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Analysis of Hedge Funds Indices' Jensen's Alphas



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by

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I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College as a whole.



Reece Smith

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Table of Contents

Acknowledgements iii
List of Tables v
List of Figures vi
Abstract vii
Chapter 1: Introduction 1
Chapter 2: Literature Review 3
Section I: Early Frameworks 3
Section II: Capital Asset Pricing Model 6
Section III: Empirical Use of CAPM and Jensen's Alpha 10
Section IV: Fama-French Three-Factor Model 13
Section V: Carhart Four-Factor Model and Mutual Fund Returns 15
Section VI: Fama-French Five-Factor Model 16
Chapter 3: Data 18
Section I: Collection 18
Section II: Understanding the Data 19
Section III: Descriptive Characteristics 20
Chapter 4: Analysis 24
Section I: Sharpe Ratios 24
Section II: Regressions 26
Section III: Index Analysis 29
Subsection A: BHSTCR 30
Subsection B: BHMARB 31
Subsection C: BHCBA 32
Subsection D: BHFEMN 32
Subsection E: BHVOLA 33
Subsection F: BHINS 34
Section IV: Themes 34
Chapter 5: Conclusion 35
Appendix 37
Bibliography 39
About the Author 41

List of Tables

Table 3.1 23
Table 4.1. 25
Table 4.2 28
Table 4.3 29

List of Figures

Figure 2.1. 4
Figure 2.2 8
Figure 2.3 12
Figure 3.1 23
Figure 4.1 30

Abstract

One of the main questions in the investment management industry is whether it is possible for investment funds to earn excess returns (returns greater than expected for the level of risk assumed). Most analyses done to determine the existence of excess returns are done using mutual fund data, due to its accessibility. Hedge funds are often ignored, to the detriment of the literature, since there are important differences between them that may result in different findings for each fund type. In this analysis I will use three asset-pricing factor models to generate Jensen's Alphas, a measure of excess returns, using data from Bloomberg's hedge fund indices as proxies for hedge funds. I identified six indices with significant positive Jensen's alphas, providing evidence for the ability of some hedge funds to generate excess returns. These results challenge the efficient markets hypothesis and has implications for investment fund regulation.

Chapter 1: Introduction

One of the main questions looming over the investment management industry is whether or not it is possible to outperform the overall return of the market. While financial professionals come down on either side of the argument, academic literature is continually evolving and debating the outcome of statistical analysis of this question (Ying). While the main body of literature currently asserts that money managers are not able to systematically outperform the market, such analyses were performed based on returns of mutual funds. This paper will attempt to determine whether these findings hold true for hedge funds, specifically, whether a regression on hedge fund returns using the Carhart four-factor model has a significant positive Jensen's Alpha, one measure of outperformance.

This analysis on hedge funds is materially different from those performed on mutual funds due to the distinct differences between these funds, which largely results from different regulatory treatment. Hedge funds have the ability to engage in investment activity which mutual funds are prohibited from; such as purchases of options, use of leverage, short selling, and investment actions around particular events, like IPOs (Investopedia). As well, hedge fund managers do not have to worry about mass withdrawals disrupting their investment strategies due to lock up periods which empower the manager to prevent withdrawals. Furthermore, investments in hedge funds are restricted to accredited investors, which in most cases means individuals with a one-million-dollar net worth or yearly income above $300,000 (*Accredited*). Investments in mutual funds do not have this legal requirement, meaning many more individuals can invest in them rather than hedge funds (Investopedia). Such differences may result in hedge funds outperforming mutual funds, which perform in line with the overall market, and therefore could mean that hedge funds can systematically outperform the market.

Due to data limitations, I was unable to directly analyze the returns of hedge funds. Instead, I used hedge fund indices, which are composites of multiple funds, broken down by the investment strategy employed. One of the drawbacks of this is the averaging effects experienced by indices, which makes their return characteristics dissimilar to mutual funds', and makes our default expectation of results to not

be a significant positive alpha. From our analysis, I identified six indices with significant positive Jensen's alphas, which shows evidence of hedge funds having the capability to earn excess returns.

These findings have multiple implications. Firstly, it would imply that the identified strategies employed by hedge funds outperform the market, which would contradict the Efficient Market Hypothesis. According to Burton Malkiel, in his 2003 paper, *The Efficient Market Hypothesis and Its Critics*, the market is inefficient whenever someone can consistently earn excess returns beyond their level of risk. A positive Jensen's alpha means that the returns of the fund are beyond what our model, the Carhart four-factor model, would predict based on our levels of risk. As well, since the period of our data covers ten years, it also means that that overperformance would be consistent, and therefore be an inefficiency. However, we must also consider that our amount of expected return based on risk level is dependent on the model we use to analyze returns. If a model does not accurately capture the risk associated with the investment it may not accurately compute the level of excess returns. To continue, if, after such findings are revealed, more investors employ those strategies, therefore changing relative prices in the market so that they no longer overperform, that would provide evidence for the Efficient Market Hypothesis, which asserts that this is the behavior one expects when there is a discovery of outperformance. Since one could no longer use the strategies to outperform the market, then there are no longer any exploitable patterns that enable investors to earn returns beyond what their risk level would allow for.

Secondly, our findings prompt the consideration of whether the prohibition of other funds from using these strategies prevents enough investment activity to alter relative prices in the market in a way that eliminates their overperformance. This would mean that it is the Securities and Exchange Commission (SEC) regulation which creates exploitable patterns that enable hedge funds to outperform the market. Furthermore, since investments in hedge funds are essentially limited to the wealthy, that would mean that it is SEC policy to restrict market participation to allow the wealthy to earn returns that their level of risk would not otherwise be able to. This would mean that the SEC is intervening in the market in order to make exploitable patterns for the rich to earn returns above what their risk levels would

permit. If this is the case, then the SEC may decide to repeal their regulations on hedge funds in some way that eliminates the exploitable pattern, and thus no longer enable only the wealthy to outperform the market. These implications make it a worthwhile endeavor to ascertain whether hedge funds have the ability to outperform the market.

In total, this paper will utilize the Carhart Four-Factor model to determine if hedge funds have significant Jensen's alphas, and thus whether their managers can outperform the market. The Carhart four-factor model will be used due to its greater empirical explanatory power over other models. Hedge funds will be analyzed instead of mutual funds due to their ability to use different investment strategies, protection against unplanned withdrawals, and since there is less literature conducting such an analysis. Due the difficulty of obtaining data for hedge funds, I will employ Bloomberg's hedge fund indices as proxies for particular investment strategies. The identification of six indices in my analysis with Jensen's alphas provides evidence for market inefficiency and has implications for the current regulatory regime associated with hedge funds.

Chapter 2: Literature Review

Section I: Early Frameworks

Harry Markowitz's 1952 paper *Portfolio Selection* attempts to explain the investment decision process that investors undergo. He begins by refuting the idea that investors are simply investing in the securities with the highest return; this would imply people keep all their money in one asset, which is disproved by observation of diversification of investments. Furthermore, it is not the case that people simply invest in securities with the highest returns and allow for the law of large numbers to reduce the risk; the highly correlated nature of securities means the law of large numbers does not apply. Instead, Markowitz explains that theories of decision making must correspond with what we observe, particularly the phenomenon of diversification.

Markowitz proposes the expected return-variance rule, which states investors want high returns and low variance in their investments. This means that for a given return investors attempt to minimize variance, and for a given variance they attempt to maximize return. This establishes a return-risk trade

off, where some portfolios are expected return-variance efficient. If you plot the expected returns and variances of all securities and possible combinations of securities on a graph with expected return on the x-axis and variance on the y-axis, it graphs a round blob that is the investment opportunity set, all possible investments you could make. The bottom left boundary of the investment opportunity set is the expected return-variance efficient frontier, meaning that for these portfolios, for their given variance they have the highest expected return, and for their given expected return they have the lowest variance. The portfolios on the efficient frontier are the ones which satisfy the expected return-variance rule, and thus the ones investors should invest in.

Investment Opportunity Set

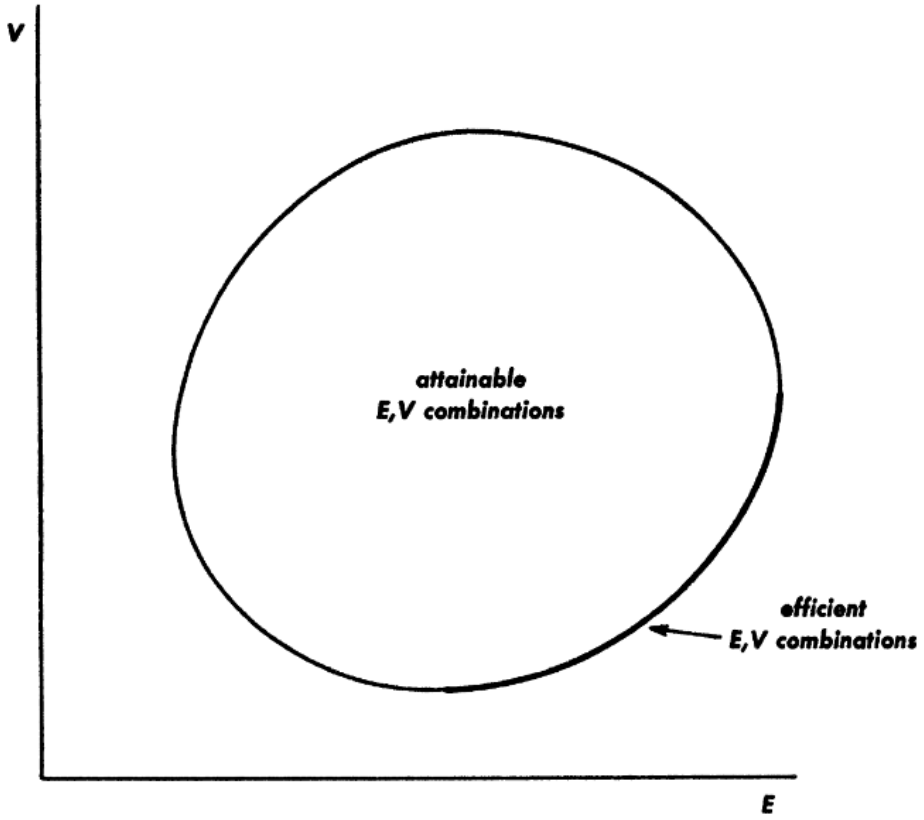

Figure 2.1 Investment opportunity set with efficient frontier. From Markowitz 1952.

The curve of the efficient frontier demonstrates the tradeoff between risk and return. If one wishes to have a higher expected return, they must take on more variance, and if they wish to have less variance, they must take on a lower expected return. Markowitz explains that where investors fall on the

efficient frontier is based on their own risk tolerance and preferences. Markowitz also states that where the efficient frontier is located on the graph and what securities comprise it are empirical questions, and must be determined via statistical analysis. Overall, Markowitz makes a significant contribution to the literature on which this research is based by articulating the expected return-variance rule and using it to deduce the investment efficient frontier.

James Tobin then expands upon Markowitz's investment opportunity set and efficient frontier in his 1958 paper *Liquidity Preference as Behavior Towards Risk.* Tobin begins his analysis by asking the question, 'why do people hold cash?' Since a Federal Reserve note is an obligation of the federal government just like a Treasury bond, why would anyone ever hold the non-interest-bearing version? Of course, such a decision to hold cash is derived from the need for liquidity. In no case does an individual's cash receipts align with their cash disbursements so perfectly that they are able to never carry a balance of cash. Therefore, individuals will hold cash for the purpose of fulfilling anticipated expenditures. Cash held for this purpose is called a transaction balance. Cash which is not held in the transaction balance is thus not expected to be drawn down on in the normal course of one's life activities. This cash is held in what is called an investment balance.

Tobin narrows the scope of his analysis to how individuals proportion their investment balance between cash and monetary securities, which he describes as "marketable, fixed in money value, free of default risk." One factor in this decision is the inelasticity of interest rate expectations. Essentially, individuals have expectations of return from holding either cash or marketable securities, and since investors are certain about their expectations of return, they will choose whichever they expect will have the highest return. This is not the whole picture though, as it implies people keep their entire investment balance in one asset or the other, which does not align with reality. Tobin explains that another factor is uncertainty about future interest rates. Now, uncertainty about those expected returns has been added to the model, since the interest rate may change, it could alter the capital gain from holding onto that monetary security, and thus its overall return. Individuals are now faced with the decision of how much of their investment balance to invest in cash, and how much into monetary assets.

Since monetary securities generally have a positive expected return and have variation, while cash has an expected return of zero and zero variation, individuals face an expected return-variance trade off; the greater proportion of their balance held in monetary securities the greater expected return and variation they have. Tobin then analyzes how an individual's asset allocation will change as the interest rate changes. To illustrate, consider the raising of the interest rate. Individuals will undergo a substitution effect, where the greater interest rate will induce them to take on more risk. At the same time, there will be an income effect, the higher yield means they can shift more of their balance to cash while still earning the same return as before. Tobin explains, this means whether a change in interest rates results in a higher or lower demand for cash is unclear, and will be determined by the shape of the indifference curves of individuals. Overall, Tobin describes his analysis as a theory of liquidity preference described by risk aversion, which alters an individual's indifference curve; but it is most used as a stepping stone to the Capital Asset Pricing Model.

Section II: Capital Asset Pricing Model

William Sharpe, in his 1964 paper, *Capital Asset Prices - A Theory of Market Equilibrium under Conditions of Risk*, lays out his Capital Asset Pricing Model, which describes an equity's expected return in equilibrium. He begins his paper by explaining that there is not a significant body of work regarding the microeconomic conditions of risk and how investors can achieve portfolio investments along the capital allocation line. Sharpe builds upon Markowitz's and Tobin's work by explaining that Tobin's analysis of how investors allocate their investment balances between cash and monetary assets can be applied to an allocation between a risky portfolio and a risk-free asset through the separation theorem. The separation theorem explains that investors make their investment decision by first deciding on a preferred risky portfolio (r), that is on the expected return-variance efficient frontier described by Markowitz. Secondly, investors decide on how much of their investment balance should be invested in that risky portfolio and how much in a risk-free asset (f), analogous to the decisions investors face in deciding how much to invest in monetary assets and cash in Tobin's liquidity preference theory.

Now, an investor's portfolio can be considered an investment of some proportion (ɣ) in the risky portfolio (which is or between 0 and 1), and some proportion (1-ɣ) of the risk-free asset. The return on this portfolio is a weighted average of the returns of the risky portfolio and the risk-free asset with their weights being their proportion of the overall portfolio.

$$E(R_p) = \gamma(E(R_r)) + (1-\gamma)R_f$$

(1)

Since the risk-free asset has no variation its correlation with the risky portfolio must be 0. Therefore, the standard deviation of the portfolio is the proportion of the standard deviation of the risky asset, such that it is the same proportion of how much of the portfolio is invested in the risky asset.

$$\sigma_p = \gamma\sigma_r$$

(2)

Now, along with the assumption that the investor can borrow at the risk-free rate for the purpose of investing in the risky portfolio, the investment opportunity set is expanded and a new frontier must be identified. Sharpe explains that there is a particular optimal portfolio on the efficient frontier such that when investors invest in some proportion of it and the risk-free asset, they generate a new efficient frontier for their investments. It is the portfolio in the original efficient frontier, that when a line is drawn connecting it and the risk-free asset, the line is tangent to the investment opportunity set. To move along this frontier, instead of selecting a different portfolio, they alter the proportion of their investment in the optimal portfolio and in the risk-free asset. This includes being able to invest a negative proportion in the risk-free asset, thus borrowing at the risk-free rate for the purpose of investing in the optimal risky portfolio, which expands the theoretical frontier infinitely (of course there are limits on how much could be borrowed and how much could even be bought).

Investment Opportunity Set with New Efficient Frontier

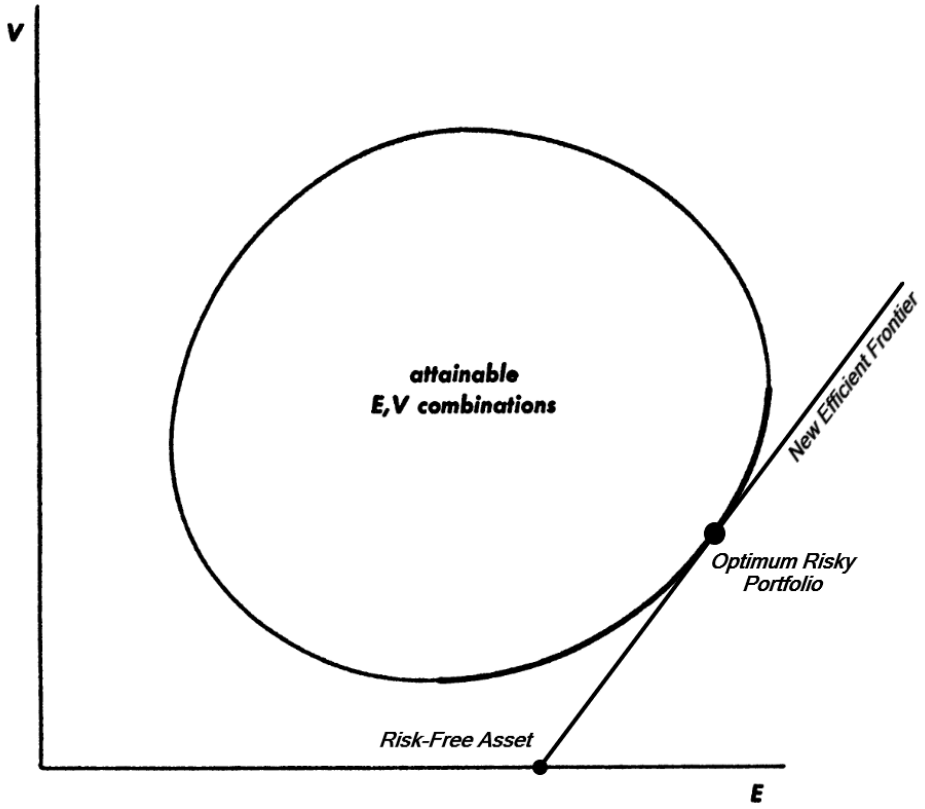

Figure 2.2 Investment opportunity set with new efficient frontier. Edited From Markowitz 1952

Sharpe continues to explain that all investors would be able to determine the optimal risky portfolio, which would cause greater investment in it, raising its price, and thus lowering its expected return. Such a change would have the effect of "pushing in" the efficient frontier (making it more linear), and this process would repeat until the efficient frontier of the investment opportunity set has become linear, with the use of the risk-free asset extending that line beyond the investment opportunity set. Now, there are multiple different portfolios along the efficient frontier, and presumably every asset is included in at least one of them due to the importance of diversification.

From there, a particular assets' returns (R_i) and variance correlate (β_i) with a portfolio on the efficient frontier that contains it, enabling a mathematical construction of the relationship between expected return of the asset (i), and the expected return of a portfolio along the efficient frontier. The

portfolio on the efficient frontier selected to construct the CAPM is the market portfolio (m), which contains all assets in proportion to their overall market values. Of course, such a selection only works if the market portfolio is along the efficient frontier, which is important to note. Regardless, Sharpe is able to create a model which relates the return of a particular asset to the market portfolio.

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$

(3)

This is an equilibrium model, which asserts that the expected returns of equities (R_i) are a function of the risk-free return (R_f) plus firm specific sensitivity (β_i) multiplied by the expected market return (R_m) minus the risk-free rate. Under this model, β_i is asset specific risk that cannot be diversified away. Also, β_i can also be interpreted as a sort of relative proportion that describes the proportion of the variation of the market portfolio which can be ascribed to the specific asset. The fundamental insight of this model is that the expected return of an asset is a function of the market risk premium and its sensitivity to that market risk premium.

Of course, such a relatively simplistic model has numerous shortcomings and critiques, many of which are addressed in Eugene Fama and Kenneth French's 2004 paper *The Capital Asset Pricing Model - Theory and Evidence*. One critique of the model that their paper discusses is the employment of the assumption that investors only care about the return of a one period investment. Individuals care about their returns through many periods, and its covariance with their salary and investment opportunities; therefore, one is not simply maximizing their return on one period. Another issue with the model is its assumption of complete agreement, which the authors explain as, "given market clearing asset prices at t-1, investors agree on the joint distribution of asset returns from t-1 to t." Of course, investors do not agree about the probabilities of returns, which is evident by the ceaseless debate between "expert" investors. As well, the assumption of borrowing and lending at the risk-free rate, regardless of how much borrowed or the risk of activities borrowed for is overtly wrong, despite being such an integral aspect of the theory

behind the CAPM. Clearly, the CAPM has some theoretical shortcomings which thus question its validity.

Section III: Empirical Use of CAPM and Jensen's Alpha

Michael Jensen, in his 1968 paper *The Performance of Mutual Funds in the Period 1945 - 1964,* uses an empirical version of the CAPM for an analysis on mutual funds. He begins by explaining that there are two measures of performance of mutual funds which investors care about, the manager's ability to generate returns and their ability to limit risk. Jensen continues, that the CAPM is meant to account for both of these metrics and thus, is a viable framework for analyzing performance. As well, he laments that most performance analyses rely on comparing the relative performance of mutual funds, and that an objective measure would be helpful to judge the performance of a fund manager. To make the model applicable to empirical data, the expected returns are now realized returns, and therefore an error term is added to the model, which has an expected value of zero. Additionally, a temporal element is added so that the regression can run through time. This empirical model can be written as:

$$R_{it} = R_{ft} + \beta_i(R_{mt} - R_{ft}) + e_{it}$$

(4)

Then, for the ease of statistical analysis, the risk free return is subtracted from both sides of the equation such that the market risk premium is regressed on the security's risk premium to estimate its systemic risk factor, β_i. Jensen explains that such a regression would produce an efficient estimate for singular securities; however, when done for mutual funds, if the fund manager is proficient at forecasting future securities prices and invests accordingly, e_{it} would be greater than 0 at a significant level. This would mean that the fund is receiving a higher-than-normal risk premium for the level of risk taken on. This can be corrected for by not restricting the regression line to pass through the origin, allowing for an intercept. Such an equation would now appear as:

$$R_{it} - R_{ft} = \propto_i + \beta_i(R_{mt} - R_{ft}) + u_{it}$$

(5)

The term u_{it} has an expected value of zero and Jensen's alpha, $\propto_i$, would be the intercept of the regression line. A random buy and hold strategy would result in an $\propto_i$ of zero, and if fund managers can effectively forecast the future prices of securities the $\propto$ of their fund will be positive at a significant level. This provides an objective measure of performance that accounts for both risk and return, as well as time, allowing for alphas of funds to be compared across time. In Jensen's analysis he finds some mutual funds with significantly positive Jensen's alphas; however, he explains this could be due to random chance, based on the distribution of alphas and their significances from the mutual funds he analyzed.

Along with the critiques of its theory, there are also empirical tests which can be done to ascertain the CAPM's validity; however, they also provide little evidence for it. Fama and French (2004) also examines these empirical shortcomings. They explain that based on the CAPM equation, if you graph the returns and betas of particular securities there should be a linear relationship between the two, and the slope of the graph should be the market risk premium, and the intercept the risk-free rate. However, there are some confounding factors when this analysis is done with singular securities. This is corrected by making portfolios out of different levels of beta, and plotting their returns and beta instead. While this plot does show a linear relationship between return and beta, as we would expect, the relationship is flatter than the market risk premium would be. If we plot a line with an intercept of the risk-free rate and slope of the market risk premium along with our empirical data, we find the empirical line of best fit is above the theoretical line when beta is low, and below when beta is high. Such findings do not align with the theory of the CAPM and indicate either issues with the theory or in how we gather empirical data.

Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on Prior Beta, 1928–2003

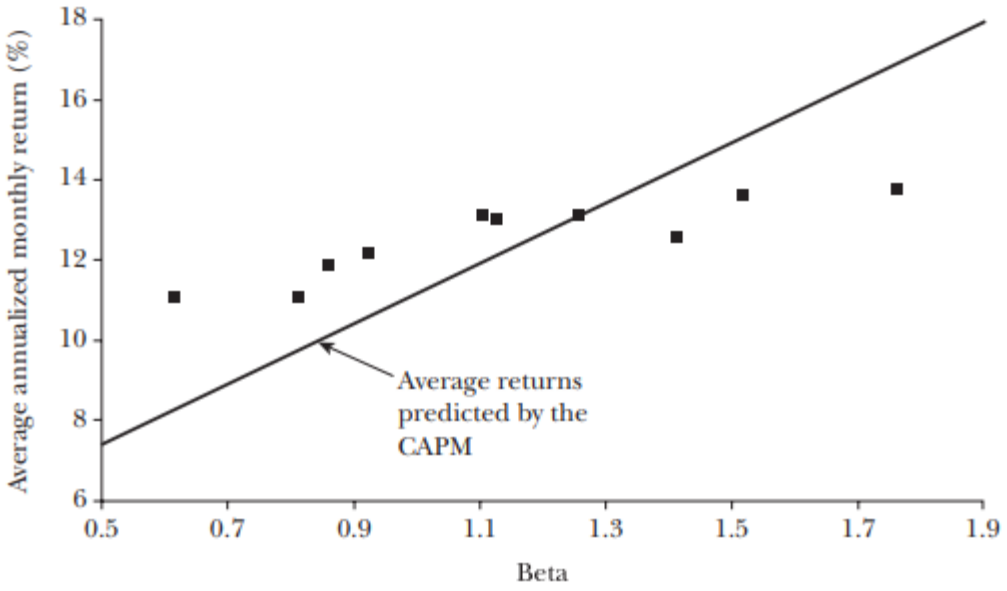

Figure 2.3 Graph demonstrating the empirical relationship between beta and annualized returns versus the theoretical expectations. From Fama (2004)

Another issue with the CAPM demonstrated by empirical tests is whether other variables have explanatory powers over the return of an asset. According to the theory, the market portfolio must be expected return-variance efficient, and thus, differences in the expected returns of assets must be due solely to beta. To test this empirically one regresses beta and another variable on the returns of the asset. If the difference in returns is due only to beta, then the coefficient on the other explanatory variable would not be significant. However, there are many other factors which researchers have been able to identify which have significant coefficients, and thus call into question whether the market portfolio is mean variance efficient or if there is an issue with the CAPM. Fama and French point out that many of these other factors are variables involving price, which is not surprising considering price includes expectations about cash flows and the rate used to discount those cash flows. Therefore, these factors may provide information about what discount rate to use in valuation analysis and thus influence the returns of the asset. In total, empirical tests cast some doubt on the validity of the CAPM, however, they are not the

death knell, as there are other possible explanations for these empirical results besides theoretical shortcomings of the CAPM.

Section IV: Fama-French Three-Factor Model

There are a myriad of factors which have empirical explanatory power over the returns of equities, which thus contradict the CAPM, since it states that the beta for the market risk premium should be the sole factor. Eugene Fama and Kenneth French discuss these factors in their 1992 paper *The Cross-Section of Expected Stock Returns*. They identify four factors with additional explanatory power and run regressions to see if they are significant. First is the size factor, from Banz (1981), which refers to the market capitalization of the firm. A size premium (SMB) is determined by subtracting the return of large firms from that of small firms. Next, they discuss the leverage factor of Bhandari (1988), with a leverage premium created from subtracting the returns of firms with low leverage from those with high leverage. They also address the value factor of Stattman (1980) and Rosenberg, Reid, and Lanstein (1985), which refers to a firm's book value to market value ratio. A premium (HML) is created by subtracting returns of low ratio firms from the returns of high ratio firms. And finally, they discuss the price-to-earnings ratio factor from Basu (1983). Again, a premium is created by subtracting the returns of low ratio firms from high ratio firms.

Fama and French then take these premiums, along with the market risk premium, and regress them on the returns of equities to ascertain their betas and how significant they are. Through their research they find that the size and value factors have additional explanatory power on the returns of equities, and when included, the explanatory power of leverage and the price-to-earnings ratio dissipates. They explain that since these factors are related to price, they may provide information about risk and discount rates for future cash flows. As well, since all are related to price, when used together it makes sense some would be redundant. This leads them to construct a new asset pricing model with greater explanatory power than the CAPM, which is as follows.

$$R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iHML}HML + u_{it}$$

(6)

They continue to explain that if assets are priced rationally then their results suggest that equity risk is multidimensional, and that size and value proxy for those other dimensions. They provide two possible explanations for what the value factor could be proxying. One explanation is that it is proxying the distress of the firm. Worse prospects results in a lower price and thus a higher book to market ratio, and since they are in distress they have a higher cost of capital, and thus a higher rate of return. Another example could be reversion to the mean for their book to market ratios. For firms with higher ratios to return to the average they need to have their prices relatively increase, resulting in overperforming the low ratios, who need to relatively decrease their prices, resulting in lower returns. Regardless, the selection of these two factors is the result of empirical fact finding as opposed to theoretical deliberations.

Since the three-factor model has greater explanatory power than the CAPM, Jensen's alphas of returns for funds are generally smaller when generated by the three-factor model as opposed to the CAPM. Since Jensen's alphas are signs of exploitable patterns, and thus market inefficiencies, how we determine what the expected level of return is for a given level of risk is significant. The greater explanatory power of the three-factor model indicates we can more accurately judge what the expected level of return should be, and thus more accurately determine whether there is an exploitable pattern and a market inefficiency.

Fama and French continue their research on their three-factor model in their 1993 paper *Common Risk Factors in the Returns on Stocks*. The CAPM is meant to apply to assets beyond just stocks, so they endeavor to employ their model in the analysis of bond returns. The results of their research shows that their three-factor model works well for bond returns, further evidence in support of the reliability of their model. However, whenever they added the factors of maturity and credit risk into the model the explanatory power of the other three factors disappeared, except for short term corporate bonds. Such

results call into question the feasibility of creating a model which applies to all assets. At the very least, it points to the Fama-French three-factor model mainly applying to equity returns.

Section V: Carhart Four-Factor Model and Mutual Fund Returns

Mark Carhart adds to this model in his 1997 paper *On Persistence in Mutual Fund Performance,* which adds the momentum factor, from Jegadeesh and Titman (1993), which is the premium (PR1YR) of the returns of companies with positive returns in the previous year minus the returns of companies with negative returns in the previous year, along with a sensitivity coefficient.

$$R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iHML}HML + \beta_{iPR1YR}PR1YR + u_{it} \quad (7)$$

Carhart justifies the inclusion of this factor by explaining that he is not attempting to perform a risk analysis, but rather, to create a statistical model which explains returns. He also adds that there is little correlation between factors which indicates multicollinearity should not be an issue in his regressions. Overall, based on Carhart's analysis, his model has stronger explanatory power than the Fama-French three-factor model and the CAPM. Again, this greater explanatory power should result in a more accurate prediction of expected returns, which will in turn result in a more precise Jensen's alpha, which is why it will be employed in the analysis of hedge funds in this paper.

In his paper, Carhart also discusses how many fund characteristics influence their returns. One characteristic is expense ratios. Fund managers would argue that higher expense ratios are indicative of higher performance, since the higher fees go into more research and hiring superior managers; however, Carhart's analysis reveals that higher expense ratios result in lower net returns for investors. Similarly, regarding asset turnover, managers claim that they do not make trades unless it will benefit the fund net of fees, and thus higher turnover indicates activity generating returns. Again, Carhart disproves this by demonstrating higher turnover results in worse performance. He also shows that funds with load fees underperform funds without them. Another factor Carhart considers is the liquidity of the securities held, showing that funds holding more illiquid securities perform worse than those holding more liquid assets,

presumably due to the higher transaction costs associated with illiquid securities. These findings are particularly relevant to this research, since hedge funds tend to be characterized by higher fees, higher turnover, and sometimes less liquid equities than mutual funds. Therefore, there is the possibility that hedge funds underperform the market by an even greater extent than mutual funds, or that the strategies employed by hedge funds are superior enough to also compensate for these added costs. Overall, though Carhart concludes that there is some evidence that funds with positive alphas retain positive alphas, meaning that managers are the source of the overperformance of the fund relative to the factor model, the results are not significant enough. This research endeavors to ascertain whether there is evidence for manager performance, and if it is significant, for hedge funds.

Section VI: Fama-French Five-Factor Model

If the results from analysis with the Carhart four-factor model have significant Jensen's alphas it may be due to incomplete explanatory power of the model and a failure to accurately account for the expected return based on the level of assumed risk. Therefore, it may be worthwhile to complete the analysis with a different asset pricing model. One model that would be worthwhile is Fama and French's five-factor model, which they discuss in their 2015 paper, *A Five-Factor Pricing Model*. This model adds two additional factors to their three-factor model. First is a profitability factor, which is the premium (RMW) of the returns of equities with robust profitability minus the returns of equities with weak profitability. The second is an investment factor. This is the premium (CMA) of returns of equities with more conservative investment profiles minus the returns of equities with aggressive investment profiles. The new model appears as follows.

$$R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iHML}HML + \beta_{iRMW}RMW + \beta_{iCMA}CMA + u_{it} \quad (8)$$

There are two motivations for the inclusion of these variables. First are the insights from the dividend discount model of equity price. This model states that the price of a stock is the discounted value of all future dividends. Fama and French are able to algebraically alter the model such that profitability

and investments are factors that determine market price, and thus returns. This prompted research to find proxies for those two factors; Novy-Marx (2013) identified the profitability factor proxy, and Aharoni, Grundy, and Zeng (2013) identified the investment factor proxy. Then, this research prompted the second motivation for these factors' inclusion in the model, empirical evidence of their explanatory power. Therefore, there is a general theoretical underpinning for the inclusion of these factors in an asset pricing model, as well as practical empirical considerations.

Fama and French then go on to run numerous regressions to determine the explanatory capability of the five-factor model and other combinations of their five factors. Their results show that the five-factor model and a four-factor model which excludes the value factor have similar explanatory power. Therefore, the value factor is largely redundant, and its influence on returns is captured by profitability and investment. Fama and French explain that this is because value is a noisy proxy for returns, since it varies due to changes in profitability and investment, and therefore those two factors on their own may be better explainers. However, they did add the caveat that such results may be specific to their data and further analysis may be required.

Regardless, if hedge funds appear to have positive Jensen's alphas with Carhart's four-factor model, it may be a worthwhile endeavor to conduct the same analysis with the Fama-French five-factor model, since it has a different explanatory capability. The reason we will do our initial analysis with the Carhart model is that, with the inclusion of the momentum factor, it is better suited for the analysis of managed funds, whereas the Fama-French five-factor model is better suited for analyzing the returns of individual assets. With that said, it may prove fruitful to use a five-factor model which does not include the value factor and instead utilizes the momentum factor, combining the explanatory power of both Carhart's model and the Fama-French five-factor model. Such a model would appear as follows.

$$R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iPR1YR}PR1YR + \beta_{iRMW}RMW + \beta_{iCMA}CMA + u_{it} \quad (9)$$

This model may be the most accurate in capturing the risks associated with hedge fund investments, and thus have the best prediction for expected returns, which would make its Jensen's alpha the most precise for informing us about market inefficiency. While this seems to be an improvement in the model, we would not want to use it as the main model for analysis since it is not an already existing model with extensive research into its explanatory capability.

Chapter 3: Data

Section I: Collection

To begin a statistical analysis, one needs to obtain data. Beginning with the premiums for the model factors, they were retrieved them from Kenneth French's online data library (Kenneth). Here, he keeps extensive records for the factor premiums, which will enable this research to employ a consistent method of calculating these premiums through time and amongst each of the factors. Therefore, this research would be more reliable than collecting this data from multiple sources. Moreover, since the Fama-French model is so closely related to the Carhart model there are added benefits of employing the same data used by the authors in their analyses.

While obtaining data for the factors is easy, gathering consistent data for hedge fund returns has been elusive. Since investment in them is restricted to accredited investors, they are not required to make their returns public, and thus it is difficult for researchers to obtain the data necessary for analysis. Many funds only release returns to prospective investors, and if researchers do obtain returns, they often will not have access to returns for a long time period. Additionally, funds can be inconsistent in the types of returns released; some will release gross returns, some net of fees, some will only release yearly, some monthly. Furthermore, if firms do release their returns, it prompts the question, why? Most likely it is because they are doing disproportionately well. Thus, the funds you can obtain data for are most likely not representative of hedge funds on the whole, but rather are high performing hedge funds, and thus will skew the results of the analysis. These issues pose significant challenges for researchers and are a significant factor in why there is less research regarding hedge funds than mutual funds. Fortunately, Bloomberg has hedge fund indices, which will be utilized in this analysis.

Section II: Understanding the Data

Bloomberg has thirty-five hedge fund indices, which are aggregates of hedge funds, separated by strategy. Bloomberg divides hedge fund strategies into six broad strategies, equity hedge, credit hedge, event driven, macro, relative value, and insurance. Equity hedge strategies involve being long or short on equities and their derivative products, which encompasses a wide range of different investment strategies. Analogously, credit hedge involves being long and short various credit instruments, and their derivatives. Event driven refers to strategies which take advantage of price actions which are the result of corporate actions. Relative value is essentially arbitraging strategies which eliminate risk factors and attempts to take advantage of pricing discrepancies. Macro strategies focus on the movements in economies as a whole, as opposed to looking at individual securities. Finally, there is insurance, which invests in, as one may guess, insurance related investments (Bloomberg). Besides Insurance, each of these strategies breaks down into a handful of more specific sub-strategies.

Bloomberg has indices for each strategy, each sub-strategy, and one for all hedge funds (Munro). An index is calculated as an equal-weighted aggregate of all hedge funds which report data to Bloomberg and belong to that strategy classification, rebalanced each month. Returns are calculated net of fees. While Bloomberg does try to maintain at least twenty funds per index, and there are over 18,000 funds in total, selection bias is still at play, as firms with better performances are more likely to report their returns to Bloomberg. As well, while there is data for the indices for almost a decade, it does not mean that the same funds have been consistently included, so there is the possibility that funds report when they are doing good and do not report when doing bad, skewing the results of the indices. I am unable to see which funds compose an index and for how long they have been included.

As for the analysis of the indices, we must keep in mind that the return characteristics of an index will not look like the return characteristics of a hedge fund. Since it is a composite, it will have an average return as compared to funds which are a part of it. Additionally, many funds can fall under the same strategy while pursuing different investments, which will make the individual funds less correlated with one another than a group of large cap growth mutual funds would be with each other. This will result in a

breadth of diversification which may bring on even lower returns. Additionally, there will be significant declines in variance as compared to what one would see with an aggregate of large cap growth mutual funds. As well, we must remember that it is very easy for individual funds to have negative alphas, it simply means that the portfolio is not on the efficient frontier of the investment opportunity set. Since it is so much easier to have a negative alpha than a positive alpha, we would predict that the positive alpha funds are outnumbered, and thus outweighed, by the negative alpha funds, presumably resulting in a negative alpha for the index. Therefore, just because an index does not have a significant positive alpha it does not mean that a particular strategy is unable to generate excess or returns, or even that no hedge fund currently does, just that at the very least, inefficient allocations outweigh allocations generating excess returns. Hence, negative alphas will not tell us much in our analysis, as we expect them by default.

This does mean that if an index has a significant positive alpha, it is an area worth further research. If the index was able to overcome this default and have a significant positive alpha, it could mean a handful of things. First, it may be the case that the selection bias of funds entering the index during strong performance and exiting during weak performance limits the variation in returns, resulting in alpha. Second, it may be the case that the strategy returns alpha generally, which warrants study of that particular strategy. Third, it may be the case that individual funds in the index obtain alpha, which warrants study to see if those managers are able to sustain alpha in the long run, though, this will prove complicated as per the data gathering hurdles previously discussed. Fourth, no fund may have a significant positive alpha, but when combined together, they do; this would mean the strategy is worth further study and suggests the funds would find greater success if they performed their strategy with a wider array of securities. This is not an exhaustive list of possibilities, but it does demonstrate that finding an index with a significant positive alpha is meaningful, and therefore this research is worthwhile.

Section III: Descriptive Characteristics

As previously mentioned, our analysis is a regression of 35 indices on three factor models, the Carhart Four Factor model, Fama-French Five Factor model, and an amalgamation of the two. The time period being regressed is from 2014 to March 2023, there are 111 monthly returns per model. While we

have a satisfactory number of data points it would have been ideal to have a longer window of time (admittedly, it always better to have more) due to the long time-horizon in which hedge funds invest. Regardless, within our time frame we have 6 years of consistent growth, the flash 2020 recession, and the proceeding rebound, providing for an interesting market background for these investment activities. Table 3.1 shows the summary statistics for the dataset.

As we see, over our period the Market returns on average 0.9425% per month, with a standard deviation of 4.5517%. Only one Index has a higher return, BHCRYP, with a return of 3.3197% per month and a standard deviation of 13.5581%. This is an unexpected result, because as previously discussed, hedge funds are generally riskier investments with higher returns, meaning we would predict more than one index would have an average return greater than the market. Presumably, what is taking place is that the hedge funds composing the indices are canceling one another out, as one has high returns another has low returns, and vice versa. Furthermore, if funds are pulling the averages down so much as to make the return of the index lower than the market, it shows that funds only reporting when returns are good may not be as widespread an issue as anticipated. Overall, this does not pose too much of an issue with our analysis, since excess return is not about getting the highest return possible, but rather, getting more return than expected for the level of risk you assume; it's about getting more bang (return) for your buck (risk). With all this in mind, what is the BHCRYP Index? It is the Index of hedge funds investing cryptocurrency, which has had an incredible bull run in the past decade, explaining why this index did so much better compared to the others, and was able to overcome the averaging effects present in the other indices. Also, cryptocurrency is incredibly volatile, explaining why it also had the highest standard deviation. Besides BHCRYP, only one other index had a standard deviation larger than the market, BHACT, with an average return of 0.8997% and standard deviation of 4.5587%, statistics which are very close to that of the market. BHACT is the activist investing index. Activist funds buy large shares in firms for the purpose of obtaining a seat on the board of directors and creating significant change in the firm in the hopes of unlocking shareholder value (Bloomberg). With the second highest return and standard deviation, one might be inclined to predict that this may be due to the high correlation between the hedge

Summary Statistics					
Index	Observations	Mean	Standard Deviation	Minimum	Maximum
BHEDGE	111	0.0030	0.0174	-0.0857	0.0527
BHEQTY	111	0.0036	0.0263	-0.1208	0.0794
BHEQLS	111	0.0033	0.0230	-0.1026	0.0684
BHEQLB	111	0.0048	0.0355	-0.1624	0.1111
BHEQMS	111	0.0022	0.0230	-0.1116	0.0503
BHEQLO	111	0.0061	0.0390	-0.1867	0.1137
BHCRDT	111	0.0030	0.0138	-0.1087	0.0272
BHCRLS	111	0.0031	0.0187	-0.1576	0.0486
BHSTCR	111	0.0043	0.0135	-0.1139	0.0339
BHEMDB	111	0.0018	0.0192	-0.1048	0.0513
BHCRMS	111	0.0027	0.0133	-0.1002	0.0276
BHDL	111	0.0050	0.0017	-0.0080	0.0088
BHEVT	111	0.0039	0.0210	-0.1274	0.0611
BHDIST	111	0.0042	0.0263	-0.1642	0.0697
BHSS	111	0.0035	0.0220	-0.1102	0.0552
BHMARB	111	0.0042	0.0135	-0.0934	0.0447
BHEVMS	111	0.0036	0.0208	-0.1137	0.0754
BHACT	111	0.0090	0.0456	-0.1943	0.1451
BHMACR	111	0.0018	0.0135	-0.0360	0.0356
BHDMAC	111	0.0028	0.0155	-0.0557	0.0455
BHCTA	111	0.0019	0.0210	-0.0624	0.0584
BHGAA	111	0.0015	0.0146	-0.0378	0.0366
BHCOM	111	0.0036	0.0136	-0.0306	0.0433
BHMMS	111	0.0016	0.0120	-0.0283	0.0355
BHCURR	111	0.0003	0.0225	-0.1013	0.0710
BHCRYP	111	0.0332	0.1356	-0.2281	0.4512
BHRV	111	0.0030	0.0098	-0.0547	0.0227
BHSTA	111	0.0013	0.0200	-0.0839	0.0916
BHCBA	111	0.0040	0.0143	-0.0928	0.0391
BHFIA	111	0.0030	0.0108	-0.0782	0.0255
BHRVMS	111	0.0044	0.0199	-0.1087	0.0622
BHFEMN	111	0.0031	0.0094	-0.0401	0.0270
BHQEMN	111	0.0034	0.0116	-0.0596	0.0327
BHVOLA	111	0.0064	0.0213	-0.0725	0.0906
BHINS	111	0.0032	0.0087	-0.0674	0.0131
MktRF	111	0.0087	0.0456	-0.1339	0.1365
SMB	111	-0.0014	0.0285	-0.0828	0.0711
HML	111	-0.0018	0.0375	-0.1387	0.1275
RMW	111	0.0036	0.0210	-0.0475	0.0720
CMA	111	0.0005	0.0232	-0.0683	0.0772
RF	111	0.0007	0.0009	0.0000	0.0036

Mom	111	0.0011	0.0402	-0.1599	0.0998
Mkt	111	0.0094	0.0455	-0.1326	0.1365

Table 3.1 Summary Statistics for the Indices (acquired from Bloomberg) and Factors (acquired from Kenneth French Data Library), including number of observations, Mean, Standard Deviation, and Minimum and Maximum Values. Name of indices available in appendix 1 (ordered by appearance) and 2 (alphabetical).

funds as compared to other strategies; however, this is unlikely, as the nature of activist investing means that funds are often working on their own to reform firms, meaning that most activist funds are most likely not investing in the same firms, lowering their correlations. Despite the greater probability of relatively lower correlations, this index is able to have the second highest return, which points to this strategy having strong returns for the component funds.

Correlation Matrix

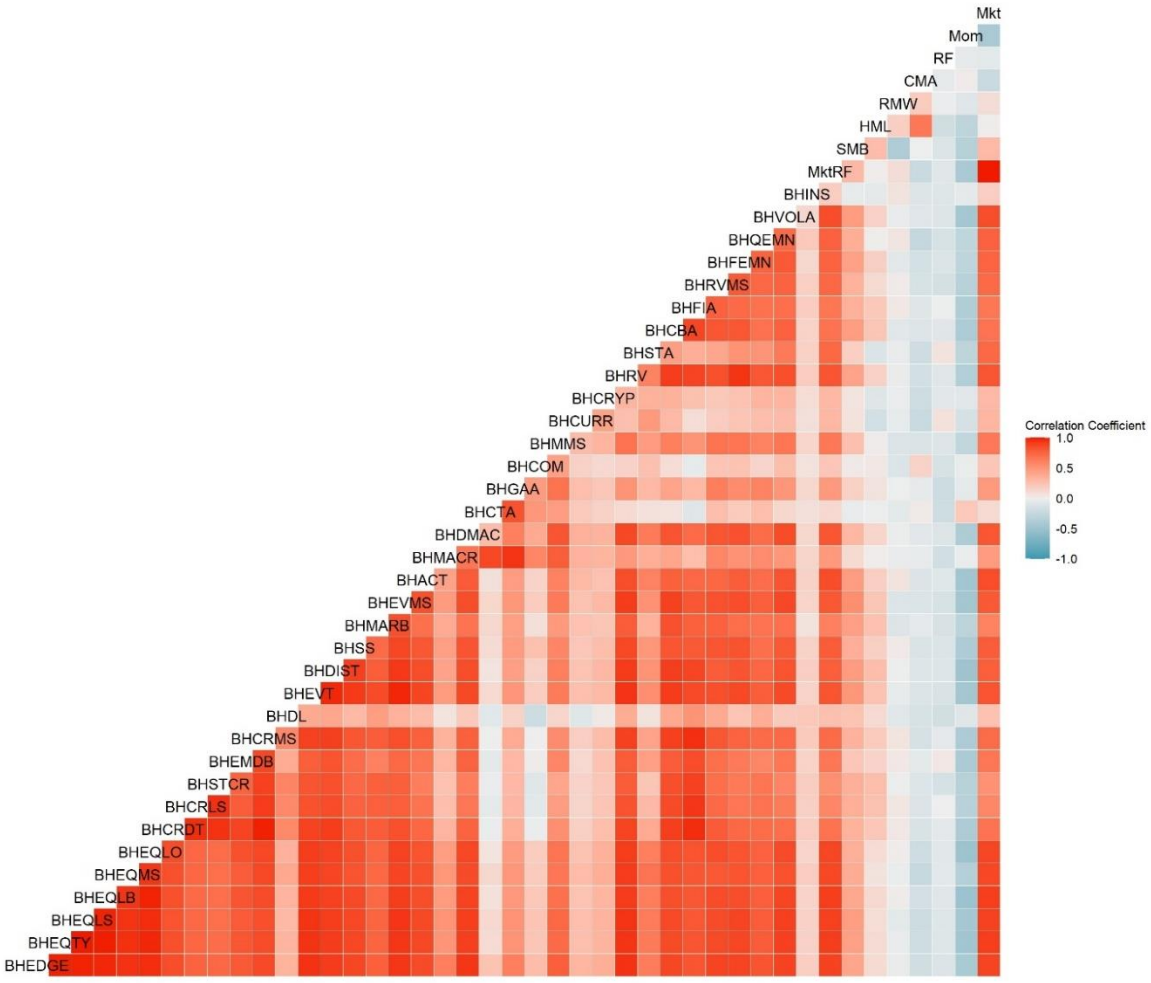

Figure 3.1 Correlation Matrix of Indices and Factors

Here we have a correlation matrix between the indices and the factors. As shown, a lot of the indices are highly correlated with each other, though there are some outliers. Those with with lower correlation coefficients employ strategies which do not depend on equities, bonds, or their derivatives. BHINS appears to be less correlated with the other indices; it is the insurance hedge fund index, containing funds which invest in insurance-linked securities, which involve risk securitization (Bloomberg). In addition, BHCRYP, is less correlated with our securities, which would be expected, since it focuses on cryptocurrencies, and not equities. BHCURR, the currency strategy index, also has less correlation with the group. BHCOM and BHCTA both involve commodity investments, and hence, are not correlated with the multitude of other indices. BHDL is the Direct Lending strategy index, which, as the name suggests, lends funds directly to firms; because these are not uniform bonds their prices do not fluctuate with the bond market, hence the lower correlation coefficient. Besides the above-mentioned indices, the others focus on equities, bonds, and their derivatives, and while they invest in different securities, the high degrees of correlation point to the overall market moving in tandem.

Chapter 4: Analysis

Section I: Sharpe Ratios

To begin our analysis, we are going to generate and compare Sharpe ratios; which are considered a measure of how much return you are getting for taking on a unit of risk, with higher values indicating greater return for the risk being assumed. This is a similar idea to excess returns, getting more return than you would expect for the risk taken on; however, with how they are conceived, they are not the same thing. For example, Sharpe ratios are purely comparative, and, as previously discussed, alpha is meant to be an objective and stand-alone result. With that said, we expect some relationship between significant positive alphas and higher Sharpe ratios to exist, so we will use them as a baseline to see how the indices stack up against the market. Sharpe ratios are calculated by taking the average return, subtracting the average risk-free return, and dividing that by the standard deviation.

Sharpe Analysis (Sorted by Sharpe Ratio)			
Index	Sharpe Ratio	Mean	Standard Deviation
BHDL	2.5162	0.005037	0.001719
BHINS	0.2827	0.003170	0.008700
BHVOLA	0.2668	0.006404	0.021341
BHSTCR	0.2634	0.004260	0.013472
BHMARB	0.2556	0.004154	0.013468
BHFEMN	0.2521	0.003069	0.009355
BHCRYP	0.2396	0.033197	0.135581
BHRV	0.2317	0.002976	0.009776
BHCBA	0.2312	0.004016	0.014297
BHQEMN	0.2293	0.003364	0.011571
BHCOM	0.2117	0.003579	0.013552
BHFIA	0.2114	0.002995	0.010802
Mkt	0.1915	0.009425	0.045517
BHRVMS	0.1868	0.004422	0.019861
BHACT	0.1818	0.008997	0.045587
BHCRDT	0.1691	0.003044	0.013799
BHEVT	0.1505	0.003867	0.020976
BHCRMS	0.1461	0.002650	0.013270
BHEQLO	0.1384	0.006108	0.038994
BHEVMS	0.1378	0.003579	0.020829
BHDIST	0.1338	0.004231	0.026301
BHDMAC	0.1321	0.002756	0.015487
BHEDGE	0.1305	0.002986	0.017438
BHCRLS	0.1270	0.003085	0.018702
BHSS	0.1247	0.003459	0.022040
BHEQLB	0.1163	0.004835	0.035448
BHEQLS	0.1104	0.003253	0.023020
BHEQTY	0.1091	0.003581	0.026319
BHMACR	0.0826	0.001829	0.013539
BHMMS	0.0740	0.001601	0.012032
BHEQMS	0.0654	0.002213	0.022973
BHCTA	0.0587	0.001944	0.021011
BHEMDB	0.0575	0.001816	0.019227
BHGAA	0.0547	0.001511	0.014625
BHSTA	0.0294	0.001297	0.019954
BHCURR	-0.0175	0.000317	0.022487

Table 4.1 Sharpe ratios, mean, and standard deviation of indices and market, sorted by Sharpe ratio.

As shown, 12 of the 35 indices have Sharpe ratios higher than the market's 0.1914. Besides one index, the other 11 are not too different from the market, ranging from 0.2114 to 0.2826. These 11 consist

of at least one from each of the main strategies, except for the equity hedge. That means, at least according to the Sharpe ratios, holding a whole market ETF would be a more efficient investment than the hedge fund strategies focused on equity investments. Furthermore, while the other five main strategies have at least one index with a higher Sharpe ratio than the market, six of them belong to the relative value strategy. Five of the seven sub-strategies and the main strategy have higher Sharpe ratios, meaning that they are more efficient than simply holding a whole market ETF. Overall, we expect the indices we identify with significant positive alphas to also be members of this group of 11, since they earn more return per unit of risk assumed as compared to the market.

As for the 12th index, BHDL stands out with a Sharpe Ratio of 2.5162, over 10 times the size of the second highest ratio. What caused this anomaly? It has an average return of 0.5037%, which is on the higher side, but is not out of the ordinary compared to the other indices. Its standard deviation, on the other hand, is incredibly low, 0.1719%, the second lowest is 0.8699%. Why is the standard deviation of BHDL so low? It is the index for funds which engage in direct lending, since these long-term loans are unique, they are not priced on the market daily, instead they sit on the balance sheet of funds with stable prices. The Sharpe ratio only works if the variation in the value of a security serves as a proxy for its risk, but for BHDL, that is not the case; the risks associated with the investment are not captured by the variations in pricing. That is why the its standard deviation is so low, its Sharpe ratio so high, and why we should not consider its Sharpe ratio an accurate measurement.

Section II: Regressions

Now, we can regress the various factors on the returns of each our indices. As a reminder, our regressions are as follows:

Carhart Four-Factor Model:

$$R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iHML}HML + \beta_{iPR1YR}PR1YR + u_{it}$$

(10)

Fama-French Five Factor Model:

$$R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iHML}HML + \beta_{iRMW}RMW + \beta_{iCMA}CMA + u_{it} \quad (11)$$

Amalgamation Model:

$$R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iPR1YR}PR1YR + \beta_{iRMW}RMW + \beta_{iCMA}CMA + u_{it} \quad (12)$$

From each regression we will store the Jensen's Alpha and the P-Value and Standard Error of the Jensen's Alpha. Jensen's alpha will tell us the excess returns received by the funds generated by the managers of the constituent funds. The P-Value will tell us the significance level of the alpha, the lower it is the more significant our findings are. The Standard Error is the variation in the alpha among individual data points. By evaluating these factors concurrently, we can determine if indices have excess returns. Table 4.2 shows the results from the analysis.

This is a lot of information to digest and analyze. Instead, let's narrow down this information to points of interest. First, we will filter our indices with negative alphas. As stated before, negative alphas are not that interesting, as it is very easy to manage a fund which is on the inefficient side of the efficient frontier. That leaves 20 indices for the Carhart Four-factor model regression, 22 for the Fama-French Five-factor model regression, and 21 for my amalgamation model. Next, we should filter out indices with P-Values greater than 0.05. P-Values are the percentage chance we would get a more extreme alpha if we recollected the data given that the population alpha is 0; the smaller the P-Value, the less likely the alpha is zero. Significance levels are 1 minus the P-Value, so by limiting ourselves to P-Values beneath 0.05, we are only looking alphas with significance levels above 95%, the normal statistical standard for research. After filtering those values out, we are left with 7 indices for the Carhart Four-factor model regression, 9 for the Fama-French Five-factor model regression, and 7 for my amalgamation model, with 7 indices included in all three. While this is a small proportion it is not unexpected, as previously explained, with the way our data is constructed we would expect non-significant and/or negative alphas. Additionally, this does not mean that the indices that were filtered out represent poor strategies or that

funds following these strategies cannot obtain alpha. The results of the remaining indices are in Table 4.3.

Regression Results									
	Carhart Four-Factor			Fama-French Five-Factor			Amalgamation		
Index	Alpha C	P-Value C	Std. Error C	Alpha F	P-Value F	Std. Error F	Alpha A	P-Value A	Std. Error A
BHEDGE	-0.000399	0.593304	0.000744	-0.000109	0.882898	0.000738	-0.000281	0.711748	0.000759
BHEQTY	-0.001075	0.282154	0.000994	-0.000791	0.426279	0.000990	-0.000875	0.385557	0.001004
BHEQLS	-0.000853	0.347713	0.000905	-0.000505	0.571689	0.000891	-0.000617	0.497178	0.000906
BHEQLB	-0.001181	0.385800	0.001356	-0.001116	0.425211	0.001394	-0.001058	0.445311	0.001381
BHEQMS	-0.002162	0.044407	0.001063	-0.001582	0.136709	0.001055	-0.001956	0.071048	0.001073
BHEQLO	-0.000319	0.857089	0.001764	-0.000077	0.966159	0.001800	-0.000018	0.991976	0.001786
BHCRDT	0.000854	0.372968	0.000955	0.001097	0.248614	0.000945	0.000804	0.422932	0.001000
BHCRLS	0.000760	0.593205	0.001419	0.001124	0.423857	0.001399	0.000590	0.692080	0.001485
BHSTCR	0.002551	0.019348	0.001074	0.002947	0.005982	0.001050	0.002529	0.027446	0.001131
BHEMDB	-0.001035	0.455648	0.001382	-0.001038	0.463655	0.001411	-0.001022	0.469369	0.001408
BHCRMS	0.000366	0.676384	0.000875	0.000571	0.511206	0.000866	0.000303	0.740256	0.000912
BHDL	0.004245	0.000000	0.000193	0.004332	0.000000	0.000194	0.004245	0.000000	0.000198
BHEVT	0.000549	0.583596	0.000998	0.000903	0.363386	0.000990	0.000535	0.618035	0.001070
BHDIST	0.000546	0.698963	0.001408	0.000887	0.529581	0.001406	0.000497	0.742082	0.001505
BHSS	-0.000216	0.866837	0.001285	0.000028	0.982863	0.001295	-0.000266	0.842339	0.001332
BHMARB	0.002235	0.022821	0.000967	0.002628	0.008028	0.000972	0.002259	0.027695	0.001012
BHEVMS	0.000455	0.656871	0.001022	0.000865	0.391581	0.001006	0.000590	0.579246	0.001060
BHACT	0.002133	0.305986	0.002073	0.001793	0.394419	0.002096	0.001585	0.456169	0.002119
BHMACR	-0.000436	0.708611	0.001163	-0.000090	0.940633	0.001201	-0.000382	0.745005	0.001172
BHDMAC	-0.000209	0.813178	0.000881	-0.000039	0.964646	0.000873	-0.000134	0.879513	0.000882
BHCTA	-0.000007	0.997384	0.001990	0.000740	0.724707	0.002095	0.000083	0.967326	0.002013
BHGAA	-0.000771	0.540308	0.001255	-0.000410	0.754509	0.001308	-0.000810	0.528268	0.001280
BHCOM	0.002096	0.114305	0.001316	0.002188	0.087237	0.001268	0.002214	0.083913	0.001269
BHMMS	-0.000540	0.555119	0.000912	-0.000307	0.734136	0.000902	-0.000314	0.728450	0.000902
BHCURR	-0.001715	0.410402	0.002075	-0.001643	0.437443	0.002108	-0.001308	0.536983	0.002112
BHCRYP	0.023432	0.069369	0.012772	0.026115	0.045280	0.012889	0.025354	0.051627	0.012879
BHRV	0.000904	0.085165	0.000520	0.001160	0.027176	0.000518	0.000926	0.091754	0.000544
BHSTA	-0.002329	0.078289	0.001310	-0.002259	0.086062	0.001304	-0.001970	0.137985	0.001318
BHCBA	0.001910	0.045266	0.000943	0.002202	0.020998	0.000940	0.001960	0.047890	0.000979
BHFIA	0.001160	0.130594	0.000761	0.001273	0.099576	0.000766	0.001085	0.174619	0.000794
BHRVMS	0.001195	0.371138	0.001330	0.001389	0.305186	0.001348	0.001165	0.393425	0.001359
BHFEMN	0.001146	0.044293	0.000563	0.001495	0.009645	0.000567	0.001187	0.046619	0.000590
BHQEMN	0.001044	0.157129	0.000733	0.001164	0.116737	0.000736	0.000992	0.176254	0.000729
BHVOLA	0.002794	0.005692	0.000990	0.002852	0.004964	0.000994	0.002791	0.006203	0.000999
BHINS	0.002032	0.019768	0.000859	0.002078	0.018760	0.000871	0.002036	0.021213	0.000870

Table 4.2 Carhart Model: $R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iHML}HML + \beta_{iPR1YR}PR1YR + u_{it}$

Fama-French Model: $R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iHML}HML + \beta_{iRMW}RMW + \beta_{iCMA}CMA + u_{it}$

Amalgamation Model: $R_{it} - R_{ft} = \propto_i + \beta_{iRMRF}(R_{mt} - R_{ft}) + \beta_{iSMB}SMB + \beta_{iPR1YR}PR1YR + \beta_{iRMW}RMW + \beta_{iCMA}CMA + u_{it}$

Regression Results: Filtered								
	Index	BHSTCR	BHDL	BHMARB	BHCBA	BHFEMN	BHVOLA	BHINS
Carhart Four-Factor	Alphas C	0.002551	0.004245	0.002235	0.001910	0.001146	0.002794	0.002032
	P-Value C	0.019348	0.000000	0.022821	0.045266	0.044293	0.005692	0.019768
	Std. Error C	0.001074	0.000193	0.000967	0.000943	0.000563	0.000990	0.000859
Fama-French Five-Factor	Alpha F	0.002947	0.004332	0.002628	0.002202	0.001495	0.002852	0.002078
	P-Value F	0.005982	0.000000	0.008028	0.020998	0.009645	0.004964	0.018760
	Std. Error F	0.001050	0.000194	0.000972	0.000940	0.000567	0.000994	0.000871
Amalgamation	Alpha A	0.002529	0.004245	0.002259	0.001960	0.001187	0.002791	0.002036
	P-Value A	0.027446	0.000000	0.027695	0.047890	0.046619	0.006203	0.021213
	Std. Error A	0.001131	0.000198	0.001012	0.000979	0.000590	0.000999	0.000870

Table 4.3 Regression results for the initial seven indices with significant positive Jensen's Alphas

Again, BHDL appears as an outlier, with an inordinately small P-Value, which is the result of its small standard error, because its value variation does not properly represent the risk it assumes. Therefore, it would be inaccurate to use this model to determine that this index has excess returns, since it cannot properly measure the risk it is assuming. Hence, BHDL should not be included in this subset of indices.

Section III: Index Analysis

Now that we have Identified 6 indices which have statistically significant positive alphas we should dig deeper into these indices and determine if there is any pattern or if there is a particular reason why these indices would have excess returns.

Figure 4.1 shows a correlation matrix of the 6 indices and the market. While BHINS is not particularly correlated with the other indices, the rest are correlated with one another, having correlation coefficients between 0.5886 and 0.8467. Also, they are correlated with the market, having correlations between 0.5256 and 0.8514. This demonstrates that of the 5 indices (excluding BHINS), they may have similar causes of their excess returns. All of the indices have average returns less than the market, ranging from 0.3069% to 0.6404%. Moreover, they all have smaller standard deviations, ranging from 0.8700% to 2.1341%. Additionally, they all have larger Sharpe ratios, ranging from 0.2312 to 0.2827; furthermore, our 6 indices include the top 2nd to 6th and 9th ranked Sharpe ratios (and remember, the largest Sharpe ratio is BHDL, which we are not considering as an accurate result). This outcome makes sense; as we explained previously, if these indices are able to earn excess returns, it makes sense they would have high

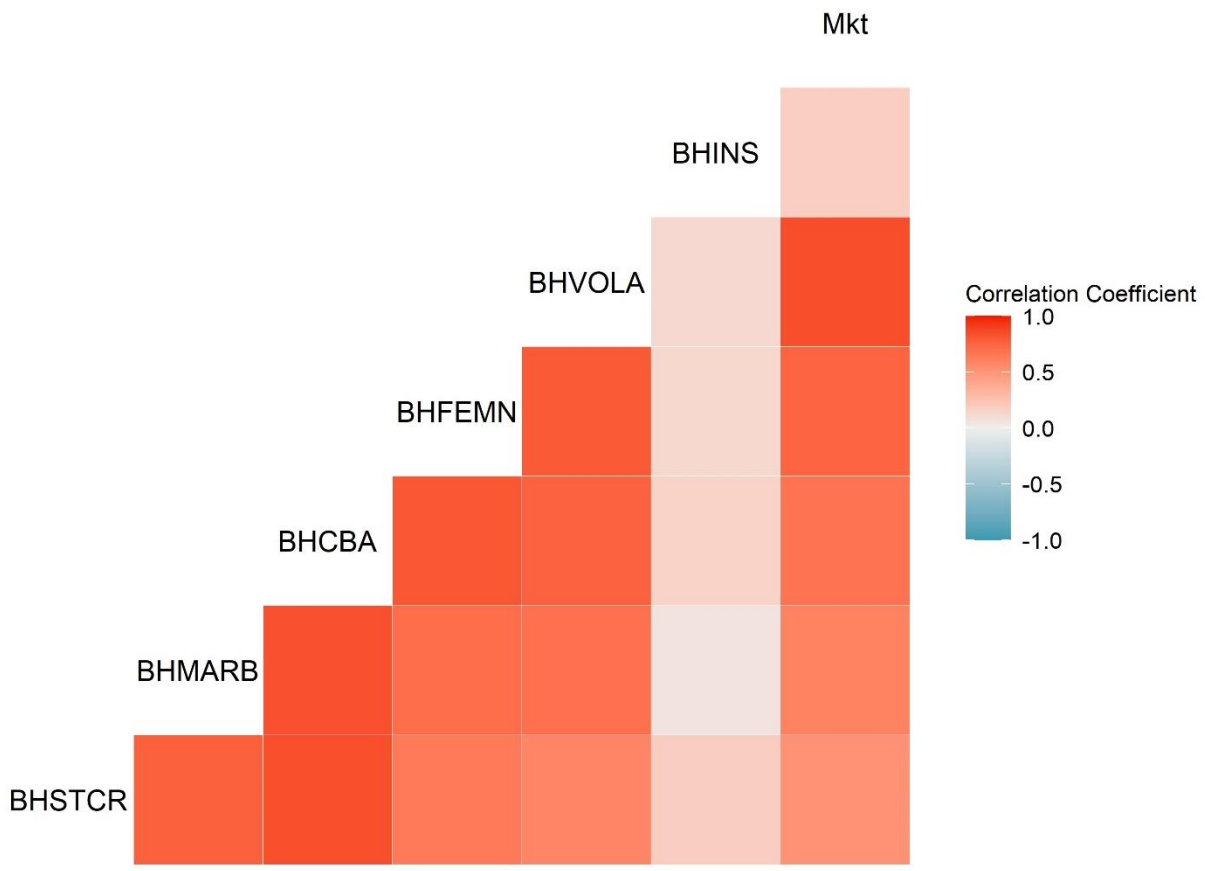

Figure 4.1 Correlation Matrix of Indices with Significan Positive Jensen's Alphas

returns per unit of risk. Additionally, it should be noted that the Carhart Four-factor model generated the lowest alpha for four of the six indices, whereas the combined model generated the lowest alphas for BHSTCR and BHVOLA. The Fama-French Five factor model generated the highest alpha and lowest P-Value for all the indices. The combined model generated the highest P-Value for all the indices.

Subsection A: BHSTCR

BHSTCR is the index for hedge funds which pursues a structured credit strategy and falls under the credit hedge main strategy. Structured credit instruments are securities in which similar debt obligations are pooled together and securitized; the most famous of which are mortgage-backed securities (Guichard). The BHSTCR index has a mean return of 0.4260%, a standard deviation of 1.3472%, and a

Sharpe ratio of 0.2634, all of which are midrange compared to the other 5 indices. From the regressions, it has alphas between 0.2529 % and 0.2947% and P-Values between 2.7446% and 0.5982%. Why might this strategy produce excess returns? At first, one might point out that due to the more illiquid nature of these investments there is a greater risk associated them which is not captured by price fluctuations; however, the illiquid nature causes greater price swings in the market for these securities, and therefore, that added risk is properly accounted for (Niemann). Instead, this excess return may come from the fact that not as many investors know and invest in these products, preventing the normal market mechanism which eliminates excess returns from functioning. This would mean that as more people learn about structured debt the excess returns will start to dissipate. Keep in mind we cannot determine the cause of excess returns simply with the information provided, these are just hypotheses; the existence of excess returns here should prompt further investigation.

Subsection B: BHMARB

BHMARB is the index of hedge funds which engage in a merger arbitrage strategy, and is contained in the event driven index. This strategy involves the buying and selling of the stocks of companies engaging in a merger deal; because there is a chance for the deal to fall through, that would result in beneficial price changes for the investor (Frankenfield). BHMARB has an average return of 0.4154%, a standard deviation of 1.3468%, and a Sharpe ratio of 0.2556, all of which are comparatively midrange. BHMARB has alphas ranging from 0.2235% to 0.2628% and P-Values from 2.7695% to 0.8028%. One argument for why this index is able to earn excess returns is that its strategy is prohibited from being used in mutual funds, limiting the investors who can engage in it and thus affecting the price and returns. According to this argument, if we were to alter the law and allow mutual funds to pursue this strategy the greater number of investors would alter the prices of securities in such a way as to eliminate the excess return. Another argument for the existence of excess returns is that this is an arbitrage strategy. The goal of arbitrage is to invest in opportunities with greater return than should be possible for the level of risk, which is exactly what excess return is. Therefore, the excess returns associated with this index just indicate that the fund managers were able to find arbitrage opportunities. Even with that, one could then

argue that by restricting this strategy to hedge funds, it limits the number of investors looking for arbitrage opportunities, allowing each of the investors to find more opportunities than they otherwise would. Hence, allowing mutual funds to pursue this strategy would limit the number of opportunities per fund and thus limit the excess returns. Both of these arguments mean that the government is using its legal authority to restrict excess returns to those who are already wealthy. Again, however, these are possibilities for why excess returns exist, there may be other explanations.

Subsection C: BHCBA

The BHCBA index pursues arbitrage opportunities relating to convertible bonds, and is contained in the relative value index. Convertible bonds are bonds with the ability to be converted into equity. Arbitrage opportunities occur with significant enough divergence between the prices of the convertible bond and the underlying security (Hayes). BHCBA's average return is 0.4016% and its standard deviation is 1.4297%, again, both somewhat midrange for the group. Its Sharpe ratio is 0.2312, the lowest of the group. Its alphas range from 0.1910% to 0.2202%, and its P-Values are from 4.7890 % to 2.0998%. As for how this strategy is able to generate excess returns there are a couple factors at play. First, like the previous strategy, this involves arbitrage opportunities, so if the funds are able to identify and execute arbitrage opportunities, we would expect to see excess returns generated. Unlike the previous fund, mutual funds are allowed to follow a convertible bond arbitrage strategy, however, they are pretty rare (*Absolute*). That means that the level of excess returns may be the proper result of the arbitrage opportunities, or there may also be additional excess returns from the level of awareness about the strategy. If more people were aware of the strategy, it could prompt greater investment, altering prices and limiting excess returns. Since this strategy is employed by some mutual funds, a next step in research would be to see if any of those funds have excess returns.

Subsection D: BHFEMN

BHFEMN is an equity market neutral strategy index, and is also a part of the relative value category. This strategy entails a fund manager going long and shorting very similar stocks, which, if one is long the relatively better performing stock, is meant to perform positively either way the market moves.

Due to this structure, this is considered a pure stock picking strategy, as all the return is generated from the managers ability to pick stocks. If they pick the relatively worse stock, the fund will produce losses either way the market moves as a whole (Chen). BHFEMN's average return is 0.3069%, standard deviation is 0.9355%, and Sharpe ratio is 0.2521, all relatively low for the group. Its alphas are between 0.1146% and 0.1495%, and P-Values between 4.6619% to 0.9645%. We cannot claim that lack of investment activity is the result of this index's excess returns because going long and short on equities is a very common action. As well, this is not some sort of arbitrage activity generating risk free returns. It appears that this alpha is indeed the result of the stock picking ability of fund managers. Many in the investment industry are skeptical of the ability to effectively pick stocks over prolonged periods of time; however, the existence of investors like Warren Buffet and Peter Lynch show that it is possible. This should prompt greater look into the index, as it could potentially be the case that few individual funds can garner significant positive alpha, because most managers do not get a large enough portion of their picks correct; but, the index overall has positive alpha because in each time period a significant enough portion make the right pick, offsetting the wrong picks, and generating excess returns for the index. Additionally, most analyses which produce results showing few managers are able to effectively pick stocks may be suffering from selection biases. These are analyses done with mutual funds, and perhaps all managers who could pick stocks move on to being hedge fund managers, particularly using this strategy, leaving behind only those unable to pick stocks left for the analysis. Although these are just speculations, they are questions that the result of this analysis prompt.

Subsection E: BHVOLA

BHVOLA is the index for hedge funds pursuing a volatility arbitrage strategy, which is also contained in the relative value classification. This entails exploiting the differences in what the managers expect the price volatility of an asset to be and the implied volatility from the derivatives of the asset. For this strategy to work, the manager must be correct about whether or not the actual volatility is more or less than the implied volatility (Downey). BHVOLA has an average return of 0.6404%, standard deviation of 2.1341%, and Sharpe ratio of 0.2668, all of which are high for the group. Its alpha's range

from 0.2791% to 0.2852% and P-Values range from 0.6203% to 0.4964%. Since it requires fund managers to be able to accurately determine whether the actual volatility is more or less the implied volatility, and there's no baseline investment for this strategy, it seems improper to argue that part of the excess return is due to underinvestment from the lack of knowledge about this investment. Instead, it seems more likely that the excess return is a result of an inaccurate measurement of risk – that the price variations do not accurately encapsulate the risk assumed with this strategy – or that this level of excess return is simply the result of seizing these arbitrage opportunities. We cannot determine what exactly is the cause from this analysis, but these are worthwhile strings to tug on for further research.

Subsection F: BHINS

As previously described, BHINS is the index for hedge funds which invest in insurance securities. Its average return is 0.3170% and its standard deviation is 0.8700%, both low for the group. It also has the highest Sharpe ratio, at 0.2827. Its alphas range from 0.2032% to 0.2078%, and its P-Values from 2.1213% to 1.8760%. As compared with the other indices the explanation for excess returns is probably most similar to BHSTCR. Again, this strategy may generate excess returns due to the lack of knowledge about this strategy, and if there was wider knowledge about this strategy and the ability to earn excess returns then more people may invest in it, altering prices, and thus eliminating excess returns. Overall, though, we must remember that the analysis done in this research cannot determine, for certain, the explanations for why there are excess returns; instead, we are proposing possible explanations in order to prompt further research on these topics.

Section IV: Themes

At first, we speculated that due to their correlations we would see the five indices besides BHINS have similar reasons for excess returns. That was not the case, and we even theorized that BHINS and BHSTCR have similar reasons for excess returns. With that said though, there are some general themes which appeared to us.

One is that the excess returns may be a result of limited investment activity, due either to legal restriction or a lack of knowledge. The idea is that if a greater number of investors pursued these

investments that would change the pricing of the securities and eliminate the excess returns. If this is the case for a strategy, that means those excess returns can easily vanish.

As well, another answer for the existence of excess returns is that there are risks associated with the investment which are not captured by the model, and therefore the model says there are excess returns when in reality there are not. The factor models measure the risk of an investment by its variation in returns, so if there are risks which are not captured by those variations in returns, as we saw with BHDL, then the model will say we are getting more return than we would expect for our level of risk, when in reality we are not. In these scenarios, we would say that the shortcomings of the factor models create a mirage of excess returns which do not exist.

Another theme was that arbitrage may be the cause of excess returns. There are five arbitrage-based strategy indices we analyzed, three of which had significant positive alphas, the others were BHSTA and BHFIA. The omission of these two indices from our list of significant positive alphas does not mean that arbitrage does not result in excess returns; as discussed, there are many reasons we would expect an index to not produce a significant positive alpha, such as the fact it is much easier to manage a fund which is inefficient. In these scenarios we would expect some level of excess returns to exist in perpetuity as compensation for the arbitrage activities, though they could be driven lower by increased investment activities with these strategies. Again, the analysis cannot assert any of these possibilities are the reason for these excess returns, they are just hypotheses to guide the next levels of research.

Chapter 5: Conclusion

Unfortunately, our analysis faced numerous hurdles due to the shortcomings of our data, an issue which plagues research into the world of hedge funds. Due to the shroud over our data, we were unable to uncover more information, such as the strength of particular strategies, the characteristics of various funds, or the effects of fund fees, asset turnover, and illiquidity of assets, which Carhart detailed. Despite these challenges, I was able to identify 6 indices with significant positive alphas. These findings point to the efficient market hypothesis being incorrect, since the indices are able to earn excess returns; however, the alphas could be the result of the shortcomings of the analysis, such as a faulty theoretical model, the

improper transformation of that theoretical model into an empirical one, the inability for the models to account for risk not associated with price variation, or some sort of bias in our data. With that said, the analysis of Sharpe ratios provides evidence for genuine alphas for our 6 indices. Their alphas may be the result of limited investment activity – due to legal barriers or perhaps lack of knowledge – which alters the return characteristics. As well, they could be a natural result of arbitrage opportunities, as what makes an arbitrage opportunity is some way to exploit pricing to earn a risk-limited return. There could be additional explanations as well; while our analysis cannot tell us exactly why alpha is there, we can speculate. Due to the data limitations surrounding the analysis of hedge funds, there is a plethora of research waiting to be conducted. While this research is not extensive, it is meant to be an early step into this realm; the results of this analysis provide many opportunities for next steps. From here, further research should be done into the strategies which had excess returns and the funds which employ these strategies. Additionally, research could be done to test the many hypotheses argued here as explanations of excess returns. Furthermore, research should be done on other explanations of alpha, and the other strategies should be examined more closely. Overall, the results of this analysis points preliminarily to the existence of excess returns in some hedge funds.

Appendix

Description of Indices (Sorted by Strategy)

BHEDGE	Bloomberg All Hedge Fund Index
BHEQTY	Bloomberg Equity Hedge Fund Index (Long/Short and Long-biased)
BHEQLS	Bloomberg Equity Long/Short Hedge Fund Index
BHEQLB	Bloomberg Equity Long Biased Hedge Fund Index
BHEQMS	Bloomberg Equity Multi-Strategy Hedge Fund Index
BHEQLO	Bloomberg Equity Long Only Hedge Fund Index
BHCRDT	Bloomberg Credit Hedge Fund Index
BHCRLS	Bloomberg Credit Long/Short Hedge Fund Index
BHSTCR	Bloomberg Structured Credit Hedge Fund Index
BHEMDB	Bloomberg Emerging Market Debt Hedge Fund Index
BHCRMS	Bloomberg Credit Multi-Strategy Hedge Fund Index
BHDL	Bloomberg Direct Lending Hedge Fund Index
BHEVT	Bloomberg Event Driven Hedge Fund Index
BHDIST	Bloomberg Distressed Debt Hedge Fund Index
BHSS	Bloomberg Special Situations Hedge Fund Index
BHMARB	Bloomberg Merger Arbitrage Hedge Fund Index
BHEVMS	Bloomberg Event Driven Multi-Strategy Hedge Fund Index
BHACT	Bloomberg Activist Hedge Fund Index
BHMACR	Bloomberg Macro Hedge Fund Index
BHDMAC	Bloomberg Discretionary Macro Hedge Fund Index
BHCTA	Bloomberg Commodity Trading Advisors Hedge Fund Index
BHGAA	Bloomberg Global Asset Allocation Hedge Fund Index
BHCOM	Bloomberg Commodity Hedge Fund Index
BHMMS	Bloomberg Macro Multi-Strategy Hedge Fund Index
BHCURR	Bloomberg Currency Hedge Fund Index
BHCRYP	Bloomberg Cryptocurrency Hedge Fund Index
BHRV	Bloomberg Relative Value Hedge Fund Index
BHSTA	Bloomberg Statistical Arbitrage Hedge Fund Index
BHCBA	Bloomberg Convertible Bond Arbitrage Hedge Fund Index
BHFIA	Bloomberg Fixed Income Arbitrage Hedge Fund Index
BHRVMS	Bloomberg Relative Value Multi Strategy Hedge Fund Index
BHFEMN	Bloomberg Fundamental Equity Market Neutral Hedge Fund Index
BHQEMN	Bloomberg Quantitative Equity Market Neutral Hedge Fund Index
BHVOLA	Bloomberg Volatility Arbitrage Hedge Fund Index
BHINS	Bloomberg Insurance Hedge Fund Index

Appendix 1

Description of Indices (Alphabetical)

BHACT	Bloomberg Activist Hedge Fund Index
BHCBA	Bloomberg Convertible Bond Arbitrage Hedge Fund Index
BHCOM	Bloomberg Commodity Hedge Fund Index
BHCRDT	Bloomberg Credit Hedge Fund Index

BHCRLS	Bloomberg Credit Long/Short Hedge Fund Index
BHCRMS	Bloomberg Credit Multi-Strategy Hedge Fund Index
BHCRYP	Bloomberg Cryptocurrency Hedge Fund Index
BHCTA	Bloomberg Commodity Trading Advisors Hedge Fund Index
BHCURR	Bloomberg Currency Hedge Fund Index
BHDIST	Bloomberg Distressed Debt Hedge Fund Index
BHDL	Bloomberg Direct Lending Hedge Fund Index
BHDMAC	Bloomberg Discretionary Macro Hedge Fund Index
BHEDGE	Bloomberg All Hedge Fund Index
BHEMDB	Bloomberg Emerging Market Debt Hedge Fund Index
BHEQLB	Bloomberg Equity Long Biased Hedge Fund Index
BHEQLO	Bloomberg Equity Long Only Hedge Fund Index
BHEQLS	Bloomberg Equity Long/Short Hedge Fund Index
BHEQMS	Bloomberg Equity Multi-Strategy Hedge Fund Index
BHEQTY	Bloomberg Equity Hedge Fund Index (Long/Short and Long-biased)
BHEVMS	Bloomberg Event Driven Multi-Strategy Hedge Fund Index
BHEVT	Bloomberg Event Driven Hedge Fund Index
BHFEMN	Bloomberg Fundamental Equity Market Neutral Hedge Fund Index
BHFIA	Bloomberg Fixed Income Arbitrage Hedge Fund Index
BHGAA	Bloomberg Global Asset Allocation Hedge Fund Index
BHINS	Bloomberg Insurance Hedge Fund Index
BHMACR	Bloomberg Macro Hedge Fund Index
BHMARB	Bloomberg Merger Arbitrage Hedge Fund Index
BHMMS	Bloomberg Macro Multi-Strategy Hedge Fund Index
BHQEMN	Bloomberg Quantitative Equity Market Neutral Hedge Fund Index
BHRV	Bloomberg Relative Value Hedge Fund Index
BHRVMS	Bloomberg Relative Value Multi Strategy Hedge Fund Index
BHSS	Bloomberg Special Situations Hedge Fund Index
BHSTA	Bloomberg Statistical Arbitrage Hedge Fund Index
BHSTCR	Bloomberg Structured Credit Hedge Fund Index
BHVOLA	Bloomberg Volatility Arbitrage Hedge Fund Index

Appendix 2

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