HEDGE FUNDS PERFORMANCE EVALUATION

BY

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ABSTRACT

This paper uses the traditional sharpe and some modern ratios to evaluate the performance of Credit Suisse/Tremont hedge funds index in comparison to the equity, bond and commodity markets. As concluded by previous studies, hedge funds have higher sharp ratios, negative skewness and positive kurtosis than the equity, bond and commodity indices. I found that hedge funds generally exhibit low correlation with the equity (but MSCI world), bond and commodity indices, even during financial crises. This makes hedge funds suitable for portfolio diversification. However, this diversification benefit may be minimized by the fact that the correlation between the hedge fund strategies are moderate, and slightly increase during financial crises. Also, hedge fund strategies generally exhibit higher correlation with MSCI World, Dow Jones-AIG commodity and Dow Jones corporate bond indices, than they exhibit with the other indices.

Given the high degree of non-normality hedge funds returns distribution and autocorrelation of returns, modern performance measure were employed in ranking hedge fund, equity, bond and commodity indices for the entire period, during financial and non-financial crises. The sharpe ratio and modern performance measures indicate that hedge funds generally outperformed the equity, commodity and bond (excluding Dow Jones corporate bond) indices more for the non-financial and entire crises periods than during financial crises. Finally, evidence of hedge fund managers' security selection skills (significant positive alphas) was found, except for managers' market timing abilities. Also, hedges show low exposure to the market (S&P500 index) movements.

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CHAPTER ONE: INTRODUCTION

1.1 Problem definition

The main purpose of this thesis is to evaluate and rank the performance, as well as study the risk and return properties of hedge funds (Credit Suisse/Tremont hedge fund benchmark broad index) in comparison to the equity, bond and commodity markets. Is the hedge funds risk and return the same as those of the equity, bond and commodity markets considered? Can hedge funds play a role in portfolio diversification? Are hedge fund immune to financial crises? Do hedge fund managers exhibit market timing and security selection skills?

The analysis part of this thesis will begins with the descriptive statistics of hedge funds and the other traditional asset classes (equity, bond and commodity indices). Their respective sharpe ratios, normality test, and autocorrelation will be obtained. Many academic researchers such as Kat and Lu (2002), Agarwal and Naik (2000), and Brooks and Kat (2002) found that hedge funds have lower standard deviation, higher mean return, lower skewness, and higher kurtosis. Also, a number of publications on hedge funds also found that their returns exhibit strong positive autocorrelation.

Although some research have shown that hedge fund index is strongly correlated to standard assets, many came to the conclusion that individual hedge funds are loosely correlated to equity and bond markets. This makes them suitable for improving the mean return to volatility ratio of a portfolio. However, Lhabitant and Learned (2002) argued that diversifying a portfolio by adding hedge funds reduce positive skewness and increase kurtosis of the portfolio. Hence, it is a trade-off between profit potential and reduced probability of loss. The correlation between the hedge funds strategies, and with the equity, bond and commodity market will be verified in different market environment.

Hedge fund industry has experienced huge increase in Assets Under Management (AUM of about $2.5 trillion by summer 2008) and gained interest of institutions in recent years. This may be due to their performance, even during financial or as supported by some previous research works, hedge funds outperform standard asset classes, and can serve diversification purposes. The sharpe ratio and other modern performance measures which consider return distribution or autocorrelation will be used to rank

both the hedge funds, equity, bond and commodity markets. The performance analysis will also be conducted periods of financial crises and non-financial crises to verify which asset class is better in either of the market situations.

Finally, hedge fund managers' market timing and security selection skills will be observed using Treynor and Maguy (1966) model. A number of studies have shown the hedge fund managers do not exhibit market timing skills, while others found evidence of significant positive alphas (fund managers' security selection ability).

1.2 Organization of thesis

After this chapter, some theoretical materials about hedge funds will be reviewed, from definition of hedge fund to benefit of hedge funds. Chapter three will present traditional portfolio theory, where in brief discussion about old and new performance measures will be made. I will talk about data used in this thesis and possible biases in hedge fund data. In chapter five, the performance measures and ranking of hedge funds in comparison to equity, bond and commodity indices will be obtained. Concluding remark and possible biases will round up this thesis.

CHAPTER TWO: LITERATURE REVIEW OF HEDGE FUNDS

2.1 Hedge Fund Definition

Hedge funds are vehicles that allow private investors to pool assets to be invested by a fund manager, for which the fund manager charges a management and a substantial incentives fees which together amounts to 20% of any investment profits. However, some investment pool may possess attributes that are associated with hedge funds. Many hedge funds authors have defined hedge funds in different ways, due to its complexity.

Lhabitant (2004) defines hedge funds as "privately organized, loosely regulated and professionally managed pools of capital not widely available to the public"

Unlike mutual funds, hedge funds are exempted from direct regulation by the Security and Exchange Commission (SEC) and other regulatory bodies, and exhibits "lock-ups" (periods for which investors cannot withdraw their investments), hence they tend to heavily use derivatives, short sales and leverage.

The main hedge funds characteristics and styles will be elaborated later in this chapter.

2.2 History of Hedge Fund

The concept of hedge fund is sometimes hard to understand. But we may know more about hedge fund when we look at the history of hedge fund.

Many hedge fund authors believed that hedge fund was first started by the Australian Alfred Winslow Jones in 19949. However, Lhabitant (2006) indicated that the statistician Karl Karsten formed a small fund in December 1930 that looked much like a hedge fund, which generated a 78% return in just six months.

According to Mario J Gabelli (2008), Alfred Winslow Jones formed the first hedge fund in 1949. After his 1948 Fortune article on the current fashions in investing and market forecasting, Jones discovered he had a better money management system. In 1949 he raised $100,000 (of which $40,000 was his) to form

a general partnership. The partnership; A.W. Jones & Co. was made of four friends (Allan Rappeport: 27 march 2007)

The main strategy used was long-short stock positions and healthy dose of leverage to protect against market risk. Hence, the term hedge fund was born. In 9152, he transformed the partnership into a limited partnership and implemented an incentive fee scheme of 20% of the profit for him as the fund manager. This incentive fee structure remains peculiar of hedge fund today.

The attention of many wealthy individuals and talented professional investors was drawn towards hedge fund after an article in Fortune titled "The Jones' that nobody can keen up with" as published in 1966. This article revealed that Jones' partnership performed 44% above the best performing Mutual Fund that year, and 85% (net of all fees) beyond the best five-year performing mutual fund (Mario J Gabelli, 2008).

In the year ending 1968, the SEC survey revealed there were 215 investment partnerships, with 140 of the investment partnership being hedge funds, and most of which were formed that year (Caldwell, 1995). Unfortunately, after the rapid growth between 1967 to 1968, the hedge fund industry experienced big losses in 1969-1970 and 1973-1974 bear market. This was the "Dark age" for the hedge fund industry because during the bull market of the 1960's, many funds managers were tired of using the long-short strategy; rather they were more heavily involved in long investments and levering up. Hence, were exposed to the stock market.

Within 1969-1970 when the bear market kicked in, the market started to slide and many hedge funds managers liquidated and a 70% decline in assets managed by the 28 largest hedge funds (Alan Rappeport, 2007), while the more prudent hedge fund managers made it through. Even more funds collapsed during the 1973-1974 recession (Sæbø, 2007), and 1984 Sandra Maske' (founder of Treamont Partner) could identify only 68 hedge fund managers (Gabelli, 2000)

Hedge funds once more became unpopular until 1986, when an article in Institutional Investors published the tremendous performance of Julian Robertson's fund. According to the reports, Julian Robertson fund had compounded annual interest returns of 43% (net of expenses and incentives fee) over its first six years of operation (David A. Hseih and William Fung, 1999). This reignited interests in hedge funds, and also attracted lots of trading desk and commodity-trading advisors (CTA) (Allan Rappeport, 2007). But on October 1987 (also referred to as the "Black Monday"), many hedge funds suffered hugged losses and Dow Jones was down 22.6% (Lhabitant, 2006). However, the market was fortunate to have recovered quickly and regained all the lost ground by 1989.

Unfortunately, the hedge fund industry went through some tough years in 1997 and 1998. Global Macro funds were blamed for the 1997 Asian crisis, and funds managers were described as "wild-eyed speculators operating outside government regulations" (Lhabitant, 2006). But the most remarkable event in the history of hedge fund industry was in august 1998, when Long-Term Capital Management (LTCM) collapsed. In reference to the International Monetary Fund (IMF) report, LTCM had $4.5 billion in capital but was managing $120billion (Alan Rappeport, 2007). LTCM specialized in interest-rate spread, dealt in swaps, options, stocks, bonds and derivatives. LTCM were short U.S. treasury bonds and long Russian government bonds. Unfortunately, the LTCM lost enormous amounts both on their positions. This was due to the devaluation of the roubble and the default on domestic debt by the Russian government, and flight-to-liquidate situation where investors preferred the U.S. treasury bonds to the Russian government bond. The lost incurred by the fund was approximately $1.85billion of its capital (Wikipedia, 2007).

The New York Federal Reserve in fear of the unacceptable risks of abrupt an disorderly liquidation of LTCM would have caused to the U.S. economy, orchestrated a rescue plan with 14 banks and security firms, and bailed out the fund with $3.625 billion (Lhabitant,2006). The fund was finally liquidated in early 2000 (Wikipedia, 2007). However, the main reason of the collapse of LTCM was its excessive use of leverage (over $124.5 billion borrowed with just $4.73 billion in equity). After this remarkable crisis, hedge fund managers agreed to induce more transparency and leverage reduction.

Due to the 1997-1998 crises, the U.S. Federal Reserve cut interest rate which was favorable for the U.S. economy and the financial market in the proceeding years. This developed a Hubble that burst in March, 2000. Hedge fund industry performed well although major indices performed very poor. Most hedge funds employed a mix of long-short, event-driven, and multi-strategy approaches, while interest in emerging markets and funds of funds grew as well.

The hedge fund industry has dramatically grown in the past 17-18years (Figure 2.1). According to the 2008 hedge fund Asset Flows and Trend Report published by Hedgefund.net and Institution Investor News estimated a total assets of $2.68trillion in Third Quarter 2007 (Wikipedia, 2008) and there are approximately 9,500 hedge funds managers (Hennessee Group LLC, 2007). However, the asset under management dropped sharply through the combination of trading losses and investors' asset withdrawal from funds (Wikipedia, 2009). And so by summer 2008, the asset managed by the hedge fund industry peaked at $2.5 trillion (Wikipedia, 2009).

Large institutional investors such as Pension funds, Insurance companies, Corporations and Foundation will be the main source of future growth in the hedge fund industry. This can be exemplified by the allocation of $1billion to hedge funds in 2000 by California Public Employees Retirement System (CalPERS) (Lhabitant, 2006).

2.3 Hedge Fund Characteristics

There exist investments pools that closely resemble hedge funds which are regarded as different investment type. Hence a close examination of some traits of hedge funds will help us distinguish them from the conventional investment funds.

2.3.1 Performance fees charge and targeting absolute return

Hedge funds also differ from mutual funds in its compensation structure. Unlike mutual fund managers, who only charge management fee equal to a fix percentage of Asset (for instance; 1%-.5% annually for a typical equity fund), hedge fund managers charge both management (1%-2% of Asset) and incentive fees (20% of profit or more).

Incentive fee is a strong managerial incentive which motivates managers to obtain maximum return possible. This incentive fee partly explains why hedge funds performance outweighs that of mutual funds, but without increased total risk of the hedge funds.

Many hedge funds target absolute returns. This absolute return target must be reached no matter the situation in the bond or stock markets; that is the fund must be profitable.

Numerous hedge funds also have an absolute return clause in their offering memorandum. This clause states a return floor (hurdle rate) the hedge fund manager must achieve net of the cumulative returns before they earn the incentive fee.

Unlike the traditional investment vehicles whose performance is compared to standard market benchmarks, hedge funds target absolute returns (profitability) no matter the atmosphere in the bond or stock market; in order for hedge fund managers to be rewarded with incentive fees.

Moreover, to avoid managers with poorly established and executed strategies from being attracted by the high fees involved in the hedge funds management, most hedge funds request their managers to commit a huge portion of his/her personal wealth in the fund as do other investors.

2.3.2 Limited Transparency

Hedge funds have refused to disclose their positions or trade details to the public. Most recently, hedge funds investors have often requested information on hedge fund position and risk (Hans Hufschmid, 2007 confirmed this). This limited transparency is due to the fact that hedge fund managers think the funds' performance would be adversely affected by the disclosure of their specific positions or strategies (Veran Allen: 2006, confirm this). Also, on like mutual funds managers that are required by the SEC to offer total transparency, hedge funds are not compelled to disclose publicly their performance information, other positions or strategies.

In recent years, the SEC oversight of hedge funds have increased and other financial associations like Investors Risk Committee (IRC) of the International Association of Financial Engineers (IAFE) and Capital Market Risk Advisors, Inc (CMRA) have taken a step towards striking the appropriate balance between disclosure of meaningful information to investors and protection of hedge funds managements' proprietary investment knowledge (Alternative Investment Management Association Ltd (AIMA), 2003).

2.3.3 Liquidity limitation

Traditional Investment funds like mutual funds are examples of open-end investment companies that are ready to redeem or issue share at their net value whenever investors (either on the same or the following day) wish (shares redemption or issue may involve sales charges).

However, hedge funds being example of closed-end investment companies limits subscription to accredited investors, and redemption possibilities by imposing lock-up (period as long as several years during which investments cannot be withdrawn). Also, hedge funds restrict entry or exit to certain times in a year (monthly, quarterly or annually basis) and often require advanced notice of investment withdrawal. Some hedge fund managers charge investors redemption (when fund is organized as limited partnership) or withdrawal (if fund is corporate entity) fees if investors withdraw their money from the

hedge fund before a minimum duration of their investment in the funds. Hedge fund managers require minimum investment depending on their quality and reputation, significant amount of money needed, and lock-up periods.

2.3.4 Target Group of Investors

Unlike mutual funds that target retail investors, hedge funds target accredited investors and institutional investors. In USA, an accredited investor is an individual with net worth of at least $1,000,000 or has made a minimum of $200,000 in every of the previous two years ($300,000 with spouse if married) and expects to make the same amount in the current year (Wikipedia)
Accredited investors are ideal for hedge funds since they have sufficient wealth to invest and commit themselves in a fund as partners in the long run.

2.3.5 Flexible investment Policies

These flexible investment policies also distinguish hedge funds the traditional investments funds. Hedge fund managers concentrate on investment and performance, rather than on cash management, and impose lock-up. This enables them obtain the flexibility to pursue other investment styles with an aim of outstanding returns (alpha), to invest in illiquid assets and other asset classes.

2.3.6 Special Regulation Rules

Hedge funds are organized in various legal forms, with the intension to prevent the numerous regulations levied on the other financial intermediaries and / or to minimize their tax bill, when the hedge funds invest on offshore hedge funds.

Hedge funds are mostly organized as limited partnership or limited liability companies in the U.S. and offshore investors companies (corporation) established in tax-favorable jurisdictions outside the United State, so that the investors possibly receive dividends and capital gains or losses, and not flow of interest expense. Unfortunately, the US is stepping forward to restrict offshore tax havens and their abusive tax shelters. Moreover, hedge funds being investment companies are required by the Investment

Company Act of 1990 to register with the U.S. Security and Exchange Commission (SEC), though exempted from numerous SEC regulation. Hedge funds are not required to submit to numerous regulation such as; disclosure regulations, regulations limiting the use of leverage, regulations requiring shares to be redeemable at anytime, regulation requiring certain degree of liquidity, regulations protecting against conflict of interest, regulations to assure fair pricing of fund shares.

Furthermore, Hedge funds are not required to register under Federal Security Laws. They are not required to register under SEC because they sell ownership as private placement to accredited investors; they do not publicly offer their securities and are not allowed to make public offering of securities anywhere in the world. Conversely, according to Hennessee Hedge Fund Manager survey, 86 percent of hedge funds were registered with some regulatory body (such as the Securities and Exchange Commission or Commodity Futures Trading Commission) in 2006. Also, hedge funds monitor and keep the portions of their funds attributed to plan assets below 25% in order not to be classified as plan asset and to escape regulation from Employee Retirement Income Security (ERISA) which regulates the investment management of plan asset. With this limited regulations, hedge funds managers have tremendous flexibility in making their investment decisions.

In June 1997, the SEC encouraged investment in hedge funds by allowing hedge funds to exceed their previous limit of 100 investors without altering their regulation and disclosure. This change in SEC regulations also accounts for the rapid growth in hedge funds in the past decade and will promote future growth in hedge funds. Although hedge funds are loosely regulated, the Federal Security Laws prevent them from abuse and fraud. Also, the US may increase registration requirement for hedge funds, and may step up regulation for hedge fund institution that can cause systematic risk to the US economy.

2.4 Hedge Fund Styles

Hedge fund investments exhibit less restrictions and managers employ a plethora of investment styles that much differ in approaches, objectives and outcomes. Although many consultants, investor and managers have classified hedge funds styles into more homogenous groups, there is no standard classification of different hedge fund strategies.

The Credit Suisse/Tremont hedge fund index is the leading asset-weighted index and has classified hedge funds under ten strategies. Hence, the classification of hedge funds styles by Credit Suisse/Tremont hedge fund index (benchmark broad index) will be used since the index will be the data

source of this thesis. The various sector weights of the credit Suisse/ Tremont hedge fund index is presented in figure 2.4.
These ten styles include:

2.4.1 Convertible Arbitrage

Managers seek to make profit from the pricing anomalies between convertible bonds and their underlying equity by taking long positions in convertible securities (bond), and hedge the equity portion of the long securities positions, by shorting the underlying common stock.

2.4.2 Dedicated Short Bias

The fund managers focus on companies whose securities are overpriced (or companies with weak cash flow generation) and short the stock of these companies if they anticipate that the companies' stocks prices will decrease. This strategy will be profitable if they later buy back the stocks at lower prices. However, fund managers offset the long positions to minimize the risk associated with shorting of those stocks.

2.4.3 Emerging markets

These funds invest in all types of securities in country with "emerging" or developing markets. The strategy consists of buying sovereign or corporate debt/or equity and other instruments in that country. Investments are mostly long since many emerging market does not allow short selling nor offer viable futures or other derivatives to hedge their risk exposure.

2.4.4 Equity Market Neutral

This style seek to make profit by exploiting the pricing inefficiency between related equity securities while neutralizing exposure to market risk by offsetting long position in underpriced security and short position in overpriced securities . The profit involved in this strategy may come from the purchase

undervalued security whose price is increasing, and from sales of overvalued security whose price is dropping, or from sector/country bets.

2.4.5 Event Driven

Funds invest in debts and equities , and seek to harvest from potential mispricing of companies facing a specific situation in their life cycle such as; spin-offs, mergers and acquisitions, bankruptcy, re-organization, re-capitalization and share buybacks. Distressed, multi-strategy, and risk arbitrage are sub-strategy of the event driven style.

i) **Distress securities** funds invest in debt or equity (capital structure) of companies experiencing financial or operational distress or facing bankruptcy, reorganization or other corporate restructuring. These companies' securities are purchased by the investors at a discount, due to difficulties in accessing their proper value, fears of traditional investors to keep holding these securities and low market liquidity. The aim of this strategy is to profit when the securities of these companies appreciate after survival from the distress. Hence, the distress securities funds are long term in nature. Some funds managers hedge the risks associated with this strategy with put options on the underlying market, or may strategically be involved in the managing the companies through the distress.

ii) **Multi-strategy** fund managers utilize multiple investment strategies across asset classes to better diversify their portfolio or to exploit the shift in economic cycles. The multiple investment strategies may include; risk arbitrage, distress securities and sometimes micro and small capitalization public companies that are raising money in private capital markets.

iii) **Risk Arbitrage (Merger Arbitrage)** fund manager invest in event driven situations such as leverage buy-out, merger or acquisition. With this strategy, the fund will buy the stocks of the target company while shorting the stock of the acquiring company in order to capture the spread in merger or acquisition transactions. The risk in this style is breakage of the deal after announcement.

2.4.6 Fixed Income Arbitrage

Fixed income arbitrage funds use a spectrum of strategies to exploit the inefficiencies and price anomalies between related fixed income securities typical strategies include yield curve arbitrage, corporate versus treasury yield spread, mortgage-backed securities arbitrage, municipal bond versus treasury yield spread, etc. fixed income arbitrage managers limit volatility by hedging exposure to the market and interest rate risk in their portfolio, and enhancing returns by large amount of leverage.

2.4.7 Global Macro

These fund managers make leveraged opportunistic investments in global currency, equity, bond and commodity markets on a discretionary basis (models). They employ a "top-down" global approach to focus on forecasting the effects of economic, political and market factors on the valuation of securities. Global macro managers profit by correctly forecasting global market price movements. Hence, the manager's quality is the sole key to the funds' success since they have large portfolio with heavy use of derivatives, and have to profit by correctly forecasting global market price movements.

2.4.8 Long/Short Equity

This strategy is based on investing on both long and short sides of equity market in order to diversify or hedge against market exposure. However, funds with either net long or net short positions are exposed to market conditions since they are significantly correlated with traditional markets. Also, managers have the flexibility to switch between the sub-strategies of the long/short equity style. According to Lhabitant, these sub-strategies include;

i) **Value**

It is an equity-based strategy where in managers strive to exploit mispricing of stocks. Managers profit by shorting stocks that are believed to be overpriced and taking long positions in stock deemed to be underpriced, given that the market later adjusts by fairly pricing the underlying stocks.

ii) **Growth**

Growth fund managers may either invest in companies that have or is expected to grow earnings per share. These companies are mostly micro, small, or mid-capitalization in size since they will be in their growth stage. Also, manager that pursue growth strategy generally take short positions.

iii) **Market Neutral-Security Hedging**

Hedge funds managers that follow this strategy, try to minimize market exposure of their managed portfolio by equally investing in both short and long securities. Securities with expected price decrease will be short, while long securities whose prices are expected to appreciate.

iv) **Opportunistic**

The opportunistic fund managers continuously try to take advantage of current market conditions and opportunities by use of different strategies.

2.4.9 Managed Futures (Commodity Trading Advisors or CAT)

Fund managers in pursue of this strategy mainly invest in listed bonds, equity, commodity futures and currency markets. CTA's are usually systematic traders or discretionary traders. Systematic traders rely on historic price data and market trends to predict future price movements. Hence, they heavily depend on computer-generated trading signals. On the other hand, the discretionary traders base their decision on fundamental and technical market analysis, the experience and trading skills they gained over the years. However, managed futures funds managers employ substantial amounts of leverage since they invest in future contracts.

2.4.10 Multi-strategy

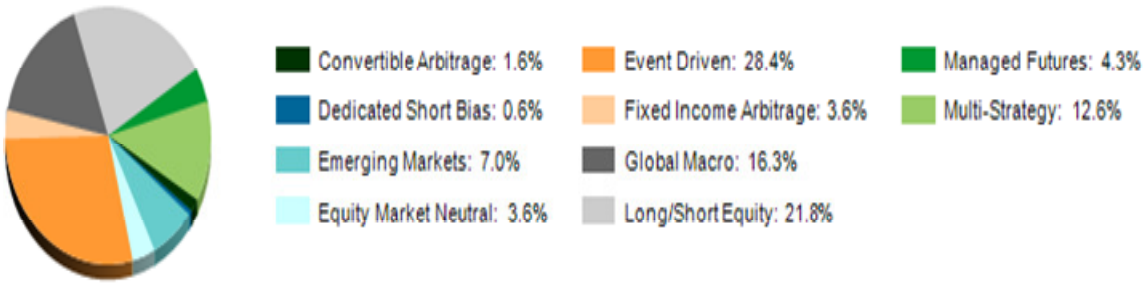
Multi-strategy funds invest among several hedge fund strategies to profit from perceived opportunities and to diversify their portfolio. The combination of hedge funds seek to minimize potential effect of poor performance and deliver a more consistent long term investment return (as traditional diversified portfolios) than any of the individual fund.

However, this idea has given rise to funds of hedge funds (funds of funds) that allows investors to allocate their capital to different managers and gain diversification through a single investment. A style specific fund of funds manager is a fund of fund manager that allocates capital within a single strategy. While a multi-strategy fund of funds manager allocates capital to a variety of managers in multiple strategies.

The performance of funds of funds will not be evaluated in this work since Credit Suisse/Tremont hedge fund index does not include funds of funds.

Sector Weights

Figure 2.4 the current sector weights of Tremont/Suisse hedge funds benchmark broad index



2.5 Benefits of hedge funds

Investors invest in hedge funds for two main reasons. Firstly, historically, hedge funds have higher risk-adjusted and absolute returns than benchmarks. Also, hedge funds have historically outperformed on a long-term basis and shown ability to limit loss in down markets.

Secondly, hedge funds provide diversification benefits to investors' portfolios. This is because hedge funds historically exhibit low correlation with the general stock and bond markets, and their managers use risk management techniques that are generally uncommon within a traditional investment portfolio. However, some researchers such as Lhabitant and Learned (2002) argued that diversifying a portfolio by adding hedge funds is not a "free lunch" because hedge funds reduce positive skewness and

increase kurtosis of the portfolio. Hence, diversifying portfolios using hedge funds is a trade-off between profit potential and reduced probability of loss.

CHAPTER THREE: TRADITIONAL PROTFOLIO THEORY

3.1 Correlation

In statistics and probability theory, the correlation (correlation coefficient) between two random variables represents the degree and direction of their linear relationship. Among the numerous correlation coefficients, Pearson product-moment and Spearman's rank correlation coefficients are the most commonly used methods of estimating the correlation between two random variables. Unlike the Spearman's rho, the Pearson's coefficient is less accurate when the distributions are non-normally distributed. Hence, the Spearman's rank correlation will be used because it is more accurate regardless of the variable frequency distribution. It is defined as:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \qquad (3.1)$$

Where d_i is the i^{th} squared difference between the corresponding rankings, n is the number of values in each data set. The correlation coefficient lies between the interval of -1 and 1. If the Spearman's rho is 1 (-1), the rankings have perfectly linear relationship in the same direction (reverse direction). Also, with positive (negative) rho, shows increasing (decreasing) agreement between the rankings. While a rho of zero implies independent or no linear relationship between rankings.

3.2 The centralized distribution moments

The centralized distribution moments are the distributional less the distribution mean, μ. The nth moment about the mean of the stochastic variable, X is given by $E(X-\mu)^n$. where E is the expectation operator. We will use the first four moments due to return distribution in hedge funds, as will be discussed later.

3.2.1 Expectation / Mean

Expectation or mean, *E(X)* is the first moment of a distribution;

$$\mu = E(\widetilde{X}) = \sum_{t=1}^{T} p_t X_t \tag{3.2}$$

Where P_t is the probability distribution of the random variable, and X_t is the random variable.

The centralized first moment equals zero. Hence, they are hardly used.

3.2.2 Variance

It is the second centralized distributional moment. Variance is the measure of statistical dispersion from the expected return (mean return). Hence, it is a measure of risk. It is given by

$$\sigma^2 = E((\widetilde{X} - \mu)^2) = \sum_{t=1}^{T} p_t (X_t - \mu)^2 \tag{3.3}$$

The squared root of the variance (σ^2) called standard deviation (σ)is also used as a measure of risk (dispersion).

3.2.3 Skewness

The third centralized moment is skewness, and it is a measure of symmetry of a distribution. The normal distribution (symmetric distribution) has a skewness of zero.

Skewness $= \mu^3 / \sigma^3$

Where σ is the standard deviation, and μ^3 is the third moment about the mean, given by

$$\mu_3 = E((\widetilde{X} - \mu)^3) = \sum_{t=1}^{T} p_t (X_t - \mu)^3 \qquad (3.4)$$

With a skewness greater than zero (positive skewness), the standard deviation overestimates risk. While with a negative skewness (skewness less than zero), the standard deviation underestimates risk.

3.2.4 Kurtosis

Kurtosis is the fourth central moment that measures how tall and skinny or short and squart a distribution is, in relation to the normal distribution of the same variance. It is defined as:

Kurtosis = (μ^4 / σ^4)

Where μ^4 is the fourth moment about the mean, given by:

$$\mu_4 = E((\widetilde{X} - \mu)^4) = \sum_{t=1}^{T} p_t (X_t - \mu)^4$$

Excess Kurtosis = $(\mu^4 / \sigma^4) - 3$ (3.5)

The excess kurtosis of a normal distribution is zero. A distribution with excess kurtosis above zero will have fatter tail than would be observed in the normal distribution. Conversely, an excess kurtosis than zero, then the distribution has skinny tail than does the normal distribution.

3.3 The Mean-Variance framework

When allocating investment funds between risk-free assets and risky portfolio, investors seek knowledge of risk-reward relationship of the assets. This is explained by the mean-variance framework (analysis). The analysis assumes the investors are generally risk averse. That is, investors prefer portfolio with higher expected return and lower variance.

According to the framework, investors only care about their portfolio return means and variances. Hence, assuming normal distribution of their portfolio returns. The mean-variance analysis also assumes frictionless financial markets (free of transaction costs, purchase and sales taxes, tradable asset price and quantity restriction).

However, investors differ in risk aversion. The quadratic utility function estimates investors' risk-reward preference given their levels of risk aversion. It is given by;

$$U= E(r)-0.5\,A\sigma^2$$

Where U is utility value, A is an index of the investor's risk aversion, r is the assets return, and σ^2 is the variance.

Harry Markowitz (1952) first introduced the mean-variance framework. His model of portfolio selection embodying diversification principles led to the efficient frontier of risky assets. The efficient frontier is the best possible portfolio given the constituent assets' expected return and standard deviation.

Given the expected returns, variance and covariance, we can plot the minimum-variance frontier (lowest possible variance against target portfolio expected return). The frontier has a convex shape, and whose degree of convexity depends on the correlation between the individual assets.

The capital allocation line is drawn when a risk-free asset is added to the portfolio of risky assets. If this line connects the risk-free return with the tangency portfolio (portfolio with the highest sharpe ratio on the efficient frontier), it is designated the Capital Market Line (CML). The market portfolio is the tangency portfolio. The equation of the CML is represented as:

$$E(R_p) = R_f + \sigma_p \frac{E(R_M) - R_f}{\sigma_M} \tag{3.6}$$

Where Rf is the risk-free rate of return, E(Rm) the market portfolio expected return, and σ_m and σ_p are the standard deviation of market portfolio and portfolio, P, respectively. The diagram below shows the relationship between the efficient frontier and the capital market line.

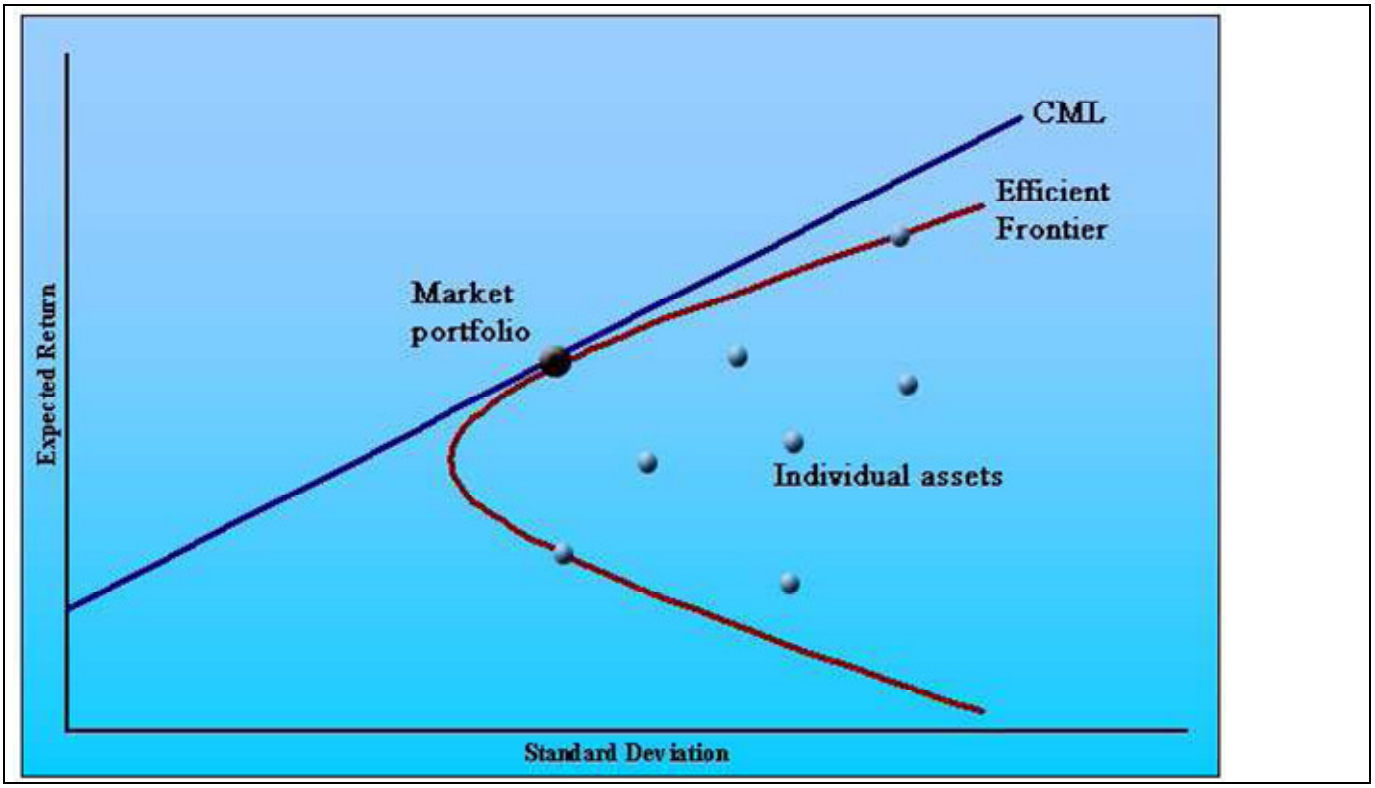


Figure 3.1: Graph that shows the CML, the efficient frontier and the market portfolio

3.4 Asset Pricing Model

3.4.1 The Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model (CAPM) was developed by William Sharpe (1964), John Linter (1965) and Jan Mossin (1966). The CAPM is built on the Harry Markowitz (1959) model of portfolio choice (mean-variance-efficient portfolio).

Sharpe (1964) and Linter (1965) add two key assumptions to Markowitz's mean-variance-efficient portfolio model. They assume that investors agree on the joint distribution of asset returns, and all investors borrow and lend at risk-free rate. Also, for his work, William Sharpe was awarded the Nobel prize in 1990. The CAPM predicts the expected return of an asset from the general market risk and risk-free rate. It is given by:

$$E(R_i) = R_f + \beta_i \left[E(R_M) - R_f \right] \tag{3.7}$$

βi measures the sensitivity of Asset *I* on the market, and $E(R) - Rf$ is the expected market premium (reward for taking risk above the risk-free rate). The Emperical Index Model of equation (3.7) is the ex-post counterpart to CAPM. An ordinary least square (OLS) regression of $Ri - Rf$ on $R_m - R_f$, estimates βi, and α_i and ε_I should be statistically equal to zero in an efficient market (if $\alpha_i = 0$, the asset is fairly priced).

$$R_i = \alpha_i + R_f + \beta_i (R_M - R_f) + \varepsilon_i \tag{3.8}$$

The CAPM is attractive due to its simplicity, intuitive prediction of relation between expected return and risk. Unfortunately, the CAPM has received criticism by many researches for its empirical problems. For instance, the CAPM uses the systematic risk in the market rather the risk (standard deviation) to price a financial asset. Hence, leaving out the effect of assets' specific risk on the price of financial of those assets.

3.5 Absolute Performance Measurements

Evaluating performance base on average return is not enough, since different investments (or assets) exhibit different risk exposure. Hence, many researchers have developed risk-adjusted performance measures, which estimate managers' or funds' performance. In this thesis, three traditional and four modern performance measures will be presented, since hedge funds do not often have benchmarks.
The traditional performance measures assume normality of return distribution (but hedge funds returns are non-normally distributed). Consequently, the modern performance measures were developed to accommodate the non-normality of hedge fund returns. In the following, let R_i denote the mean return of asset *i* over the sample period, and R_f and R_m be the mean of the risk-free asset and market portfolio, respectively.

3.5.1 Traditional Measurements

3.5.1.1 Jensen Alpha

The Jesen Alpha is a performance evaluation measurement named after Michael C. Jensen (1968).The CAPM predicts that the alpha (α_i) for every asset should be zero (if assets are fairly priced). The Jensen alpha, α_i, is the average realized return of the assets above (below) that predicted by the CAPM. Investors tend to prefer (buy) securities with superior (positive alpha) over securities with negative alpha. It is defined as:

$$\alpha_i = R_i - E(R_i) \tag{3.9}$$

Where $E(R_i)$ is the expected return predicted by CAPM and R_i is the realized average return. Estimating the Jensen Alpha ex-post, we use OLS regression of equation (3.10) below;

$$R_i - R_f = \alpha_i + \beta_i(R_M - R_f) + \varepsilon_i \tag{3.10}$$

The statistical significance of Jensen Alpha can be verified using the standard student t-statistic (adjusted for heteroskedasticity and autocorrelation in the error term)

3.5.1.2 The Sharpe Ratio

The Sharpe Ratio (reward-to-volatility ratio) is a commonly used risk-adjusted performance measure. It is defined as the average excess return per unit standard deviation of the return over the sampling period. The sharpe ratio best suited for undiversified investors since it uses standard deviation as total volatility. It is formulated as:

$$SR_i = \frac{R_i - R_f}{\sigma_i} \tag{3.11}$$

Where σ_i is the standard deviation. However, the sharpe ratio is based on the mean-variance theory and is valid for normally distributed returns. Hence, it cannot be applied to hedge funds (whose returns are non-normally distributed) because standard deviation is not an adequate measure of risk associated with hedge fund.

3.5.1.3 The Treynor Ratio

The Treynor Ration (TR) is named after Jack L. Treynor (1965). The Treynor Ratio is defined as the excess return per unit systematic risk, βi, instead of total risk, σ_i, as in Sharpe Ratio. The Treynor ratio is

best suited for well diversified investors. Also, same as the sharpe ratio, the treynor ratio does not quantify the value added, rather better (worse) performance with higher (lower) ratio. TR is defined as:

$$TR_i = \frac{R_i - R_f}{\beta_i} \tag{3.12}$$

3.5.1.4 Theoretical problems

Traditional indicators best suite returns that follow a normal (symmetrical) distribution. The standard deviation of these returns represents the risk. Conversely, hedge funds returns series are non-normally distributed and show strong autocorrelations. Hence, traditional performance measures suffer from theoretical problem when applied to hedge funds.

3.5.1.4.1 Non-normality of Hedged Funds Return Distribution

As mentioned above in (3.2.3) and (3.2.4), skew and kurtosis (or excess kurtoses) are used to determine the normality of a distribution. The skew coefficient measures the asymmetry coefficient of a distribution, while kurtosis coefficient measures the tail depth of the return distribution.

Test of normality

The Jarque-Bera test will be used to determine the normality of the return distribution. The Jarque-Bera statistisis defined by:

$$JB = n\left[\frac{skewness^2}{6} + \frac{(kurtosis-3)^2}{24}\right] \quad (3.13)$$

Where n is the number of observations in the sample period. The Jarque-Bear statistic has a chi-squares distribution (with two degrees of freedom) under the null hypothesis of normality. The null hypothesis is a joint hypothesis of skew equal zero and excess kurtosis being zero.

3.5.1.4.2 Presence of Autocorrelation in Hedge Funds Return Series

Lo (2002) documents that the Sharpe ratio is overstated in the case of positive autocorrelation of hedge funds returns. Also, Getmansky and Mackinlay (2004) show that hedge funds strong serial correlation (autocorrelation) can be attributed to the combination of illiquidity and "performance smoothing". In so doing, ranking hedge funds based on Sharpe ratio should take consideration of autocorrelation of their returns.

Test for Autocorrelation

The Ljung-Box (1978) test is a well-known autocorrelation (serial correlation) test. Its statistic is given by:

$$Q = n(n+2)\sum_{j=1}^{h}\frac{\hat{\rho}_j^2}{n-j} \tag{3.14}$$

Where n is the sample size, $\hat{\rho}_j$ is the sample autocorrelation at lag j, and h is the number of lags being tested. The Ljung-Box statistic has a chi-squared distribution, with null hypothesis of no autocorrelation. For significance level α and h, the number of lags hypothesis of no autocorrelation (randomness) is rejected if

$$Q > \chi^2_{1-\alpha,h}$$

Therefore, hedge funds with high (significant) positive or negative autocorrelation coefficient will reflect high Q-statistic.

3.6 Innovative Absolute Performance measurement

3.6.1 The Sortino

Sortino and Price (1994) developed the Sortino ratio. It is a performance measurement which accounts for the asymmetry of hedge funds distribution.

Unlike the Sharpe ratio, Sortino replaces standard deviation (σ_i) with downside deviation. Consiquentlt, the sortino ratio is more appropriate when the distribution is left-skewed (often the case for hedge funds returns). It is formulated as:

$$\text{Sortino}_i = \frac{R_i - MAR}{DD_i} \tag{3.15}$$

Where *MAR* (Minimum Acceptable Return) for hedge funds often is set to either zero or to the risk-free rate. R_i is the average return of the asset, T is the number of sub-periods, and DD_i is the downside deviation given by:

$$DD_i = \sqrt{\frac{1}{T}\sum_{t=0}^{T}\left(R_{it} - MAR\right)^2} \quad if\ R_{it} < MAR$$

The downside deviation differs from the standard deviation by considering only those returns in the series that fall below the MAR (threshold).

The shortcoming of the Sortino ratio is that it does not solve the problem of excess kurtosis and autocorrelation.

3.6.2 Upside Potential Ratio (UPR)

Sortino, Van Der Meer and Plantinga (1999) proposed the UPR which is the probability-weighted average of returns above the reference rate. In other words, the ratio of potential for success to the risk of failure (down side risk as calculated in sortino ratio). It is represented as;

$$UPR = \frac{\sum_{t=1}^{T} \iota^{+} \frac{1}{T}(R_t - MAR)}{\left[\sum_{t=1}^{T} \iota^{-} \frac{1}{T}(R_t - MAR)^2\right]^{1/2}} \qquad (3.16)$$

Where T is the number of period in the sample, R_t is the return of an investment in period t, $\iota^+ = 1$ if R_t >MAR, else $\iota^+=0$, and $\iota^- = 1$ if R_t =<MAR, else $\iota^- =0$.

Unlike the sortino ratio, the UPR uses a consistent reference rate to evaluate both profit and losses.

3.6.3 Autocorrelation-adjusted Sharpe ratio

Lo (2002) propose an autocorrelation-adjusted Sharpe ratio in order to avoid overestimation of the Sharpe ratio of hedge fund returns. The ratio is defined as:

$$\text{“AR-adjusted SR}_i\text{”} = SR_i \times \frac{q}{\sqrt{q + 2\sum_{k=1}^{q-1}(q-k)\rho_k}} \qquad (3.17)$$

Where SR_i is the regular Sharpe ratio on a monthly basis, P_k is the k^{th} autocorrelation for hedge fund returns, and the annualized autocorrelation-adjusted Sharpe ratio is given for q=12 (q is the number of months).

3.6.4 Modified Sharpe Ratio

The Autocorrelation-adjusted Sharpe ratio (in 3.6.3 above) proposed by Lo (2002) only takes autocorrelation of hedge funds into consideration. However, the modified Sharpe ratio captures the non-normality (significant skew and excess kurtosis) of hedge fund returns. The modified Sharpe ratio differs from the regular Sharpe ratio in that the modified value at risk take into consideration skewness, excess kurtosis (including mean and standard deviation) and captures the risk better than does the standard deviation (as with regular sharp ratio).

$$\text{“Modified SR}_i\text{”} = \frac{R_i - R_f}{MVaR_i} \tag{3.18}$$

R_i= return of the portfolio, R_f= risk-free rate, and $MVaR_i$ is modified value at risk, given by:

$$MVaR_i = \mu_i - \left[z_c + \frac{1}{6}\left(z_c^2 - 1\right)S_i + \frac{1}{24}\left(z_c^3 - 3z_c\right)K_i - \frac{1}{36}\left(2z_c^3 - 5z_c\right)S_i^2 \right] \times \sigma_i$$

Where,

μ_i = asset *i*'s drift term (often set to Ri),

z = the critical value for probability (1 – α) with a standard normal distribution (-1.96 for 95%),

S_i = the skewness of asset *i*,

K_i = the excess kurtosis of asset *i*, and

σ_i = asset *i*'s standard deviation.

3.6.5 The Omega

The Omega is a measure introduced by Keating and Shadwick (2002) which incorporates all the moments of the return distribution. It requires no parametric assumption on the return distribution or on the utility function of the investor. Hence, ranking is always possible at any threshold level. Omega is expressed as the ratio between the gain and loss with respect to the threshold, L. in continuous time, it is given by:

$$\Omega_i(L) = \frac{\int_L^b (1 - F(R_i))dR_i}{\int_a^L F(R_i)dR_i} \tag{3.19}$$

Where L is the required return threshold, a and b are return intervals and F(x) is the cumulative distribution of return below threshold, L.

Gupta, Kazemi, and Schneewies (2003) intituively expressed the Omega as:

$$\Omega(L) = \frac{C(L)}{P(L)}$$

Where C(L) and P(L) are essentially the European call option and put option written on the investment, respectively.

Moreover, Omega formula in a discrete time was provided by De Souza and Gokcan (2004);

$$\Omega_i(L) = \frac{\sum_a^b Max(0, R_{it}^+)}{\sum_a^b Max(0, |R_{it}^-|)}$$

Where R^+ (R^-) is the return above (below) a threshold, L. hence, at a given threshold, L, a higher Omega is preferred.

3.6.6 The Kappa

Kaplan and Knowles (2004) introduced the Kappa as a generalized downside risk-adjusted performance measure. "Generalized" is associated to Kappa because it can become any risk-adjusted return measure, through a single parameter, n. Kappa in expressed as:

$$K_n(\tau)_i = \frac{R_i - \tau}{\sqrt[n]{LPM_n(\tau)_i}} \tag{3.20}$$

Where Ri is the expected periodic return, τ is the investor's minimum acceptable or threshold periodic return and LPM is the lower partial moment. The Sortino ratio equal to k_2 and Omega equal k_1+1. n is strictly greater than zero and n=3 is used to calculate the kappa in this thesis.

Kappa can be calculated using discrete return data (or parametric based calculation), and by deriving a continuous return distribution from the values of the first four moments. The n^{th} lower partial moment of continuous and discrete time, respectively. And are defined as:

$$LPM_n(\tau)_i = \int_{-\infty}^{\tau} (\tau - R_i)^n \, dF(R_i) \tag{3.21}$$

$$LPM_n(\tau)_i = \frac{1}{T} \sum_{t=1}^{T} Max(\tau - R_{it}, 0)^n \tag{3.22}$$

3.7 Market timing

Treynor and Mazuy (1966) first proposed the model to assess the timing ability. The model adds a squared term (market premium) to the usual linear index model (SCL). It is given by:

$$r_p - r_f = \alpha_p + \beta_p [r_m - r_f] + \gamma_p [r_m - r_f]^2 + \varepsilon_p \quad (3.23)$$

Where rp is portfolio return, εp is the residual. There is evidence of market timing if γp is greater than zero (positive), because the characteristic line will be steeper.

Also, Henriksson and Merton (1981) proposed a similar model to Treynor and Mazuy market timing model, but for the introduction of a dummy variable in the second market premium term as given by:

$$r_p - r_f = \alpha_p + \beta_p [r_m - r_f] + \gamma_p [r_m - r_f] D + \varepsilon_p \quad (3.24)$$

Where D is a dummy variable that equals 1 for $r_m > r_f$ and zero otherwise. So, the second term becomes relevant when market return is greater than risk free rate. Similarly, a manager's market timing ability is perceived when γ_p is positive. Hence, the portfolio beta equals β_p in bear market ($r_m < r_f$) and $\beta_p + \gamma_p$ is bull market ($r_m > r_f$)

CHAPTER FOUR: DATA DESCRIPTION

4.1 Data Used In This Thesis

In this thesis, I use hedge funds monthly returns data net of fees from Credit Suisse/Tremont Hedge Fund Index (Benchmark Broad Index) from January 1994 to November 2008. The Credit Suisse/Tremont Hedge Fund Index is the leading Asset-weighted index and consists of primary subcategories (strategies) based on the investment styles of their constituent funds (strategies and sub strategies are defined in chapter two). The index which began in January 1994, is compiled by Credit Suisse Tremont Index LLC and tracks more than 900 funds with $50 million Asset Under Management (AUM), at least one-year track record and recent audited financial report.

Moreover, data is also collected from equity, commodity and bonds indices for comparison with hedge funds returns. They include:

- The equity indices considered are S&P500, NASDAQ composite and MSCI world indices.
- The Philadelphia Gold and silver, and Dow Jones-AIG commodity indices represent the commodity market.
- And the bond indices used are 30-year US Treasury Bills and Dow Jones Corporate Bond index (total).

The 3-month US Treasury bill represents the risk-free rate. Moreover, S&P500 Index is the proxy for market performance index (benchmark). It consists of a collection of 500 large-cap common stocks actively traded in the United States, for which almost all the stocks are among the 500 American largest market capitalization stocks.

4.2 Possible Biases In Hedge Funds Data

Several biases may exist in hedge fund databases (indices). This is more likely to occur because of the way each database is constructed and some hedge funds managers tend to manipulate their data to make them attractive to potential investors. Therefore, such biases (errors) should be corrected to allow credible results and conclusions of the researcher. Some significant biases and their possible corrections will be addressed below;

i) Survivorship bias

Survivorship bias can be defined as the performance difference between surviving and dissolve funds, or as performance difference between existing and all funds. It occurs when databases only reflect information on "existing funds". The "non-existing" may be liquidated funds or existing funds (defunct funds) that no longer report their results to the databases. But some existing funds stop reporting because they do not want to attract new investment. Therefore, bad funds that fail generate an upward bias on returns, while good funds that close (or stop reporting) exert a downward bias.

According to Amin and Kat (2003), survivorship bias also generate upward bias in the skewness, downward bias in the kurtosis, and downward bias on the standard deviation. However, Credit Suisse/Tremont Hedge Fund Index minimizes the effect of survivorship bias by not removing funds in their liquidation process in order to capture all of the potential performance before the funds stop reporting.

ii) Backfill bias

Backfill bias (instant history bias) occurs when funds that are joining a database are allowed to backfill their earlier good returns, while their bad performance records are not backfill.

Malkiel and Saha (2005) show that bacfillied returns significantly biases hedge funds returns upward. Also, to estimate and test for backfill bias in TASS database, they test the difference between the means (using t-statistic) and medians (using chi-squared statistic) of "backfilled" and "not backfilled" hedge funds returns.

Conversely, for a new fund to be listed in the Suisse/Tremont Hedge Fund Index, it must provide its historical performance record since inception. This prevents backfilling bias.

iii) Selection bias

On like regular mutual funds, privately organized hedge funds are not required to publish their performance data to the public. So, hedge funds managers decide what information, when and to which

database to report. This may result in self selection bias because the characteristics and performance of the different databases do not represent the whole hedge fund universe. This is also the case when only funds with good results tend to join a database (upward bias), and high-performance managers no longer report their performance, probably because they have attained optimum size (downward bias). Fung and Hsieh (2000) estimate that these two opposite effects may result in negligible bias.

iv) Infrequent pricing and illiquidity bias

The natural tendency for hedge fund managers to "manage" optimally their monthly net asset value in order to smooth their returns posses a serious problem to hedge fund data. According to Lhabitant (2006), this problem is incident to hedge funds holding illiquid securities or securities that are difficult to price (such as small cap stocks, emerging market bonds, over-the –counter securities and distress assets), and most U.S onshore limited partnerships value their own portfolio. This consequently results in illiquidity bias because managers tend to smooth their returns (and systematically underestimate their portfolio volatility and their correlations with traditional indices) to look very attractive.
Hedge funds managers must also provide their respective audited financial statements to Suisse/Tremont Hedge Fund Index in order to remain listed or to join the index. This minimizes the ability of the listed hedge fund managers to optimally "manage" their net asset value (or smooth their returns)

v) Database/Sample selection bias

Choosing a database or sample of hedge funds to evaluate is likely another major source of performance bias. Every existing fund database does not represent the entire fund universe. This is because most of the databases (including Suisse/Tremont Hedge Fund Index) have specific criteria that eligible members must meet (such as minimum asset under management, audited financial statement, minimum years of existence). Also, several data vendors exclude particular hedge fund styles, for example Suisse/Tremont Hedge Fund Index excludes funds of hedge funds. These result in selection bias because hedge funds managers that do not meet these criteria and or particular hedge fund styles are excluded from the databases.

Moreover, other incidence of select Suisse/Tremont Hedge Fund Index ion biases occur when managers report to one or two databases, but rarely to all. Hence, giving rise to various databases with different data collection methods.

CHAPTER FIVE: PERFORMANCE EVALUATION

5.1 Descriptive Statistics

5.1.1 Previous Studies

Kat and Lu (2002) studied the statistical behavior of individual hedge funds returns. They used monthly net of fee and portfolio of hedge funds returns of 376 individual hedge funds and 103 funds of hedge from June 1994- May 2001 (from Tremont TASS). To investigate the statistical behavior of hedge funds returns, they classified all the individual funds into various strategy groups, and also derived equally weighted portfolio returns of all funds in each strategy group. Firstly, they showed that on average the individual funds within various styles exhibit significant skewness and kurtosis (excess kurtosis). Also, individual hedge funds' return distributions are negatively skewed, with global macro and long/short equity being exceptions. And found that different styles exhibit contrasting return behavior. Secondly, the portfolio of hedge funds has lesser standard deviation, skewness and kurtosis than do the average individual funds (exception of merger arbitrage and distress securities funds).

Agarwal and Naik (2000) evaluate the performance of hedge funds by formulating passive option-based strategies and buy-and-hold strategies as benchmark. They were searching for adequate benchmark which can be used to evaluate the performance of managed portfolios, especially hedge funds whose risks are non-linearly exposed to standard asset markets. They used 586 funds from the Hedge Funds Research (HFR) database from January 1990 to October 1998, and found out that but for short and macro, all the hedge fund strategies are negatively skewed. Also, they found that hedge fund returns have significant kurtosis. However, they obtained the summary statistics of some equity, bonds and commodity indices. They showed that these indices returns were closer to normality (but for Lehman High Yield Index and the Momentum Factor) than do the individual hedge funds.

Brooks and Kat (2002) studied the statistical properties of monthly returns of 48 hedge fund indices constructed by HFR, Zurich Capital Market, CSFB/Tremont, Hennessee, VAN, Altvest, and TUNA from January 1995 to April 2001 obtain summary statistics for some equity and bonds indices for

comparison. The y found that most hedge fund index returns have higher mean and lower standard deviation than do stocks and bonds. This would have violated the law of market efficiency but for the fact that most of the hedge fund returns exhibit lower skewness and high kurtosis than do stocks and bonds. This means that the hedge funds are more likely to make negative returns.

Other researchers such as Getmansky, Lo and Makarov (2004), and Saha (2004) reported that hedge funds exhibit negative skew and higher kurtosis than do traditional Assets. Malkiel and Saha (2005), and Valeri and Steen (2008) also support negative skewed and positive kurtosis of hedge funds returns.

5.1.2 Summary statistics Credit Suisse/ Tremont Hedge Fund Index and the indices for comparison

As shown on table 5.1.2, the summary statistics of Credit Suisse/ Tremont Hedge Fund Index monthly returns for the whole analysis period (January 1994-November 2008) is obtained. Also, descriptive statistics of MSCI World, Nasdaq Composite, S&P 500, Philadelphia Gold & Silver, Dow Jones-AIG commodity and Dow Jones corporate bond, and 30-years US Treasury bond indices.

All the returns means are positive, but for 30 years US Treasury. Also, hedge funds generally have higher (significant) mean than the equity, bond and commodity indices considered. The highest hedge fund mean return is 1.03% (Global Macro) while the lowest is 0.06% (Dedicated short Bias). According to Lu and Mulvey (2001) hedge funds that exhibit positive skew tend to have lower returns because they are the more desirable funds. This is the case with dedicated short bias with highest positive skewness (0.77) but low insignificant returns (0.06%).

Considering standard deviation, hedge funds returns generally exhibit lower standard deviation than do equity and commodity indices (but for bond market) employed. The hedge fund strategy with the highest standard deviation is dedicated short bias (4.91%) while risk arbitrage (1.25%) has the least. However, both Philadelphia Gold & Silver, and Nasdaq composite indices have distinctly higher standard deviation of 10.64% and 7.42%, respectively. Contrary to hedge fund returns low standard deviation, Brooks and Kat (2001) found that autocorrelation of hedge fund returns underestimates the standard deviation of hedge funds returns.

Taking skewness and kurtosis into account, the results are similar to previous studies. Most of the hedge fund strategies are negatively skewed, but for dedicated short bias (0.77), long/short equity (0.02) and managed future (0.00). Equity market netural (-11.99) and fixed income arbitrate (-4.65) are the most negatively skewed strategies. Also, all the hedge fund strategies, including the equity, bonds and commodity indices exhibit positive kurtosis. Amongst, the hedge fund strategies, equity market neutral (154.61), fixed income arbitrage (30.00) and convertible arbitrage (19.65) have the highest kurtosis while managed future (0.11) and dedicated short bias (1.70) are the least. In general, hedge funds have higher kurtosis and more negatively skewness than do equity, bonds and commodity indices (traditional Assets), Agarwal and Naik (2004) supports this.

Considering autocorrelation, hedge funds generally show higher and significant positive first and second order autocorrelation coefficient than do the equity, bond and commodity indices. In exception of dedicated short bias, equity market neutral, hedge funds at least show significant first (AR(1)) and second (AR(2)) order autocorrelation coefficients, most of which are positive. Within hedge funds, convertible arbitrage (0.569) and fixed income arbitrage (0.5) have the highest first order autocorrelation, as opposed to managed future (0.068) equity market neutral (0.082) having the lowest first order autocorrelation coefficients. Also, the commodity indices at least exhibit significant first and second order autocorrelation (mostly negative coefficients). Whereas the equity and bond indices do not exhibit first or second order autocorrelation, but for MSCI world and DJ- corporate bond indices.

Moreover, as indicated by their highly significant Jarque-Bera statistics, hedge funds are non-normally distributed, excluding managed futures. The equity, commodity and bond indices also have lower significant Jarque-Bera statistics than do hedge funds.

On average, hedge funds indices have higher Sharpe ratios than do the equity, commodity and bond indices considered. But as supported by Amin and Kat (2001), the Sharpe is not an appropriate performance measure for hedge funds because Sharpe ratio does not consider the non-normality of hedge fund returns distribution.

Table 5.1.2 Descriptive statistics of Credit Suisse/Tremont hedge fund index, equity, bond and commodity indices from 01/1994 to 11/2008

	Mean	Min	Max	St.Dev	Excess Kurtosis	Skewness	Mean excess return	AR(1)	AR(2)	Jarque-Bera	Sharpe ratio
Hedge Fund Index	**0.73***	-7.55	8.53	2.30	2.33	-0.18	0.60	**0.214***	**0.105***	**41.61***	0.26
Convertible Arbitrage	**0.47***	-12.59	3.57	1.98	19.65	-3.58	0.34	**0.569***	**0.267***	**3262.27***	0.17
Dedicated Short Bias	0.06	-8.69	22.71	4.91	1.70	0.77	-0.07	0.094	-0.081	**39.24***	-0.01
Emerging Markets	**0.65**	-23.03	16.42	4.59	4.60	-0.73	0.52	**0.316***	**0.053***	**173.73***	0.11
Equity Market Neutral	**0.52**	-40.45	3.26	3.19	154.61	-11.99	0.39	0.082	0.062	**182587.71***	0.12
Event Driven	**0.79***	-11.77	3.68	1.76	15.02	-2.73	0.66	**0.3768**	**0.214***	**1905.87**	0.38
Distressed	**0.88***	-12.45	4.10	1.94	12.87	-2.45	0.75	**0.377***	**0.214***	**1414.38***	0.39
Even Driven Multi-Strategy	**0.76***	-11.52	4.66	1.88	10.72	-2.08	0.62	**0.328***	**0.203***	**986.06***	0.33
Risk Arbitrage	**0.57***	-6.15	3.81	1.25	5.07	-1.08	0.44	**0.313***	**0.004***	**226.38***	0.35
Fixed Income Arbitrage	**0.31***	-14.04	2.07	1.73	30.00	-4.65	0.17	**0.5***	**0.122***	**7356.32***	0.10
Global Macro	**1.03***	-11.55	10.60	3.06	3.01	-0.03	0.90	0.097	0.037	**67.62***	0.29
Long/Short Equity	**0.82***	-11.43	13.01	2.96	3.50	0.02	0.69	**0.221***	**0.097***	**91.26***	0.23
Managed Futures	**0.63***	-9.35	9.95	3.45	0.11	0.0000002	0.50	0.068	**-0.176***	0.10	0.14
Multi-Strategy	**0.60***	-7.35	3.61	1.57	6.80	-1.99	0.47	**0.33***	**0.229***	**454.90***	0.30
Equity indices											
msci world	0.32	-19.05	8.91	4.23	2.48	-1.05	0.18	**0.162***	**0.022**	**78.82***	0.04
Nasdaq composit	0.66	-22.90	21.98	7.42	0.98	-0.37	0.53	0.095	-0.006	**11.14***	0.07
S&P500	0.45	-16.83	9.67	4.33	1.43	-0.80	0.32	0.105	-0.009	**34.38***	0.07
Commodity indices											
Philadelphia Gold&Silver	0.52	-38.22	53.39	10.64	3.30	0.44	0.39	**-0.128***	**-0.178***	**87.02***	0.04
Dow Jones-AIG	0.28	-21.59	10.12	4.54	2.50	-0.84	0.15	**0.159***	**-0.044***	**67.77***	0.03
Bond indices											
30yrs US treasury bond	-0.28	-25.00	15.87	4.42	5.45	-0.53	-0.41	0.013	-0.133	**230.26***	-0.09
Dow Jones corporate bond	**0.49***	-6.22	6.25	1.66	2.85	-0.34	0.35	0.026	**-0.21***	**51.00***	0.21

Significant coefficients at 10% degree of freedom are in bold and * at 5% significance level. St.Dev is the respective standard deviation, AR (1) and AR (2) are first and second order autocorrelation coefficients. Min and Max represent minimum and maximum returns, respectively.

5.2 Correlation

In this sub chapter, the Pearson correlation between the returns of hedge fund strategies and with the indices for comparison (equity, bond and commodity indices) will be verified for the whole period (January 1994- November 2008) and during financial crises.

5.2.1 Previous Studies

Brooks and Kat (2001) report that most of the hedge fund index returns exhibit high correlation with the equity indices, but low and typically negative correlation with the bond market. They also found that most unsmoothed hedge fund return exhibit higher correlation with both stock and bond indices than do those of the original return series.

Kat and Lu (2002) found that individual hedge fund returns exhibit moderately low positive correlation with equity market, close to zero correlation with bonds which varies inversely with the correlation with stocks. They formed equally weighted portfolios of individual hedge funds which exhibit significantly higher correlation with both equity and bond indices than do the correlation between individual hedge funds and traditional Assets (equity and bond). They also demonstrate that most individual hedge funds have low correlation with funds in the same and different strategy group.

Onlike Kat and Lu (2002), Fung and Hseih (2001) report that individual hedge funds are loosely correlated to standard Asset classes, while the hedge fund indices exhibit strong positive correlation with most of the standard Asset. Schneeweis and Spurgin (1998), Brown, Goetzmann, and Ibbolson (1999) also support that individual hedge funds are loosely correlated to standard asset indices.

5.2.2 Correlation between hedge fund strategies

Unlike Kat and Lu (2002), hedge funds generally exhibit moderate correlation (averagely 0.27) between different strategies. Also, as opposed to Kat and Lu (2002) the correlation of hedge funds within a strategy (event driven strategy) is high. The highest correlation within a strategy is between event driven and event driven-multi strategy (0.95) followed by event driven and distress (0.94), while the least between distress and risk arbitrage (0.59).Also, dedicated short bias exhibit negative moderate correlation (-0.34 on average) with other hedge fund strategies, but for managed future (0.003). Managed futures shows the very low (mostly negative) correlation series with other hedge fund strategies, while, event driven, distress and event driven-multi strategy exhibit higher correlation series with other funds strategies. However, the highest inter strategy correlation is between convertible arbitrage and fixed income arbitrage (0.78), and long/short equity and event driven (0.72).

Table 5.2.2 Rank Correlation between individual credit Suisse/hedge funds index strategies for whole period (January 1994 to November 2008) and during financial crises

	Convertible Arbitrage	Dedicated Short Bias	Emerging Markets	Equity Market Neutral	Event Driven	Distressed	Even Driven Multi Strategy	Risk Arbitrage	Fixed Income Arbitrage	Global Macro	Long/Short Equity	Managed Futures
Dedicated Short Bias	-0.23 **-0.19**											
Emerging Markets	0.42 **0.51**	-0.53 -0.65										
Equity Market Neutral	0.21 0.19	-0.12 -0.13	0.12 0.12									
Event Driven	0.66 **0.69**	-0.57 **-0.57**	0.70 **0.81**	0.28 **0.29**								
Distressed	0.60 **0.64**	-0.57 -0.60	0.63 **0.76**	0.33 **0.37**	0.94 **0.97**							
Multi-Strategy	0.65 **0.69**	-0.50 -0.52	0.70 **0.82**	0.22 **0.23**	0.95 **0.98**	0.79 **0.89**						
Risk Arbitrage	0.49 **0.54**	-0.46 -0.43	0.49 **0.72**	0.14 **0.15**	0.69 **0.80**	0.59 **0.73**	0.66 **0.80**					
Fixed Income Arbitrage	0.78 **0.88**	-0.17 **-0.16**	0.39 **0.45**	0.33 0.33	0.54 **0.57**	0.50 **0.54**	0.52 **0.57**	0.31 **0.39**				
Global Macro	0.37 **0.45**	-0.12 **0.01**	0.46 0.44	0.07 0.02	0.42 **0.45**	0.36 **0.37**	0.46 **0.50**	0.22 **0.35**	0.42 **0.50**			
Long/Short Equity	0.44 0.44	-0.68 **-0.67**	0.64 **0.70**	0.17	0.72 **0.75**	0.64 **0.72**	0.70 **0.72**	0.57 **0.61**	0.37 **0.40**	0.47 0.43		
Managed Futures	-0.08 -0.26	0.10 **0.32**	-0.05 -0.19	-0.02 -0.07	-0.08 -0.30	-0.08 -0.28	-0.09 -0.31	-0.09 -0.27	-0.07 -0.18	0.27 **0.28**	0.04 -0.06	
Multi-Strategy	0.67 **0.79**	-0.16 **-0.06**	0.23 **0.25**	0.34 **0.38**	0.50 0.47	0.43 **0.46**	0.50 0.45	0.32 **0.33**	0.62 **0.78**	0.26 **0.39**	0.40 **0.40**	0.04 -0.10
Average correlation	**0.36** **0.45**	**-0.34** **-0.30**	**0.35** **0.40**	**0.17** **0.17**	**0.48** **0.49**	**0.43** **0.46**	**0.46** **0.49**	**0.33** **0.39**	**0.38** **0.42**	**0.30** **0.35**	**0.37** **0.38**	**-0.01** **-0.12**

The figures in black and green are the correlation between the strategies for the whole period and during financial crises, respectively. The bolded green figures represent correlation coefficients that increase during financial crises. The total average correlation between hedge fund strategies are 0.27 for whole period and 0.30 during financial crises. the correlation averages are obtained by including to the missed figures on the table (without their self correlation of 1).

I also studied the correlation between hedge strategies during financial crises, and found some similarities and changes.

Same as for the whole period, managed futures still exhibit low correlation (-0.01 on average) with other funds strategies, and dedicated short bias maintains moderate negative correlation with other strategies (averagely -0.34).

In general, the correlation between individual hedge funds is moderate, but the average correlation slightly increases from 0.27 in whole period to 0.30 during financial crises. This minimizes the diversification effect of a portfolio of hedge funds. Liang (2003) explained that higher correlation between hedge funds during financial crises is due to liquidity squeeze, since fund managers are compelled to invest in limited securities and follow similar strategies.

5.2.3 Correlation of hedge funds with stock, bond and commodity indices

5.2.3.1 Whole period (January 1994 – November 2008)

As shown on table 5.2.3.2 below, hedge funds exhibit low correlation with commodity, bonds and equity indices, but for MSCI world. Long/short equity (0.68), event driven (0.67), and distress (0.65) have the highest correlation with MSCI world index, whereas dedicated short bias shows negative correlation with the other indices (but for S&P500 and Philadelphia gold and silver). On average, hedge funds are more loosely correlated to nasdaq composite (0.03) and S&P500 (0.06) indices, but moderately correlated to MSCI Worldindex (0.36).

The Philadelphia gold and silver index also shows low and mostly negative correlation (averagely -0.09) with hedge funds, while Dow Jones –AIG commodity index is moderately correlated to hedge funds (0.27 on average).

Although hedge funds are loosely correlated to the considered commodity indices as a whole, they show higher correlation with Dow Jones-AIG commodity index as opposed to very low and dominantly negative correlation with Philadelphia gold and silver index. They also show low and mostly positive correlation with the bond indices.

5.2.3.2 During financial crises

Table 5.2.3.2 presents the correlation between hedge funds and equity, bond, and commodity indices during five major global financial crises. They include;

- Asian financial crises (July 1997 to June 1998)

- Russian debt crises/long-term capital management fiasco (August 1998 to June 1999)
- Dot com bubble burst (March 2000 to March 2001)
- 9/11 world trade center attacks (September 2001 to December 2001)
- Current subprime market fallout (January 2008 to November 2008). The current subprime market fallout is only analyzed till November 2008, because November 2008 is the limit of analysis period in this thesis.

As with the entire period, hedge funds generally show higher positive correlation with MSCI world than with nasdaq composite and S&P500 indices during. Long/short equity (0.76), event driven (0.71), emerging markets (0.70), and distress (0.70) exhibit the highest correlation with MSCI world index , while dedicated short bias shows the lowest (-0.73). Also, Philadelphia gold &silver index exhibit negative correlation with almost all the hedge fund strategies, as opposed to averagely increased correlation between Dow Jones-AIG commodities during financial crises (from 0.27 in whole period to 0.33 during financial crises).

However, bonds correlations with hedge funds generally increase during financial crises (averagely from 0.12 to 0.17). This is due to increase hedge funds correlation with 30 years bonds and Dow Jones corporate bonds during financial crises.

Table 5.2.3.2 Credit Suisse/Tremont hedge funds index strategies Correlation with equity, bond and commodity indices for the whole period (Jan1994- Nov 2008) and during financial crises

	msci world	Nasdaq composite	S&P500	Average correlation with equities	Phlx Gold & Silver	DJ-AIG	Average correlation with commodities	30yrs US treasury bond	DJ corporate bond	Average correlation with bonds
Convertible Arbitrage	0.41	0.08	0.16	0.22	-0.03	0.36	0.16	0.05	0.37	0.21
	0.50	0.06	0.20	**0.25**	-0.04	0.47	**0.22**	0.11	0.49	**0.30**
Dedicated Short Bias	-0.71	-0.01	0.01	-0.24	0.17	-0.13	0.02	-0.10	-0.12	-0.11
	-0.73	0.07	0.11	**-0.18**	0.40	-0.13	**0.13**	-0.09	-0.10	**-0.09**
Emerging Markets	0.59	0.004	-0.03	0.190	-0.14	0.28	0.068	0.12	0.17	0.14
	0.70	-0.05	-0.07	**0.195**	-0.25	0.39	**0.071**	0.14	0.23	**0.19**
Equity Market Neutral	0.23	-0.0003	0.02	0.08	-0.16	0.23	0.04	0.41	-0.23	0.09
	0.26	-0.02	0.003	0.08	-0.24	0.28	0.02	0.65	-0.34	**0.15**
Event Driven	0.67	-0.003	0.04	0.24	-0.20	0.35	0.07	0.18	0.17	0.17
	0.71	-0.05	0.01	0.22	-0.35	0.38	0.02	0.27	0.20	**0.23**
Distressed	0.65	0.03	0.07	0.25	-0.18	0.31	0.07	0.17	0.17	0.17
	0.70	-0.02	0.05	0.24	-0.39	0.37	-0.01	0.29	0.18	**0.23**
Even Driven Multi-Strategy	0.61	-0.04	0.01	0.19	-0.20	0.34	0.07	0.16	0.15	0.15
	0.67	-0.08	-0.05	0.18	-0.31	0.36	0.03	0.24	0.19	0.21
Risk Arbitrage	0.54	0.07	0.19	0.27	-0.15	0.22	0.04	0.10	0.21	0.15
	0.64	0.03	0.16	**0.28**	-0.21	0.33	**0.06**	0.19	0.23	**0.21**
Fixed Income Arbitrage	0.38	0.04	0.08	0.17	-0.06	0.42	0.18	0.07	0.27	0.17
	0.46	0.08	0.13	**0.22**	-0.08	0.51	**0.21**	0.16	0.37	**0.27**
Global Macro	0.25	-0.01	-0.04	0.07	0.002	0.21	0.11	-0.16	0.26	0.05
	0.20	0.02	-0.10	0.04	-0.02	0.30	**0.14**	-0.17	0.38	**0.11**
Long/Short Equity	0.68	0.13	0.12	0.31	-0.17	0.31	0.07	0.05	0.22	0.13
	0.76	0.12	0.11	**0.33**	-0.26	0.39	0.06	0.07	0.35	**0.21**
Managed Futures	-0.09	-0.01	-0.09	-0.06	0.02	0.21	0.12	-0.16	0.12	-0.02
	-0.22	0.19	0.06	**0.01**	0.25	0.15	**0.20**	-0.38	0.19	-0.09
Multi-Strategy	0.42	0.11	0.18	0.24	-0.08	0.38	0.15	0.14	0.27	0.21
	0.44	0.17	0.33	**0.31**	-0.01	0.46	**0.22**	0.12	0.44	**0.28**
Average	0.36	0.03	0.06	0.15	-0.09	0.27	0.09	0.08	0.16	0.12
	0.39	0.04	0.07	0.17	-0.12	0.33	0.11	0.12	0.22	0.17

The figures in black and green represent pearson correlation of hedge funds returns for the whole period and during financial crises, respectively. Also, the correlation coefficient in red and blue are the total correction for the whole period and during fincial crises, respectively.

In conclusion, the correlation between hedge funds of different strategies is moderate, but high between hedge funds within the event driven strategy. Also, the correlation between and within (the event driven strategy and sub strategy) hedge funds strategies slightly increases during financial crises. On the contrary, managed futures and dedicated short bias experience negative (lowest) correlation with the other hedge fund strategies for the whole period and during financial crises. Moreover, excluding MSCI world, hedge funds are loosely correlated to equity indices over the entire period and financial crises. Hedge funds generally exhibit low correlation with bonds, but exhibit fair correlation with Dow Jones corporate bonds (0.22) during financial crises.

Finally, hedge funds are loosely (mostly negative) correlated to Philadelphia gold and silver, but moderately correlated to Dow Jones-AIG commodity. For the whole period and during financial crises, hedge funds show higher correlation with MSCI World (0.36, 0.39), Dow Jones –AIG (0.27, 0.33) and Dow Jones corporate bond (0.16, 0.22) than with the other indices for comparison.

5.3 Performance Measurement of Hedge Funds in comparison to equity, commodity and bond indices

The performance of hedge funds in comparison to the equity, bond and commodity indices will be analyzed using performance measures such as the Sortino, upside potential, Omega, Kappa, Sharpe, modified Sharpe, and autocorrelation-adjusted Sharpe ratios for the whole, non-financial crises and financial crises periods.

Also, the effects of autocorrelation and distribution (kurtosis and skewness) of returns for the entire period will be observed, as represented by ΔASR and ΔMSR on table 5.3.1, respectively.

5.3.1 The entire period (Jan1994-Nov 2008)

The monthly sharpe ratio of the Credit Suisse/Tremont hedge fund index and its strategies ranges between 0.386 to -0.014, with distress and dedicated short bias funds being the highest and lowest,

respectively. The Credit Suisse/Tremont hedge funds generally have higher Sharpe ratios than do the equity, bond and commodity indices.

Considering the Sortino ratio, the hedge funds' Sortino ratios range from 0.779 (risk arbitrage) to 0.020 (dedicated short bias) for minimum accepted return (MAR) equal zero and from 0.599 (risk arbitrage) to -0.023 (dedicated short bias) for MAR equals the risk free rate. But for the poor performance of the dedicated short bias, hedge funds have greater Sortino ratios than do the indices for comparison (Dow Jones corporate bond excluded). The equity and commodity indices have positive Sortino ratios, meanwhile 30 years US treasury bond index has negative Sortino ratios which are much smaller compared to Dow Jones corporate bond index.

Moreover, hedge funds together with equity, bond and commodity indices show positive upside potential ratios (UPR) both for MAR=0 and MAR=rf. That is, they performed greater than the MAR. However, equity market neutral, fixed market arbitrage and 30 years US treasury bonds have the least UPR compared to the other hedge fund strategies and indices for comparison (equity, bond and commodity indices). In exception of equity market, fixed income arbitrage and convertible arbitrage, hedge funds exhibit higher UPR than do equity, commodity and bond (excluding Dow Jones corporate bond) indices.

Dedicate short bias has the least Omega among the hedge funds. Also, leaving out dedicated short bias, hedge funds show higher Omega compared to equity, commodity and Dow Jones corporate bond) indices.

Only 30 years US Treasury bond index and dedicated short bias among others have negative kappa, for MAR equals zero and or MAR equals the risk free rate. This is because their respective mean returns are less than the threshold or MAR of zero or risk free rate. Also, without dedicated short bias and equity market neutral, hedge funds generally have higher kappa ratios that do the other indices, but for Dow Jones corporate bonds.

Looking at the respective modified Sharpe ratios, once more only 30 years US Treasury bond index, and dedicated short bias and equity market neutral have higher modified Sharpe ratios (MSR). Also, but for dedicated short bias and equity market neutral, hedge funds generally exhibit greater MSR than do the equity, commodity and bond indices (but Dow Jones corporate bond). Although, hedge funds have generally dominated in terms of MSR, they suffer the most when the regular Sharpe ratios are adjusted for skewness and excess kurtosis. These reductions are represented as ΔMSR (Modifie Sharpe

Ratio minus Sharpe Ratio) on table 5.3.1 below. Conversely, dedicated short bias and 30 years US Treasury bonds' MSR increased in reference to their respective regular Sharpe ratios.

Hedge funds also generally dominate in terms of autocorrelation-adjusted Sharpe ratio (ASR) than do the equity, commodity and bond (but Dow Jones corporate bond) indices. Within hedge funds, dedicated short bias (-0.056) has the least ASR (annualized), whereas risk arbitrage (0.936) has the most. 30 years US Treasury bonds also have negative ASR of -0.368. Onlike for MSR, most of the hedge funds and the other indices' ASR are less than their respective regular annualized Sharpe ratios. The decrease is represented as ΔASR (annualized autocorrelation-adjusted Sharpe ratio less annualized Sharpe ratio) on table 5.3.1 below. Generally, hedge funds regular annualized Sharpe ratio are more negatively affected (that is lower ΔASR) than the equity, commodity and bond indices. This is due higher positive autocorrelation in hedge funds returns, since they hold illiquid assets. Conversely, managed futures, Philadelphia gold & silver and Dow Jones corporate bond indices' respective ASR are higher than their respective regular annualized Sharpe ratios. This is so because they averagely exhibit negative autocorrelation of returns.

In summary, although hedge funds' performances generally appear to dominate, dedicated short bias (in some cases equity market neutral) performed poorer than do the equity, commodity and bond indices. The 30 years US Treasury bonds averagely appear to have the worst performance, whereas Dow Jones corporate bonds outperformed many hedge fund strategies. Also, risk arbitrage, distress, event driven, and event driven-multi strategies have the best performance than do the other hedge fund strategies (and the hedge fund index). The hedge fund index also outperforms most of its constituent strategies, the equity, and bond and commodity indices.

In reference to 5.3.1(b), about 54% of hedge funds strategies outperformed all the equity, bond and commodity indices considered. But if the Dow Jones corporate is excluded, approximately 92% of hedge fund strategies outperformed the equity, bond and commodity markets.

Table 5.3.1(a) Performance Ratios of Credit Suisse/Tremont Hedge Fund index, Equity, Bond and Commodity indices from January 1994 to November 2008 (whole period)

	Sortino		UPR		Omega		Kappa		SR	MSR	√12SR	ASR	ΔASR	ΔMSR
	mar=0	mar=rf	mar=0	mar=rf	mar=0	mar=rf	mar=0	mar=rf						
Hedge Fund Index	0.544 6	0.446 6	0.930 4	0.832 4	2.412 8	2.072 8	0.355 4	0.283 5	0.260 7	0.103 4	0.900	0.673 7	-0.228 15	-0.157 14
Convertible Arbitrage	0.293 11	0.211 11	0.583 16	0.510 18	2.014 11	1.686 11	0.162 11	0.116 11	0.172 10	0.051 11	0.595	0.324 13	-0.271 16	-0.121 11
Dedicated Short Bias	0.020 20	-0.023 20	0.624 12	0.589 12	1.033 20	0.964 20	0.016 20	-0.018 20	-0.014 20	-0.009 19	-0.050	-0.056 20	-0.006 4	0.006 2
Emerging Markets	0.204 12	0.163 12	0.639 10	0.602 11	1.470 14	1.361 14	0.131 12	0.103 12	0.113 13	0.042 12	0.391	0.376 11	-0.015 5	-0.071 9
Equity Market Neutral	0.172 14	0.128 13	0.272 21	0.235 21	2.712 6	2.196 7	0.073 16	0.054 16	0.122 12	-0.047 21	0.423	0.359 12	-0.064 11	-0.169 15
Event Driven	0.646 3	0.539 3	0.915 5	0.811 6	3.399 3	2.840 2	0.348 5	0.286 4	0.376 2	0.103 5	1.302	0.863 3	-0.439 20	-0.273 20
Distressed	0.668 2	0.568 2	0.941 3	0.844 3	3.427 2	2.901 1	0.361 3	0.303 3	0.386 1	0.108 3	1.336	0.872 2	-0.464 21	-0.278 21
Event Driven Multi-Strategy	0.595 4	0.491 5	0.885 7	0.784 7	3.054 4	2.562 4	0.331 6	0.268 6	0.332 4	0.096 6	1.151	0.788 5	-0.363 18	-0.236 18
Risk Arbitrage	0.779 1	0.599 1	1.094 1	0.909 2	3.473 1	2.680 3	0.449 2	0.335 2	0.353 3	0.113 2	1.222	0.936 1	-0.286 17	-0.239 19
Fixed Income Arbitrage	0.202 13	0.115 14	0.459 19	0.385 20	1.789 12	1.417 13	0.109 13	0.062 15	0.100 14	0.031 14	0.348	0.216 14	-0.132 12	-0.069 8
Global Macro	0.594 5	0.518 4	0.995 2	0.912 1	2.580 7	2.301 5	0.563 1	0.483 1	0.294 6	0.117 1	1.017	0.841 4	-0.176 13	-0.177 16
Long/Short Equity	0.478 9	0.401 8	0.898 6	0.821 5	2.138 10	1.897 9	0.307 9	0.252 7	0.232 8	0.094 7	0.803	0.627 10	-0.177 14	-0.138 13
Managed Futures	0.306 10	0.242 10	0.816 10	0.757 9	1.600 13	1.449 12	0.221 10	0.171 10	0.145 11	0.067 10	0.502	0.643 8	0.141 1	-0.078 10
Multi-Strategy	0.543 7	0.423 7	0.849 9	0.733 10	2.771 5	2.273 6	0.325 7	0.249 8	0.297 5	0.094 8	1.028	0.640 9	-0.388 19	-0.203 17
msci world	0.099 17	0.058 17	0.558 17	0.524 17	1.217 17	1.122 17	0.067 17	0.039 18	0.043 17	0.017 17	0.150	0.113 18	-0.037 8	-0.026 5
Nasdaq composite	0.128 16	0.102 15	0.602 15	0.581 14	1.269 16	1.210 16	0.091 15	0.072 13	0.071 16	0.031 13	0.246	0.210 15	-0.036 7	-0.040 6
S&P500	0.143 15	0.101 16	0.613 13	0.576 15	1.352 15	1.251 15	0.099 14	0.069 14	0.073 15	0.030 15	0.252	0.195 16	-0.057 10	-0.043 7
Philadelphia Gold&Silver	0.075 19	0.056 18	0.603 14	0.588 13	1.141 19	1.104 18	0.054 19	0.040 17	0.037 18	0.018 16	0.128	0.187 17	0.059 2	-0.018 3
Dow Jones - AIG	0.085 18	0.045 19	0.557 18	0.525 16	1.180 18	1.093 19	0.058 18	0.031 19	0.033 19	0.013 18	0.116	0.092 19	-0.023 6	-0.020 4
30yrs US treasury bond	-0.085 21	-0.125 21	0.455 20	0.429 19	0.842 21	0.778 21	-0.055 21	-0.080 21	-0.093 21	-0.037 20	-0.322	-0.368 21	-0.046 9	0.056 1
Dow Jones corporate bond	0.490 8	0.364 9	0.884 8	0.770 8	2.247 9	1.832 10	0.311 8	0.226 9	0.212 9	0.082 9	0.736	0.757 6	0.022 3	-0.130 12

The numbers in red are rankings. SR is the monthly Sharpe ratio, √12SR is the annualized Sharpe ratio, MSR stands for the modified Sharpe ratio on monthly basis, and ASR is the annualized autocorrelation adjusted Sharpe ratio. ΔASR is the difference between the annualized autocorrelation adjusted Sharpe ratio and the regular annualized Sharpe ratio (ASR-√12SR). ΔMSR represents the difference between the monthly modified Sharpe ratio and the regular monthly Sharpe ratio

(MSR- SR). UPR is the upside potential ratio, rf is the risk free rate, and mar is the minimum accepted return required by an investor.

Table 5.3.1(b) the ranks of average ranks of hedge funds, equities, bonds and commodities performance

Hedge Funds/indices	Ranks in whole period	Hedge Fund/indices	Ranks in non-financial crises period	Hedge Fund/indices	Ranks during financial crises
Risk Arbitrage	1	Equity Market Neutral	1	Managed Futures	1
Distressed	2	Event Driven	2	Risk Arbitrage	2
Global Macro	3	Event Driven Multi-Strategy	3	Dow Jones corporate bond	3
Event Driven	4	Distressed	4	Global Macro	4
Event Driven Multi-Strategy	5	Multi-Strategy	5	Dedicated Short Bias	5
Hedge Fund Index	6	Hedge Fund Index	6	Distressed	6
Multi-Strategy	7	Fixed Income Arbitrage	7	Long/Short Equity	7
Long/Short Equity	8	Risk Arbitrage	8	Event Driven	8
Dow Jones corporate bond	9	Long/Short Equity	9	Event Driven Multi-Strategy	9
Managed Futures	10	Convertible Arbitrage	10	Nasdaq composite	10
Emerging Markets	11	Global Macro	11	S&P500	11
Convertible Arbitrage	12	Emerging Markets	12	Multi-Strategy	12
Equity Market Neutral	13	Dow Jones corporate bond	13	Convertible Arbitrage	13
Fixed Income Arbitrage	14	Dow Jones-AIG	14	Philadelphia Gold&Silver	14
S&P500	15	msci world	15	Equity Market Neutral	15
Nasdaq composite	16	Nasdaq composite	16	Hedge Fund Index	16
Philadelphia Gold&Silver	17	Managed Futures	17	Fixed Income Arbitrage	17
msci world	18	S&P500	18	msci world	18
Dow Jones -AIG	19	Philadelphia Gold&Silver	19	30yrs US treasury bond	19
Dedicated Short Bias	20	30yrs US treasury bond	20	Emerging Markets	20
30yrs US treasury bond	21	Dedicated Short Bias	21	Dow Jones-AIG	21

The average rankings of hedge funds, equities, bonds and commodities are obtained by averaging their respective ranks as indicated by their comparative performance measures; that is the red figures in tables 5.3.1(a), 5.3.2 and 5.3.3. In calculating the average rankings, each performance measure is assigned equal weight. See Appendix on how the average ranks are obtained.

5.3.2 Non-financial crises period

Same as for the whole period, only dedicated short bias and 30 years US Treasury bonds exhibit negative Sharpe ratios. Also, but for dedicated short bias, hedge funds generally have higher Sharpe ratios.

Hedge funds and, equity, commodity and bond indices have positive upside potential ratio (UPR) and omega ratios. Whereas only dedicated short bias and 30 years US Treasury bonds exhibit negative Sortino ratios. With exception of dedicated short bias and managed futures, hedge funds have higher Sortino, UPR and omega ratios than do the equity, and bond and commodity markets. Unlike for the whole period, global macro show negative kappa ratio.

Considering modified sharpe ratios (MSR) and Autocorrelation –adjusted Sharpe ratio (ASR), dedicated short bias and 30years US Treasury bonds exhibit negative (and the least) MSR and ASR during period of non-financial turmoil. Also, hedge funds (excluding managed futures and dedicated short bias) have higher MSR and ASR than do the equity, bond and commodity markets.

In summary, same as for the whole period, most hedge funds outperform the equity, bonds and commodity indices during times of non-financial crises. Also, dedicated short bias and 30 years US Treasury bonds generally have the worst performance. Surprisingly, equity market neutral generally have the best performance in non-financial turmoil period, whereas it is one of the least performed strategies when considering the whole period. Equity market neutral, event driven (including event driven multi-strategy and distress) relatively have the best performance. The hedge fund index performed fairly compared to its constituent strategies.

In reference to 5.3.1(b), about 85% of hedge funds strategies outperformed all the equity, bond and commodity indices considered, in contrast to 54% for the whole period.

Table 5.3.2 Performance Ratios of Credit Suisse/Tremont Hedge Fund index, Equity, Bond and Commodity indices in times of non-financial crises

	SR	Sortino		UPR		Omega		Kappa		MSR	ASR
		mar=0	mar=rf	mar=0	mar=rf	mar=0	mar=Rf	mar=0	mar=Rf		
Hedge Fund Index	0.470 7	1.279 8	1.055 6	1.620 8	1.414 6	4.748 8	3.939 6	0.812 9	0.679 6	0.202 6	1.373 7
Convertible Arbitrage	0.445 9	1.012 10	0.755 11	1.395 10	1.154 11	3.643 11	2.892 11	0.674 10	0.511 10	0.154 11	0.858 14
Dedicated Short Bias	-0.062 21	-0.044 21	-0.087 21	0.544 21	0.510 21	0.925 21	0.855 21	-0.035 20	-0.069 20	-0.035 21	-0.221 21
Emerging Markets	0.341 12	0.746 12	0.658 12	1.155 12	1.076 12	2.823 12	2.573 12	0.499 11	0.443 11	0.151 12	1.169 11
Equity Market Neutral	0.763 1	3.434 1	2.323 1	3.726 1	2.640 1	12.749 1	8.325 1	2.120 1	1.476 1	0.281 1	1.767 4
Event Driven	0.751 2	2.032 2	1.660 2	2.310 2	1.961 2	8.304 2	6.523 2	1.220 2	1.018 2	0.239 2	1.922 2
Distressed	0.708 3	1.775 4	1.487 3	2.059 4	1.791 4	7.257 3	5.904 3	1.041 4	0.890 4	0.225 5	1.804 3
Event Driven Multi-Strategy	0.645 4	1.834 3	1.487 4	2.137 3	1.810 3	7.041 4	5.601 4	1.147 3	0.946 3	0.230 3	1.767 5
Risk Arbitrage	0.467 8	1.376 6	0.977 9	1.732 5	1.360 8	4.860 7	3.556 8	0.874 6	0.639 8	0.178 9	1.312 8
Fixed Income Arbitrage	0.568 6	1.379 5	0.983 8	1.710 6	1.33 9	5.165 6	3.774 7	0.878 5	0.639 9	0.179 8	1.308 9
Global Macro	0.408 10	0.958 11	0.823 10	1.285 11	1.163 10	3.924 9	3.421 9	-0.620 21	-0.538 21	0.172 10	1.435 6
Long/Short Equity	0.404 11	1.194 9	0.989 7	1.617 9	1.424 5	3.818 10	3.274 10	0.839 7	0.702 5	0.228 4	1.038 13
Managed Futures	0.109 18	0.239 16	0.171 17	0.761 16	0.705 16	1.458 18	1.320 18	0.175 15	0.126 16	0.052 17	0.432 16
Multi-Strategy	0.569 5	1.360 7	1.065 5	1.668 7	1.394 7	5.416 5	4.236 5	0.837 8	0.666 7	0.188 7	1.977 1
msci world	0.201 15	0.389 15	0.317 15	0.848 15	0.788 15	1.847 15	1.673 15	0.267 14	0.220 14	0.083 15	0.617 15
Nasdaq composite	0.122 16	0.221 18	0.186 16	0.686 17	0.658 17	1.475 17	1.393 16	0.154 16	0.130 15	0.054 16	0.357 17
S&P500	0.120 17	0.222 17	0.170 18	0.679 18	0.634 19	1.486 16	1.367 17	0.152 17	0.117 17	0.048 18	0.351 18
Philadelphia Gold&Silver	0.074 19	0.132 19	0.110 19	0.654 19	0.636 18	1.254 19	1.209 19	0.100 18	0.083 18	0.036 19	0.333 19
Dow Jones-AIG	0.235 14	0.453 14	0.382 14	0.906 14	0.844 14	1.999 14	1.826 14	0.325 13	0.275 13	0.100 14	1.222 10
30yrs US treasury bond	-0.044 20	-0.018 20	-0.066 20	0.587 20	0.550 20	0.970 20	0.893 20	-0.014 19	-0.051 19	-0.026 20	-0.181 20
Dow Jones corporate bond	0.261 13	0.638 13	0.461 13	1.075 13	0.928 13	2.461 13	1.986 13	0.429 12	0.317 12	0.110 13	1.041 12

SR is the monthly sharpe ratio, MSR stands for the modified sharpe ratio on monthly basis, and ASR is the annualized autocorrelation adjusted sharpe ratio. UPR is the upside potential ratio, rf is the risk free rate, and mar is the minimum accepted return required by an investor. Numbers in red are rankings.

5.3.3 During financial crises

Unlike for the whole and non-financial crises period, during financial crises, six hedge funds strategies (and hedge fund index) and, the equity, commodity and 30 years US Treasury bond indices have negative Sharpe ratios.

Also, six strategies (and the hedge fund index) and, the equity, commodity and 30years US Treasury bond indices have negative Sortino and kappa ratios at either MAR equals zero or MAR equals risk free rate. These results are different from the obtained in whole and non-financial crises periods.

Most hedge funds strategies relatively have higher Sortino and UPR ratios, where in emerging markets and fixed income arbitrage have one of the least Sortino and UPR ratios.

The hedge funds index, emerging markets, event driven and distress funds, and all the equity and commodity indices have negative modified Sharpe ratios (MSR). Also, six hedge funds strategies (and the hedge fund index), the equity, commodity and 30 years US Treasury indices exhibit negative autocorrelation adjusted Sharpe ratios. This because their mean returns are less than the risk free rate. Moreover, about half or just the majority of hedge funds have higher MSR and ASR than do the hedge fund index, equity and commodity indices. Hedge funds do not dominate the other indices as they did for the whole period and times of non-financial turmoil.

In summary, contrary to the whole period, the hedge funds index underperforms about the majority of its constituent strategies. Hedge funds have more negative performance ratios during financial crises than in either of the other periods. However, in relation to equity, commodity and bond indices (exception of Dow Jones corporate bond), managed futures, risk arbitrage, global macro, and dedicated short bias have relatively great performance during financial crises. Also, managed futures, dedicated short bias and Dow Jones corporate bonds' performances relatively improved in financial times more than their relative performance in whole period and non-financial times. Hence, they may be suitable for portfolio diversification. On the other hand, equity market neutral and emerging markets' performances relatively dropped during financial crises. 30 years US Treasury bond index relatively performed very poor throughout.

Although managed futures, risk arbitrage, global macro and dedicated short bias funds' performance are among the best during financial crises, hedge funds do not dominate the equity, commodity or bond indices in times of financial crises than for the whole period and time of non-

financial crises. Excluding Dow Jones corporate bonds, about 62% of hedge funds strategies performed better than the equity, bond and commodity indices, which is smaller than those obtained for the whole and non-financial crises periods. This is the case because equity (without MSCI world), Philadelphia gold & silver, and Dow Jones corporate bond indices outperform a couple of hedge funds strategies (including the hedge funds index).

Table 5.3.3 Performance Ratios of Credit Suisse/Tremont Hedge Fund index, Equity, Bond and Commodity indices during financial crises

	SR	Sortino		UPR		Omega		Kappa		MSR	ASR
		mar=0	mar=rf	mar=0	mar=rf	mar=0	mar=rf	mar=0	mar=rf		
Hedge Fund Index	-0.059 16	-0.016 15	-0.078 16	0.503 10	0.455 10	0.969 15	0.854 16	-0.012 15	-0.058 16	-0.036 17	-0.174 16
Convertible Arbitrage	-0.034 14	0.010 13	-0.038 14	0.369 16	0.328 16	1.028 13	0.895 13	0.006 13	-0.025 13	0.015 9	-0.069 13
Dedicated Short Bias	0.061 5	0.146 5	0.106 5	0.778 3	0.742 2	1.232 7	1.167 5	0.122 5	0.088 5	0.044 8	0.263 5
Emerging Markets	-0.253 20	-0.254 20	-0.277 20	0.308 18	0.291 18	0.548 20	0.513 19	-0.182 20	-0.199 20	-0.743 21	-0.851 21
Equity Market Neutral	-0.017 12	0.007 14	-0.018 12	0.168 21	0.148 21	1.042 11	0.894 14	0.004 14	-0.009 11	0.001 10	-0.050 12
Event Driven	0.023 7	0.092 7	0.028 7	0.466 12	0.416 12	1.247 6	1.071 7	0.058 7	0.018 7	-0.012 15	0.063 7
Distressed	0.039 6	0.110 6	0.048 6	0.474 11	0.427 11	1.302 5	1.125 6	0.068 6	0.030 6	-0.020 16	0.108 6
Event Driven Multi-Strategy	-0.0005 9	0.062 8	-0.001 9	0.456 13	0.409 13	1.156 8	0.999 9	0.040 8	-0.0004 9	0.0005 11	-0.001 9
Risk Arbitrage	0.225 1	0.447 2	0.320 2	0.806 2	0.698 3	2.244 1	1.845 1	0.287 2	0.207 2	0.397 1	0.667 2
Fixed Income Arbitrage	-0.187 18	-0.146 17	-0.194 17	0.219 20	0.183 20	0.600 19	0.485 21	-0.095 17	-0.126 17	0.054 7	-0.439 17
Global Macro	0.113 4	0.226 4	0.168 4	0.715 5	0.665 4	1.463 4	1.338 4	0.169 4	0.126 4	0.076 6	0.306 4
Long/Short Equity	0.001 8	0.049 9	0.001 8	0.592 6	0.555 6	1.091 9	1.002 8	0.036 9	0.001 8	0.0003 12	0.002 8
Managed Futures	0.225 2	0.469 1	0.390 1	0.952 1	0.886 1	1.972 2	1.787 2	0.330 1	0.277 1	0.107 4	1.062 1
Multi-Strategy	-0.040 15	0.029 10	-0.046 15	0.420 14	0.354 15	1.074 10	0.884 15	0.020 10	-0.032 15	0.194 3	-0.078 14
msci world	-0.176 17	-0.177 18	-0.202 18	0.375 15	0.355 14	0.679 17	0.637 17	-0.133 19	-0.152 19	-0.123 19	-0.444 18
Nasdaq composite	-0.004 10	0.014 12	-0.005 10	0.551 7	0.536 8	1.025 14	0.990 10	0.010 12	-0.004 10	-0.002 13	-0.012 10
S&P500	-0.012 11	0.019 11	-0.015 11	0.537 9	0.510 9	1.037 12	0.971 11	0.014 11	-0.011 12	-0.007 14	-0.028 11
Philadelphia Gold&Silver	-0.022 13	-0.019 16	-0.034 13	0.548 8	0.536 7	0.967 16	0.941 12	-0.014 16	-0.025 14	-0.085 18	-0.158 15
Dow Jones-AIG	-0.259 21	-0.272 21	-0.295 21	0.316 17	0.301 17	0.537 21	0.505 20	-0.203 21	-0.221 21	-0.222 20	-0.790 20
30yrs US treasury bond	-0.190 19	-0.190 19	-0.218 19	0.303 19	0.287 19	0.615 18	0.569 18	-0.121 18	-0.140 18	0.100 5	-0.735 19
Dow Jones corporate bond	0.160 3	0.355 3	0.240 3	0.723 4	0.628 5	1.963 3	1.617 3	0.229 3	0.156 3	0.231 2	0.561 3

SR is the monthly sharpe ratio, MSR stands for the modified sharpe ratio on monthly basis, and ASR is the annualized autocorrelation adjusted sharpe ratio. UPR is the upside potential ratio, rf is the risk free rate, and mar is the minimum accepted return required by an investor. Numbers in red are rankings.

5.4 Performance rank correlation

Tables 5.4(a), 5.4(b) and 5.4(c) below represent the rank correlation of performance measures for whole, non-financial crises and financial crises periods, respectively. It is observed that the performance measures produce similar rankings. That is they exhibit very high rank correlation in the three periods analyzed.

However, upside potential ratio and Omega ratio do not show very high correlation with each other in the whole period analysis, as do the other performance measures. Also, modified Sharpe ratio exhibit lower rank correlation series with the other performance measures during financial crises. Hence, contrary to the whole and non-financial crises period, the modified Sharpe will not produce very similar ranks as do the other performance measures.

Table 5.4(a) spearman rank correlation of performance measures for whole period analysis

	Sortino mar=0	Sortino mar=rf	UPR mar=0	UPR mar=rf	Omega mar=0	Omega mar=rf	Kappa mar=0	Kappa mar=rf	SR	MSR
Sortino mar=rf	0.994									
UPR mar=0	0.839	0.848								
UPR mar=rf	0.788	0.804	0.985							
Omega mar=0	0.94	0.94	0.675	0.612						
Omega mar=rf	0.952	0.96	0.72	0.665	0.988					
Kappa mar=0	0.977	0.975	0.873	0.83	0.881	0.904				
Kappa mar=rf	0.965	0.977	0.898	0.862	0.865	0.901	0.986			
SR	0.984	0.986	0.8	0.744	0.961	0.978	0.947	0.945		
MSR	0.931	0.936	0.922	0.895	0.778	0.818	0.969	0.978	0.895	
ASR	0.978	0.981	0.839	0.804	0.921	0.939	0.955	0.955	0.957	0.906

Table 5.4(b) *spearman rank correlation of performance measures for non-financial crises period*

	Sortino mar=0	Sortino mar=rf	UPR mar=0	UPR mar=rf	Omega mar=0	Omega mar=rf	Kappa mar=0	Kappa mar=rf	SR	MSR
Sortino mar=rf	0.974									
UPR mar=0	0.997	0.975								
UPR mar=rf	0.969	0.99	0.973							
Omega mar=0	0.987	0.982	0.984	0.961						
Omega mar=rf	0.979	0.991	0.979	0.97	0.995					
Kappa mar=0	0.923	0.888	0.923	0.891	0.879	0.871				
Kappa mar=rf	0.899	0.906	0.903	0.912	0.866	0.875	0.977			
SR	0.983	0.982	0.982	0.957	0.994	0.995	0.887	0.879		
MSR	0.964	0.988	0.965	0.995	0.958	0.968	0.888	0.912	0.955	
ASR	0.904	0.929	0.906	0.896	0.942	0.947	0.753	0.757	0.932	0.882

Table 5.4(c) *spearman rank correlation of performance measures during financial crises periods*

	Sortino mar=0	Sortino mar=rf	UPR mar=0	UPR mar=rf	Omega mar=0	Omega mar=rf	Kappa mar=0	Kappa mar=rf	SR	MSR
Sortino mar=rf	0.97									
UPR mar=0	0.792	0.822								
UPR mar=rf	0.771	0.809	0.995							
Omega mar=0	0.982	0.955	0.725	0.704						
Omega mar=rf	0.955	0.982	0.858	0.847	0.947					
Kappa mar=0	0.999	0.969	0.787	0.765	0.981	0.953				
Kappa mar=rf	0.969	0.996	0.791	0.775	0.958	0.975	0.97			
SR	0.968	0.997	0.827	0.814	0.958	0.988	0.965	0.992		
MSR	0.608	0.53	0.342	0.3	0.592	0.477	0.626	0.565	0.518	
ASR	0.981	0.995	0.805	0.788	0.965	0.975	0.979	0.995	0.992	0.562

5.5 Alternative performance measures of hedge funds

5.5.1 Market timing

As concluded by a number of academic researchers, hedge funds do not exhibit market timing ability of their managers. As shown on Table 5.5.1, excluding equity market neutral, hedge funds show negative market timing measure. However, Ferson and Schadt (1996) argue that time variation in market risk and market premium is the cause of the funds' negative market timing measures, and Edelen (1999) stated that the negative market timing results of previous studies are due to dilution of portfolio beta by excess cash holding. Hence, Edelen (1999) proposed the time series regression (similar to Treynor-Mazuy (1966)) to control for flow related timing performance, and found that hedge funds market timing measures are rather insignificantly different from zero.

Considering hedge funds market (S&P500 index) exposure, hedge funds have very low and mostly insignificantly market betas. Asness , Krail and Liew (2001) argued that non-synchronous returns due to hedge funds' illiquid asset holdings may underestimate hedge funds actual market exposures (betas). But emerging markets, global macro and managed futures exhibit negative market. Also, only dedicated short bias (-0.075) has negative alpha (that is underperform the market), with global macro (0.907) and distress funds (0.739) having the highest alphas. And nine hedge funds strategies significantly outperform the market.

Hence, based on the OLS regression using CAPM with S&P500 index as market proxy, hedge funds generally exhibit positive significant alphas and low market exposure (beta). Conversely, Sæbø (2007) used the adjusted CAPM proposed by Dimson (1979) and Scholes and William (1977) to adjust for non-synchronous movement in returns. And also found that most hedge funds exhibit positive alphas, fewer (about 22.4%) of which are significant relative to alphas obtained in CAPM regression.

Table 5.5.1 Market timing, market exposure and alphas of hedge funds for the period; January 1994 to November 2008.

	γ_p	t-stats (γ_p)	β_M	t-stats (β_M)	α_i	t-stats (α_i)	No. of observation
Hedge Fund Index	-0.013	-1.620	0.020	0.370	**0.592***	3.380	179
Convertible Arbitrage	-0.017	-1.450	0.072	1.000	**0.317**	2.010	179
Dedicated Short Bias	-0.003	-0.260	0.012	0.130	-0.075	-0.200	179
Emerging Markets	**-0.025**	-2.140	-0.029	-0.290	0.527	1.530	179
Equity Market Neutral	0.001	0.130	0.009	0.520	0.387	1.630	179
Event Driven	**-0.014**	-2.340	0.016	0.350	**0.657***	4.960	179
Distressed	**-0.012**	-2.110	0.028	0.600	**0.739***	5.110	179
Event Multi-Strategy	**-0.015**	-2.280	0.004	0.070	**0.623***	4.410	179
Risk Arbitrage	**-0.008**	-2.160	**0.053**	1.890	**0.422***	4.700	179
Fixed Income Arbitrage	**-0.014**	-2.370	0.030	0.560	0.165	1.210	179
Global Macro	**-0.017**	-1.870	-0.028	-0.430	**0.907***	3.940	179
Long/Short Equity	-0.010	-0.990	0.077	1.130	**0.662***	2.980	179
Managed Futures	-0.001	-0.080	-0.070	-1.260	**0.521**	2.050	179
Multi-Strategy	-0.011	-1.570	0.065	1.440	**0.444***	3.590	176

γ_p represents market timing measure (coefficient of squared market premium) derived from regression of Treynor and Mazuy (1966) market timing model. But β_M and α_i are obtained from OLS regression using CAPM. β_M measures the sensitivity to the market premium and α_I is the estimated abnormal return. S&P500 is used as the market proxy and t-stats is the t-statistics with robust standard errors. Significant coefficients at 5% (critical value* 1.697) *and 1% (critical value* 2.457) *significance levels are bolded and starred, respectively.

CHAPTER SIX: LIMITATION AND CONCLUSION

6.1 Possible Bias in this thesis

To begin with the shortcomings in this thesis, the results in analyzing the performance of Credit Suisse/Tremont Hedge fund index may be affected by self-selection and sample selection bias presented in chapter 4.2 (iii) and 4.2 (v). Hedge fund managers tend not to report to all databases (self-selection bias), and with Credit Suisse/Tremont hedge fund index imposing specific listing criteria (sample selection bias), the Credit Suisse/Tremont hedge fund index does not represent the hedge fund universe. Hence, the results obtained in this work are in reference to Credit Suisse/Tremont hedge fund index.

Also, liquidity bias presented in chapter 4.2 (iv) may affect the outcome of the analysis. Hedge funds hold illiquid assets which are difficult to price, and so gives room to fund managers to "manage" their monthly net asset value. A number of researchers concluded that hedge funds investment in illiquid securities may be the reason behind the autocorrelation of their returns. The first and second lagged autocorrelation of the various asset classes is presented in table 5.1.2. However, autocorrelation-adjusted sharpe ratio is used to minimize this effect on the conclusion arrived at.

Finally, S&P500 has been used as the market proxy in verifying hedge fund managers' market timing and security selection skills presented in tables 5.5.1. However, the market proxy may affect the result since there exist differences between S&P500 and other indices, such as MSCI world index.

6.2 Concluding Remarks

The financial markets have experienced significant up and down market movement within the period of January 1994 to November 2008. The summary statistics of Credit Suisse/Tremont hedge fund index, including the equity, bond and commodity indices were first considered. Same as previous studies, hedge funds exhibit higher mean return to volatility ratios, higher negative skewness and positive kurtosis (excess kurtosis) than do the equity, bond and commodity indices. Also, hedge funds exhibit higher significant positive autocorrelation and Jarque-Bera statistics than do the other indices considered.

The correlation between the hedge funds strategies for the whole period (January 1994-November 2008) shows moderate or fair correlation, as opposed to Kat and Lu (2002). Managed futures and

dedidicated short bias show negative (low) correlation with the other hedge fund strategies for whole period and during financial crises. Whereas high correlation is observed between the event driven and its sub-strategies (distress, multi-strategies and risk arbitrage). Moreover, correlations between the hedge fund strategies are obtained for the whole period and during financial crises. I found in general that the correlation between the strategies slightly increases during financial crises (averagely from 0.27 in whole period to 0.30 during financial crises). Liang (2003) explains that higher correlation between hedge funds during financial crises is due to liquidity squeeze, wherein fund managers are compelled to invest in limited securities and follow similar strategies. Managed futures and dedicated short bias maintained low (mostly negative) correlation with other strategies during financial crises.

Furthermore, the correlation between the hedge funds and equity, bond and commodity were analyzed in chapter 5.2.3. I found that excluding MSCI world index, hedge funds are loosely correlated to the equity indices over the entire period and during financial crises. Hedge funds generally exhibit low correlation with bonds, but show moderate correlation with Dow Jones corporate bond index (averagely 0.22) during financial crises. On the other hand, hedge funds exhibit low (mostly negative) correlation with Philadelphia gold & silver index, but moderately correlated to Dow Jones-AIG commodity index. In all, for the whole period and during financial crises, hedge funds show higher correlation with MSCI World (0.36, 0.39), Dow Jones –AIG (0.27, 0.33) and Dow Jones corporate bond (0.16, 0.22) than with the other indices for comparison (the equity, bond and commodity indices considered).

In chapter 5.3, risk-adjusted performance measures such as Sharpe, Sortino, upside potential, Omega, Kappa, modified Sharpe and autocorrelation-adjusted Sharpe ratios were used to investigate and rank the performance of Credit Suisse/Tremont hedge fund index in comparison to the equity, bond and commodity indices in three periods; the entire period, financial crises and non-financial crises periods. For the entire period, hedge funds (but for dedicated short bias and in some cases equity market neutral) outperformed the equity, bond and commodity markets. Also, risk arbitrage, distress, global macro, event driven, and event driven multi-strategy exhibit the best performance among the other strategies. However, Dow Jones corporate bonds outperformed many hedge funds strategies for the whole period. The performance analysis in periods of non-financial crises maintains that most hedge funds strategies outperformed the equity, bond and commodity indices. Same as for the entire period analysis, dedicated short bias and 30 years US treasury bonds generally have the worst performance, whereas equity market neutral and event driven (including event driven multi-strategy and distress) relatively performed best. It is observed that hedge funds are not immune to financial crises. This is shown by more negative

performance ratios during financial crises than in either of the analyzed periods (as shown in chapter 5.3). Interestingly, managed futures, dedicated short bias and Dow Jones corporate bonds' performance relatively improved during financial crises compared to whole and non-financial crises periods. 30 years US Treasury bonds relatively performed very poor throughout, while the hedge fund index underperforms about the majority of its constituent strategies during financial crises than it did for the whole and non-financial crises periods. In all, relative to the equity, bond and commodity indices considered, hedge funds performed better for non-financial and whole periods than during financial crises (table 5.3b shows the average performance ranks of the asset classes for the three analysis periods). I also came to the conclusion that the choice of performance measures might have not significantly affected the rankings of the asset classes (hedge funds and the other indices considered).

Finally, hedge fund managers' market timing and security selection skills were investigated using Treynor-Mazuy (1966) model. Same as previous studies, I found evidence of hedge fund managers' security selection skills (significant positive alphas), but no evidence of fund manager's market timing abilities. The model also suggests that hedge funds are loosely exposed to the market (S&P500 index) movements.

In recommendation, more emphasis should be put on hedge funds valuation since hedge funds invest on illiquid asset, large use of derivates and other complex strategies.

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APPENDIX

Appendix 1. Ranks for whole period analysis and how average ranks are obtained

Hedge Fund/strategies	Sortino mar=0	Sortino mar=rf	UPR mar=0	UPR mar=rf	Omega mar=0	Omega mar=rf	Kappa mar=0	Kappa mar=rf	SR	MSR	ASR	Average ranks
Hedge Fund Index	6	6	4	4	8	8	4	5	7	4	7	5.73
Convertible Arbitrage	11	11	16	18	11	11	11	11	10	11	13	12.18
Dedicated Short Bias	20	20	12	12	20	20	20	20	20	19	20	18.45
Emerging Markets	12	12	10	11	14	14	12	12	13	12	11	12.09
Equity Market Neutral	14	13	21	21	6	7	16	16	12	21	12	14.45
Event Driven	3	3	5	6	3	2	5	4	2	5	3	3.73
Distressed	2	2	3	3	2	1	3	3	1	3	2	2.27
Event Driven Multi-Strategy	4	5	7	7	4	4	6	6	4	6	5	5.27
Risk Arbitrage	1	1	1	2	1	3	2	2	3	2	1	1.73
Fixed Income Arbitrage	13	14	19	20	12	13	13	15	14	14	14	14.64
Global Macro	5	4	2	1	7	5	1	1	6	1	4	3.36
Long/Short Equity	9	8	6	5	10	9	9	7	8	7	10	8.00
Managed Futures	10	10	10	9	13	12	10	10	11	10	8	10.27
Multi-Strategy	7	7	9	10	5	6	7	8	5	8	9	7.36
msci world	17	17	17	17	17	17	17	18	17	17	18	17.18
Nasdaq composite	16	15	15	14	16	16	15	13	16	13	15	14.91
S&P500	15	16	13	15	15	15	14	14	15	15	16	14.82
Philadelphia Gold&Silver	19	18	14	13	19	18	19	17	18	16	17	17.09
Dow Jones -AIG	18	19	18	16	18	19	18	19	19	18	19	18.27
30yrs US treasury bond	21	21	20	19	21	21	21	21	21	20	21	20.64
Dow Jones corporate bond	8	9	8	8	9	10	8	9	9	9	6	8.45

The entries in red are the average ranks which I used to rank the performance of the asset classes for whole, non-financial crises and financial crises period in table 5.3.1b in chapter 5.3.1 above. The average ranks are the sum of their respective ranks divided by the number of performance measures (11).