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Do Hedge Funds actually beat the market?

An empirical study of hedge funds risk-adjusted performance measures to determine whether they provide better opportunities than passive investment.

Executive Summary

In recent years, hedge funds popularity has soared significantly due to the main assumption that they provide above market returns for lower risks. This study aims to prove or disprove this assumption, and in order to do so, performance measurement models, classical and risk-adjusted, are presented in the literature review along with relevant theory. The models are then built, and analysed for the 2012-2022 decade, the analysis is split into crisis period (2020-2022) and bull market conditions (2012-2020) to contrast the performance during both periods using these models. A regression analysis is then conducted in order to built an approximation model for hedge funds returns using different securities and markets. Finally, a judgement on the findings hopes to confirm or deny the assumption that hedge funds provide a higher risk-reward trade-off.

Table of Contents

Table of Figures

1. Introduction

The recent rise of hedge funds as an alternative investment vehicle has been gaining popularity in recent years. Developed in 1949 by Alfred W. jones, under the assumption that markets cannot be predicted and that he could use his expertise to identify mispriced assets. In a nutshell, his strategy consisted of holding long positions in undervalued stocks, and short-sell overvalued ones. As late as 1984, only 64 hedge funds were in existence (Lhabitant, 2004). Assets under management grew from US$118 billion in 1997 to over US$3 trillion in 2016 (Barclay Hedge 2018a) with over 10,000 active hedge funds.

Operating mainly in the United States (US$ 2.7 trillion AUM), the United Kingdom (US$ 0.47 trillion AUM) and to a lesser extent other financial centres like Hong Kong or Switzerland (Prequin, 2019) and tend to be registered in countries like Bermuda, the British Virgin Islands, Guernsey due to their advantageous tax regimes.

Hedge funds actively benefit from loose regulation as they are not under much scrutiny as compared to mutual funds, which permits their active management strategies to explore investment portfolios beyond conventional assets to more risky securities, to include segmented markets and distressed companies for example. They also combine, as with the first hedge fund, short selling to fund long positions as well as heavy borrowing to secure investment funds (leverage) and extensive use of derivatives.

Access is limited to institutions and wealthy individuals with minimum investments ranging from US$0.5 million-US$1 million. (Barclay Hedge 2018b). Investment in illiquid markets are possible by imposing rules like lockup periods where assets redemption is not permitted.

As hedging is primarily reducing risk, and funds are investment pools that seeks profitable returns. It is in that logic that evaluating Hedge funds performance in a risk-reward framework has important implications for the funds, the investors and active strategy management as a whole.

The <u>scope</u> of this study is to evaluate hedge funds performance by strategy through classical and risk-adjusted models. To assess how these strategies and the overall index performance compare to different types securities and markets performances and draw conclusions about the risk-adjusted performance characteristic of hedge funds.

In order to fulfil the <u>aim</u> of this study which is, to prove or disprove that hedge funds offer above market returns for lower risks in different market condition.

For that purpose, research <u>objectives</u> are set as follows:

- To build statistical models and risk-adjusted models to analyse how each different hedge fund strategy performs following these models and
- To conduct a period analysis between bull and bear market conditions and how the funds' performances compare to the market.
- To run a regression analysis to uncover hedge funds investment portofio in different securities and markets.

The choice of this analysis is relevant in the sense that no analysis of this kind, as far as the date of writing, includes the recent pandemic crisis that disrupted a decade-long bull market.

The report is laid out in a logical order that facilitates the reader's understanding and clarifies the approach. In the literature review, hedge fund strategies are presented. Empirical research relevant to the study is then discussed along with a theoretical background of classical and risk-adjusted performance models. In Methodology section, a description of data and its subsections along with the time period of the study and how it was made available. Then Hedge fund strategies are analysed using classical and risk-adjusted models then compared to market performance.A period analysis and a study of correlation and how each strategy relates to market indices is then conducted.

2. Literature Review

2.1. Hedge Fund Strategies

Using credit and borrowed capital, Hedge funds are investment pools that engage in speculative activity (Oxford Dictionary, 2022). Spotting mispriced securities from stocks, commodities and currencies while protecting their positions using financial derivatives from options, SWAPs and futures contracts.

There are a range of strategies employed by hedge funds, as indicated by the Credit Suisse's Hedge Index database the major ones are:

2.1.1. Convertible Arbitrage

Where the strategy is to capitalise on mispriced convertible securities (i.e convertible bonds) by holding long positions on the convertible security and short-selling the stock or the option of the company in question. The combined position in the end should be market neutral and the profit only on the mispricing rather than stock fluctuation. (Credit Suisse, 2022)

2.1.2. Fixed Income Arbitrage

By identifying price discrepancies in fixed income securities, managers aim to generate positive returns by building long positions in undervalued bonds while short selling overvalued ones. (Credit Suisse, 2022)

2.1.3. Equity Market Neutral

Strategies invest in stocks long and short while matching them for a zero beta by doing so they keep their exposure to market risk neutral. The position should not be affected by market's ups and downs. (Credit Suisse 2022)

2.1.4. Emerging Markets

Investments are made in emerging markets securities or developing countries China, India, Brazil, Russia, Indonesia, South Africa. In these high growth markets, managers believe they can spot arbitrage opportunities. (Credit Suisse 2022).

These markets have higher risk than developed markets but can help diversify away some of the risk in developed markets.

2.1.5. Event Driven

Focuses on particular events occurring in the market, mergers & acquisitions, bankruptcy or liquidations (Credit Suisse 2022).The three subcategories: Distressed, Risk arbitrage, and Multi strategy will be ananlysed as one strategy.

2.1.6. Global Macro

Managers exploit global market opportunities by analysing effects of political and macroeconomic trends. Long position are held in the case of bull market conditions and short positions in bear markets. (Credit Suisse 2022)

2.1.7 Long/Short Equity

Managers dig for price discrepancies in equity markets where a combination of long positions in undervalued equities and short positions in overvalued ones serves as a way to hedge the long position itself or the fund it by generating more revenue. (Credit Suisse 2022)

2.1.8. Managed Futures

Initially in the form of CTAs, Commodity Trading Advisors, this strategy has shifted to include all other securities. Where investments in financial securities are made with use of derivatives like futures contracts to hedge against currency market fluctuations. Leverage can be applied as well. (Credit Suisse 2022)

2.1.9. Multi Strategy

Combining several strategies these funds are able to diversify their capital to reduce volatility and smooth returns. Managers make the most of various strategies to generate positive return independently of market conditions. (Credit Suisse 2022)

2.2. Empirical Research

Following a spike in assets under management in the 1990s, the study of hedge funds performance following a risk-return framework has shown several results. Fung and Hsieh (1997) observed a low correlation between hedge funds and usual asset classes meaning that these funds as alternative investments contributed to diversifying a portfolio and improving risk-adjusted returns. Ackermann et al. (1999) compared hedge funds and mutual funds on a risk-adjusted basis and found that hedge funds have a better performance that mutual funds but underperform market indices and that hedge funds take on more risk that both market indices and mutual funds. On the opposite side, Liang and Kat (2001), found higher volatility in the S&P500 index than in hedge funds, due to the cross-style diversification methods employed by these funds. They also show that hedge funds provide better risk-adjusted returns. A study conducted by Brown et al. (2001) found that hedge funds decrease their volatility after good interim results and increase volatility after bad results.

During financial crises, hedge funds, as shown by Liang and Kat (2001), were seriously affected by the 1998 Asian crisis, as to the Credit Default crisis of 2008, Stromqvist (2009) did not conclude that hedge funds had a deeper effect on the crisis than other financial actors. Capocci and Hubner (2004) found that hedge funds could not reach their target returns during the crisis. Shaub and Schmid (2013) compared hedge funds with illiquid portfolios to liquid portfolios and had shown that the latter had higher returns and alpha.

Boasson and Boasson (2011) found a high correlation between hedge funds and market proxies for all strategies except for Global Macro and Fixed Income Arbitrage. The correlation increases especially in crisis periods and decreases noticeably in usual periods except for Global Macro and Short Equity strategies as shown by Stoforos et al. (2016).

2.3. Financial Theory

2.3.1. Modern Portfolio Theory

Modern Portfolio Theory developed by Harry Markowitz (1966), introduced a mean-variance framework for the assessment of performance in funds, his portfolio model incites investors to diversify in order to minimize risk and maximize expected return.

By introducing risk-free assets to a risky portfolio, the combination is the Capital Allocation Line:

$$E(r_c) = r_f + \frac{\sigma_c}{\sigma}(E(r) - r_f) \quad \text{(i)}$$

$E(r_c)$ *: Expected return combined,*

$E(r) - r_f$ *: Expected return above risk-free,*

σ, σ_c *: Standard deviation of portfolio and combination.*

2.3.2. Asset Pricing Models

Assets are priced using the Capital Asset Pricing Model, and fairly priced assets should plot along the security market line.

$$E(r) = r_f + \beta(E(r_M) - r_f) \quad \text{(ii)}$$

β *: Represents market volatility*

$E(r_M)$ *: Expected return on the market,*

r_f *: Risk-free rate,*

σ *: Standard deviation*

2.4. Performance Measurement Models: Classical Models

2.4.1. Sharpe Ratio

The slope of the Capital Allocation Line from (i), represents the reward-variability ratio, introduced by William Sharpe (1966). It is a crucial part of this analysis.

The Portfolio with the highest Sharpe ratio on the efficient frontier is known as the market portfolio and combined with a risk-free asset, the Capital Market Line. It is tangent to the Efficient Frontier and effectively is the most dominant strategy of all:

$$S = \frac{E(r) - r_f}{\sigma} \quad \text{(iii)}$$

$E(r)$: Expected return of the portfolio,

r_f : Risk-free rate,

σ : Standard deviation

2.4.2. Jensen's Alpha

When using the CAPM model to predict expected return, one might wonder how accurate their predictions of return are compared to actual returns. Introducing Alpha, developed by Michael Jensen (1967) it is used to quantify management's forecasting capability and evaluate the active management component of hedge funds.

$$\alpha = \bar{r} - (r_f + \beta(E(r_M) - r_f)) \quad \text{(iv)}$$

$\bar{r}$: Actual return in the period,

$E(r_M)$: Expected return on the market,

r_f : Risk-free rate,

σ : Standard deviation

2.5. Critique of Classical Models

Although the Sharpe ratio is the most widely know performance measure (Elling and Schuhmacher, 2007). Used heavily in financial literature to conduct these studies, it assumes a normal distribution of returns that can be fully described by its mean and variance, and does not take into consideration characteristics special to hedge funds. Therefore, the adequacy is questionable as stated by Amin and Kat (2003) because hedge funds returns usually have asymmetric distributions (Umemoto 2004). The need for an adjusted performance measure that does not assume normal distribution and that best fits the special characteristics that hedge funds exhibit. Various models were then created to account for this anomaly:

2.6. Performance Measurement Models: Risk-adjusted Models

To address the issues brought forward by the critique there has been innovative attempts to modify the models to evaluate risk-adjusted performance.

2.6.1. Modified Sharpe Ratio

This Model developed by Favre and Galeano (2002) is based on the Cornish-Fisher expansion(1937). It modifies the Sharpe ratio by substituting the standard deviation in the denominator by a variable called Modified Value at Risk (MVaR) that takes into account Skewness and Kurtosis, because non-normal returns might cause issues in the Sharpe ratio and therefore the use of higher central moments can improve the measure. The Modified Sharpe Ratio:

$$MS = \frac{\bar{r} - r_f}{MVaR} \quad \text{(vi)}$$

$\bar{r}$ *: Actual return on the portfolio, mean*

r_f *: Risk-free rate,*

MVaR : Modified Value at Risk

$$MVaR = E(r) - \sigma[z_c + \frac{1}{6}(z_c{}^2 - 1)S + \frac{1}{24}(z_c{}^3 - 3z_c)K - \frac{1}{36}(2z_c{}^3 - 5z_c)S^2]$$

$E(r)$: *Expected return, mean*

σ : *Standard Deviation*

S : *Skewness*

K : *Excess Kurtosis*

z_c : *Critical value in probability z_c = -1.96 for confidence interval of P=95%.*

2.6.2. Sortino Ratio

This modification of the Sharpe ratio, penalises downside returns, it accounts for the symmetry of distribution and instead of taking into account total risk only downside risk is incorporated into the equation. It functions in a way that upside returns are counted as zero and downside returns as themselves. This ratio is particularly in times of high volatility and can show a different perspective especially in bear markets. Introduced by Frank Sortino and Price (1994):

$$Sor = \frac{\bar{r} - MAR}{DD} \quad \text{(vii)}$$

$\bar{r}$: *Actual return on the portfolio, mean*

MAR : *Minimum Acceptable Return, above which return are acceptable usually zero, r_f or the mean*

DD : *Downside Deviation*

$$DD = \sqrt{\frac{1}{N} \sum_{n=1}^{N} (r_n - MAR)^2}$$

$$DD = \begin{cases} (r_n - MAR), & r_n < MAR \\ 0, & r_n \geq MAR \end{cases}$$

In sum, the classical models will be used as preliminary findings on which the risk-adjusted models would bring a decisive confirmation.

3. Methodology

3.1. Research Philosophy

In this report as is the case with the majority of secondary data analyses, this quantitative research constitutes a statistical analysis of secondary data collected online with non-probability convenient sampling.

Following the research onion, research philosophy relates to the development of knowledge and its underlying nature and can reflect the author's view of the world. This research's philosophy follows an ontology of objectivism, in a sense that what constitutes reality and the way one understands it, is objective and does not involve a subjective opinion as the study is based on quantitative data, less prone, although not completely, to subjective opinion. Epistemology investigates what constitutes valid knowledge and how we can obtain it, in that sense this research's epistemology is positivism which sees observable evidence as the only form of defensible scientific findings and that only factual evidence from these findings can constitute legitimate knowledge (IGI Global, 2022).

3.2. Data Description

3.2.1. Credit Suisse Hedge Funds Index

Credit Suisse Hedge Fund Index is developed by Credit Suisse Hedge Index LLC belonging to Credit Suisse. The index is asset-weighted and includes only funds (i.e. no accounts). The Database that provides the index input is the Credit Suisse Hedge Fund Database, composed of more than 9000 funds that fit the following criteria: A minimum of US$50 million assets under managements, a minimum 12-months track record and Current audited financial statements.

The index is updated every month and rebalanced. It provides performance net of all fees and expenses (Credit Suisse, 2022).

3.2.2. Subcategories

In addition to the main index, to best reflect how hedge funds perform and to shed light on high achieving strategies, the index separates hedge funds into ten subcategories: Convertible Arbitrage, Dedicated Short Bias, Emerging Markets, Equity Market Neutral, Event Driven, Fixed income Arbitrage, Global Macro, Long/Short Equity, Managed Futures, Multi-Strategy.

3.2.3. Database construction: Sampling method

To match the index shape to the universe in question asset-weighting, contrary to equal-weighting, provides a more realistic image of investments in assets classes. The Credit Suisse Hedge Fund Index represents at least 85% of assets under management in every category at all times of the index universe so it is able to capture by a large margin the whole picture of hedge funds performance within the criteria. To do so it analyses the percentage of assets invested in each subcategory and select funds for the index based on those percentages (Credit Suisse, 2022). Funds weight caps can be applied to improve diversification and cut concentration risk. Also funds are not removed from the index until they go onto full liquidation or cease to publish their reports this in turn minimizes survivorship bias (Credit Suisse, 2022).

3.4. Indices for Comparison

3.4.1. S&P500

A world-renown stock market index consisting of 500 large-cap publicly traded companies in the United States. It a cross-sectional index widely used to represent the U.S. equity market performance (S&P Global, 2022).

3.4.2. MSCI World

MSCI World is a global equity index consisting of large and mid-cap stock performances in 23 developed countries. It covers 85% of market capitalisation's free float-adjusted in these markets (MSCI, 2022). To broaden the analysis there are two additional indices covering Emerging Markets and Frontier Markets.

3.4.3. U.S Bond Aggregate

S&P U.S Aggregate Bond index, is designed to track regional and global performance of fixed income securities. It is used as an investment comparison to the U.S. bond market (S&P Global, 2022).

3.4.4. GSCI

Formerly the Goldman Sachs Commodities Index, is a composite of commodities returns, it represents unleveraged, long positions only, investments in commodities futures contracts widely spread across various subsections of the commodities sector. It effectively reflects returns attainable in commodities market if investments are made (Goldman Sachs, 2022).

3.5. Description of the period

The period analysed in this study spans the 2012-2022 decade, a period characterized by a steep recovery from the 2007-2009 financial crisis, and the subsequent flash crash of 2010.

In 2012, the market had recovered from the subprime mortgage crisis and had entered a decade long bull market never seen before. The Chinese stock market crash of 2015 almost plunged global markets into distress and trade wars with the U.S in mid-2018 resulted in serious economic costs. The period has seen relevant geopolitical events like the Brexit referendum in 2016 that created uncertainty surrounding major markets. Despite all these events, market proxies still showed continuous growth throughout the period (US News, 2019).

With the yield curve inverting before the turn of the 2010s, the period is interrupted by one of the largest recessions in modern times in March 2020, with the Covid-19 pandemic and its subsequent impact on the global economy. The impact remains to this day.

Analysing this period can shed light on both performance during economic growth with contrast to times of financial distress. And can help us understand how well hedge funds perform during both periods. It would clearly show the risk-minimising characteristic of hedge funds and their management qualitites in the face of a recession.

3.6. Description of locations

As these indices represent 85% of the hedge fund universe in terms of assets under management, most which is located in the United States and to a lesser extent the United Kingdom. So the study would focuse primarily on U.S. market indices for comparison with some mentions of developed markets.

3.7. Limitations and issues

Access to hedge funds data is rare as low regulation permits, only a handful of hedge funds actually publish their reports. And because they are not legally bound to

do so, one can speculate about the reason why a fund would even publish its accounts. Funds can do so to boost reputation and attract investors especially when results are positive while some can cease to publish in the case of low results. This can create a bias which in turn paints a different picture than reality. The hedge fund index provided by Credit Suisse, provides results of the overall index without specifying each indivdual fund's returns, therefore, and as it is an asset-weighted fund, larger funds tend to be over represented.

4. Data Analysis

4.1. Data Presentation

4.1.1. Descriptive Statistics

	Mean	Median	Minimum	Maximum	Variance	Range	St. Deviation	Kurtosis	Skewness
Hedge Fund Index	0.41%	0.43%	-7.28%	3.78%	0.00018	11.06%	0.0135	8.0129	-1.5279
Strategies:									
Convertible Arbitrage	0.38%	0.33%	-6.43%	3.72%	0.00014	10.15%	0.0117	8.9277	-1.2844
Emerging Markets	0.51%	0.56%	-10.27%	6.34%	0.00050	16.61%	0.0225	3.8404	-0.9557
Equity Market Neutral	0.16%	0.09%	-4.30%	4.34%	0.00017	8.64%	0.0131	1.3280	-0.1532
Event Driven	0.45%	0.58%	-13.47%	6.75%	0.00041	20.22%	0.0202	18.6924	-2.6321
Fixed Income Arbitrage	0.38%	0.48%	-6.51%	2.67%	0.00008	9.18%	0.0091	27.9386	-3.7862
Global Marco	0.37%	0.33%	-6.19%	4.48%	0.00023	10.67%	0.0153	2.7814	-0.3802
Long/Short Equity	0.56%	0.70%	-7.41%	4.55%	0.00036	11.96%	0.0190	2.2092	-0.7801
Managed Futures	0.19%	0.21%	-7.50%	7.50%	0.00078	15.00%	0.0279	-0.2277	-0.0318
Multi-Strategy	0.51%	0.62%	-5.98%	4.19%	0.00013	10.17%	0.0113	9.0414	-1.3812
Securities:									
S&P500	1.46%	1.50%	-16.36%	61.71%	0.00479	78.07%	0.0692	48.4182	5.4391
GSCI	0.12%	0.26%	-25.62%	17.58%	0.00420	43.19%	0.0648	1.5077	-0.4699
US Agg Bond	0.21%	0.20%	-2.53%	1.95%	0.00006	4.48%	0.0080	0.7360	-0.1984
Markets:									
MSCI World	0.15%	1.46%	-13.23%	12.79%	0.00145	26.02%	0.0381	2.0275	-0.5221
Emerging Market	0.56%	0.77%	-15.40%	13.23%	0.00223	28.63%	0.0473	0.6819	-0.2128
Frontier Market	0.67%	1.16%	-21.96%	8.24%	0.00153	30.20%	0.0391	8.4634	-1.8101

*Source: Author**

Table 1: Descriptive Statistics

At first sight, the overall Hedge Fund Index shows a mean monthly return of 0.41% on investment from 1/1/2012 to 1/1/2022. While keeping a range of returns just over 11% influenced by a -7.28% minimum figure recorded in March 2020 during the first Covid-19 lockdown. And a maximum of 3.78% in December 2020 following the announcement of the start of the vaccination campaign.

Although outperforming the commodities index GSCI, the bond index USAGB and the MSCI World developed markets. The returns figure is eclipsed by the S&P500 index that averaged 1.46% Emerging and Frontier equity markets have also higher returns on average than the Hedge Fund Index. A performance that comes at a price, looking at the S&P500 range it is clearly disproportionate due to an outlier in November 2017, if excluded the mean is around 1%.

Looking at the strategies, the highest performing strategy is Long/Short equity (0.59%) and Multi-strategy (0.51%) while the safest strategies recorded the lowest standard deviations around the 1% mark, with Fixed-income Arbitrage (0.0091) and Covertible Arbitrage (0.0117) leading the table along with Long/Short and Multi-Strategy.

|	HFI	CA	EM	EMN	ED	FIA	GM	LSE	MF	MS	S&P500	GSCI	USAGB	MSCI W	MSCI EM	MSCI FM
Hedge Fund Index	1.0000															
Convertible Arbitrabge	0.7034	1.0000														
Emerging Markets	0.7520	0.7432	1.0000													
Equity Market Neutral	0.4845	0.3708	0.4068	1.0000												
Event Driven	0.8882	0.7874	0.7238	0.3458	1.0000											
Fixed Income Arbitrage	0.6659	0.6759	0.5940	0.3686	0.7072	1.0000										
Global Marco	0.8521	0.4798	0.5695	0.3482	0.6656	0.4762	1.0000									
Long/Short Equity	0.9069	0.6186	0.6712	0.5100	0.7993	0.5168	0.6561	1.0000								
Managed Futures	0.3964	-0.0519	0.1032	0.1086	0.0720	-0.0024	0.4746	0.2384	1.0000							
Multi-Strategy	0.9027	0.5976	0.5971	0.5504	0.7410	0.6446	0.7596	0.8134	0.3675	1.0000						
S&P500	-0.0323	-0.0866	-0.0150	-0.0478	-0.0434	-0.0825	-0.0341	0.0090	-0.0177	-0.0394	1.0000					
GSCI	0.0893	0.0461	0.0368	-0.0053	0.1800	0.0355	0.0893	0.0578	-0.1339	0.0848	0.3417	1.0000				
US Agg Bond	-0.1454	-0.1420	-0.0381	-0.2250	-0.1191	-0.1378	-0.2451	-0.0585	-0.0227	-0.1830	0.0695	-0.0807	1.0000			
MSCI World	0.8167	0.6383	0.7016	0.3707	0.7993	0.4627	0.6065	0.8670	0.1259	0.6576	0.0590	0.1423	-0.0141	1.0000		
Emerging Market	0.6768	0.6884	0.8138	0.3703	0.6372	0.4810	0.5021	0.6516	0.0867	0.5375	0.0078	0.0918	-0.0626	0.7750	1.0000	
Frontier Market	0.6851	0.6489	0.6471	0.3904	0.7349	0.6125	0.4709	0.6468	-0.0140	0.5917	-0.0421	0.1266	-0.0233	0.6662	0.6317	1.0000

*Source: Author**

Table 2: Correlation coefficients of strategies and different indices

Looking at the correlation figures, our strategies have very low negative relation with the S&P500 index except Long/Short. A low positive relation with the commodities index at the exception of Managed Futures (-0.13) that traditionally deals with commodity future contracts. The US Agg Bond idex has surpisingly shown significant negative correlation with our strategies especially with Global Macro (-0.24) and Fixed Income Arbitrage that exploit this kind of trends.

In terms of markets, the MSCI World developed markets has very high correlation with all indices at the exception of Managed Futures figures above 0.7 in Event Driven (0.79) and Long/Short (0.86). MSCI Emerging Markets index has also high correlation notably with the Emerging Market strategy (0.81) Event Driven and Convertible Arbitrage(0.68). MSCI Frontier Markets is the same with figures above 0.6 mark in 5 different strategies.

This shows how diverse the Hedge Fund Portfolio is, and how creative investing explores markets and commodities beyond usual while keeping the risk lower. (see figure 3)

Mean-variance logarithmic scatter plot

$$y = 0.0002e^{181.03x}$$
$$R^2 = 0.76$$
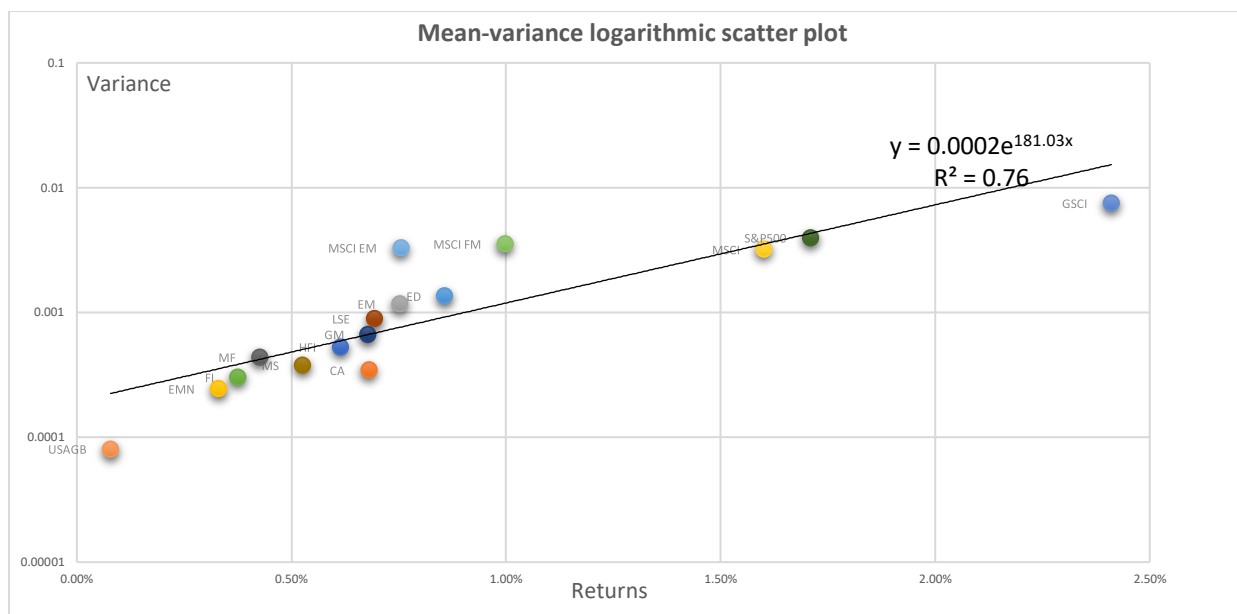
Source: Author*
Table 3: Mean-variance scatter plot of monthly returns by strategy

Hedge Funds are indeed able to provide satisfactory returns. Although lower than equity market indices these returns come at a much lower risk. As shown these funds mean-variance is situated at the edge of the theoretical efficient frontier dicussed in the theory chapter and the capital market line and can therefore provide very efficient investment opportunites a result we hope to confirm in later chapters.

4.2. Econometric Models Analysis

|	Sharpe Ratio		Beta	Jensen's Alpha	Treynor Ratio		Modified Sharpe	Sortino Ratio
Hedge Fund Index	0.0570		-0.1640	0.0026	-0.0047		0.0203	0.0754
Strategies:								
Convertible Arbitrabge	0.0448		-0.5057	0.0062	-0.0010		0.0155	0.0618
Emerging Markets	0.0789		-0.0458	0.0023	-0.0386		0.0322	0.1088
Equity Market Neutral	-0.1338		-0.2500	0.0011	0.0070		-0.0597	-0.1704
Event Driven	0.0572		-0.1477	0.0028	-0.0078		0.0155	0.0722
Fixed Income Arbitrage	0.0554		-0.6253	0.0076	-0.0008		0.0138	0.0663
Global Marco	0.0241		-0.1533	0.0021	-0.0024		0.0095	0.0340
Long/Short Equity	0.1182		0.0326	0.0019	0.0690		0.0440	0.1681
Managed Futures	-0.0516		-0.0436	-0.0009	0.0330		-0.0255	-0.0702
Multi-Strategy	0.1548		-0.2389	0.0044	-0.0073		0.0455	0.2183
Securities:								
S&P500	0.1630		0.9917	0.0001	0.0114		-0.1166	0.4193
GSCI	-0.0331		0.3619	-0.0062	-0.0059		-0.0146	-0.0439
US Agg Bond	-0.1582		0.5978	-0.0080	-0.0021		-0.0671	-0.1975
Markets:								
MSCI World	-0.0477		0.1062	-0.0030	-0.0171		-0.0203	0.4235
Emerging Market	0.0477		0.0113	0.0021	0.1994		0.0215	0.0685
Frontier Market	0.0869		-0.0739	0.0042	-0.0459		0.0281	0.1128

*Source: Author**

Table 4: Econometric models results

Over the period (2012-2022), the strategies scored satisfactory figures on all models highlighting the risk-reward relationship characterising their investment strategies. The Hedge Fund Index (HFI) has a Sharpe ratio of 0.057 with Multi-strategy performing as high as 0.1548 equivalent to the S&P500, Long/Short (0.1182) outperforms the rest of the indices while Managed Futures and Equity Market Neutral show negative figures (-0.13) equivalent to the Goldman Sachs Commodities Index and the US Aggregate Bond Index.

Management's forecasting ability, best illustrated by Jensen's Alpha, shows good results compared with the rest of the indices. The S&P500 index was used as a market proxy to build the Model so does not appear on the figure. Notable performances are Fixed income Arbitrage (0.0076) and Convertible Arbitrage (0.0062) while Managed Futures scored negative due to its hazardous nature. It is perhaps the only clear difference that Hedge Funds are able to make along with relatively low risk up to this point.
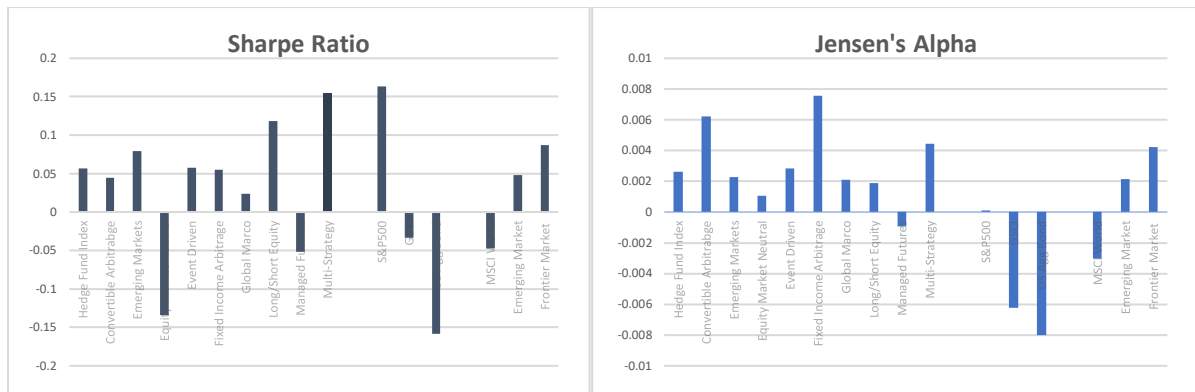
Source: Author*

Table 5: Classical models Sharpe (Left) and Jensen (Right)
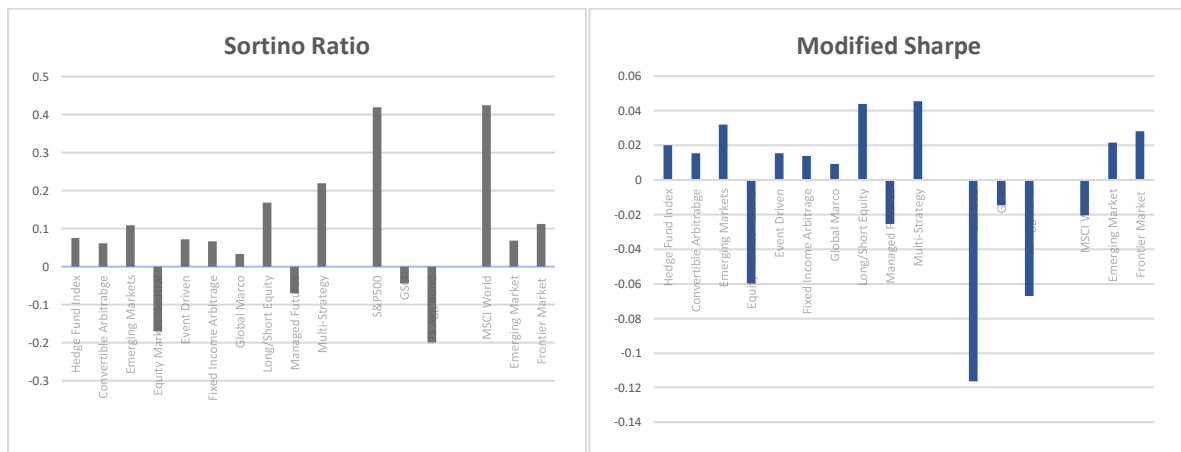
Source: Author*

Table 6: Risk-adjusted models Sortino (Left) and Modified Sharpe (Right)

The Sortino ratio, that penalises downside returns shows returns shaded by high S&P500 and MSCI World figures although Multi-Strategy (0.21) and Long/Short (0.16) are able to keep pace with the rest of the indices.

The Modified Sharpe shows an absolute contrast compared to the previous models as the overall index and four strategies have scored positive results while four of the benchmarks are in negative territory. The strategies show above market results that we hope to confirm in the next chapter.

Risk-adjsuted models presented a challenge building them but the results are much more fiable. These models will best fit the period analysis and therefore be discussed in the next part in more detail.

4.3. Period Analysis

Source: Author*

Table 7: Sharpe ratio (left) and Jensen's Alpha (right) in bull (2012-2020) and bear (2020-2022) market conditions

Fixed Income Arbitrage scored respectively the second-lowest Sharpe ratio and highest Jensen's Alpha during the crisis. Showing management's special forecasting ability but its inefficiency to translate it into returns. Fixed income strategy is highly dependent on central bank's policies and interest rates. As the US aggregate Bond index sunk this strategy followed. While Convertible Arbitrage on the other hand did extremely well due to the nature of the derivative in question, that permits the optional change from debt to equity securities.
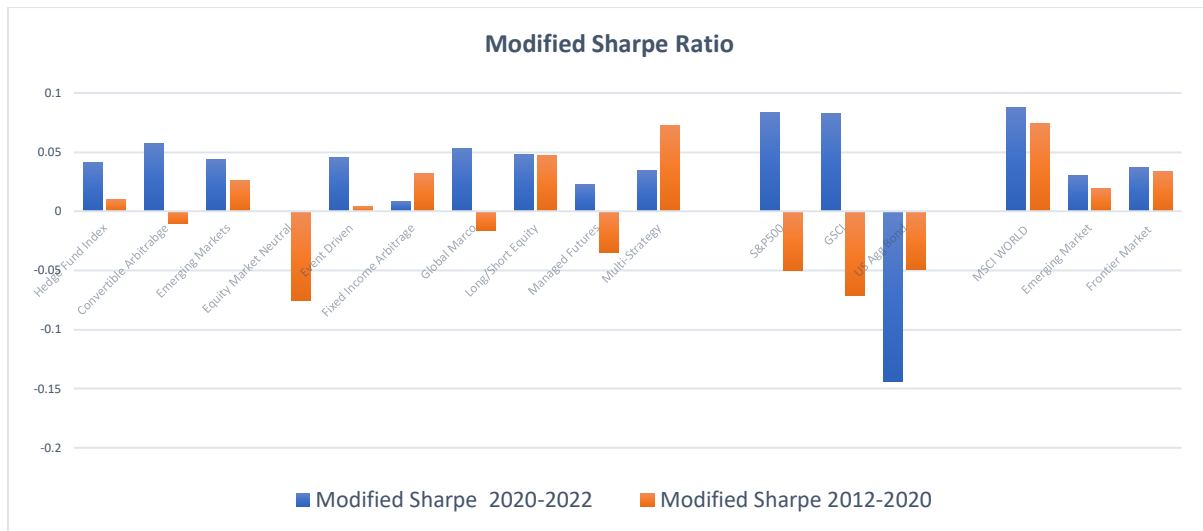
Modified Sharpe Ratio

Table 8: Modified Sharpe in bull (2012-2020) and bear (2020-2022) market conditions

The Modified Sharpe will certainly yield a decisive picture on the funds performances. During the Covid crisis, while the S&P500 again has a higher figure than the rest, Covertible Arbitrage (0.057) and Global Macro (0.052) lead the table along with Long/short. While the Commodities index has toppled all others. The triumphant figures are due to their extensive use of derivatives contracts to hedge systematic risk and relaxed borrowing regulation during the pandemic embodied in the US aggregate Bond index scoring the lowest figure (-0.014). During the bull market period, Multi-strategy and Long/short are again the favourites over market indices while Equity Maket Neutral (-0.075) and Managed Futures (-0.034) had large losses trying to hedge against the market. Market indices had lower results than most of the strategies confirming a higher outcome for hedge funds using this metric.

Sortino Ratio

Legend: ■ Sortino Ratio 2020-2022 ■ Sortino Ratio 2012-2020

Table 9: Sortino ratio in bull (2012-2020) and bear (2020-2022) market conditions

The Sortino ratio only penalises downside returns and is relevant during periods financial distress like the Covid crisis. The overall index scored higher than the rest of the strategies a results that can be attributed to any bias present or the size of large funds overrepresented and capable of mitigating their losses much better than the rest.

During the pandemic, Equity Market Neutral (-0.39) is the biggest loser according to the Downside return method along with managed futures due to their unpredictable nature and use of short selling. These strategies do take the hit when markets do not dip very low or when they recover swiftly.

Overall Multi-Strategy and Long/short are the best performing strategies both in bull and bear market conditions as they are versatile enough to make the most of any condition while also standing out to the dominant S&P500 and MSCI World indices. Other strategies seems to lack diversity of investment options and consistency in maintaing gains when conditions are unfavourable.

4.4. Regression Analysis

4.4.1. Regression overview

In an attempt to understand how hedge funds structure their investments a regression analysis is conducted first on the Hedge Fund Index then on each individual strategy. Input variables have been chosen so as to provide a varied coverage of securities (Equity, Commodities and Bonds) and markets (Developed, Emerging and Frontier) this would enable us to build an approximation model to approach the Hedge Fund Index.

Regression Statistics								
Multiple R	0.850537608							
R Square	0.723414222							
Adjusted R Square	0.708728252							
Standard Error	0.007289318							
Observations	120							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	6	0.015703969	0.002617328	49.25886387	2.59256E-29			
Residual	113	0.006004159	5.31342E-05					
Total	119	0.021708128						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.001617359	0.000730826	2.213055758	0.028903391	0.000169461	0.003065258	0.000169461	0.003065258
S&P500	-0.007925024	0.010423438	-0.760308119	0.448653905	-0.028575735	0.012725686	-0.028575735	0.012725686
GSCI	-0.006585411	0.011184949	-0.588774342	0.557187772	-0.028744812	0.01557399	-0.028744812	0.01557399
US Agg Bond	-0.218789331	0.084772669	-2.580894696	0.011134988	-0.386739278	-0.050839385	-0.386739278	-0.050839385
MSCI WORLD	0.229052555	0.029993057	7.636852658	7.76164E-12	0.1696309	0.28847421	0.1696309	0.28847421
Emerging Market	0.005031291	0.023176715	0.217083868	0.82853445	-0.040885961	0.050948543	-0.040885961	0.050948543
Frontier Market	0.083768096	0.023859108	3.510948311	0.000642569	0.036498899	0.131037293	0.036498899	0.131037293

Source: Author*

Table 10: Regression Analysis of the Hedge Fund Index and different variable

The regression analysis (Table 11) has an R-square of 0.72, where input variables explain 72% of the fluctuations in the HFI. Althought most of it comes from MSCI World (0.66). Only four of the input variables are statistically significant at a 5% level (p-value<0.05) and three at a 1% level (p-value<0.01). The Commodities index and S&P do not seems to bear any signficant relation with the Index, while the US Aggregate Bond and both MSCI developed (World) and emerging markets are highly relevant and will be used to built our approximation model. The intercept is relevant at 5% confidence level but not at 1%.

4.4.2. Regression of different strategies

	Regression Statistics									
	Hedge Fund Index	Convertible Arbitrabge	Emerging Markets	Equity Market Neutral	Event Driven	Fixed Income Arbitrage	Global Marco	Long/Short Equity	Managed Futures	Multi-Strategy
Multiple R	0.850537608	0.757590318	0.835499653	0.482378684	0.856341405	0.638573751	0.658163832	0.878586373	0.237554337	0.711711652
R Square	0.723414222	0.57394309	0.69805967	0.232689194	0.733320603	0.407776435	0.43317963	0.771914014	0.056432063	0.506533475
Adjusted R Square	0.708728252	0.551320599	0.68202744	0.191947028	0.719160635	0.376330936	0.403082973	0.759803254	0.005331111	0.480331713
Standard Error	0.007289318	0.007869933	0.012663428	0.011801266	0.010694286	0.007150325	0.011785146	0.009330722	0.027806234	0.008151675
Observations	120	120	120	120	120	120	120	120	120	120

Source: Author*

Table 11: Regression Statistics of different Strategies

Following the same pettern, we conduct the regression analysis on each strategy with the input variables. although half of the strategies can be explained at least to 50% by the input (R-sq>0.5) only two strategies, Event Driven (0.73) and Long/Short (0.77) can be explained above 70% followed by Emerging markets (0.68). Multi-strategy seems to fail the adjusted-R along with Global Macro, while Managed Future has the lowest (0.05).

	P-value									
	Hedge Fund Index	Convertible Arbitrabge	Emerging Markets	Equity Market Neutral	Event Driven	Fixed Income Arbitrage	Global Marco	Long/Short Equity	Managed Futures	Multi-Strategy
Intercept	0.028903391	0.000838106	0.107360403	0.34661085	0.477767924	2.07807E-05	0.066508476	0.273513933	0.741016611	2.74093E-05
S&P500	0.448653905	0.325671812	0.955350274	0.960606872	0.11741689	0.597643596	0.572521592	0.924860501	0.864697059	0.586094078
GSCI	0.557187772	0.597095243	0.286000102	0.368236151	0.157329323	0.60796024	0.959237623	0.118750326	0.113874809	0.790504507
US Agg Bond	0.011134988	0.086079098	0.977802137	0.010489057	0.055712158	0.112221207	0.001611772	0.225620346	0.695468989	0.012072161
MSCI WORLD	7.76164E-12	0.162575722	0.261703464	0.323499184	3.35532E-11	0.861302467	3.30481E-05	5.40599E-20	0.112746948	1.88902E-05
Emerging Market	0.82853445	0.000336259	4.93639E-11	0.425746802	0.338182153	0.248707927	0.893215638	0.157029671	0.941631848	0.738301823
Frontier Market	0.000642569	0.000372085	0.006740107	0.044194394	5.21071E-07	1.60351E-06	0.290268191	0.019510329	0.191342379	0.003531846

Source: Author*

Table 12: P-value statistic of different strategies

On the relevance of input data to each strategy. P-values showing statistical significance are highlighted in (Table 13) yellow, orange and brown for 1%, 5% and 10% conficence levels respectfully. The most significant input is the Frontier Markets MSCI and Developed MSCI showing a risk-taking tendency and appetit for segmented or illiquid markets while also balancing the risk out with invetments in developed markets. Surprisignly enough the US Aggregate Bond Market does show significance although at higher confidence levels (5% and 10%) mainly due to the highly leveraged investment strategies and their reliance on borrowing, another reason could be the funds involvement in debt markets investing althought Fixed Income Arbitrage fails the significance threshold by a slight margin (0.11).

Both S&P500 and GSCI are statistically insignificant which shows how uncorrelated the investment strategies are to these markets and therefore their exposure limited to market crashes.

	Coefficients									
	Hedge Fund Index	Convertible Arbitrabge	Emerging Markets	Equity Market Neutral	Event Driven	Fixed Income Arbitrage	Global Marco	Long/Short Equity	Managed Futures	Multi-Strategy
Intercept	0.001617359	0.002707932	0.002060709	0.001118268	0.000763698	0.003185327	0.002189324	0.001029384	0.00092367	0.003573922
S&P500	-0.007925024	-0.01110923	0.00101612	-0.000835358	-0.024127704	-0.005411808	-0.009538262	-0.00126119	0.006790783	-0.00636531
GSCI	-0.006585411	-0.006401196	-0.020830365	-0.016358941	0.023360092	-0.005644093	-0.000926305	-0.02250662	-0.067983084	-0.003330747
US Agg Bond	-0.218789331	-0.15848212	0.004106851	-0.357209107	-0.240436277	-0.133113524	-0.44295213	-0.132209933	-0.126908151	-0.24185731
MSCI WORLD	0.229052555	0.045517443	0.05877593	0.048151507	0.323392071	0.005152092	0.209726381	0.429250173	0.182877798	0.149840131
Emerging Market	0.005031291	0.092550618	0.292832852	0.029994891	-0.032705517	0.026360347	0.005041369	-0.042264161	0.006487792	-0.008680819
Frontier Market	0.083768096	0.094530815	0.114412493	0.078605617	0.186372688	0.118544179	0.040986105	0.07236527	-0.119637563	0.079506059

Source: Author*

Table 13: Regression Coefficients of different strategies

Now that statistically significant variables are uncoved the regression analysis is able to generate the following models in Table 14 (highlighted only) which can best approximate how each strategy behaves and eventually predict its returns.

The most complete model is the overall Hedge Fund Index and has therefore been chosen for the next section's model construction.

4.4.3. Regression Model

4.4.3.1. At 5% p-value

Following the regression analysis results a model that approximates the Hedge Fund Index is constructed. This model is based on a linear regression model and has an R-square of 0.72.
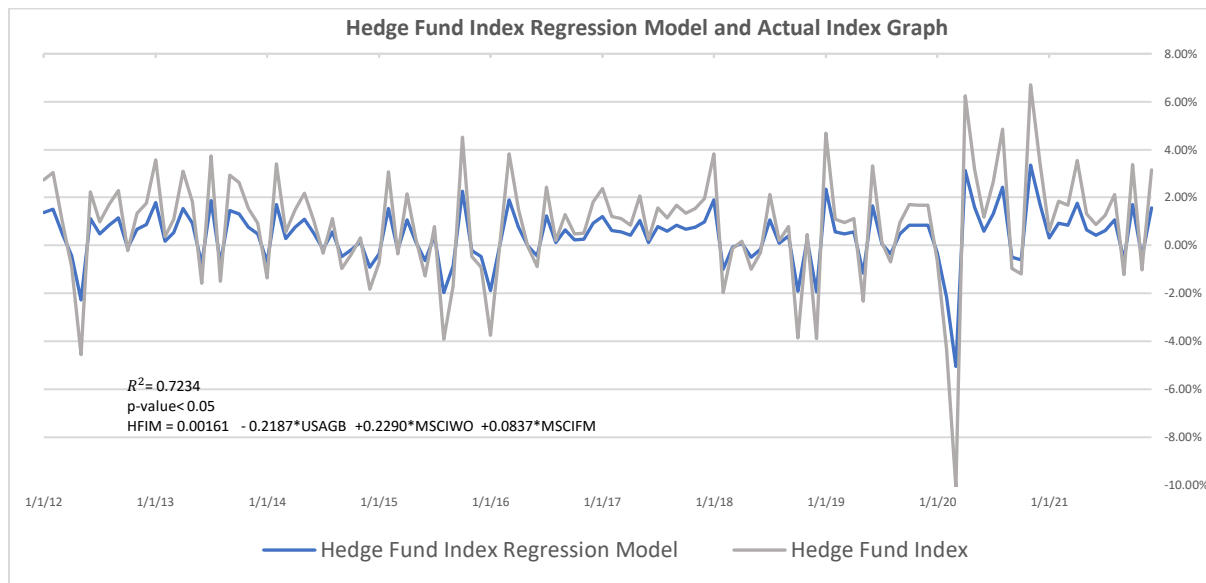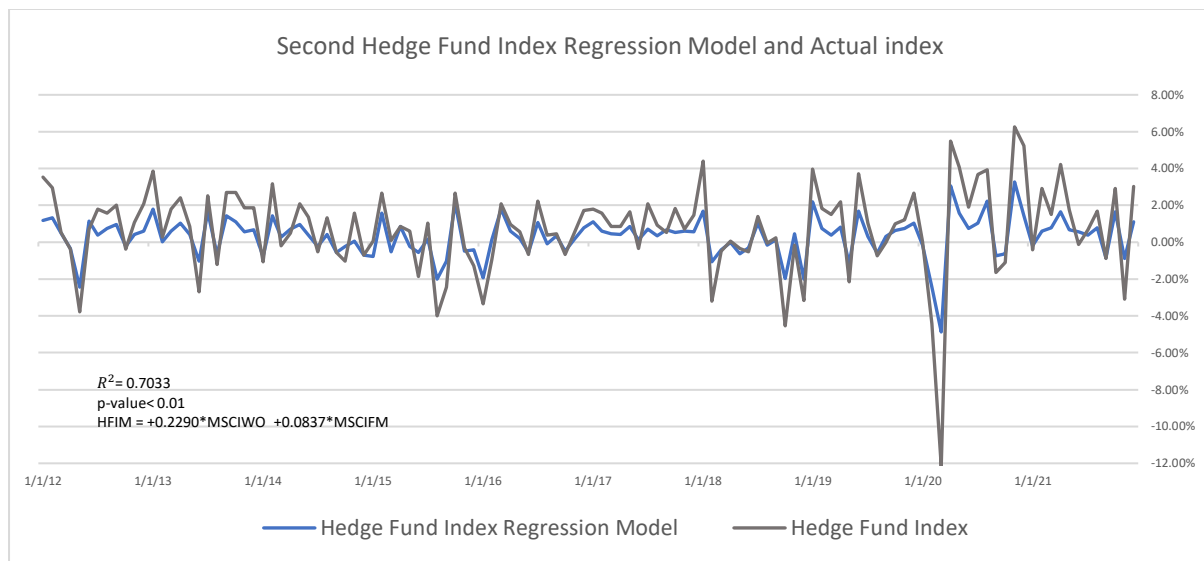

Source: Author*

Table 14: Hedge Fund Index Regression model at 5% P-value with Actual Index graph

The model is made up of a debt part (USAGGB) and an equity part, split into developed (MSCIWO) and frontier markets (MSCIFM) a constant intercept at 5% p-value.

It is is designed to account for gearing and leverage practices (Bond) while also containing both elements of risk-seeking (Frontier) and risk-aversion (Developed) in equity markets.

4.4.2.1. At 1% p-value

Second Hedge Fund Index Regression Model and Actual index

$R^2 = 0.7033$
p-value < 0.01
HFIM = +0.2290*MSCIWO +0.0837*MSCIFM

Hedge Fund Index Regression Model   Hedge Fund Index

Source: Author*

Table 15: Hedge Fund Index Regression model at 1% P-value with Actual Index graph

A much more precise model, statistically speaking, at 1% p-value only contains MSCI world and Frontier markets, with no intercept and no debt element. This model is more simple to build and requires less input data while not covering different aspects of hedge funds like borrowing.

5. Conclusion

Concluding the analysis, the study has been successful in uncovering how each hedge fund strategy behaves and performs compared to various securities and markets. The study has been successful in proving that hedge funds do provide relatively lower risk but has failed to prove that hedge funds provide higher returns clearly outshined by the S&P500 index and on occasions by the MSCI World.

The risk-reward trade-off edge held by hege funds over the market, which constitutes the null hypothesis of this study, therefore cannot be proven by the classical models, even though satifying Sharpe ratios only shadowed by the S&P market proxy and outstanding Jensen's Alphas during the Covid crisis period with consistent strategies like Long/Short and Multi-strategy.

The risk-adjusted models, on which this conclusion will be based, confirm the S&P's superior risk-reward trade-off without undermining that of dominant hedge fund strategies (Long/short and Multi-strategy) highlighted by the Sortino model and the Modifed Sharpe. The null hypothesis is therefore rejected vis-a-vis the S&P500 but acceptable with slight variations for all other market indices.

The regression analysis, has proven highly useful in uncovering hedge funds investment portfolios best illustrated by the constructed approximation model. It also displays each strategy's relation to different securites and markets which helps understand each individual strategy's investment schedule. With variations, most strategies bear a relation to developed and frontier equity markets in common along with the US bond market, while having almost no relation to the S&P500 and commodities trading.

The approximation model shows hedge funds high gearing and leverage practices personified in a debt input while also contains both elements of risk-seeking (frontier markets) and risk-aversion (developed markets) in an equity input.

6. Recommendations

The model used to simulate the market proxy is based on the CAPM model and can be upgraded to account for more variables using Arbitrage pricing models. Fama and French three factor model and Carhart's four factor model can provide better market approximations. Also, the regression analysis relies on linear interpolation methods, a much more elaborated method would be to use the complex method or to allow for exponential variables. Dummy variables can also be implemented to improve accuracy.

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Appendices

Appendix 1: Statistical Properties of Hedge Funds:

1.1. Return

Returns represent the fraction of incremental change in value of a fund divided by its previous value:

$$R = \frac{(V_n - V_{n-1})}{V_n}$$

1.2. The n-th Central moment

$$\mu_n = E((r - E(r))^n)$$

1.3. Mean

The Mean is simply:

$$\mu = E(r) = \bar{r}$$

The expected return or the expected value of the R variable, it is simply the average of all values.

The first Central Moment about the mean of a Distribution:

$$\mu_1 = E((r - E(r)))$$

$$= \frac{1}{N}\sum_{n=1}^{N}(r_n - \bar{r})$$

1.4. Variance

The

The second Central Moment about the mean of a Distribution:

The Variance:

$$\mu_2 = E(\,(r - E(r))^2\,)$$

$$= \frac{1}{N} \sum_{n=1}^{N} (r_n - \bar{r})^2 = \bar{\sigma}^2$$

Standard Deviation:

$$\bar{\sigma} = \sqrt{\mu_2}$$

$$\bar{\sigma} = \sqrt{\frac{1}{N} \sum_{n=1}^{N} (r_n - \bar{r})^2}$$

The variance represents the squared deviation from the mean (i.e how large it is)

The Standard deviation is the average deviation from the mean

It is a very useful tool to quantify risk and volatility as we shall see in the future.

In a normal distribution, 66% of values are within 1 SD from the mean and 96% of values are within 2SD from the mean.

1.5. Skewness

The third Central Moment about the mean of a Distribution:

$$\mu_3 = E(\,(r - E(r))^3\,)$$

Skewness:

$$S = \bar{\mu}_3 = \frac{\mu_3}{\sigma^3}$$

$$\bar{\mu}_3 = \frac{E(\,(r - E(r))^3\,)}{\sigma^3}$$

$$= \frac{1}{N} \sum_{n=1}^{N} \frac{(r_n - \bar{r})^3}{\bar{\sigma}^3}$$

The Skewness is the cubed deviation from the mean. It measures the symmetry of a distribution

If positive, the distribution has longer positive tails i.e. smaller losses and bigger gains. And if negative, it has longer negative tails i.e. bigger losses and smaller gains.

1.6. Excess Kurtosis

The fourth Central Moment about the mean of a Distribution:

$$\mu_4 = E(\ (r - E(r))^4\ )$$

Kurtosis:

$$K = \ \bar{\mu}_4\ =\ \frac{\mu_4}{\sigma^4}$$

$$\bar{\mu}_4 = \ \frac{E(\ (r - E(r))^4\ )}{\sigma^4}$$

$$= \frac{1}{N}\ \sum_{n=1}^{N} \frac{(r_n - \bar{r})^4}{\bar{\bar{\sigma}}^4} = \ \bar{\mu}_4$$

Excess Kurtosis:

$$Ek = K - 3\ =\ \bar{\mu}_4 - 3$$

Because normal distribution has a Kurtosis of 3 its is used to centre it around zero.

Excess Kurtosis measures the degree of peakiness. It characterises the tails of the distribution i.e. the probability of extreme values.

If positive, the distribution has "fat" tails and peakiness i.e. more values are expected around the mean but has higher probability of extreme values than normal distribution.

If negative, the peak is softer and tails have "shoulders" i.e. lower probability of extreme values and less expected values around the mean than normal distribution.

Appendix 2: Treynor ratio

2.4.3. Treynor Ratio

In major events, systematic cannot be diversified away and is to an extent imposed on all market participants. This ratio although similar to the Sharpe ratio, focuses only on systematic risk. Introduced by Jack Treynor (1965), it is a performance measure with the market proxy as a benchmark.

$$T = \frac{\bar{r} - r_f}{\beta} \quad \text{(v)}$$

$\bar{r}$: Actual return in the period,

r_f : Risk-free rate,
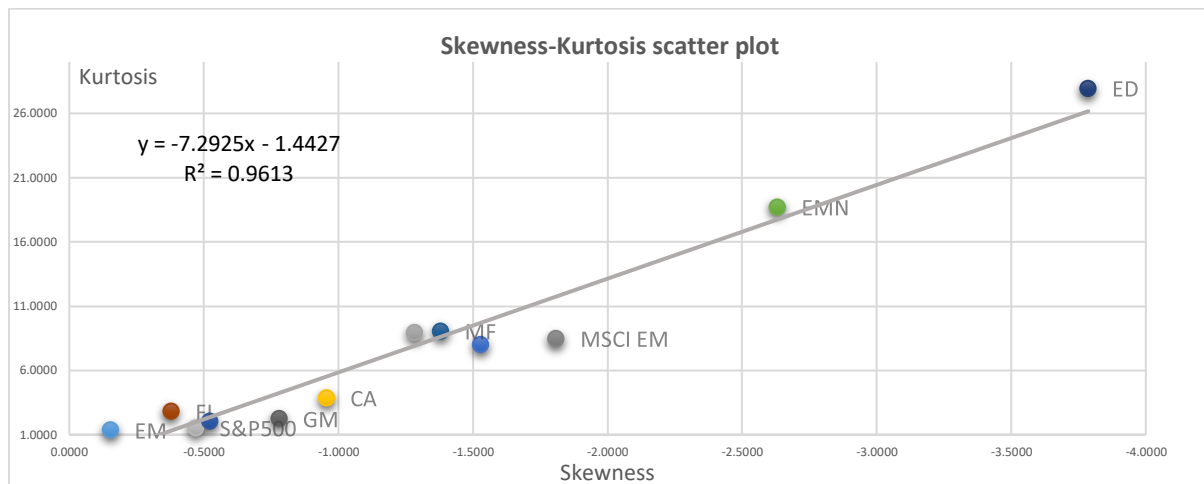
β : Market volatility

Appendix 3: Treynor ratio and Beta of multiple strategies

Table 16: Treynor ratio and market Beta in bull (2012-2020) and bear (2020-2022) market conditions

Appendix 4: Skewness-Kurtosis scatter plot of monthly

Source: Author*

Table 17: Skewness-Kurtosis scatter plot of monthly returns by strategy

A negative skewness means longer negative tails and therefore bigger losses and smaller gains although it is a common characteristic among all the data (except S&P500) while high positive kurtosis figures, signify "fat" tails and peakiness so more values are expected around the mean but a higher probability of extreme values than a normal distribution (K=3).

Appendix 5: Ethics approval

Certificate of Ethical Approval

Applicant: Omar Achour

Project Title: Hedge fund Research

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Low Risk

Date of approval: 14 Feb 2022

Project Reference Number: P132411