, traditional Sharpe ratio and Sortino ratio for the whole period.

The tables 4.7, 4.8 and 4.9 illustrate the global hedge and the different strategies related Alpha (α) and their associated market risk (β) over the time period with the percentage of significance level at 1%, 5% and 10%. Four models were estimated for each strategy individually. Sharpe and Sortino ratio measurement results are demonstrated in table 4.10 and table 4.11 as other significant risk reward metrics.

As presented in Table 4.7, for whole period, the models assessed are statistically significant with a p-value of the F statistic < 0.01 apart from Managed Futures strategy. Managed Futures strategy displays non-significant betas for all the models except for Carhart model and non-significant alphas for Carhart and the FF-5 models; underpinning its underperformance when exposed to the Carhart and the FF-5 risk factors. Eurekahedge global hedge fund and the different hedge fund strategies produce significant and positive alphas suggesting their outperformance over the market. The four factor models provided similar results in terms of the rankings of the strategies; Emerging Markets, Distressed Debt are the best performing strategies pursued by Multi-Strategy and Managed Futures only with the CAPM model. Relative value strategies produce the lowest alphas according to the CAPM and the FF-5 and Along Long/Short Equity for FF-3 and Carhart models.

Table 4.7: Eurekahedge Strategies' (α) and Market risk (β)

	CAPM		FF-3 Model		Carhart Model		FF-5 Model	
Indices	**α**	**B**	**α**	**B**	**α**	**B**	**α**	**β**
Eurekahegde Hedge Fund Index	0.0046*	0.261*	0.0039	0.256*	0.0038*	0.277*	0.004*	0.259*
Relative Value Strategies								
Convertible Arbitrage	0.0036*	0.138*	0.0033*	0.136*	0.0034*	0.136*	0.0033*	0.131*
Fixed Income	0.0042*	0.186*	0.0038*	0.186*	0.0039*	0.180*	0.0037*	0.178*
Market Neutral	0.0023*	0.047*	0.0020*	0.046*	0.0015*	0.081*	0.0013*	0.068*
Event Driven Strategies								
Event Driven	0.0046*	0.384*	0.0039*	0.381*	0.0039*	0.375*	0.0039*	0.363*
Distressed Debt	0.0060*	0.277*	0.0052*	0.277*	0.0052*	0.257*	0.0054*	0.257*
Multi-Strategy	0.0049*	0.237*	0.0044*	0.235*	0.0042*	0.249*	0.0042*	0.232*
Directional Strategies								
Global Macro	0.0045*	0.133*	0.0043*	0.131*	0.004*	0.149*	0.0039*	0.139*
Managed Futures	0.0053*	0.014	0.0051*	0.013	0.0041	0.073*	0.0042	0.046
Long/Short Equity	0.0043*	0,413*	0.0036*	0.407*	0.0034*	0.425*	0.0038*	0.392*
Emerging Markets	0.0070*	0.414*	0.0062*	0.411*	0.0061*	0.417*	0.0064*	0.379*

* Significant at 1% level

Most of the strategies exhibited significant levels of market risk *(β)* at different degrees. Emerging Markets, with the highest alpha, has the highest risk exposure *(β)* under CAPM and FF-3 models, whereas Long/Short Equity has the highest market risk under Carhart and FF-5 models. Relative Value and Global Macro strategies have the least systematic risk exposure. It appears that the strategies with the highest risk adjusted performance tend to have higher risk exposure. For Credit Suisse database (see Table 4.8), models are statically significant with a p-value of the F statistic < 0.01 and F statistic < 0.05 except Market Neutral and Managed Futures. Market Neutral delivered non-significant alphas for all the models while Managed Futures produced non-significant alphas for all the models and a sole significant exposure to the Carhart model.

Table 4.8: *Credit Suisse Strategies' (α) and Market risk (β)*

	CAPM		FF-3 Model		Carhart Model		FF-5 Model	
Indices	**α**	**B**	**α**	**β**	**A**	**B**	**α**	**β**
Credit Suisse Hedge Fund Index	0.0026*	0.258*	0.0021*	0.256*	0.0016*	0.294*	0.0018*	0.256*
Relative Value Strategies								
Convertible Arbitrage	0.0024*	0.227*	0.0019**	0.225*	0.0011**	0.221*	0.0015**	0.186*
Fixed Income	0.0021*	0.307*	0.0017**	0.306*	0.0016**	0.338*	0.0015**	0.329*
Market Neutral	-0.0002	0.181*	-0.0005	0.181*	-0.0007	0.199*	6,6E-05	0.133*
Event Driven Strategies								
Event Driven	0.003*	0.307*	0.0023*	0.306*	0.0018**	0.338*	0.0016**	0.329*
Distressed Debt	0.0036*	0.256*	0.0029*	0.255*	0.0028*	0.261*	0.0031*	0.237*
Multi-Strategy	0.0034*	0.210*	0.0030*	0.208*	0.0026*	0.234*	0.0027*	0.203*
Directional Strategies								
Global Macro	0.0049*	0.159*	0.0046*	0.158*	0.0044*	0.173*	0.0037*	0.168*
Managed Futures	0.0026	-0.004	0.0026	-0.005	0.0007	0.12*	0.0004	0.084
Long/Short Equity	0.0025*	0.387*	0.0019*	0.384*	0.0011**	0.441*	0.0015**	0.393*
Emerging Markets	0.0040*	0.448*	0.0033*	0.444*	0.0029*	0.466*	0.0034*	0.413*

* 1 % significance; ** 5% significance

Global Macro, Emerging Markets, Distressed Debt and Multi-Strategy; are the strategies with the highest alphas while Relative Value strategies deliver the lowest alphas as reported by the CAPM and are the less performing with Long/Short Equity for FF-3 Carhart and the FF-5.

Market risk exposure is significant for the majority of the distinct strategies; Emerging Markets have the highest significant beta compared to the other strategies, Event Driven strategies with their high significant alphas such as Distressed debt and Event Driven demonstrate a high-risk exposure. Long-Short strategy, which seems to have a low risk-adjusted performance have a significant exposure level. Relative Value strategies (Market Neutral and Convertible Arbitrage), Global Macro and Multi-Strategy have the lowest significant betas and therefore the least market risk exposure.

Table 4.9: CISDM strategies' (α) and Market risk (β)

	CAPM		FF-3 Model		Carhart Model		FF-5 Model	
Indices	**α**	**B**	**α**	**β**	**α**	**B**	**α**	**β**
CISDM Hedge Fund Index	0.0032*	0.37*	0.0026*	0.36*	0.0025*	0.373*	0.0028*	0.344*
Relative Value Strategies								
Convertible Arbitrage	0.0032*	0.225*	0.0027**	0.224*	0.0033*	0.208*	0.0025**	0.203*
Fixed Income	0.0021**	0.187*	0.0016***	0.187*	0.0017**	0.18*	0.0014***	0.164*
Market Neutral	0.0027*	0.082*	0.0025*	0.081*	0.0023*	0.096*	0.0024*	0.085*
Event Driven Strategies								
Event Driven	0.0039*	0.188*	0.0034*	0.185*	0.0034*	0.189*	0.0032**	0.199*
Distressed Debt	0.0039*	0.221*	0.0033*	0.219*	0.0034*	0.225*	0.0036*	0.198*
Multi-Strategy	0.0015*	0.197*	0.0011**	0.194*	0.0006***	0.223*	0.0009**	0.189*
Directional Strategies								
Global Macro	0.0032*	0.092*	0.0031*	0.090*	0.0028*	0.107*	0.0029*	0.103*
Managed Futures	0.0040*	0.022	0.0039*	0.02	0.0026***	0.103*	0.0024	0.080**
Long/Short Equity	0.0028*	0.375*	0.0022*	0.371*	0.0019*	0.392*	0.0021*	0.373*
Emerging Markets	0.0055***	0.323*	0.0043**	0.339*	0.0041**	0.358*	0.0069**	0.23*

* 1 % significance; ** 5% significance *** 10% significance

For CISDM database (see Table 4.9), the majority of hedge fund indices record positive and significant alpha over the period of time. The estimated models were valid statically with a p-value of the F statistic < 0.01, F statistic< 0.05 and F static< 0.1 except Managed Futures strategy which showed a significant risk exposure to Carhart and the FF-5 models. Managed Futures delivered a non-significant alpha for the Five-Factor model, which implies that it fails to outperform the market when taking into consideration exotic risks inherent to this model. Emerging Markets, Distressed Debt, Event driven and Managed Futures (under CAPM, and FF-3); are the strategies with the highest alphas while Multi-Strategy, Long/Short Equity and Relative Value strategies like Fixed Income and Market Neutral record the lowest alphas.

Market risk level *(β)* was significant for almost all the strategies in different degrees; Emerging Markets and Long/Short equity strategies have high significant betas comparing to the other strategies. Relative value strategies like Fixed Income and Market Neutral have the lowest alphas with the least exposure level. Global Macro strategy has the best risk/return profiles among all the strategies with a high performance and a lower risk.

Seeking alpha might not be enough for investors who are looking forward to having a deep and a complete evaluation of hedge funds' performance. In this case, other tools like Sharpe ratio (Table 4.10) and Sortino ratio (Table 4.11) can be used to measure the risk-adjusted returns of hedge funds adopting dissimilar strategies.

Table 4.10: Performance measurement with Sharpe ratio

INDICES	Eurekahedge	Credit Suisse	CISDM
Hedge Fund Index	1.353	0.800	0.821
Relative Value Strategies			
Convertible Arbitrage	1.614 (2)	0.594 (8)	0.761 (6)
Fixed Income	1.452 (4)	0.599 (7)	0.578 (10)
Market Neutral	1.287 (6)	0.042 (10)	1.535 (1)
Event Driven Strategies			
Event Driven	1.013 (9)	0.713 (5)	0.851 (4)
Distressed Debt	1.316 (5)	0.923 (2)	1.119 (2)
Multi-Strategy	1.520 (3)	1.024 (1)	0.620 (8)
Directional Strategies			
Global Macro	1.632 (1)	0.830 (3)	0.896 (3)
Managed Futures	1.084 (8)	0.292 (9)	0.612 (9)
Long/Short Equity	0.971 (10)	0.635 (6)	0.724 (7)
Emerging Markets	1.261 (7)	0.741 (4)	0.828 (5)
Benchmark			
MSCI World	0.455	0.455	0.455

Numbers in () indicates the rank order of each strategy

As exhibited in Table 5.10, hedge fund strategies of the three databases have higher Sharpe ratios than the MSCI world benchmark except Market Neutral strategy for Credit Suisse database.

For Eurekahedge, the highest Sharpe ratio 1.632 belongs to Global Macro strategy followed by Convertible Arbitrage (1.614) and Multi-Strategy (1.520). Emerging Markets, Event Driven and Managed Futures strategies were among the best performing strategies according to their average returns and following their alpha results but these strategies lost their rankings according to Sharpe ratio's results. Emerging Markets, Event Driven and Managed Futures strategies have the highest standard deviations among all, which refers to price fluctuations and higher risk. Their additional risk is more significant than their high returns.

Convertible Arbitrage and Fixed Income strategies are among the lowest performers following average returns and alphas results but recorded higher Sharpe ratios on account of their low standard deviations, low standard deviations lead to higher Sharpe ratios with steady decent returns.

For Credit Suisse database, Multi-Strategy registered the highest Sharpe ratio (1.024) followed by Distressed Debt (0.923) and Global Macro (0.830) while Long/Short Equity and Market neutral record the lowest Sharpe ratios. The ranking results didn't change significantly comparing to alpha's results and based on average returns means. Multi-Strategy and Distressed Debt strategies surpassed Emerging Markets and Global Macro which is due to their difference in terms of the risk they take on in comparison to the high returns they provide. One the other hand, Managed Futures strategy is under the least performing strategies with a low return compared to other strategies and the highest standard deviation among all.

For CISDM, Market Neutral reported the highest Sharpe ratio (1.535) followed by Distressed Debt (1.119) and Global Macro (0.896) while Managed Futures (0.612) and Fixed Income (0.578) are the lower ranked strategies. The strategies Emerging Markets and Managed Futures produced the highest alphas but lost their rankings according to Sharpe ratio's results. In spite of their relatively superior returns, they could not keep their rankings due to their important volatilities. With the lowest standard deviation, Market Neutral strategy managed to register the highest Sharpe ratio after recording the lowest alpha and average return due to its decent return and low volatility.

Table 4.11: Performance measurement with Sortino ratio

INDICES	Eurekahedge	Credit Suisse	CISDM
Hedge Fund Index	0.477	0.231	0.247
Relative Value Strategies			
Convertible Arbitrage	0.374 (6)	0.138 (7)	0.189 (7)
Fixed Income	0.303 (8)	0.103 (9)	0.090 (10)
Market Neutral	0.386 (5)	0.006 (10)	0.595 (2)
Event Driven Strategies			
Event Driven	0.266 (9)	0.181 (5)	0.226 (6)
Distressed Debt	0.360 (7)	0.250 (2)	0.302 (4)
Multi-Strategy	0.475 (3)	0.284 (1)	0.181 (8)
Directional Strategies			
Global Macro	0.890 (1)	0.201 (4)	0.673 (1)
Managed Futures	0.585 (2)	0.138 (6)	0.329 (3)
Long/Short Equity	0.198 (10)	0.131 (8)	0.137 (9)
Emerging Markets	0.425 (4)	0.215 (3)	0.288 (5)
Benchmark			
MSCI World	0.089	0.089	0.089

Numbers in () indicates the rank order of each strategy

Whereas Sharpe ratio considers both upside and downside volatility, Sortino ratio only looks at the standard deviation of the downside risk since positive volatility is a benefit. Most investors, analysts and portfolio managers are primarily concerned about the downside volatility. Table 4.11 illustrates the results from Sortino ratio risk-adjusted performance measurements.

Table 4.11 shows that hedge fund strategies indices exceed the MSCI WORLD benchmark index. Only Market Neutral strategy for Credit Suisse database fail to record a highest Sortino ratio than the benchmark, this result was also observed in Sharpe ratio risk-adjusted returns' results. Among the highest Sortino ratios for the three databases in common, Global Macro and Emerging Markets strategies. For the other efficient strategies, Managed futures delivered high Sortino ratios for Eurekahedge (0.585) and CISDM (0.329), Multi-strategy reported high Sortino ratios for Eurekahedge (0,475) and Credit Suisse (0.284) and Distressed Debt registered appealing Sortino ratios for Credit Suisse (0,250) and CISDM (0.302). The lowest recorded Sortino ratios for the three databases are produced by Fixed Income and Long/Short equity strategies.

Taking downside volatility into account with Sortino ratios modified the ranking of the strategies in comparison to Sharpe ratio's results and showed similarities to alpha's results for Eurekahedge and CISDM. Indeed, Emerging Markets and Managed Futures strategies regained their leading positions following Sortino ratios' measurement; which implies that their volatilities can be beneficial for investors. On the other hand, Fixed Income and Long/Short Equity strategies dropped in the rankings after computing the Sortino ratios. Fixed income, with its moderate return and Long/Short equity with its high risk compared to the other strategies when only harmful risk is taken into consideration, could not advance the other strategies. Event Driven strategy's Sortino ratios' outcomes are similar to Sharpe ratios. Credit Suisse Sortino ratios' results didn't have much change compared to Sharpe ratios' and alphas' results; the highest and the lowest ranked strategies remained the same.

4.1.2.2 Performance Comparison: Sub-Periods.

In the previous part, the performance measures of hedge fund strategies for the whole period (2001-2020) were reported. To understand deeply hedge fund strategies' behavior and to better interpret their performance results, this part will put forward the same analysis using the same performance measurement elements over different sub-periods. Tables 4.12, 4.13 and

4.14 provide the alphas delivered from regression using the factor models for the global hedge fund and for the ten strategies.

Table 4.12: Eurekahedge Strategies' (α) for Sub-periods

EUREKAHEDGE	ALPHA	1st Period	2nd Period	3rd Period	4th Period
		2001-2005	*2006-2010*	*2011-2015*	*2016-2020*
	CAPM	0.0079*	0,0059*	0,0023*	0,0014***
ALL HEDGE FUND	FF-3	0.0055*	0,0058*	0,0024*	0,0017**
	CARHART	0.0055*	0,0058*	0,0023*	0,0018*
	FF-5	0.0057*	0,0058*	0,0029*	0,0018**
		RELATIVE VALUE STRATEGIES			
	CAPM	0.0044*	0.0049*	0.0031*	0.0022*
CONVERTIBLE	FF-3	0.0035*	0.0048*	0.0032*	0.0021*
ARBITRAGE	CARHART	0.0035*	0.0048*	0.0030*	0.0020*
	FF-5	0.0035*	0.0057*	0.0032*	0.0022*
	CAPM	0.0071*	0.0042*	0.0035*	0.0015
FIXED	FF-3	0.0061*	0.0041*	0.0037*	0.0027**
INCOME	CARHART	0.0060*	0.0041*	0.0038*	0.0028*
	FF-5	0.0061*	0.0042*	0.0038*	0.0025**
	CAPM	0.0029*	0.0027*	0.0035*	-0.0007
MARKET	FF-3	0.0011***	0.0026*	0.0035*	-0.0006
NEUTRAL	CARHART	0.0012*	0.0026*	0.0032*	-0.0005
	FF-5	0.0009***	0.0020*	0.0037*	-0.0007
		EVENT DRIVEN STRATEGIES			
	CAPM	0.0085*	0.0067*	0.0019*	0.0006*
EVENT	FF-3	0.0055*	0.0063*	0.0024*	0.0024**
DRIVEN	CARHART	0.0057*	0.0064*	0.0024*	0.0025**
	FF-5	0.0057*	0.0068*	0.0033*	0.0023**
	CAPM	0.0118*	0.0062*	0.0031*	0.0027
DISTRESSED	FF-3	0.0079*	0.0058*	0.0037*	0.0044*
DEBT	CARHART	0.0078*	0.0059*	0.0033*	0.0046*
	FF-5	0.0083*	0.0050**	0.0039*	0.0044*
	CAPM	0.0092*	0.0062*	0.0024*	0.0009
MULTI-STRATEGY	FF-3	0.0074*	0.0061*	0.0025*	0.0014**
	CARHART	0.0074*	0.0061*	0.0027*	0.0015**
	FF-5	0.0075*	0.0063*	0.0028*	0.0015***
		DIRECTIONAL STRATEGIES			
	CAPM	0.0077*	0.0062*	0.0021*	0.0016
GLOBAL	FF-3	0.0060*	0.0061*	0.0019*	0.0014
MACRO	CARHART	0.0061*	0.0061*	0.0019**	0.0015
	FF-5	0.0060*	0.0061*	0.0023*	0.0015
	CAPM	0.0084*	0.0084*	0.0026	0.0009
MANAGED	FF-3	0.0056***	0.0084*	0.0020	-0.0004
FUTURES	CARHART	0.0058***	0.0083*	0.0012	-0.0003
	FF-5	0.0062***	0.0074*	0.0018	-0.0002
	CAPM	0.0078*	0.0051*	0.0021**	0.0016
L/S EQUITY	FF-3	0.0050*	0.0049*	0.0024*	0.0021**
	CARHART	0.0050*	0.0049*	0.0024*	0.0021*
	FF-5	0.0052*	0.0050*	0.0034*	0.0022*
	CAPM	0.0152*	0.0086*	0.0008	0.0032***
EMERGING	FF-3	0.0123*	0.0086*	0.0013	0.0042**
MARKETS	CARHART	0.0122*	0.0086*	0.0020	0.0044**
	FF-5	0.0120*	0.0090*	0.0017	0.0043*

* 1 % significance; ** 5% significance *** 10% significance

According to the regression results in Table 4.12, the majority of hedge fund strategies' indices exhibit significant positive alphas apart from Emerging Markets, Managed Futures in the third period 2011-2015 and Market Neutral, Managed Futures and Global Macro for the 2016-2020 period. For the strategies with non-significant alphas, it cannot be stated for sure that these strategies' indices have alpha equal to or greater than zero. Thus, these strategies'

outperformance in comparison to the market cannot be stated in the third and the fourth period. The sub-period analysis demonstrate that performance vary over time as most strategies' indices' alphas declined over time. Furthermore, the best performing strategies in the whole period "Emerging Markets, Distressed Debt, Managed Futures and Multi-Strategy were not the best performing in every period, Indeed, their rankings changed over time.

Directional strategies like Emerging Markets and Managed Futures strategies produced higher alphas in the first two periods but their alphas dropped in the third and fourth periods. Among Event Driven strategies, Event Driven and Multi-Strategy recorded high significant alphas in the first two periods and their alphas declined in the last two periods. Meanwhile, Relative Value strategies (Market Neutral, Convertible Arbitrage and Fixed Income) as the least performing strategies for the whole timespan, produced highest alphas in the third period and in the fourth period for Fixed Income and Convertible Arbitrage.

Aiming to identify market events and trend reversals that may have affected hedge fund strategies' performance more closely, a Bai-perron test (2003) were run to detect structural breakpoints in factor loadings (Appendix 1). The results pointed significant structural breaks for all the strategies and these breaks coincide with special market events that took place in the history. The first structural break came in 2004 for all the strategies Except Emerging Markets. The second one, in 2007 and 2008, for almost all the strategies except Event Driven, Managed Futures, Emerging Markets and Multi-Strategy. Other structural breaks happened in 2010 for Multi-Strategy and Global Macro and finally 2016 for Market Neutral. These dates reflect some financial market events in the history. 2004 is characterized by the several trend reversals that took place in all sectors such as the trend reversal on interest rates and on metals and oil price.

The other dates 2007-2008 coincide with the infamous financial crisis that took the financial world by surprise. 2010 was marked by the European sovereign debt crisis and 2016 by the sharp drop of oil price.

Table 4.13 demonstrates that some hedge fund strategies indices record positive and significant alphas especially in the first and second period. Yet, some alphas are negative and many are statistically not significant especially in the last period. Thus, it is not possible to state that the related strategies' indices have alphas equal to zero or below zero.

Table 4.13: CREDIT SUISSE strategies' (α) for Sub-periods

CREDIT SUISSE	ALPHA	1st Period	2nd Period	3rd Period	4th Period
		2001-2005	*2006-2010*	*2011-2015*	*2016-2020*
	CAPM	0.0047*	0.0035**	0.0016***	0.0001
ALL HEDGE FUND	FF-3	0.0027*	0.0034**	0.0016***	0.0002
	CARHART	0.0027*	0.0033**	0.0010	0.0004
	FF-5	0.0025*	0.0035**	0.0021**	0.0002
	RELATIVE VALUE STRATEGIES				
	CAPM	0.0031**	0.0035	0.0015*	0.0016*
CONVERTIBLE	FF-3	0.0018	0.0034	0.0022**	0.0023**
ARBITRAGE	CARHART	0.0018	0.0035	0.0025**	0.0024**
	FF-5	0.0022	0.0048***	0.0031*	0.0024**
	CAPM	0.0029*	0.0008	0.0036*	0.0015
FIXED	FF-3	0.0019***	0.0008	0.0038*	0.0027**
INCOME	CARHART	0.0019***	0.0025	0.0036*	0.0028**
	FF-5	0.0013	0.0008	0.0042*	0.0026**
	CAPM	0.0041*	-0.0046	0.0016	-0.0016
MARKET	FF-3	0.0038*	-0.0051	0.0017	-0.0016
NEUTRAL	CARHART	0.0038*	-0.0051	0.0010	-0.0015
	FF-5	0.0038*	0.0003	0.0018	-0.0014
	EVENT DRIVEN STRATEGIES				
	CAPM	0.0070*	0.0046*	-0.0001	-0.0013
EVENT	FF-3	0.0039***	0.0044*	0.0004	0.0003
DRIVEN	CARHART	0.0039***	0.0043*	-0.0003	0.0003
	FF-5	0.0035	0.0037*	0.0017	0.0002
	CAPM	0.0030*	0.0030***	0.0018	-0.0007
DISTRESSED	FF-3	0.0027*	0.0027***	0.0024**	0.0013
DEBT	CARHART	0.0027*	0.0027***	0.0016	0.0013
	FF-5	0.0024*	0.0024	0.0029**	0.0012
	CAPM	0,0050*	0.0029*	0.0045*	0.0011
MULTI-STRATEGY	FF-3	0.0038*	0.0028***	0.0046*	0.0011
	CARHART	0.0038*	0.0028***	0.0041*	0.0012
	FF-5	0.0037*	0.0033**	0.0055*	0.0010
	DIRECTIONAL STRATEGIES				
	CAPM	0.0090*	0.0066***	0.0029	0.0006
GLOBAL	FF-3	0.0079*	0.0067***	0.0022	0.0010
MACRO	CARHART	0.0078*	0.0068***	-0.0003	0.0012
	FF-5	0.0077*	0.0089**	0.0019	0.0010
	CAPM	0.0051	0.0045	0.0011	-0.0011
MANAGED	FF-3	0.0018	0.0044	-0.0005	-0.0038
FUTURES	CARHART	0.0020	0.0041	-0.0028	-0.0036
	FF-5	0.0025	0.0023	-0.0022	-0.0038
	CAPM	0.0035*	0.0036**	0.0021**	-0.0003
L/S EQUITY	FF-3	0.0008	0.0036*	0.0021**	-0.0005
	CARHART	0.0010	0.0035*	0.0016	-0.0004
	FF-5	0.0005	0.0034**	0.0037*	-0.0006
	CAPM	0.0096*	0.0050**	0.0002	0.0012
EMERGING	FF-3	0.0071*	0.0049**	0.0003	0.0022
MARKETS	CARHART	0.0071*	0.0048**	0.0003	0.0024
	FF-5	0.0067*	0.0056*	0.0002	0.0023

* 1 % significance; ** 5% significance *** 10% significance

The sub-period analysis demonstrates that the alphas produced by the distinct strategies' performance are not constant and change over time. Most hedge funds strategies indices' alphas diminished upon the different sub-periods. Furthermore, the best performing strategies in the whole period "Emerging Markets, Global Macro, Distressed Debt and Multi-Strategy" are not the best performing in every period. Global Macro and Emerging Markets deliver the highest alphas for the first and second period, however, they recorded insignificant results in the following periods which implies a fail to outperform the market with an alpha close to zero. Event Driven strategy showed the same pattern with increased alphas during the first two periods and insignificant results in the last two periods. Relative Value strategies,

Convertible Arbitrage and Fixed Income reported significant alphas in the third period and are the only strategies producing significant alphas in the last period.

Bai-Perron structural breaks test was performed following these results to detect extreme market events and changes in returns pattern during the studied period (Appendix 2). According to the results, there was structural breaks affecting the different strategies and the related break dates concur with market changes that occurred over time.

A first structural break happened for almost all strategies in 2004 except Global Macro, Emerging Markets, Distressed Debt, Fixed Income and Market Neutral. Indeed, it is difficult for markets to stay trendless for a long time and there are multiple factors that can insert volatility and start trends on treasury, equity and commodity markets. In fact, the Federal Reserve raised interest rates in 2004 to curb inflation and cool off an overheated economy. There were also trends on metals and oil prices. Another significant structural break, that match the great financial crisis, occurred in 2007 and 2008 for all the strategies apart from Event Driven and Managed Futures strategies. Other structural breaks were detected for Fixed Income and Event driven strategy in 2010 and for market neutral in 2011. It is important to note that these dates conform the European debt crisis that started in 2010.

In the first period, Directional Strategies (Global Macro, Emerging Markets) and Event Driven strategies (Event Driven, Multi-Strategy) performed better than Relative Value strategies. In the second period, these same strategies maintained their superior performance. In the last two periods, Fixed Income and Convertible Arbitrage strategies performed better than other strategies. Almost all hedge fund strategies outperformed the market and recorded positive alphas during the period covering the financial crisis.

Table 4.14 indicates that hedge fund strategies produce mainly positive alpha especially in the first two periods. The results show that performance is not persistent over time and tends to decline. For CISDM, the best performing strategies for the full time period such as Emerging Markets, Managed Futures, Event Driven and Distressed Debt were not leading in terms of performance for every period. Event Driven strategy produced significant alphas in the first and second period; however, its alphas decreased in the third period and became insignificant in the third period (FF-3, Carhart) and the fourth period for all the estimated models. Emerging Markets reported increased alphas in the first and second periods except for the FF-5 but the estimated alphas decreased and became insignificant in the third and fourth periods. Managed Futures registered the highest alphas in the second period. For Relative Value

strategies, Convertible Arbitrage is one of the best performing with significant high alphas for the third period along Market Neutral and for the fourth period.

Table 4.14: CISDM strategies' (α) for Sub-periods

CISDM	ALPHA	1st Period	2nd Period	3rd Period	4th Period
		2001-2005	*2006-2010*	*2011-2015*	*2016-2020*
	CAPM	0.0057*	0.0041*	0.0005	0.0020
ALL HEDGE FUND	FF-3	0.0037*	0.0039*	0.0006	0.0029**
	CARHART	0.0037*	0.0039*	0.0004	0.0030**
	FF-5	0.0039*	0.0040*	0.0012	0.0029**
		RELATIVE VALUE STRATEGIES			
	CAPM	0.0035*	0.0043***	0.0032*	0.0036**
CONVERTIBLE	FF-3	0.0028**	0.0040**	0.0034*	0.0047*
ARBITRAGE	CARHART	0.0028**	0.0041**	0.0037*	0.0048*
	FF-5	0.0030**	0.0051**	0.0038*	0.0046*
	CAPM	0.0041*	0.0029	0.0018*	-0.0008
FIXED	FF-3	0.0037*	0.0027	0.0020*	0.0017
INCOME	CARHART	0.0037*	0.0028	0.0018*	0.0019
	FF-5	0.0036*	0.0026***	0.0023*	0.0011
	CAPM	0.0031*	0.0025*	0.0041*	0.0007
MARKET	FF-3	0.0016*	0.0025*	0.0040*	0.0006
NEUTRAL	CARHART	0.0016*	0.0025*	0.0037*	0.0006
	FF-5	0.0019*	0.0021*	0.0048*	0.0006
		EVENT DRIVEN STRATEGIES			
	CAPM	0.0060*	0.0060*	0.0029***	0.0001
EVENT	FF-3	0.0032*	0.0058*	0.0024	0.0014
DRIVEN	CARHART	0.0032*	0.0057*	0.0030	0.0014
	FF-5	0.0033*	0.0053*	0.0032***	0.0011
	CAPM	0.0085*	0.0035**	0.0026*	0.0014
DISTRESSED	FF-3	0.0055*	0.0031**	0.0032*	0.0022***
DEBT	CARHART	0.0056*	0.0031**	0.0030*	0.0023**
	FF-5	0.0056*	0.0032**	0.0033*	0.0024**
	CAPM	0.0030*	0.0004	0.0009	0.0013
	FF-3	0.0009	0.0003	0.0009	0.0017***
MULTI-STRATEGY	CARHART	0.0009	0.0002	0.0005	0.0017***
	FF-5	0.0007	0.0001	0.0015***	0.0018***
		DIRECTIONAL STRATEGIES			
	CAPM	0.0033*	0.0033*	0.0015	0.0046
GLOBAL	FF-3	0.0012	0.0034*	0.0012	0.0046
MACRO	CARHART	0.0013	0.0034*	0.0011	0.0047
	FF-5	0.0011	0.0033*	0.0015	0.0050
	CAPM	0.0042*	0.0068**	0.0016	0.0022
	FF-3	0.0011	0.0069**	0.0004	0.0040
MANAGED	CARHART	0.0012	0.0067**	-0.0008	0.0005
FUTURES	FF-5	0.0016	0.0049***	-0.0018	0.0005
	CAPM	0.0039*	0.0028**	0.0020*	0.0009
	FF-3	0.0012	0.0027*	0.0022*	0.0015
L/S EQUITY	CARHART	0.0012	0.0026*	0.0020*	0.0016
	FF-5	0.0014	0.0026***	0.0029*	0.0016
	CAPM	0.0127*	0.0122*	0.0063*	0.0002
	FF-3	0.0084*	0.0138***	0.0071	-0.0011
EMERGING	CARHART	0.0084*	0.0141***	0.0069	-0.0008
MARKETS	FF-5	0.0079*	0.0119	0.0127**	-0.0001

* 1 % significance; ** 5% significance *** 10% significance

Structural break test was run on the different strategies and significant breaks were detected. One in 2004 for Managed Futures strategy, another structural breaks: in 2007 for Fixed Income and Long/Short Equity strategies, in 2008 for Distressed Debt and Convertible Arbitrage strategies, 2009 for Multi-Strategy, in 2010 for Long Short Equity and in 2016 for Market Neutral. These breaks coincide with extreme market events that occurred at the times.

A strategy's performance may change according to market situation and to the manager skill in his way of response to market events. The majority of hedge fund strategies outperformed the market and recorded positive alphas during the financial crisis related period.

Table 4.15 exhibits the results of the Sharpe ratio performance measurement for the divided sub-periods to interpret hedge fund strategies performance and to analyze how their performance changed during the time interval.

Table 4.15: Hedge Fund strategies' (**Sharpe ratio**) for sub-periods

INDICES	EUREKAHEDGE				CREDIT SUISSE				CISDM			
	2001-2005	2006-2010	2011-2015	2016-2020	2001-2005	2006-2010	2011-2015	2016-2020	2001-2005	2006-2010	2011-2015	2016-2020
ALL HEDGE FUND	2.512	1.193	1.213	0.931	1.769	0.592	0.897	0.563	1.361	0.613	0.561	0.923
RELATIVE VALUE STRATEGIES												
CONVERTIBLE ARBITRAGE	2.776	1.228	2.207	1.552	0.929	0.404	0.782	0.912	1.449	0.613	1.508	1.217
FIXED INCOME	3.840	0.990	1.932	0.850	1.328	0.113	2.701	0.798	5.234	0.490	1.380	0.223
MARKET NEUTRAL	1.787	1.329	2.920	0.094	2.817	-0.29	0.732	-0.12	2.241	1.435	2.464	0.703
EVENT DRIVEN STRATEGIES												
EVENT DRIVEN	2.160	0. 909	0.846	0.677	1.517	0.827	0.364	0.372	1.537	1.454	0.865	0.350
DISTRESSED DEBT	2.999	0.850	1.225	1.007	2.479	0.553	0.818	0.378	2.656	0.580	1.194	0.842
MULTI-STRATEGY	3.441	1.390	1.231	0.819	2.148	0.481	2.106	0.748	1.291	0.091	0.716	0.906
DIRECTIONAL STRATEGIES												
GLOBAL MACRO	2.466	1.841	1.300	0.994	3.418	0.711	0.443	0.606	1.156	1.310	0.786	0.878
MANAGED FUTURES	1.320	1.656	0.798	0.433	0.498	0.495	0.165	-0.07	0.598	0.968	0.300	0.532
L/S EQUITY	1.631	0.727	0.879	0.865	0.807	0.490	0.843	0.542	1.353	0.500	0.934	0.738
EMERGING MARKETS	2.820	1.042	0.517	1.041	1.536	0.527	0.400	0.676	1.665	0.910	0.660	0.387
BENNCHMARK												
MSCI WORLD	-0,030	0,002	0,482	0,668	-0,030	0,002	0,482	0,668	-0,030	0,002	0,482	0,668

For Eurekahedge, the majority of hedge fund strategies report higher Sharpe ratios than MSCI world apart from Managed Futures and Market Neutral strategies in the last period (2016-2020). The strategy with the highest Sharpe ratio for the whole period, Global Macro (see Table 5.10), maintained its place among the leading strategies in the sub-periods. Distressed Debt, Emerging Markets and Event Driven, recorded high alphas for the first two periods but demonstrate a lower ranking for their Sharpe ratios due to their high standard deviation. Managed Futures report low Sharpe ratios in three periods and are among the top performing strategies in the second period. For Relative Value strategies, the results differ from alpha's results as Fixed Income strategy recorded the highest Sharpe ratio in the first period and was under the best performing along Market Neutral and Convertible arbitrage in the third period. Convertible Arbitrage delivered the highest Sharpe ratio in the last period.

For Credit Suisse, all the strategies have a higher Sharpe ratio than the MSCI in the first period. In the second period, Market Neutral didn't outperform the market according to its Sharpe ratio. In the third period, Emerging Markets, Managed Futures, Global Macro and Event Driven strategies recorded Sharpe ratios below the MSCI's one. In the last period, six out of the ten strategies have Sharpe ratios less than the market Sharpe ratio. Convertible Arbitrage, Fixed Income, Multi-Strategy and Emerging Markets are the only strategies with higher Sharpe ratios than the market benchmark for this period. The strategy with the highest Sharpe ratio for the whole period, Multi-Strategy, registered high Sharpe ratios in the third and fourth periods. Emerging Markets and Global Macro were among the best strategies in term of performance the first and second periods but then reported low Sharpe ratios in the last two periods. Managed Futures are among the worst performing strategies in three periods but the strategy delivered a high Sharpe ratio in the second period (2005-2010) along Global Macro and Event Driven. Fixed Income and Convertible Arbitrage reported low Sharpe ratios in the first and the second period, and then recorded a high performance in the third and fourth period. Market Neutral recorded a high risk-adjusted performance in the first period.

For CISDM, hedge fund strategies deliver higher Sharpe ratios than the market in the first and second period. In the third period, Managed Futures strategy is the only strategy that have a Sharpe ratio lower than the market benchmark. For the fourth period, Emerging Markets, Managed Futures, Event Driven and Fixed Income didn't exceed the market according to Sharpe ratios. Market Neutral, the best performing strategy for the full time period according to Sharpe ratios' results for whole period, reported high Sharpe ratios in the first three periods. Distressed Debt strategy one of the best performing strategies for the whole period recorded a low Sharpe ratio in the second period.

Emerging Markets and Event Driven strategies recorded low Sharpe ratios in the last two periods while Relative Value strategies managed to deliver higher Sharpe ratios in these periods. Managed futures strategy is under the best performing strategies in the second period (2005-2010) along Global Macro and Event Driven.

All the strategies except market Neutral for Credit Suisse performed better than the market benchmark in the second period covering the financial crisis. Nevertheless, some strategies couldn't outperform the market in the third (2011-2015) and fourth period (2016-2020) of this study.

Overall, Emerging Markets and Distressed Debt are among the best performing strategies in common for the three databases in the first period (2001-2005), Global Macro and Managed Futures are for the second period (2006-2010), Convertible Arbitrage and Fixed

Income are for the third period (2011-2015) and Convertible Arbitrage is commonly among the best in the last period (2016-2020). Fixed Income is under the list of the best performers for Eurekahedge and CISDM in the first period. For Credit Suisse and CISDM, they have in common Market Neutral as one the best in the first period and Event Driven in the second period.

Adopting the downside risk framework, Sortino ratios were calculated for the different strategies for the sub-periods in Table 4.16 to differentiate downside deviation from the overall standard deviation taking just bad risk into account.

Table 4.16: Hedge fund strategies' (**Sortino ratio**) for sub-periods

INDICES	EUREKAHEDGE				CREDIT SUISSE				CISDM			
	2001-2005	2006-2010	2011-2015	2016-2020	2001-2005	2006-2010	2011-2015	2016-2020	2001-2005	2006-2010	2011-2015	2016-2020
ALL HEDGE FUND	1.246	0.429	0.446	0.308	0.869	0.170	0.335	0.169	0.560	0.178	0.189	0.269
RELATIVE VALUE STRATEGIES												
CONVERTIBLE ARBITRAGE	1.297	0.248	0.830	0.608	0.313	0.077	0.392	0.275	0.521	0.128	0.681	0.277
FIXED INCOME	2.071	0.247	0.739	0.212	0.438	0.020	1.141	0.172	4.655	0.111	0.542	0.042
MARKET NEUTRAL	0.734	0.398	0.930	0.031	2.792	-0.03	0.324	-0.05	0.825	0.468	1.175	0.349
EVENT DRIVEN STRATEGIES												
EVENT DRIVEN	0.735	0. 261	0.300	0.176	0.392	0.248	0.117	0.091	0.527	0.584	0.266	0.095
DISTRESSED DEBT	1.398	0.243	0.429	0.255	0.597	0.159	0.296	0.100	1.380	0.140	0.427	0.313
MULTI-STRATEGY	1.784	0.421	0.440	0.265	1.038	0.123	0.775	0.220	0.490	0.023	0.276	0.286
DIRECTIONAL STRATEGIES												
GLOBAL MACRO	1.453	0.869	0.494	0.465	1.951	0.186	0.119	0.237	0.508	0.681	0.358	0.954
MANAGED FUTURES	0.612	1.142	0.359	0.176	0.208	0.275	0.075	-0.03	0.297	0.592	0.160	0.247
L/S EQUITY	0.408	0.160	0.180	0.169	0.231	0.098	0.172	0.120	0.212	0.117	0.188	0.131
EMERGING MARKETS	1.151	0.312	0.180	0.332	0.649	0.134	0.129	0.205	0.659	0.277	0.269	0.121
BENNCHMARK												
MSCI WORLD	-0,011	-0,000	0,178	0,189	-0,011	-0,000	0,178	0,189	-0,011	-0,000	0,178	0,189

Table 4.16 indicated that for Eurekahedge: Market Neutral, Event Driven, Long/Short Equity and Managed Futures demonstrate low Sortino ratios than the market benchmark in the last period. For Credit Suisse, strategies underperforming the market are: Market Neutral in the second period; Emerging Markets, Managed Futures, Global Macro, Long/Short Equity and Event Driven in the third period and for the last period: Market Neutral, Fixed Income, Managed Futures, Long/Short Equity, Event Driven and Distressed Debt.

Concerning CISDM, Managed Futures record lower Sortino ratios than the market benchmark in the third period and Emerging Markets, Long/Short Equity, Event Driven and Fixed Income didn't perform better than the market in the last period.

The results are not overly different from the Sharpe ratios in terms of ranking in comparison to the whole period analysis. Nonetheless, there was a slight change in positions

among strategies in which strategies like Managed Futures and Global Macro gained positions and strategies like Event Driven and Long/Short equity lost some positions which is due the downside risk framework. Taking harmful volatility into account made a slight impact on the outcomes without changing the overall results.

In the first period (2001-2005), Distressed Debt is among the best performers in common for the three databases. Emerging Markets and Market Neutral strategies are among the best for Credit Suisse and CISDM; Global Macro one of the best in common for Eurekahedge and Credit Suisse and Fixed Income is among the best in common for Eurekahedge and CISDM. For the second period (2006-2010), Global Macro, Managed Futures and Event Driven are under the best performing strategies in common for the three databases and Market Neutral is one of the best for Eurekahedge and CISDM. In the third period (2011-2015), Relative Value strategies (Convertible Arbitrage, Market Neutral, Fixed Income) are the best performing strategies for all the databases. Finally, in the last period (2016-2020), Convertible Arbitrage, Global Macro and Multi-Strategy are the best performing strategies for the three databases in common.

For the least performers, Managed Futures and Long/Short Equity strategies are among the less performing in the first period (2001-2005) for the three databases, Convertible Arbitrage is under the list of the less efficient strategies for Credit Suisse and CISDM. For the second period (2006-2010), Fixed Income, Long/ Short Equity and Convertible Arbitrage are the worst performers in common for the three databases and Multi-strategy is among the least performing for CISDM and Credit Suisse. In the third period (2011-2015), Event Driven, Managed Futures, Emerging Markets and Long/Short Equity are the underperforming strategies for the three databases and for the last period (2016-2020) Event Driven, Managed Futures, Long Short Equity are under the list of the least successful strategies in addition to Market Neutral for Eurekahedge and Credit Suisse.

4.2 Comparative Analysis of Hedge Funds and Mutual Funds' Performance

In this part of the study, hedge funds will be compared to mutual funds in terms of risk-adjusted performance in order to find out whether or not hedge funds perform better than mutual funds following similar strategies. Performance measurement tools will be applied to hedge funds and mutual funds strategies' indices for the three studied databases.

4.2.1 Descriptive Statistics

Table 4.17 displays the means and the standard deviations of global indices (Eurekahedge hedge fund index, Credit Suisse Hedge Fund index, CISDM Hedge Fund index and Vanguard as a proxy for mutual funds global index). Moreover, it exhibits the means and the standard deviations of hedge funds strategies' indices for the three databases and the distinct mutual funds' indices following similar strategies as hedge funds over the period time.

Table 4.17: Descriptive Statistics for Hedge Funds and Mutual Funds strategies

	MUTUAL FUND		EUREKAHEDGE		CREDIT SUISSE		CISDM	
INDICES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
GLOBAL FUND INDICES	0,0076	0.04	0.0042	0.013	0.0042	0.02	0.0038	0.018
				RELATIVE VALUE STRATEGIES				
CONVERTIBLE ARBITRAGE	0.0022	0.156	0.0041	0.01	0.0031	0.021	0.0047	0.017
FIXED INCOME	0.0004	0.023	0.0049	0.011	0.0031	0.017	0.0026	0.014
MARKET NEUTRAL	0.0023	0.017	0.0027	0.005	-0.0014	0.036	0.0026	0.006
				EVENT DRIVEN STRATEGIES				
EVENT DRIVEN	0.0062	0.084	0.0050	0.02	0.0024	0.017	0.0032	0.017
MULTI-STRATEGY	0.0017	0.046	0.0041	0.012	0.0039	0.014	0.0009	0.011
				DIRECTIONAL STRATEGIES				
GLOBAL MACRO	0.0037	0.067	0.0038	0.008	0.0040	0.027	0.0032	0.015
MANAGED FUTURES	-0.0013	0.028	0.0043	0.014	0.0022	0.03	0.0040	0.023
L/S EQUITY	0.0016	0.112	0.0042	0.02	0.0034	0.021	0.0032	0.017
EMERGING MARKETS	0.0031	0.055	0.0044	0.023	0.0023	0.026	0.0057	0.041
				BENCHMARK				
MSCI WORLD	0.0038	0.045	0.0038	0.045	0.0038	0.045	0.0038	0.045

According to the descriptive statistics in Table 4.17, almost all mutual funds indices generate a positive average return (mean) except the one adopting the Managed Futures strategy. Hedge fund strategies produce mainly positive average returns with the exception of Credit Suisse data with the Market neutral strategy. In comparison with mutual funds, hedge funds have significantly higher average returns for Relative Value strategies except Market Neutral for Credit Suisse and for Directional Strategies like Managed Futures and Long/Short equity. Mutual funds following Event Driven strategy surpassed hedge funds in terms of average returns advancing all the databases. Mutual funds following Multi-Strategy and Global Macro strategies have higher average returns than CISDM's Global Macro and Multi-strategy while mutual funds following Market Neutral and Emerging Markets strategies recorded higher average returns than Credit Suisse's Market Neutral and Emerging Markets strategies. Compared with the benchmark, apart from the global index represented by Vanguard Index and

the mutual funds adopting event driven strategy, all mutual funds adopting similar strategies as hedge funds recorded lower average returns than market benchmark for the time period. On the other hand, for hedge fund strategies, some strategies could report higher average returns than the MSCI World Index: Multi-strategy and Global Macro for Credit Suisse; Convertible Arbitrage, Managed Futures and Emerging Markets for CISDM and all the strategies except Market Neutral for Eurekahedge.

All Mutual funds strategies indices present a higher volatility than hedge fund strategies indices and higher than the market for some of them. Therefore, hedge fund strategies are exposed to less risk than mutual funds and the market. On the whole, hedge fund strategies with a lower risk exposure do not always outperform mutual funds adopting the same strategy according to average returns' results but can however outperform for the majority of strategies.

4.2.2 Performance Measurement Results

The results of the descriptive statistics showed a side for hedge funds and mutual funds indices performances according to the strategies used for the period time. Still, the average returns alone are not adequate to compare hedge funds and mutual funds. In fact, risk exposure of the different strategies should be taken into consideration to achieve this comparison. For that, Alpha based on the CAPM, traditional Sharpe ratio and Sortino ratio are utilized as risk-adjusted return assessment tools. Tables (4.18, 4.19 and 4.20) report mutual funds and hedge fund strategies' indices performance results for the comparison time period.

Table 4.18: Hedge Funds and Mutual Funds strategies' (**α**)

	MUTUAL FUND	EUREKAHEDGE	CREDIT SUISSE	CISDM
GLOBAL FUND INDICES	0.0045*	0.0029*	0.0013***	0.0017*
		RELATIVE VALUE STRATEGIES		
CONVERTIBLE ARBITRAGE	0.0020***	0.0031*	0.0016***	0.0038*
FIXED INCOME	0.0003	0.0038*	0.0019***	0.0019**
MARKET NEUTRAL	0.0013	0.0020*	-0.0027	0.0023*
		EVENT DRIVEN STRATEGIES		
EVENT DRIVEN	0.0044	0.0033*	0.0010	0.0029**
MULTI-STRATEGY	-0.0006	0.0028*	0.0026*	0.0002
		DIRECTIONAL STRATEGIES		
GLOBAL MACRO	0.0005	0.0030*	0.0029	0.003**
MANAGED FUTURES	-0.0012	0.0037*	0.0017**	0.0038**
L/S EQUITY	0.0097	0.0024*	0.0015***	0.002*
EMERGING MARKETS	-0.0003	0.0025**	0.0007	0.0043

* 1 % significance; ** 5% significance *** 10% significance

Table 4.18 illustrate the global indices (Eurekahedge hedge fund index, Credit Suisse Hedge Fund index, CISDM Hedge Fund index and Vanguard as a proxy for mutual funds global

index), the different hedge strategies indices for the three databases and the different mutual fund indices following the same strategies and their related alphas over the time period with the percentage of significance level at 1%, 5% and 10%.

For the comparison time period (2008-2019), the majority of mutual fund indices' given alphas are not significant; only Vanguard and mutual funds following the Convertible Arbitrage strategy deliver significant alphas. Unlike mutual funds, hedge fund indices present more significant alphas implying that hedge fund managers perform on average better than mutual fund managers. Hedge fund indices non-significant alphas correspond to Market Neutral, Event Driven, Global Macro and Emerging markets for Credit Suisse and to Multi-strategy and Emerging markets for CISDM. For the significant results, it can be stated that the vanguard index outperforms global hedge fund indices of the three databases and the convertible arbitrage indices of Eurekahedge and CISDM outperform the mutual fund index following the strategy. This outperformance can be related to the period study (2008-2019) as it conforms with the period after the GFC and the absence of a bear market since. Furthermore, Vanguard index is known for its low expense ratios, therefore, with their higher fees, hedge funds might not have matched the net performance of the Vanguard index for this period.

For mutual funds adopting specific strategies similar to hedge funds, delivered alphas are mostly not significantly different from zero. Thereby, it is not possible to claim that they underperform the market index but it can be said that they didn't succeed to outperform it. In contrast to mutual funds, hedge fund strategies indices scored alphas significantly different than zero for the majority of the strategies and with that they could outperform the market and their mutual fund competitors for most of the strategies.

Thus, hedge funds do not always outperform mutual funds since the vanguard mutual fund index could beat the global hedge fund indices (Eurekahedge, Credit Suisse, CISDM) and the mutual fund index following the Convertible Arbitrage strategy could defeat Credit Suisse Convertible Arbitrage index.

Sharpe ratio measurement results are illustrated in Table 4.19 as another important performance measurement tool in order to compare the global indices (Eurekahedge hedge fund index, Credit Suisse Hedge Fund index, CISDM Hedge Fund index and Vanguard as a proxy for mutual funds global index) and hedge fund strategies indices for the three databases with mutual fund indices following the same strategies in terms of performance during the time interval.

Table 4.19: Hedge Funds and Mutual Funds strategies' 'Sharpe ratio'

	MUTUAL FUND	EUREKAHEDGE	CREDIT SUISSE	CISDM
GLOBAL FUND	0.175	0.280	0.146	0.160
		RELATIVE VALUE STRATEGIES		
CONVERTIBLE ARBITRAGE	0.156	0.354	0.123	0.265
FIXED INCOME	0.023	0.394	0.152	0.178
MARKET NEUTRAL	0.134	0.362	-0.053	0.381
		EVENT DRIVEN STRATEGIES		
EVENT DRIVEN	0.084	0.225	0.113	0.181
MULTI-STRATEGY	0.046	0.286	0.222	0.076
		DIRECTIONAL STRATEGIES		
GLOBAL MACRO	0.067	0.379	0.127	0.205
MANAGED FUTURES	-0.044	0.261	0.057	0.171
L/S EQUITY	0.102	0.186	0.138	0.180
EMERGING MARKETS	0.055	0.168	0.088	0.136
		BENCHMARK		
MSCI	0.072	0.072	0.072	0.072

Table 4.19 show that all hedge fund strategies have higher Sharpe ratios than MSCI world index for Eurekahedge and CISDM and for most strategies from the Credit Suisse database with the exception of Market Neutral and Managed Futures. Among mutual fund indices, five strategies indices failed to produce a Sharpe ratio better than the market (Fixed Income, Multi-strategy, Global Macro, Managed Futures and Emerging Markets).

In comparison with mutual fund indices, all hedge fund strategies indices from Eurekahedge and CISDM databases generate risk-adjusted returns (Sharpe ratios) higher than mutual fund indices employing the same strategy. For Credit Suisse database, Convertible Arbitrage and Market Neutral strategies indices provide lower Sharpe ratios than mutual funds following the same strategies. For global indices, vanguard index' Sharpe ratio delivered a higher Sharpe ratio than Credit Suisse global hedge fund and the CISDM global hedge fund indices which can be due to the selected period of study (2008-2019) and the difference in expense fees.

Risk adjustment can be very important to evaluate and compare funds' performance. Indeed, when taking risk into consideration performance results changed comparing to average returns results only. Hedge funds performance became more prevailing when taking Sharpe ratio into account and all the strategies from EUREKAHEDGE and CISDM outperformed mutual funds strategies' indices. The only unchanging result is for Credit Suisse and only for Market Neutral strategy index.

Comparing with alpha results, the findings remained the same and the only noticeable difference concerns Eurekahedge Global index as it was underperforming the Vanguard index according to alpha but became outperforming following the Sharpe ratios' results.

This can be explained by its low standard deviation comparing to other global hedge fund indices that makes a difference when calculating the Sharpe ratio.

Within a downside risk framework, Sortino ratios were computed in Table 4.20 for global indices and the different strategies of hedge funds and mutual funds.

Table 4.20: Hedge Funds and Mutual Funds strategies' 'Sortino ratio'

	MUTUAL FUND	EUREKAHEDGE	CREDIT SUISSE	CISDM
GLOBAL FUND	0.190	0.354	0.156	0.196
		RELATIVE VALUE STRATEGIES		
CONVERTIBLE ARBITRAGE	0.204	0.353	0.115	0.243
FIXED INCOME	0.023	0.435	0.104	0.180
MARKET NEUTRAL	0.151	0.426	-0.031	0.529
		EVENT DRIVEN STRATEGIES		
EVENT DRIVEN	0.088	0.252	0.128	0.184
MULTI-STRATEGY	0.046	0.350	0.212	0.075
		DIRECTIONAL STRATEGIES		
GLOBAL MACRO	0.070	0.614	0.135	0.644
MANAGED FUTURES	-0.076	0.454	0.094	0.311
L/S EQUITY	0.148	0.149	0.104	0.141
EMERGING MARKETS	0.061	0.198	0.090	0.134
		BENCHMARK		
MSCI	0.074	0.074	0.074	0.074

Table 4.20 shows that all hedge fund strategies' indices register higher Sortino ratios than the MSCI World benchmark for Eurekahedge and CISDM. For Credit Suisse, only Market Neutral strategy failed to provide a higher Sortino ratio than the market. On the other hand, the majority of mutual fund indices didn't deliver higher Sortino ratios than the market.

In comparison to mutual funds, the majority of Eurekahedge hedge fund strategies indices reported high Sortino ratios than the mutual funds indices. For CISDM, all strategies indices except Long/Short Equity performed better than mutual fund indices and for Credit Suisse database, only three strategies failed to outperform its mutual funds peers (Convertible Arbitrage, Market Neutral and Long/Short Equity). The rest of the strategies could outduel mutual funds following the same strategy. For the global funds, only Credit Suisse global hedge fund produced lower Sortino ratio than the mutual global fund Vanguard for this study period.

Sortino ratio's results are similar to Sharpe ratio's findings with an only noticeable difference concerning Long/Short Equity and CISDM global hedge fund. Indeed, after taking only downside deviation into account, the strategy became underperforming in comparison to the mutual fund adopting the same strategy which implies that this strategy for CISDM present a high bad volatility which made it lose in term of performance and on the other side CISDM global hedge fund index became outperforming after considering downside risk. Credit Suisse is underperforming mutual funds compared to Eurekahedge and CISDM which demonstrated a solid performance and a noticeable dominancy against mutual funds.

4.3 Cointegration Analysis Results

Cointegration approach will be employed to determine if hedge fund strategies present similar management styles or hold assets that are similar in terms of risk profiles that could eliminate diversification opportunities and lead to an unappealing performance.

The stationarity is inspected in tables 4.21, 4.22; the Phillips-Peron (PP) and The Augmented Dicky-Fuller (ADF) unit root tests were run based on model with constant and trend, the number of lags was selected according to the minimum Akaike Information Criterion (AIC) (see Appendix 4). Based on Table 4.21 the hypothesis of unit root at level is accepted for Eurekahedge and Credit Suisse, which implies that data is not stationary for Eurekahedge and Credit Suisse while time series for CISDM are stationary at level which means they are at I (0). The same tests were made for Credit Suisse and Eurekahedge at first difference and all data variables became stationary at first difference, which means that they are integrated at same order, I (1).

Table 4.21: Unit root tests For Eurekahedge and Credit Suisse

INDICES	Eurekahedge				Credit Suisse			
	ADF		PP		ADF		PP	
	Level	1st Diff.	Level	1st Diff	Level	1st Diff	Level	1st Diff
Convertible Arbitrage	1.23	-11.82*	1.12	-11.88*	-0.18	-10.70*	-0.24	-10.66*
Fixed Income	0.37	-13.00*	0.35	-12.89*	-0.07	-9.33*	-0.10	-9.21*
Market Neutral	-0.99	-14.13*	-0.97	-14.11*	-2.21	-14.64*	-2.44	-14.69*
Event Driven	0.10	-12.55*	-0.05	-12.55*	-0.89	-12.30*	-0.97	-12.36*
Distressed Debt	0.26	-10.74*	0.08	-10.93*	-1.11	-11.82*	-1.19	-12.16*
Global Macro	0.19	-13.30*	0.16	-13.30*	-0.81	-15.56*	-0.64	-20.49*
Managed Futures	-0.91	-16.33*	-0.94	-16.35*	-1.84	-15.97*	-1.78	-16.27*
L/S Equity	0.96	-12.25*	1.06	-12.25*	-0.52	-12.41*	-0.48	-12.41*
Emerging Markets	0.58	-12.14*	0.59	-12.04*	-0.30	-12.53*	-0.28	-12.51*

* 1% significance level

Time series for CISDM are stationary at I (0) which implies that hedge fund strategies for CISDM database are not cointegrated. Before applying the Johansen's cointegration test for Eurekahedge and Credit Suisse which are stationary at I (1), proper lag is selected with the lowest AIC value. The value matches with lag 12 for Eurkahedge and Credit Suisse (see Appendix 4). Cointegration was verified through critical trace statistics and maximum Eigen value (As illustrated in Table 4.22-4.23).

Table 4.22: Johansen's Cointegration of Eurekahedge Fund strategies

	No. Cointegration Equation (s)	Eigenvalue	Statistics	Critical value (0.05)	Probability
Trace	**0***	0.284448	258.7686	197.3709	0.000
	1*	0.203050	179.1097	159.5297	0.002
	2*	0.138431	125.0924	125.6154	0.053
	3	0.099264	89.6304	95.75366	0.122
	4	0.096525	64.74924	69.81889	0.118
	5	0.084416	40.59059	47.85613	0.202
	6	0.040790	19.60067	29.79707	0.450
	7	0.032810	9.688997	15.49471	0.305
	8	0.007323	1.749296	3.841466	0.186
Maximum Eigenvalue	**0***	0.284448	79.65888	58.43354	0.000
	1*	0.203050	54.01729	52.36261	0.033
	2	0.138431	35.46202	46.23142	0.430
	3	0.099264	24.88116	40.07757	0.774
	4	0.096525	24.15865	33.87687	0.444
	5	0.084416	20.98992	27.53434	0.276
	6	0.040790	9.911674	21.13162	0.752
	7	0.032810	7.939701	14.26460	0.384
	8	0.007323	1.749296	3.841466	0.186

Note : Macinnon haug Michels (1999) p-values

The result of trace statistics in Table 4.22 exhibits that there are 2 series of cointegrating vectors at 5% confidence interval while Maximum Eigen value demonstrates 1 cointegration equation. These results indicate that hedge fund strategies indices are not strongly cointegrated and there may by uncertainty about their moving in equilibrium in the long run. There is still a scope for diversification due to the presence of uncertainty and the difference in the characteristics associated to each strategy.

The result of trace statistics in table 4.23 shows that there are 2 series of cointegrating vectors at 5% confidence interval while Maximum Eigen value demonstrates 1 number of cointegration equation. The result suggests that although there is evidence of cointegration among selected hedge fund strategies, which can imply similar assets in terms of risk exposures or an overlapping in portfolio management for some strategies. Yet, there is scope for efficient portfolio diversification across these strategies. Further study should be carried out to find the factors that are responsible for the co-movement of these strategies together.

Table 4.23: Johansen's Cointegration of Credit Suisse Hedge Fund strategies

	No. Cointegration Equation (s)	Eigenvalue	Statistics	Critical value (0.05)	Probability
Trace	**0***	0.280730	263.2261	197.3709	0.000
	1*	0.202463	184.8007	159.5297	0.001
	2*	0.156809	130.9586	125.6154	0.022
	3	0.112488	90.36479	95.75366	0.110
	4	0.090893	61.96359	69.81889	0.180
	5	0.056857	39.28392	47.85613	0.249
	6	0.050709	25.35191	29.79707	0.149
	7	0.032346	12.96640	15.49471	0.116
	8	0.021368	5.140798	3.841466	0.123
Maximum eigenvalue	**0***	0.284448	79.65888	58.43354	0.000
	1*	0.203050	54.01729	52.36261	0.033
	2	0.138431	35.46202	46.23142	0.430
	3	0.099264	24.88116	40.07757	0.774
	4	0.096525	24.15865	33.87687	0.444
	5	0.084416	20.98992	27.53434	0.276
	6	0.040790	9.911674	21.13162	0.752
	7	0.032810	7.939701	14.26460	0.384
	8	0.007323	1.749296	3.841466	0.186

Note: Macinnon haug Michels (1999) p-values

4.4 Discussions

In this part of the study, the findings of the comparative analysis of performance of hedge fund strategies, the comparative analysis of hedge funds and mutual funds as well as the cointegration results are interpreted and discussed respectively.

4.4.1 Hedge Fund Strategies Comparative Analysis of Performance

4.4.1.1 Discussions for the whole period

In the study research, all the variables like return, risk, correlation, skewness, kurtosis were examined for the three hedge fund databases. While studying the kurtosis of the different strategies for the distinct databases, the majority of the strategies were defined as leptokurtic implying extreme fluctuations except directional strategies for Eurekahedge; Managed Futures, Long Short equity for Credit Suisse; Managed Futures, Emerging markets and Market neutral for CISDM which implies that these strategies' platykurtic distributions are predictable and stable and that there may rarely provide extreme returns for investors. Skewness was also evaluated to study the tail of returns' distributions for the three databases; the majority of hedge fund strategies are negatively skewed with a probability of extreme negative returns. Only Managed Futures and Global Macro recorded a positive skewness for Credit Suisse and CISDM with the addition of Market Neutral for this database; making them desirable for investors.

These results are similar to those of Brooks/Kat (2002) that documented low skewness and high kurtosis for many hedge fund indices and that managed futures possess positive skewness and less kurtosis than the majority of other hedge fund strategies.

From the Jacque-Bera test, all hedge fund strategies' returns are not normally distributed for Eurekahedge and the majority of strategies except Managed Futures being the only normally distributed for Credit Suisse and CISDM. Therefore, the assumptions of validation of the mean-variance framework are not pleased according to Tobin (1958). For that, additional tools should be applied to evaluate hedge fund strategies' indices.

Before performing risk-adjusted performance metrics to assess hedge fund strategies performance, the distinct strategies' correlations were analyzed among them and with the market. With a correlation below 1 for all hedge fund strategies, the is no perfect positive correlation between hedge fund strategies and with the market implying that there will be diversification opportunities from adding a hedge fund to a portfolio of traditional assets. Previous study researches on hedge funds all found moderate to low correlations between hedge funds and traditional assets. Fung and Hsieh (1997), Schneeweis and Spurgin (1998), Liang (1999), Agarwal and Naik (1999). Capocci and Hübner (2004), Eling and Faust (2010). They assume that hedge funds improve the trade-off between risk and return in a portfolio because of their weak correlation with traditional assets. In addition to that, Managed Futures strategy showed the lowest correlation with other hedge fund strategies being the most uncorrelated strategy to the market.

Based on the findings from the full investigation period, the majority of hedge fund indices outperform the MSCI World benchmark index. Similar findings were concluded by Ackermann et al. (1999), Brown (1999), Liang (1999), Capocci and Hübner (2004), Bali, et al. (2013) and Nikola and Vijay (2017). When comparing hedge funds with passive index benchmarks such as S&P500, they came with the result that most hedge funds perform better than traditional benchmark indices during their period studies. According to the efficient market hypothesis, the only way to get returns better than the market is by including more risky assets and hedge fund strategies exhibit a high-risk exposure. Only Market Neutral and Managed Futures strategies failed to outperform the market for Credit Suisse. For Eurekahedge and CISDM databases, Managed Futures strategy failed to outperform the market when exotic risks were considered. Indeed, a hedge fund can exhibit a high alpha in a model more than the other because its exotic risk exposures performed well. When risk factors are considered, Emerging Markets and Distressed Debt are the best performing hedge fund strategies for all the databases followed by Event Driven and Global Macro strategies which ranking differs depending on a

database. It is important to note that generated returns for hedge fund strategies can stem from managerial skill as well which can explain certain discrepancies among hedge fund databases. On the other hand, Relative Value strategies and Long/ Short Equity strategies are the least efficient strategies in terms of performance.

Over the whole period, almost all strategies were subject to significant amounts of market risk to different degrees. Emerging Markets and Long/Short Equity have the highest risk exposure for the three databases. Event Value strategies, which have the most successful strategies like: Distressed Debt and Event Driven record a high level of systematic risk. Overall, Relative Value and Global Macro strategies have the least market risk exposure. Managed Futures strategy demonstrated a significant exposure only when exotic risks were taken into consideration like the momentum for all the databases and like the return spreads of the five-factor model for CISDM. Bali, Brown and Caglayan (2012) argue that hedge funds with higher exposure to systematic risk achieve better risk-adjusted performance. A similar result was obtained in this study in which Relative Value strategies with a low exposure to market risk were the less performing while strategies from Directional and Event Driven categories with a higher risk level achieved a better performance. The differences noticed are for Long/Short Equity and Global Macro strategies. Indeed Long/Short Equity strategy achieves poor risk-adjusted returns compared to other Directional strategies with one of the highest exposure levels. This may be due to portfolios made of positions with a strong sensitivity to market changes. Again, a manager's investment style plays an important role in the risk management of hedge funds. Furthermore, Global Macro strategy displays a low correlation in comparison to its peers while providing appreciated risk-adjusted returns. It can be explained by the growing implementation of risk management techniques aiming to contain volatility for this strategy. Overall, Global macro and Multi-strategy has the best risk/return profile among all the strategies.

As another performance measurement metric, Sharpe ratio is calculated for a comparative analysis between funds with similar historical returns. Investors learn how much additional gain they are getting in return of the given risk they are taking. Whereas a fund's R-squared must be high and p-values meaningful for alpha to be significant. Sharpe ratios are meaningful all the time. After assessing performance by calculating Sharpe ratios, the results demonstrated that hedge funds displayed a superior performance to the market with the only exception of Market Neutral strategy for Credit Suisse database. It is found that Global Macro and Distressed Debt strategies were among the most efficient strategies in common for the three databases. Using more than one risk adjustment metric can be meaningful to get a deep

comparison of indices' performance. The results obtained from Sharpe ratios were a bit different from Alphas outcomes and from the mean returns in terms of the rankings of the different strategies. While comparing the performance of hedge funds with market indices using alpha and Sharpe ratio, Ackermann et al. (1999) came across varied results for which they argued as possibly being driven by their risk adjustments for systematic risk through betas. Alpha measures the return earned in comparison to the market benchmark, it is associated with market risk and other exotic risks considered by the different asset models while the Sharpe ratio is related to the inherent risk of a fund revealed by its standard deviation. The higher the Sharpe ratio, the better hedge fund returns have been relative to the risk they have taken on and the higher the standard deviation, hedge funds need to earn higher returns to get a high Sharpe ratio. Strategies with high volatilities dropped in the rankings while strategies with low volatilities climbed. The differences between Alpha and Sharpe ratio's results are driven by the difference in the risk adjustment followed by the two metrics.

According to Alpha and Sharpe ratio's results, hedge fund strategies are proved to provide an appreciated performance. They tend to outperform the market and the strategies diverse in term of performance level. Global Macro and Distressed Debt are among the best performing strategies for the three databases.

Given the limitations of the Sharpe ratio on asymmetric distributions and the return distributions properties of hedge funds, the Sortino ratio, is a significant performance assessment tool which differentiates harmful volatility from the overall volatility by using only the standard deviation of negative returns 'downside deviation'. A better approach than the Sharpe ratio, this performance evaluation tool is useful for investors and portfolio managers to evaluate hedge fund strategies returns for a given level of bad risk. The findings revealed that most hedge fund strategies outperform the MSCI WORLD benchmark index with the only exception of Market Neutral for Credit Suisse database. The best commonly performing strategies for the three databases are Global Macro and Emerging Markets. Under the top performing: Managed futures for Eurekahedge and CISDM, Multi-strategy for Eurekahedge and Credit Suisse and Distressed Debt for Credit Suisse and CISDM. The least performing strategies in common for the three databases are Fixed Income and Long/Short Equity.

Considering only downside deviation when computing Sortino ratios, the results were a bit different from Sharpe ratio, which takes the overall standard deviation into account. The findings showed also some similarities with alpha's performance rankings, which underlie the importance of using distinct risk-adjusted performance metrics. Investors can make their decisions according to their evaluation needs, a comparison with a market benchmark or a

comparison using the inherent risk of two hedge fund strategies using Sharpe ratio or Sortino ratio. For that, Sortino ratio seems more reliable because it portrays a more realistic measure of the downside risk embedded in the hedge fund and investors are more concerned about the bad volatility.

The findings are summarized below under the distinct performance metrics:

	Alpha	**Sharpe ratio**	**Sortino ratio**
Best Performing Strategies	*Emerging Markets *Distressed Debt *Managed Futures (Eurekahedge, CISDM) *Multi-strategy (Eurekahedge, Credit Suisse)	*Global Macro *Distressed debt *Multi-strategy	*Global Macro *Emerging Markets *Multi-strategy (Eurekahedge, Credit Suisse) *Distressed Debt (Credit Suisse, CISDM) *Managed Futures (Eurekahedge, CISDM)
Least Performing strategies	*Market Neutral *Fixed Income *Long/Short Equity	*Managed Futures *Long/Short Equity *Fixed Income	*Fixed Income *Long/Short Equity *Convertible Arbitrage

Overall, the results demonstrate that hedge fund strategies are an attractive investment that deliver better value for investors, they mainly outperform the market and the most efficient strategies are mostly Directional (Global Macro, Emerging Markets) and Event Driven strategies (Distressed Debt, Multi-strategy). These results are similar with Nikola and Vijay (2019) in which they found Global Macro, Multi-strategy and Emerging Markets to be the best performing strategies in their study period (2007-2017). According to their risk preferences, investors may pick one or more strategies from different categories in attempt to diversify or to maximize their profits. Risk loving investors will go with Emerging Markets or Managed Futures strategies known for their high volatilities. Risk-adverse investors may lean towards Relative Value strategies for their low exposure to markets. If they are looking for best risk/return ratio profiles, they may opt for Multi-Strategy or Global Macro strategies.

While evaluating hedge fund strategies from three distinct databases, minor differences were observed in term of performance and also in the rankings of the strategies from a database to another. It is important to note that there may be factors that explain hedge fund returns and can make a difference for these databases. Fung and Hsieh (2004) advances that hedge fund returns rely on management fees, fund size and leverage while Liang (1999) observed a positive relationship with performance fees, fund assets and lock-up periods. Funds with more assets are able to produce high returns at lower levels of risk leading to superior risk-adjusted performance while smaller funds have a higher possibility of delivering lower alphas.

AUM can be a standard of performance for investors, high assets under management reflect a good performance and investors are drawn to a favorable performance (Giles,2002). Not to forget that managerial talent can also have a key role in the performance of hedge fund strategies. Upon the risk adjusted performance metrics alpha, Sharpe ratio and Sortino ratio of this research, Credit Suisse is underperforming in comparison to Eurekahedge and CISDM. This dissimilarity in performance can be a result of the number of individual hedge funds in each hedge strategy index. Credit Suisse involves the smaller number of funds in comparison to the other databases, which clarifies its underperformance compared to Eurekahedge and CISDM.

4.4.1.2 Discussions for the sub-periods

Hedge fund industry provides diverse sophisticated investment strategies to appeal to investors. The distinct strategies have usually dissimilar exposures. Indeed, the risks related to the strategies followed by hedge funds are more complicated than traditional assets. There are mainly risks like market risk, credit risk or liquidity risk and each strategy can be affected by one or another, Bali, Brown and Caglayan (2012) advance that Distressed Debt strategy is exposed to liquidity and default risks, Long/Short Equity strategy can be affected by the short-squeeze risk by their brokers, while Emerging Markets strategy can face the country risk and Fixed Income funds can be exposed to credit spread widening risk. Still, there are certain exposures that are proper to nearly every hedge fund such as volatility and equity market. Furthermore, macroeconomic risk has an important role in interpreting hedge fund strategies performance and can explain hedge fund strategies and their reaction to market events.

To analyze hedge fund strategies performance and to understand each hedge fund strategy's behavior, the study period was divided into four sub-periods 2001-2005, 2006-2010, 2011-2015, 2016-2020. The same performance analysis using performance measurement elements like: Alpha, Sharpe and Sortino ratios was adopted for the different sub-periods. Moreover, Bai-Perron structural breaks test was run for the distinct strategies of the different databases to detect structural breaks during the study time period in order to see if those breaks correspond to extreme market events that happened in the past and to study the different strategies performance in response to these market circumstances.

The existence of structural breaks is reported for the majority of hedge fund strategies in dates corresponding to crisis periods and non-crisis periods. It is difficult for markets to remain trendless for long. There are a host of factors that can inject volatility and start trends

on the treasury, currency, equity and commodity markets. The main break dates were observed in the first period (2004) for the majority of strategies when trend reversals took place in all sectors and in the second period (2007-2009) when the world faced an unprecedented financial crisis. Other meaningful breaks for some strategies coincide with the European debt crisis that started in 2010 (Event Driven, Multi-Strategy, Long/Short Equity) and the sharp drop of oil price in 2016 (Market Neutral). Hedge fund strategies were mainly affected by market circumstances during the studied timespan.

Performance measurement analysis was done to determine which strategies performed better in response to these market events. The results of the three metrics were slightly different considering the characteristics of each metric. More differences were noticed for Alpha due to its correlation to the performance of the picked benchmark MSCI World and its less consideration of the variation or the volatility of hedge fund strategies that are considered while using Sharpe ratio (Standard deviation) and Sortino ratio (Downside deviation). Still, the three metrics presented more similarities than differences which helped us deduce more concrete findings and conclusions.

While evaluating the performance of hedge fund strategies from the three database sources, similar patterns were observed where some strategies had more data breakages in the first and second period, which implies that those strategies were affected by the circumstances happening around these periods of time. Moreover, an underperformance in comparison to the market benchmark MSCI World according to Alpha, Sharpe and Sortino ratios occurred around the third and the fourth period for some of the strategies while they outperformed the market in times of crises and trend reversals happening in the first two periods which conform with their goal to hedge against market risk. In crisis periods, hedge funds are an attractive asset class as they aim to conserve value for their investors and protect against market events but when there are neutral market conditions or when the market is rising, it is hard for some strategies to outperform as it is found in the third and fourth periods which goes with market efficiency hypothesis. The efficient market hypothesis suggests that with perfect information in financial markets, the market will be efficient and outperforming the market will be impossible. The strategies that manage to outperform the market are strategies that take advantages from market inefficiencies. Still, in response to market events and during bullish and neutral market conditions, each strategy's behavior differs and can be superior to another in terms of performance according to performance measurement results.

Unlike previous studies, Liang, et al. (2001), Capocci and Hubner (2004), Schmid (2013) and Stoforos et al. (2016) that studied hedge fund performance during crises and argued

that hedge funds could not achieve superior returns over passive investments; this research analyzed the period covering the financial crisis and despite having data breakage for some hedge fund strategies (2007-2009), almost all strategies generated superior returns over the market benchmark during this period. Yet, these conclusions are similar with Nikola and Vijay (2019) which demonstrated that hedge fund strategies provide superior returns over their studied market benchmark SP500 particularly in crisis times.

To interpret hedge fund strategies behavior and characteristics during these periods of time, Sortino ratio's results will be used since this ratio gave us more generalized results for the three databases and its results have more similarities with the other two metrics. Furthermore, Sortino ratio appears to be the most reliable since strategies rankings is related to their rankings over the whole period and it brings out hedge fund strategies characteristics during each period of time. Moreover, investors are more preoccupied by downward volatility and the downside risk framework is more beneficial than the standard one for analyzing risk-return characteristics of hedge fund strategies. Rosenberg et al (2004), Scherer (2004) and Chaudhary and Johnson (2008) all assume that Sortino ratio is superior to Sharpe ratio for performance measurement especially for skewed distributions which is a characteristic of hedge fund strategies.

Starting with Global Macro strategy, this strategy was among the best performing for the whole timespan, and it is among the best for most of the periods. With its top down approach, this strategy seeks profit from the direction of movements on financial markets, it is basically based on predictions and analysis on interest rates trends, political changes, general flow of funds, political relations, government policies and other broad features which made this active strategy one of the best performing strategies in the distinct periods. Global Macro managers come from the risk side of trading and tend to take directional positions following their predictions about market direction. The strategy outperforms in distinct market conditions and its performance rest on the quality and the timing of predictions.

As another directional strategy, Emerging Markets was under the top efficient strategies in the whole period and managed to be among the best in three periods. Furthermore, it registered a data breakage for only Credit Suisse and it succeeded to provide protection for Eurekahedge and Credit Suisse. It is characterized with a high volatility as it was listed under the least performing in the third period (2011-2015). This strategy consists on forecasting correctly the macro-economic changes happening in emerging markets and taking positions on a large range of financial instruments. Emerging markets attract hedge fund managers thanks

to their growth potential, the diversification they provide and the large opportunities that stem from young markets still not having reached maturity.

Distressed Debt is another best performing strategy for the full-time span and is among the event driven strategies' class. It is among the best performing during three distinct periods. The only period where the strategy registered a low performance is the period coinciding with financial crisis (2005-2010), it also registered data breakage for the three databases in the period of the financial crisis. The important factor reflecting the performance of this strategy is the presence of distressed paper, which relies on the evolution of credit spreads and on the economic style. During the economic slowdown triggered by the financial crisis, there was a credit spread widening and a flight to safety movement among investors which affected the strategy's performance.

The same pattern was noticed for Multi-strategy which recorded a high performance for the whole period and for all the periods except the second period (2006-2010), where it came across data breaks for the three databases in dates reflecting to the financial crisis and the European sovereign debt crisis. This strategy's performance was hit by the extreme circumstances happening during this period. Multi-strategy funds are similar to Global Macro funds in terms of managers' discretionary powers but they lack on investment directionality.

Unlike its category peers, Event Driven strategy was not under the best performing during the full-time period and did not provide an appreciated performance while dividing the time in sub-periods. Indeed, this strategy characterized by its high volatility; is under the least performing strategies in three sub-periods and only recorded a high performance in the period covering the financial crisis (2006-2010). Moreover, it didn't have data breaks for the three databases in the crisis period of time. This strategy achieves a good performance in periods of uncertainty and fluctuating markets as it tries to benefit from mispriced market events like takeovers or profit warnings which happen during critical and volatile periods which made the strategy stand out in the period of the financial crisis compared to other strategies and which explains its poor performance during neutral market conditions.

A similar behavior was observed for Managed Futures strategy, it achieves a good performance and is among the best performing only in the second period (2006-2010) while providing a meagre performance in the other periods. With no structural break during the second period, Managed Futures strategy succeeded to provide protection for their investors. For this strategy, Fund managers employ computerized models that effectuate trading decisions automatically. They can periodically readjust the parameters of the trading model. The weak

correlation between the models elaborated by Managed Futures' managers and the financial market gives this strategy a clear advantage for opportunities of better returns in falling markets.

Long/Short Equity strategy is among the least performing strategies for the whole time period and is one of the strategies that are most exposed to systematic risk. For the period analysis, this strategy realizes a low performance during three periods and a moderate performance in the second period (2006-2010). Long/short equity strategies is where the manager takes a long position on stock he feels the market is underpricing and short sells stock he perceives is being overpriced. In periods of market fluctuations and uncertainty, managers of this strategy try to benefit from misprices which may explain its moderate performance during the period covering the financial crisis. Furthermore, this strategy can be confronted to the short-squeeze risk in adverse market movements resulting in an excessive value erosion of the position.

Convertible arbitrage is a non-directional strategy, which focuses on the profit generated between securities rather than market movements. Still, market fluctuations affect this strategy and credit risk is involved in case of credit spreads widening. Interest rate exposure can also have an impact on this market-uncorrelated strategy. For this period analysis, this strategy is under the least performing in the first two periods 2001-2005, 2006-2010 and among the best performing strategies for the last two periods 2011-2015, 2016-2020. Moreover, this strategy has data breaks for Credit Suisse and Eurekahedge in the first period (2004) and in the second period for the three databases in the time of the financial crisis (2007-2009). This strategy seems to be affected in periods of uncertainly and by the general market environment. In the first period, in 2004, there was a trend reversal on interest rates and in the period of the great financial crisis (2007-2009), the corporate bond market was essentially broken. Credit spreads on corporate bonds experienced sudden widening causing big losses across all credit-oriented strategies. This strategy seems to have been affected by these market events which brought about its low performance. In the last two periods, this strategy managed to achieve a good performance ranking as one of the best performing strategies. In rising market conditions, this strategy appears to find good opportunities of good returns, managers seek arbitrage opportunities from shorting stocks for the associated convertible which may explain this strategy's behavior in the last two periods.

Like Convertible Arbitrage strategy, Fixed Income strategy is another relative value strategy which depends on reliable returns where interest risk is neutralized. However, it can be impacted by credit risk and credit spreads widening is a difficult scenario for hedge funds adopting the fixed income strategy. A study on fixed income funds by Fung and Hsieh (2000)

demonstrated that these funds are often exposed to yield spreads. In this study, this strategy is one of the least productive strategies for the whole period and while dividing into sub-periods, this strategy showed different results. It is among the best performing strategies in the first (2001-2005) and the third period (2011-2015) and among the least performing in the second (2006-2010) and the last period (2016-2020). Moreover, data breaks happened for this strategy mostly in the second period for the three databases in dates sending back to the financial crisis (2007-2009). During the financial crisis, investors came across challenges like increased volatility in their equity portfolios and reduced fixed income yields. These circumstances appear to have impacted the performance of this strategy in this period. The strategy achieved a low performance in the last period in comparison to other more active strategies. The strategy attains a good performance when there is an interest rate increase which may explain its performance in the first period. In this period, the Federal Reserve raised interest rates to curb inflation and cool off an overheated economy. Managers can also find opportunities of better returns in rising markets by detecting undervalued bonds as they bet on increasing interest rates.

Market Neutral strategy achieved a better performance than other relative value strategies in the second period (2006-2010) and the first period (2001-2005). This strategy is neither affected by growing or falling market conditions and it is characterized by its moderate returns and low volatility. It seems to offer some advantages in crisis periods since its performance is not correlated to market movements. This strategy was among the worst performing strategies in the last period and registered data breaks for Eurekahedge and CISDM in 2016. In that date, the share oil prices fell into the low and the average prices of energy bonds dropped close to their bankruptcy recovery values. This strategy appears to have been affected by this extreme event and could not manage to hedge her way out of the critical situation.

On the whole, hedge fund strategies achieve an appealing performance especially in critical times, they are able to significantly outperform the market for the majority of strategies and it relies on Investors' capacity to predict and pick out the most suitable strategy for a determined period of time.

These findings are close to those of Cappocci, Corhay and Hubner (2005) who analyzed hedge fund strategies in different periods of time and concluded that most hedge fuds perform better than the market and their underperformance is not significant in bullish market conditions. In accordance with these findings, Nikola and Vijay (2019) demonstrated that hedge fund strategies are able to outperform the market especially in critical stages.

4.4.2 Hedge Funds and Mutual Funds Comparative Analysis of Performance

Mutual funds and hedge are both investment pools that aim to outperform the capital markets. Still, hedge funds and mutual funds have different characteristics. Unlike hedge funds, mutual funds are regulated and bound to limitations regarding portfolio construction and choice of instruments. They cannot protect portfolios from falling markets and they rely on markets' directions where they are invested. These characteristics are not present in hedge funds which can bring about dissimilarities in terms of performance and risk-adjusted returns.

A comparison between hedge funds and mutual funds was elaborated to figure out which fund is superior in terms of performance according to the strategy employed by the distinct funds. Performance measurement tools were applied to hedge funds and mutual funds global and strategies' indices for the three studied databases. Based on the single factor Capital asset pricing model, Alpha is calculated for the sample study. Furthermore, Sharpe and Sortino ratios are assessed to compare mutual funds and hedge funds strategies' performance.

The descriptive statistics revealed that neither all hedge funds or mutual funds indices could provide average returns higher than the market benchmark MSCI World Index in the period study (2008-2019). Indeed, only Vanguard and mutual funds adopting the Event driven strategy could outperform the market. For Eurekahedge, all the strategies (except Market neutral) were able to get a higher return than the market. For Credit Suisse, Multi-strategy and Global Macro could outperform the market and for CISDM, Convertible Arbitrage, Managed Futures and Emerging Markets achieved higher average returns than the market. In comparison to mutual funds, hedge funds following Relative Value, Managed Futures and Long/ Short Equity strategies registered higher average returns than mutual funds following similar strategies for the three databases in common. Mutual fund indices showed a higher volatility than hedge fund strategies' indices and higher than the market for some mutual fund indices.

Unlike previous studies, Liang (1999) and Capocci& Hübner (2004) which assumed that hedge funds have always higher realized returns than mutual funds, this study shows that when risk is not considered, hedge fund do not always outperform mutual funds adopting the same strategy according to average returns' results but can however outperform for the majority of strategies.

However, when risk is considered and performance is measured using Alpha, the results showed that hedge fund strategies indices scored more significant alphas for the majority of the strategies when the majority of mutual funds do not produce significant alphas and with that they could outperform the market and their mutual fund competitors for most of the

strategies implying that hedge fund managers perform on average better than mutual fund managers. With this outcome, these findings join those of Ackermann et al (1999), Brown et al. (1999), Liang (2001), Kat (2001) and Eling and Faust (2010) which assume that hedge funds provide better alphas than mutual funds and that they are able to outperform them.

As a second measurement tool, and for deep comparison of hedge funds and mutual funds, Sharpe ratio was computed for all the strategies for hedge funds and mutual funds for the three studied databases, and similar to alpha's results the majority of hedge fund strategies databases generate better risk-adjusted returns than mutual funds adopting the same strategy. All the strategies from Eurekahedge and CISDM provided higher risk-adjusted returns than mutual fund strategies and only Convertible Arbitrage and Market Neutral strategies failed to generate higher risk-adjusted returns for Credit Suisse Database. Liang (1999) and Schneeweis & Martin (1998) results are consistent with this study with higher Sharpe ratios for hedge funds compared to mutual funds.

For a complete comparison between the two investment pools, only bad volatility was considered while using the Sortino ratio. The results didn't bring a dramatic change to Sharpe ratio's and alpha's results but they underlined the fact that hedge funds are superior to mutual funds with the majority of global hedge fund indices outdueling the global mutual fund Vanguard and the majority of hedge funds strategies indices outperforming its mutual fund peers and unlike mutual funds, all hedge funds following the strategies studied outperform the market benchmark with the only exception of Market Neutral strategy index in Credit Suisse database.

Overall, hedge funds are superior to mutual funds in terms of performance but when adopting a specific strategy, it is not possible to conclude that hedge fund strategies always outperform mutual funds adopting the same strategy since CISDM and Credit Suisse databases revealed strategies underperforming their mutual fund peers. An underperformance of a hedge fund compared to a mutual fund can result from their higher fees, indeed a hedge fund might not match the net performance of a mutual fund or also stem from the growing availability of information. Furthermore, hedge funds' managerial skills and the database characteristics should be mentioned as explained in the section above can be factors affecting generated returns and creating discrepancies as found in this study. But on the whole, these differences didn't impact the predominant results in which hedge fund strategies mainly provide better risk-adjusted performance than mutual funds and represent an attractive investment opportunity for investors. These findings are similar to the conclusions of Ackermann et. Al (2009), Agarwal et. al (2009), Liang (1999), Brown (1999), Schneeweis & Martin (1998), Liang and Kat (2001),

Capocci & Hübner (2004), Stulz (2007), Eling & Faust 2010) in which they argue that hedge funds dominate mutual funds and provide better risk-adjusted returns.

There are many factors that can explain hedge funds and mutual funds' differences in terms of performance and lead to hedge funds dominancy. First of all, hedge fund industry offers investment flexibilities and a mixture of motivating arrangements that the mutual industry is not allowed to offer (Capocci & Hubner 2004). Furthermore, hedge funds are characterized by a more active management than mutual funds (Eling and Faust 2010). Hedge fund managers can be more active than mutual fund managers since they are actively engaged in asset allocation and can respond quickly and efficiently to market changes in a less regulated industry. There are additional features that can be accountable for performance discrepancy of hedge funds and mutual funds such as lock-up periods, liquidity, high water mark provision and incentive fees for hedge fund managers. Hedge fund managers have lock-up periods unlike mutual funds which offer them a degree of freedom in making investment decisions as the fund manager knows when the money will be retrieved from the fund. In addition to that, hedge fund managers can manage liquidity risk by investing in illiquid positions and therefore can resort to smoothing returns practices that might affect performance assessment outcomes. While mutual funds' fee structures depend on the fund size, hedge funds have special fees based on performance grant to managers in addition to their management fees to guarantee a careful asset management and sometimes managers may own fund units and thereby their personal wealth can be closely related to their performance. Finally, hedge fund managers are confronted to high watermark provisions and below that provision, managers need to recover any losses in order to receive performance fees.

On the other hand, hedged mutual funds are affected by their regulatory system. Yet, since they offer lower minimum investment requirements and more liquidity, new investors with less experience and low incomes can undergo hedge fund alike exposure by investing in funds adopting specific hedge fund strategies.

4.4.3 Cointegration Analysis and Diversification Benefits of Hedge Fund Strategies

The majority of investors are more concerned about the long-term performances of their portfolio, the cointegration approach is an adequate approach for portfolio management and performance evaluation. In the past, there was a limited access and a lack of data resources to study hedge funds over a large timespan but overtime hedge fund databases started to provide a bigger time horizon. Cointegration analysis is reliable when a long-time span is studied, therefore, Cointegration analysis has rarely been used to evaluate the relationship between

hedge fund strategies in the long run. In this study, cointegration approach was applied over a 20 years' time horizon to analyze the long-term relationship between the different hedge fund strategies and thereby to reveal the resemblances between hedge fund strategies in terms on management style and assets' risk profiles to evaluate the diversification possibilities between hedge fund strategies.

In accordance with performance measurement tools results, hedge funds appear to be an alluring investment opportunity, investors can make use of hedge funds as an uncorrelated diversification investment vehicle to maximize their profits (Agarwal, Naik 1999; Amine and Kat 2003). Including hedge funds to a portfolio of traditional assets provides benefits of better risk-reward trade-off (Asness, Krail, Liew 2001). According to Modern Portfolio Theory, hedge funds should be incorporated in an efficient portfolio to maximize the risk-return trade-off and create diversification opportunities. Thus, exploring diversification benefits using more than a single strategy is questionable and there are rare studies covering this subject. Cointegration analysis is elaborated to explore the long run relationship among the stock markets indices of the different hedge fund strategies. A diversified portfolio of hedge funds with a global perspective is the ultimate goal of investors (Fothergill et al, 2001). Cointegration and factor analysis can be adopted to examine and prevent the incorporation of two or more managers with the same investment approaches in the same portfolio of hedge funds, (Alexander et. al 2001).

Phillips-Peron (PP) and The Augmented Dicky-Fuller time series tests were run on the sample data and revealed that data variables are stationary at level for CISDM database strategies and at first difference first difference for Eurekahedge and Credit Suisse which are integrated at same order I (1). After a proper lag selection, Johansen's cointegration test was run on the data sample for the distinct strategies of the two databases.

The result of trace statistics and Maximum Eigen values demonstrate that hedge fund strategies indices are not strongly cointegrated and that it is uncertain that they move in equilibrium in the long-run.

These results demonstrate that managers do not use the same management styles and there is an absence of asset risk level analogies and for CISDM and there may be a slight similar portfolio management approaches for Credit Suisse and Eurekahedge. Yet, there is still a scope for efficient portfolio diversification across the strategies due to the presence of uncertainty and the difference in the characteristics associated to each strategy. These results are similar with Gregoriou and Rouah (2001) who investigated the long-term relationships between the ten largest hedge funds in the ZCM/Laporte database over a ten-year period but didn't examine

hedge fund strategies due to the limitation of data at that time. They found that three of the largest hedge funds were cointegrated while the remaining seven were not.

In contrast to Sun, et. Al. (2012) who argue that managers using single investment strategies generate higher performance, this study revealed using cointegration analysis that hedge fund strategies are not strongly cointegrated and that using more than a single strategy may induce distinct risk profile assets and therefore provide diversification benefits which can lead to a higher performance. Further study should be carried out to find the factors that are responsible for the co-movement of these strategies together.

Hedge funds represent a significant diversification opportunity while managing a portfolio owing to their low correlation to the financial capital markets. Portfolio efficiency is boosted with their presence along other traditional assets. Investors may use one or more than a single strategy to diversify and to maximize profits like multi-strategy which was demonstrated in this study as one of the best performing strategies; which regroups more than one distinct strategy.

Investors should seek for skilled hedge fund managers who have a positive history of returns and who adopt unique management styles looking for investment opportunities in potential growing sectors such as biotech companies, private credit, responsible investment (RI), or environmental social and governance (ESG) amongst environmental issues and social justice trends.

CONCLUSION

A comprehension of hedge fund strategies' features and its risk and performance components is fundamental for managers and investors to make choices about performance measurement and portfolio allocation. Performance measurement metrics play a big role in the investment decision-making of hedge funds and its strategies. If an assessment tool does not reflect all performance characteristics of a certain asset, investors may be given wrong ideas and advises concerning the choice of the appropriate hedge fund strategy. The objective of performance assessment metrics is to mirror hedge funds' performance and to enable investors to compare between the distinct investment approaches.

Previous researches examined global hedge fund indices and didn't focalize on hedge fund strategies. In this study, ten hedge fund strategies are scrutinized due to the dissimilarities in the characteristics of each single strategy which can engender distinct performances. Employing three large databases, performances of the ten major strategies, for a full period time and in divided sub-periods, were examined in this study. The twenty-year data sample (2001-2020) was divided in four periods namely 2001-2005, 2006-2010, 2011-2015, 2016-2020. These samples were investigated for correlations, return distributions, risk and return, performance assessment using four asset pricing models (CAPM, FF-3, FF-5, CARHART) and reward-risk ratios (Sharpe, Sortino).

For the full period study, the majority of hedge fund strategies indices performed better than the benchmark MSCI World. Performance measurement estimations with alphas and Sharpe ratios revealed that hedge fund strategies show a significant exposure to the four asset pricing models. Moreover, the results demonstrated that Global Macro, Distressed Debt and Multi-strategy are the best performing strategies while relative value strategies and Long/Short Equity strategies are the least performing strategies. Besides, Global Macro and Multi-Strategy appeared to have the best risk/return profiles amid the strategies. Through the return distribution analysis, the key statistics and shape of distributions demonstrated asymmetricities in hedge fund strategies return data which decreases the relevance of the Sharpe ratio. To adjust the limitations of the Sharpe ratio, the Sortino ratio was utilized. Yet, the outperformance of hedge fund strategies in comparison to the market benchmark persisted with this risk-reward ratio reporting Global Macro, Emerging Markets, Distressed Debt and Multi-strategy as the most efficient strategies.

Furthermore, a sub-period analysis was operated to detect hedge fund strategies characteristics in distinct market conditions using structural break tests and performance measurement metrics. When the time is divided, hedge fund strategies outperformance with the market benchmark didn't persist and underperformance was determined for some strategies during the third (2011-2015) and fourth period (2016-2020). Besides, hedge fund strategies were revealed to do better than the benchmark during the first (2001-2005) and the second period (2006-2010). Structural break test demonstrated that in these two first periods, breaks were registered for the majority of the strategies reflecting some important market events such as trend reversals in 2004 and the GFC (2007-2009). Hedge fund strategies seem to outperform in times of crises and trend reversals and demonstrate some underperformance for some strategies in normal or rising market conditions.

Global Macro with its top down approach and Emerging Markets with its diversification advantages seem to be superior strategies that can outperform in distinct market conditions. Global Macro strategy's underperformance is related to the managers' insights while Emerging markets can suffer from its volatility. Distressed Debt and Multi-Strategy are among the most efficient strategies but they tend to be affected by the general market condition. In periods of uncertainty and fluctuating markets, Event Driven and Managed Futures have advantages for a superior performance due to the strategies characteristics while Convertible Arbitrage achieve a better performance in normal and rising market conditions. Market Neutral strategy is not related to the market condition and appears to offer some advantages in falling markets periods.

Finally, it is important to mention that managerial skill is a considerable factor for all the strategies performances and the database characteristics can affect the generated returns of hedge fund strategies and create some discrepancies in the results. Overall, incorporating hedge fund strategies in a portfolio especially in falling market periods can enhance the risk-return profile of the portfolio and it relies on Investors' capacity to predict and pick out the most suitable strategy for a determined period of time.

When compared to mutual funds adopting the same strategies using the same performance metrics, it is not possible to assume that hedge fund strategies always do better than mutual funds following the same strategies. Yet, the majority of hedge fund strategies provide better risk-adjusted performance than mutual funds and represent an attractive investment opportunity for investors. Hedge fund strategies prevailing performance is generally

due to the flexibility of hedge fund investments, the active management and the special characteristics of hedge funds such as liquidity, incentive fees, lock-up periods and high water-mark provisions.

As investors are more concerned about the long-term performances of their portfolio, cointegration analysis is a considerable approach for portfolio management and performance evaluation to investigate if hedge fund strategies are managed in similar management styles or involve similar assets in terms of risk profile which reduces the opportunities of diversification and therefore an appealing performance. Cointegration also preserves from adding managers with the same investment styles in a portfolio of hedge fund and avoid an overlapping of hedge fund strategies. The findings demonstrated that managers do not follow the same management styles and there is an absence of overlapping of asset risk levels for CISDM and there may be a slight similar portfolio management approaches for Credit Suisse and Eurekahedge. Yet, there is still a scope for efficient portfolio diversification across the strategies due to the presence of uncertainty. Investors may use one or more than a single strategy to diversify and to maximize profits of these strategies together.

Due to the complex nature of hedge funds, it is hard for investors, advisers and institutional money managers to define how much capital they should allocate across different hedge fund strategies. The decision to allocate assets to a specific hedge fund strategy should incorporate various factors and considering the potential risk and returns of each hedge fund investment style. This thesis provides practical insights to fund managers and investors on which strategies offer better value and in which market conditions.

The hedge fund industry is continuously growing and renovating its strategies structure providing a large choice of distinct hedge fund strategies, it will be interesting for future studies to examine the performances of new born strategies like energy trading, natural events, structured finance, private lending, etc. As other suggestions for future researches, the comparison of hedge fund strategies performances in different crisis periods that happened in history such as crises in (1929, 1997, 2007, 2020) and analyze the results of the distinct crisis periods to determine which strategies offer better value in distinct crisis scenarios. Another study can be of interest that includes more dynamic risk factors to determine hedge fund returns like the seven-factor model of Fung-Hsieh (2004).

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APPENDIX

APPENDIX 1: EUREKAHEDGE STRUCTURAL BREAK TEST

CONVERTBLE ARBITRAGE

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	9.076858	18.15372	11.47
1 vs. 2 *	12.55773	25.11546	12.95
2 vs. 3	3.960752	7.921505	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M03	2004M01
2	2007M11	2007M11

FiXED INCOME

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	10.35937	20.71873	11.47
1 vs. 2 *	9.269297	18.53859	12.95
2 vs. 3	4.247412	8.494823	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M03	2004M01
2	2007M11	2007M11

MARKET NEUTRAL

Sequential F-statistic determined breaks: 3

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	29.55581	59.11161	11.47
1 vs. 2 *	14.81088	29.62175	12.95
2 vs. 3 *	8.160319	16.32064	14.03
3 vs. 4	0.605795	1.211589	14.85

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M01	2004M01
2	2016M02	2008M10
3	2008M10	2016M02

EVENT DRIVEN

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	19.04995	38.09991	11.47
1 vs. 2	5.569736	11.13947	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M03	2004M03

DISTRESSED DEBT

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	18.86200	37.72401	11.47
1 vs. 2 *	6.633066	13.26613	12.95
2 vs. 3	3.557573	7.115145	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M09	2004M09
2	2008M12	2008M12

MUTLTI-STRATEGY

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	36.69250	73.38501	11.47
1 vs. 2 *	11.26659	22.53318	12.95
2 vs. 3	5.886263	11.77253	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M04	2004M04
2	2010M12	2010M12

GLOBAL MACRO

Sequential F-statistic determined breaks: 3

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	12.15036	24.30072	11.47
1 vs. 2 *	10.71658	21.43316	12.95
2 vs. 3 *	8.054631	16.10926	14.03
3 vs. 4	3.692768	7.385536	14.85

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M04	2004M04
2	2007M11	2007M11
3	2010M11	2010M11

MANAGED FUTURES

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	22.05013	44.10027	11.47
1 vs. 2	5.190894	10.38179	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M02	2004M02

LONG SHORT EQUITY

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	7.423781	14.84756	11.47
1 vs. 2 *	12.08604	24.17208	12.95
2 vs. 3	1.232677	2.465355	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M01	2004M01
2	2007M11	2007M11

EMERGING MARKETS

Sequential F-statistic determined breaks: 0

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1	4.237877	8.475754	11.47

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

APPENDIX 2: CREDIT SUISSE STRUCTURAL BREAK TEST

CONVERTBLE ARBITRAGE

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	18.22187	36.44374	11.47
1 vs. 2 *	7.856030	15.71206	12.95
2 vs. 3	6.252881	12.50576	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M04	2004M01
2	2008M12	2008M12

FIXED INCOME

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	11.21766	22.43532	11.47
1 vs. 2 *	23.32069	46.64138	12.95
2 vs. 3	2.314527	4.629054	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2007M06	2007M06
2	2010M06	2010M06

MARKET NEUTRAL

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.916894	11.83379	11.47
1 vs. 2 *	8.510266	17.02053	12.95
2 vs. 3	0.570699	1.141397	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008M11	2008M11
2	2011M11	2011M11

EVENT DRIVEN

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	20.87126	41.74251	11.47
1 vs. 2 *	7.016802	14.03360	12.95
2 vs. 3	3.052743	6.105486	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2010M12	2004M05
2	2004M05	2014M02

DISTRESSED DEBT

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	16.41152	32.82303	11.47
1 vs. 2	4.957107	9.914215	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2007M07	2007M07

MUTLTI-STRATEGY

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	10.22695	20.45390	11.47
1 vs. 2 *	21.89891	43.79782	12.95
2 vs. 3	6.352524	12.70505	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M05	2005M04
2	2008M12	2008M12

GLOBAL MACRO

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	8.055683	16.11137	11.47
1 vs. 2	1.095072	2.190145	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008M07	2008M07

MANAGED FUTURES

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	15.48300	30.96600	11.47
1 vs. 2	6.408236	12.81647	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M04	2004M04

LONG SHORT EQUITY

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	19.24725	38.49449	11.47
1 vs. 2 *	12.52773	25.05547	12.95
2 vs. 3	3.196032	6.392064	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M01	2004M01
2	2008M10	2008M10

EMERGING MARKETS

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	8.167196	16.33439	11.47
1 vs. 2	4.016975	8.033951	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008M03	2008M03

APPENDIX 3: CISDM STRUCTURAL BREAK TEST

CONVERTBLE ARBITRAGE

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	15.52551	31.05102	11.47
1 vs. 2	2.988618	5.977236	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008M07	2008M07

FIXED INCOME

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	11.96730	23.93459	11.47
1 vs. 2	5.091121	10.18224	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2007M06	2007M06

MARKET NEUTRAL

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	10.70208	21.40416	11.47
1 vs. 2	3.450240	6.900480	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2016M02	2016M02

EVENT DRIVEN

Sequential F-statistic determined breaks: 0

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1	1.261622	2.523244	11.47

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

DISTRESSED DEBT

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	14.07625	28.15249	11.47
1 vs. 2	4.348515	8.697030	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008M01	2008M01

MUTLTI-STRATEGY

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	6.025169	12.05034	11.47
1 vs. 2	1.687825	3.375650	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2009M05	2009M05

GLOBAL MACRO

Sequential F-statistic determined breaks: 0

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1	5.437359	10.87472	11.47

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

MANAGED FUTURES

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	10.92968	21.85936	11.47
1 vs. 2	3.678352	7.356704	12.95

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2004M04	2004M04

LONG SHORT EQUITY

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	13.74221	27.48442	11.47
1 vs. 2 *	15.48415	30.96830	12.95
2 vs. 3	1.047318	2.094637	14.03

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2007M06	2007M06
2	2010M06	2010M06

EMERGING MARKETS

Sequential F-statistic determined breaks: 0

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1	3.666701	7.333401	11.47

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

APPENDIX 4: LAG STRUCTURE OF THE DATABASES

EUREKAHEDGE LAG STRUCTURE

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-8566.835	NA	1.61e+20	74.90686	75.05680	74.96735
1	-4986.220	6817.242	10124174	44.50847	46.15785*	45.17387*
2	-4847.838	251.3833	7272807.	44.17326	47.32208	45.44357
3	-4750.879	167.6669	7555360.	44.19982	48.84809	46.07504
4	-4656.246	155.3800	8096420.	44.24669	50.39440	46.72683
5	-4577.080	123.0698	10077240	44.42865	52.07580	47.51370
6	-4494.326	121.4205	12386998	44.57927	53.72587	48.26923
7	-4385.362	150.3615	12400010	44.50098	55.14702	48.79585
8	-4260.005	162.0330	11074060	44.27952	56.42500	49.17931
9	-4144.393	139.3404	11155865	44.14317	57.78809	49.64787
10	-3978.029	185.9790	7530454.	43.56357	58.70794	49.67319
11	-3827.593	155.0349*	6153900.*	43.12308	59.76689	49.83760
12	-3698.443	121.8177	6453058.	42.86850*	61.01175	50.18794

CREDIT SUISSE LAG STRUCTURE

Lag	LogL	LR	FPE	AIC	SC	HQ
0	5454.514	NA	1.06e-33	-47.55034	-47.40039	-47.48985
1	8551.792	5897.002	4.53e-45	-73.72744	-72.07806*	-73.06204
2	8738.902	339.9028	2.13e-45	-74.48823	-71.33940	-73.21791*
3	8845.284	183.9613	2.03e-45*	-74.54396	-69.89569	-72.66874
4	8914.610	113.8281	2.72e-45	-74.27607	-68.12836	-71.79593
5	9006.410	142.7117	3.03e-45	-74.20446	-66.55730	-71.11941
6	9099.221	136.1756	3.41e-45	-74.14167	-64.99507	-70.45170
7	9209.640	152.3684	3.37e-45	-74.23266	-63.58662	-69.93778
8	9319.119	141.5101	3.46e-45	-74.31545	-62.16997	-69.41566
9	9426.693	129.6528	3.74e-45	-74.38160	-60.73668	-68.87690
10	9535.534	121.6739	4.17e-45	-74.45881	-59.31445	-68.34920
11	9679.894	148.7727*	3.60e-45	-74.84623	-58.20243	-68.13171
12	9804.375	117.4146	3.93e-45	-75.06004*	-56.91680	-67.74061

CISDM LAG STRUCTURE

Lag	LogL	LR	FPE	AIC	SC	HQ
0	5520.057	NA	1.36e-33	-47.29663	-47.14851	-47.23690
1	8696.461	6052.890	4.64e-45	-73.70353	-72.07428*	-73.04654
2	8885.108	343.2879	2.18e-45	-74.46444	-71.35406	-73.21020*
3	8992.496	186.2017	2.07e-45*	-74.52786*	-69.93635	-72.67636
4	9064.043	117.9145	2.69e-45	-74.28363	-68.21099	-71.83487
5	9152.912	138.8341	3.07e-45	-74.18809	-66.63431	-71.14207
6	9242.199	131.8218	3.55e-45	-74.09612	-65.06122	-70.45285
7	9351.831	152.4502	3.52e-45	-74.17881	-63.66277	-69.93827
8	9462.160	143.9486*	3.57e-45	-74.26747	-62.27030	-69.42967