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THE EMPIRICAL ANALYSIS OF PERFORMANCE DIFFERENCES OF HEDGE FUND INVESTABLE INDICES FROM NON-INVESTABLE INDICES

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TOPICS IN FIXED INCOME STRATEGIES
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Summary

Hedge fund indices provide us an overview of the performances of hedge funds. Hedge fund non-investable indices are regarded as the benchmarks and investable indices are their fully-investable counterparts. The target of this paper is to dig into the performance differences between hedge fund non-investable and investable indices, attempting to compare and analyze the extent of difference, to explore the factors that result in the differences, and to examine the performances of investable indices. According to the summary statistics, it is apparent that non-investable indices outperform the corresponding investable indices. Furthermore, the extent of the differences for each strategy is observed, and some of the differences are statistically different from zero, regardless of the sample period studied. After having an overview of performance differences, I use the Carhart four-factor model so as to explore the factors leading to the difference for each strategy-specific index. The majority of the differences are exposed to the market factor, and produce significantly negative alpha returns. Last but not least, same model is implemented on the performances of the investable indices, discovering that all investable indices have exposure to the market factor. More importantly, by adding

the performances of non-investable indices as an explanatory variable, the beta coefficients of performances of corresponding benchmarks and the negative alpha returns imply that the investable indices are less efficient than their non-investable counterparts.

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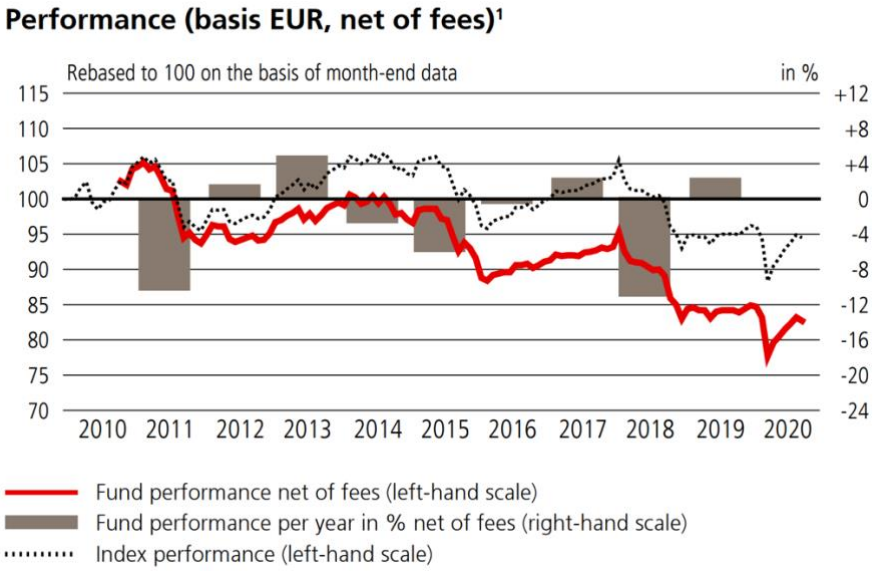
CHAPTER 1. INTRODUCTION

Hedge fund indices provide an overview of performance of hedge funds, regarded as representative benchmarks of hedge funds. The indices can be categorized as non-investable indices and investable indices. The former is constructed to capture the breadth of hedge fund performance trends across strategies and regions. The latter provides an opportunity to exploit tactical asset allocation strategies for investors to achieve benchmark performance or hedge fund returns. Included hedge funds of both non-investable and investable indices are required to meet specified criteria of index providers. However, previous researches and analyses provide evidence that the performance distinction between non-investable and investable indices exhibits, this paper has the similar results and further find that the magnitude of the difference varies from strategies to strategies. Based on the average performance, the majority of benchmark indices are superior performers. In addition, the performance during the crisis period — the financial crisis in 2008 and COVID-19 in 2019 and 2020 — are discussed.

With the explosive growth in number of hedge funds, hedge fund investable indices related products came to existence as well. For example, UBS issues an ETF that tracks the performance of HFRX index, which is the investable index for Hedge Fund Research. The name of the fund is "UBS (IE) Fund Solutions plc – HFRX Global Hedge Fund Index SF UCITS ETF", and the fund is passively managed. The investment objective of the fund is to deliver the net total return performance of the HFRX Global Hedge fund Index. The fund replicates synthetically the index performance by investing in a swap. The net asset value is 81.0551 in EUR (updated on October 27th, 2020), and the total shares outstanding is approximately 70,000. Noticeably, it is the first ETF in the market providing access to

the HFR Global Hedge Fund Index. The performance of the fund is displayed as follow:

Figure 1: Fund Performance from 2010 to 2020



The investors who are willing to but not able to invest directly in hedge funds might seek alternatives such as investable indices and related products. What investable indices actually perform becomes a concern and focus for those investors. Moreover, many investors believe they are able to gain higher returns through investing hedge funds in comparison with traditional investment vehicles. Accordingly, this paper further attempts to figure out the performance of investable indices themselves as well, to see whether they yield benchmark-like performance or whether the investment is worthwhile.

Concerning the data, three potential biases can arise when using the hedge fund indices to examine the performances. An “selection” bias occurs if hedge fund indices select hedge funds that are not representative of the universe of hedge funds. An “survivorship” bias occurs if hedge fund

indices tend to view the performance of existing hedge funds in the market as a representative comprehensive sample. An "instant" history bias occurs if database providers backfill a hedge fund's performance when adding a new fund into their indices. By selecting the adequate sample period, from the end of 2004 to 2020, I attempt to avoid survivorship bias and instant history bias. Aside from issues on data collection methods, selection bias is a natural consequence of the way hedge fund industry is organized.

With respect to the methodology, Fama and French (1992) identify five common risk factors in returns on stocks and bonds, three stock-market factors and two bond-market factors. This paper focuses on the former three stock-market factors. Their results can be used in evaluating portfolio performance. The exposures of a candidate portfolio to the risk factors can be estimated with a regression of the portfolio's past excess returns on the explanatory returns. The results suggest that a model which uses three stock-market factors, $R_m - R_f$, SMB, and HML, does well in explaining the common time-series variation in stock returns and the cross-section of average stock returns. Carhart (1997) further introduces the momentum factor to the model. The Fama-French three-factor model and Carhart four-factor model are pervasively applied to hedge fund performance; see Agarwal et al.(2009), Bollen and Whaley (2009), Bali et al.(2010). Therefore, the Carhart four-factor model is selected to analyze the performance difference and investable index performance.

This paper is organized as follows. Chapter 2 summarizes the relevant hedge fund and hedge fund index literature. Chapter 3 describes the data and factors used in the empirical analyses. Chapter 4 presents empirical results and regression results. Chapter 5 concludes the paper.

CHAPTER 2. LITERATURE REVIEW

SECTION 1. HEDGE FUNDS

Hedge funds present return profiles that are dissimilar with mutual funds. They claim to focus on absolute returns and can achieve the absolute return focus due to the various financial instruments and portfolio compositions. They can use derivative instruments such as options and futures and are able to bet on price declines by short-selling securities unlike traditional investment vehicles. Moreover, hedge funds have the ability of the usage of leverage. Hedge funds are typically organized as private investment vehicles for wealthy individuals and institutional investors. They are private pools of capital in the sense that ownership claims in hedge funds are not traded in organized exchanges. Since hedge funds are generally offered by private placements, they are exempted from the registration and disclosure requirements. There is not much transparency regarding their operations, risk and performance.

In addition, hedge funds are not liquid investments. There are lock-up periods which correspond to minimum amounts of time that investors are required to keep their money in the invested hedge funds before the permission of capital withdrawal. Even when being allowed to redeem their money, there are certain conditions that need to be satisfied. Redemption periods are often set at the end of fiscal quarters but they can even be less frequent. Moreover, an advance notice up to three months should be given to the hedge funds before redemption.

Furthermore, reported by Fung and Hsieh (1997) and verified by Brown et al. (1999), there are

many hedge-fund styles and each exhibits different return characteristics. In addition, Fung and Hsieh (1997) also find evidence that some of the styles can generate option-like returns. For example, "Systems/ Trend Following" refers to traders who use technical trading rules and take occasional bets on market events. "Global Macro" refers to managers who primarily trade in the most liquid markets in the world, betting on macroeconomic events such as changes in interest rate policies and currency devaluations. "Distressed" refers to managers who invest in companies close to, in, or recently emerged from bankruptcy or corporate restructuring.

The explosive growth of hedge funds both in numbers and in assets under management during the last two decades, leading to a significant number of studies and analyses on hedge fund performance. For example, Ackermann et al. (1999) show that since hedge funds have flexible investment strategies, strong managerial incentives, substantial managerial investment, sophisticated investors and limited government oversight, they consistently outperform mutual funds, but not standard market indices. Agarwal and Naik (2000) investigate persistence in the performance of hedge funds using a multi-period framework in which the likelihood of observing persistence by chane is lower than in the traditional two-period framework. Kosowski et al. (2007) find that top hedge fund performance cannot be explained by luck, and performance persist at annual horizons. Choi et al. (2009) link the aggregate convertible bond issuance to convertible bond arbitrage hedge fund flows, returns, and a proxy for arbitrageurs' use of leverage, finding that issuance is positively related to increases in all three capital supply measures.

The performance of hedge funds during the crisis is also discussed. Metzger and Shenai (2019)

analyze performance of various strategies during and after the crisis, using correlations, the Carhart four-factor model, persistence of performance, and reward-risk ratios. They find that some hedge fund strategies which have persistent performances are also able to outperform the benchmark in some periods. In crisis period, all strategies did better than the S&P 500. Over the entire period of the research (June 2007 to January 2017), seven strategies performed better than the S&P 500. Chelikani et al. (2019) attempt to find evidence of superior predictive ability of hedge fund managers by examining the performance of hedge funds prior to, during, and after the financial crisis. Their results show that there was no convincing evidence that hedge fund managers are able to anticipate market events and to implement superior strategies during the crisis.

SECTION 2. HEDGE FUND INDICES

Hedge fund indices are, according to their providers, recognized as the industry standard for hedge fund performance benchmarking. Investable hedge fund indices are fully investable strategy-based, providing investors an alternative to seek exposure to those indices. Investors can typically achieve the benchmark performance through the investable tracking funds, especially the investors who are willing to, yet not eligible to, invest directly into the hedge funds. The constituents of the investable indices are selected through rules-based measures and are rebalanced on a particular period basis. Performance of both indices is typically monthly-reported.

Hedge funds, at variance with mutual funds or pension funds, are exempted from disclosure requirements. Accordingly, hedge fund indexing seems to unveil the mystique of hedge funds regarding the performance. Academics and researchers have been long discussing about the

advantages and disadvantages of hedge fund indexing; for example, Amin and Kat (2003), Goltz et al. (2007), Switzer and Omelchak (2008). Among the discussion of shortcomings and deficiencies of available hedge fund indices, analysts generally point out the lack of representativeness, the overlapping reporting period, and non-audited data that are provided. Both non-investable and investable index offerings suffer from heterogeneity, and from that angle selection of one or the other will have significant consequence. Kugler et al. (2010) investigate the consistency of style returns of hedge funds across eight providers of style indices. Their findings reveal a substantial degree of heterogeneity of index returns within the same style and cast serious doubts on their usefulness as benchmarks in the asset management industry. Furthermore, similar to hedge funds, numerous data biases exhibit as well, for example, selection bias, backfilling, survivorship bias. In contrast, Gehin and Vaissie (2004) wonder whether some of the bias is mitigated in the construction of investable hedge fund indices. Heidorn et al. (2010) argue that investable indices investable funds did not suffer from survivorship or backfilling bias. Consequently, investable hedge fund indices might be regard as more indicative and suitable hedge fund benchmarks as they reduce the biases that tend to overstate the performance (Amin and Kat, 2003).

In terms of the performance of hedge fund indices, especially for the non-investable indices. For instance, Liew (2003) indicates that an actively managed fund of funds with good discernment can beat a passive hedge fund investment, arguing that passive hedge fund index investment is not a good alternative for an active search for skilled hedge fund managers. Brooks and Kat (2002) find that the published hedge fund indices exhibit relatively low skewness and high kurtosis. They demonstrate that although hedge fund indices are highly attractive in mean-variance terms, this is much less the

case when skewness, kurtosis, and autocorrelation are taken into account. Therefore, Sharpe ratios will substantially overestimate the true risk-return performance of (portfolios containing) hedge funds. Amin and Kat (2003) apply the evaluation model, which does not require any assumptions with regard to the return distribution of the funds to be evaluated, to 13 hedge fund indices. They find 12 indices to be inefficient, with the average efficiency loss amounting to 2.76% per annum. Switzer and Omelchak (2008) focus on the risk-adjusted performance of dynamic asset allocation strategies across hedge fund indices. Out-of-sample results indicate that all hedge fund index portfolios largely outperform the S&P 500 Index, both on an expected return and risk-adjusted return basis, after accounting for transaction costs. Boyson et al. (2010) use monthly hedge fund index data for the period January 1990 to October 2008 and find that worst hedge fund returns cluster across styles. Large adverse shocks to asset and hedge fund liquidity strongly increase the probability of contagion. While shocks to liquidity are important determinants of hedge fund index performance, these shocks are not captured by commonly used models of hedge fund returns. Atilgan et al. (2013) investigate the performance of various strategy specific and composite hedge fund indices. They find that most hedge fund indices have highly negative returns during market downturns although many hedge fund indices outperform a broad equity index in the full sample period. On the other hand, Boigner and Gadzinski (2015) put more emphasis on investable indices. They show the evidence that including hedge fund investable indices in a traditional portfolio is effective in mitigating volatility and drawdown. Knif et al. (2020) use a higher moment capital asset pricing model to characterize the returns of several types of hedge fund indices. The hypothesis that the parameters are stable across the distribution of returns is tested and rejected. The importance of higher co-moments (i.e., higher co-skewness and co-kurtosis) is more prevalent at the tails of the distribution of returns suggesting that there are significant tail risks.

With respect to the comparison between broad and investable indices, several studies have been conducted. Heidorn et al. (2010) suggest that investable indices underperformed their correspodnding benchmarks according to standard performance metrics. Similarly, Atilgan et al. (2013) find that non-investable indices are superior performers with respect to their investable counterparts. Boigner and Gadzinski (2013) also discover that investable indices perform worse than their corresponding hedge fund benchmarks even though some selected investable hedge fund strategies may appear worthwhile when using only risk metrics that allow for more aggressive risk tastes. Nonetheless, despite the fact that most of the research articles suggest that non-investable hedge fund indices overall outperform their investable counterparts, discovering the existence of the distinction between the hedge fund indices, few of them examine the factors of the performance difference.

The first step of this paper is to reassess how non-investable and investable indices perform during the last two decades. I visualized the average cumulative returns on both non-investable and investable indices. The return differences of investable indices from their corresponding broad indices are observed. I further dig into the one-sample t-test for the average monthly returns on investable indices minus the average performance of non-investable indices. Summary statistics provide the extent of distinction, average performance, and standard deviations for all strategies and return differences. According to t-statistics and average monthly returns, similar to previous researches, the result that the broad indices are superior to their corresponding investable indices is apparently suggested. The t-values indicates that a number of return differences are statistically different from zero, and that the extent of return differences are various among strategies. In addition, the

performances during particular periods when big events occurred— financial crisis in 2008 and COVID-19 in 2019 and 2020— are discussed.

The next step is to investigate the possible factors that give rise to the performance distinction using the Carhart four-factor model. The model allows us to clarify the exposures of return differences with their underlying investment strategies to the four common risk factors, the market, size, value, and momentum factors. Furthermore, it is evident that the performance differences are generally exposed to the market factor and that the excess returns of most of the differences are significantly negative. One might wonder whether investable indices produce positive excess returns. Accordingly, I run regressions on the monthly returns on the investable indices so as to see whether they produce positive excess returns. More importantly, the performances of the investable indices are inferior to the performances of their benchmarks when taking same or more amount of risk.

CHAPTER 3. DATA DESCRIPTION

SECTION 1. CREDIT SUISSE INDICES

Two of the most representative hedge fund data providers are selected, Credit Suisse and Hedge Fund Research, both of which offer hedge fund benchmark indices as well as investable indices. The Credit Suisse Hedge Fund Index was the industry's first asset-weighted broad index, providing a more accurate depiction of an investment in the asset class. Funds within the index are separated into ten sub-strategies that track individual hedge fund strategies. The methodology utilized to create the index starts by defining the universe it is measuring. The Credit Suisse Hedge Fund Index in all cases represents at least 85% of the assets under management (AUM) in each respective category. The methodology analyzes the percentage of assets invested in each subcategory and selects funds for the index based on those percentages. Fund weight caps may be applied to enhance diversification and limit concentration risk. The index is calculated and rebalanced monthly.

The Credit Suisse AllHedge Index is a fully investable strategy-based fund index derived from the Credit Suisse Hedge Fund Index, designed to provide transparent, representative, and objective benchmarks of the ten style-based investment strategies of the hedge fund universe. The index is composed of eligible hedge funds that meet specified eligibility conditions. Index performance data is published monthly and constituents are rebalanced semi-annually. Notably, the discussion would not include the strategy "Equity Market Neutral" due to the fund management issue in financial crisis (see Appendix A for details). Since the AllHedge Index provides data since 2004, the sample period starts at the end of 2004 and ends at the end of 2020, attempting to eliminate the survivorship bias and the

instant history bias. However, the data of "Dedicated Short Bias" was provided until 2017 and thus the sample period is from 2004 to 2017.

SECTION 2. HEDGE FUND RESEARCH INDICES

The HFRI index are broadly constructed with composite and five main strategy-specific sub-indices as a benchmark index. Constituents are equally weighted, presenting a more general picture of performance of the hedge fund industry. Any bias towards the larger funds potentially created by alternative weightings is reduced, especially for strategies that encompass a small number of funds. If a fund in an index liquidates or closes, the fund's performance will be included in the HFRI up to the fund's last reported performance update. Hedge funds are required to meet specified criteria to be eligible for inclusion. For instance, funds should meet the AUM minimum eligibility criteria, and have a fund vehicle open for new investment. All indices are rebalanced on an annual basis.

The HFRX index, as the investable counterpart of the HFRI index, constructed by utilizing a UCITS compliant methodology. The methodology includes robust classification, cluster analysis, correlation analysis, advanced optimization and Monte Carlo simulations. The included hedge funds must meet the criteria for inclusion as determined by a rigorous quantitative selection process. For instance, cluster, correlation analyses as well as Monte Carlo simulations are performed to group managers to determine adequate number and types of managers. Selected managers must provide transparency and pass extensive qualitative screening. All HFRX indices are rebalanced quarterly. For the sake of comparison, the data period is identical to the sample period of the Credit Suisse indices. Notably, the Composite and Emerging Market strategies have smaller observations owing to the data

provided.

SECTION 3. CARHART FOUR FACTORS

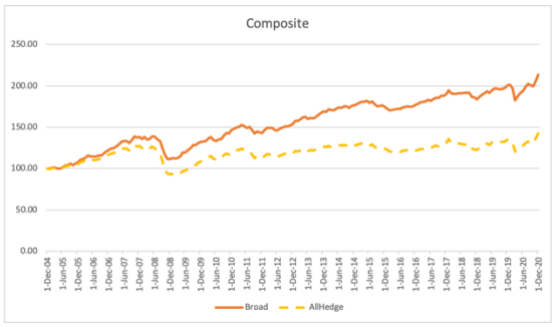
The four factors of the Carhart model are provided from the Kenneth R. French database. The Fama-French SMB and HML factors are constructed using the 6 value-weight portfolios formed on size and book-to-market. Another factor, the excess return on the market, is value-weight return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ that have a CRSP share code of 10 or 11 at the beginning of month t, good shares and price data at the beginning of t, and good return data for t minus the one-month Treasury bill rate. Eventually, the momentum factor is constructed by using 6 value-weight portfolios formed on size and prior (2-12) returns. The portfolios formed monthly are the intersections of 2 portfolios formed on size (market equity) and 3 portfolios formed on prior (2-12) return. In order to be consistent with other data, the factors are monthly returns with same selected sample period.

CHAPTER 4. EMPIRICAL ANALYSIS AND REGRESSION RESULTS

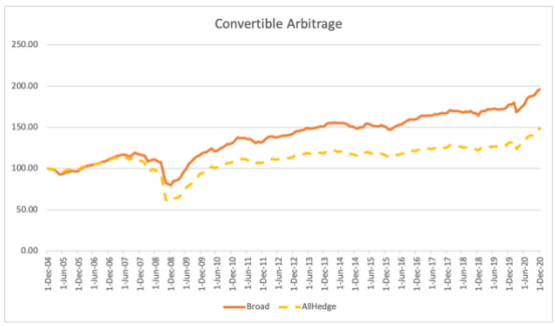
SECTION 1. PERFORMANCE DIFFERENCES

Figure 2 and 3 show the average cumulative returns on Credit Suisse Indices and Hedge Fund Research Indices, where the non-investable and investable indices are paired as strategy-based. The graphs allow us to have a basic concept of the existence of divergence between the performance of non-investable and investable indices. For both Credit Suisse and Hedge Fund Research Indices, the performance difference is apparently observed. In addition, we can observe that most of the non-investable indices outperform their investable counterparts.

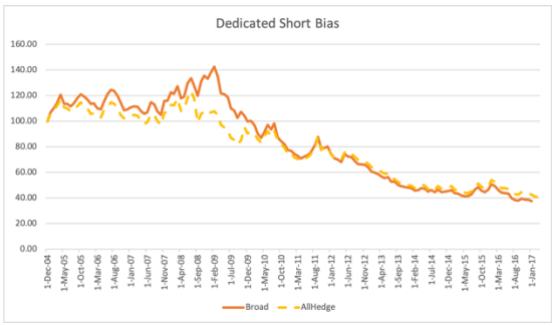
Figure 2: Performance Difference of Credit Suisse Indices



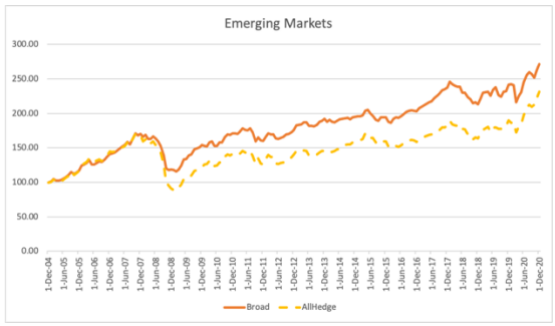
(a)Composite



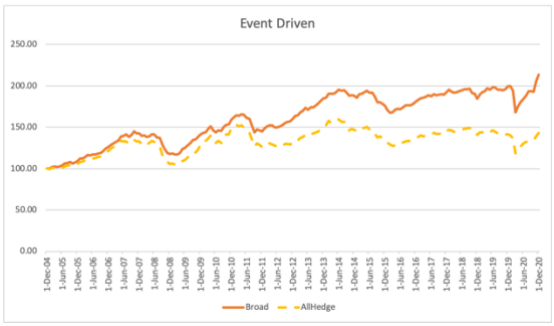
(b)Convertible Arbitrage



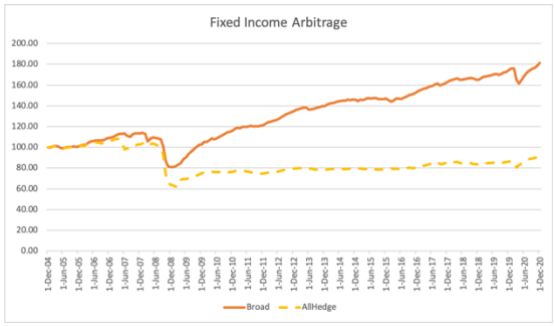
(c)Dedicated Short Bias



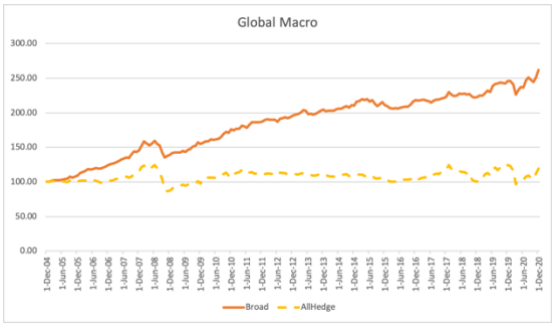
(d)Emerging Markets



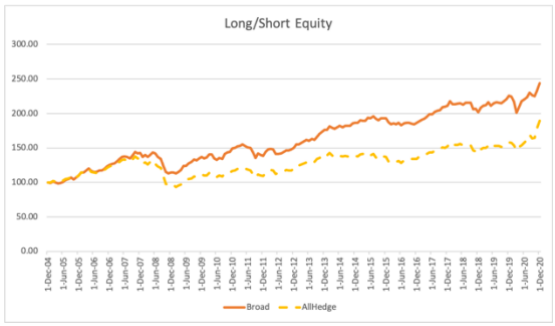
(e)Event Driven



(f)Fixed Income Arbitrage

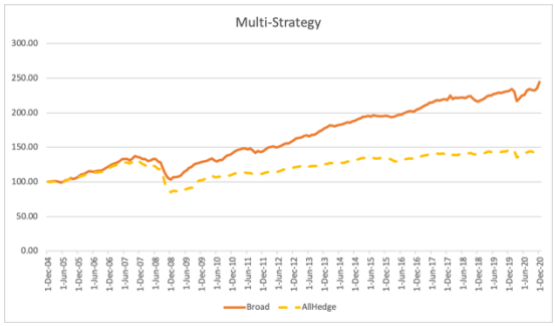


(g)Global Macro



(h)Long/Short Equity

(i)Managed Futures



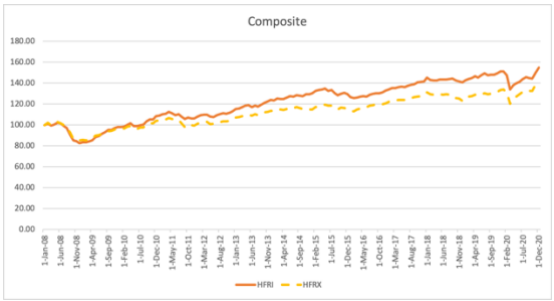
(j)Multi-Strategy

Ford et al. (2012) explore investor concerns for greater liquidity in hedge funds. Their findings provide evidence of hedged fund strategies offering the highest levels of liquidity. Managed Futures, Convertible Arbitrage as well as other macro strategies provide investors the greatest amount of liquidity, since the underlying assets held by the funds of these strategies tend to be more liquid. In cases where a lock-up period in place, these strategies also tend to be short, at an average of 2.3 months for Managed Futures and Convertible Arbitrage, 2.9 months for other macro strategies respectively. On the other hand, Event Driven hedge fund offer their investors the lowest levels of liquidity among

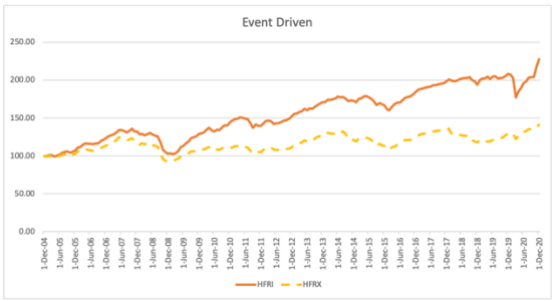
all hedge fund strategies, with the majority of funds offering quarterly redemption.

Strategies with high liquidity and shorter time horizons are expected to have smaller return differences, whereas strategies with low liquidity and longer time horizons are expected to have larger return differences. As shown in Figure 2, two strategies appear to barely have difference between the non-investable and investable indices: Dedicated Short Bias and Managed Futures. Managed Futures is recognized as a short-term strategy which provides high liquidity, and thus consistent with the results. Interesting, the underlying assets of Dedicated Short Bias are less liquid stocks. Additionally, Convertible Arbitrage and Global Macro are considered to be strategies offering liquidity with relatively short time horizons, yet we still observe apparent return differences. Global Macro even appear to have larger gaps between the performances as well as Fixed Income Arbitrage. The phenomena of Fixed Income Arbitrage might result from redemption. The funds consist of a wide range of trades and some strategies require longer time horizons to achieve higher returns. The redemption, however, restricts the managers to pursue longer-time-horizon strategies and thus managers' performance might be limited under such circumstance. Event Driven provides the lowest levels of liquidity, argued as Ford et al., doesn't appear to have larger return differences than others.

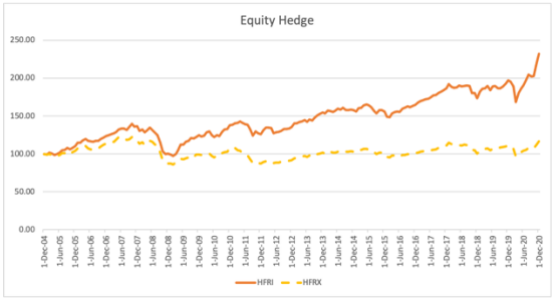
Figure 3: Performance Difference of Hedge Fund Research Indices



(a)Composite

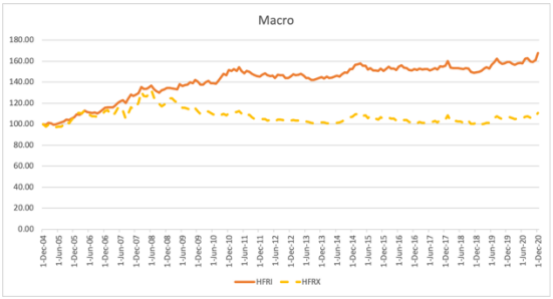


(b)Event Drive

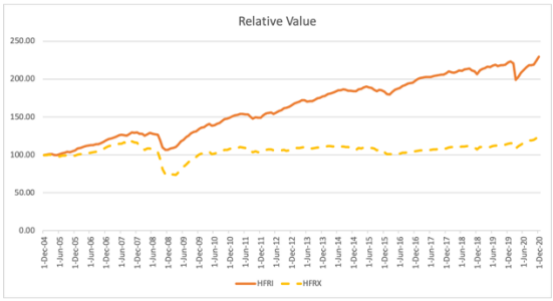


(c)Equity Hedge

(d)Emerging Markets



(e)Macro



(f)Relative Value

Figure 3 give us the abstract of performance difference for Hedge Fund Research. The Emerging Markets strategy appear to have the smallest distinction among all strategies. One possible explanation is that investable indices are vulnerable to liquidity issue, and therefore the selected funds avoid the least liquid market, leading to better performance. The result consistent with the expectation that higher liquidity leads to smaller return differences. Macro is also considered to be highly-liquid yet the difference is not smaller than other strategies. The Composite indices appear to have little distinction as well. Event Driven, on the other hand, exhibits return difference but the difference does not appear to be relatively larger than others.

Accordingly, the expectations seem not to be consistent with the results. The strategies offering high levels of liquidity is not definitely related to smaller return differences; the strategies offering low levels of liquidity, on the other hand, do not absolutely appear to have larger return differences.

Other factors and managers' skills and performance might have an impact on the return differences as well.

I further look at the performances during the crisis periods — the financial crisis in 2008 and the COVID-19 in 2019 and 2020. In most cases, we can observe significant drops during the panics, except for Dedicated Short Bias and Managed Futures for Credit Suisse. Additionally, during the crisis periods, most non-investable indices are still superior to the investable indices. It is possible that redemption results in the situation where investors desire to withdraw capitals yet constraining the fund managers' flexibility of selection of investing strategies. Namely, they cannot pursue strategies having underlying investable instruments that require longer time horizons to achieve returns. Therefore, the managers' skills might be limited under this situation. Moreover, during crisis periods, investors have a tendency to moving to assets with higher liquidity, and thus a substantial amount of capital are withdrawn from the funds. As mentioned above, liquidity plays different roles in different strategies and gives different answers. When liquidity becomes an issue during crisis period, it would result in performance difference. As presented in Managed Futures and Dedicated Short Bias, the gap between the performance of two indices is larger in financial crisis 2008. Redemption and time horizons of strategies also play a vital role in the performance as well as performance difference. Consequently, during the crises, non-investable indices are able to tolerate market panics better than investable indices. However, the explanations are inferred merely from the index performance. If having more details of what the managers actually implement, the answer would be more explicit.

For the purpose of more precise comparison, I further dived into the t-test for average monthly

returns on each pair to capture the magnitude of difference. One-sample t-test provides evidence to see whether the difference between the average monthly returns of investable and broad indices are significantly different from zero or not. It can be mathematically expressed as:

$$t = \frac{(\overline{X_i} - \overline{X_{ni}}) - \mu}{s_{i-ni} / \sqrt{n}}$$

where $\overline{X_i}$ is the average monthly return on the investable index, $\overline{X_{ni}}$ is the average monthly return on the corresponding broad index, μ is set as zero, and s_{i-ni} is the standard deviation of the performance difference. Accordingly, when focusing on the t-value calculated as above, we can have a better interpretation whether the performance distinctions of those pairs are statistically different from zero. The t-statistics, mean, and standard deviations are summarized in Table 1 and 2.

Table 1: Summary Statistics of Credit Suisse Indices

Strategy	t	$\overline{X_i}$	$\overline{X_{ni}}$	$\overline{X_i - X_{ni}}$	s_i	s_{ni}	s_{i-ni}
Composite	-5.183	0.21	0.42	-0.21	1.90	1.62	0.56
Convertible Arbitrage	-1.775	0.25	0.37	-0.13	2.64	2.02	1.00
Dedicated Short Bias	0.585	-0.55	-0.61	0.09	4.31	4.29	1.83
Emerging Markets	-0.634	0.50	0.56	-0.06	3.40	2.71	1.33
Event Driven	-3.879	0.22	0.43	-0.21	2.20	2.05	0.74
Fixed Income Arbitrage	-3.639	-0.02	0.33	-0.34	2.21	1.66	1.31
Global Macro	-2.920	0.13	0.52	-0.38	2.83	1.59	1.83
Long/Short Equity	-1.971	0.37	0.50	-0.13	2.38	2.18	0.90
Managed Futures	-0.322	0.24	0.26	-0.02	3.04	3.00	0.75
Multi-Strategy	-3.632	0.23	0.48	-0.26	1.79	1.53	0.98

For Credit Suisse Indices, we can observe performance distinction from the t-statistics as well as the average performances of both indices in Table 1. According to the average

performances, benchmark indices have better performances than their corresponding investable funds, except for Dedicated Short Bias. Additionally, the broad index of Dedicated Short Bias is the only one that has negative mean returns, yet the standard deviations are the highest. Based on the t-statistics, five strategies are statistically different from zero: Composite, Event Driven, Fixed Income Arbitrage, Global Macro, and Multi-Strategy. Among them, Composite has the lowest t-value -5.183, suggesting that the distinction is substantial.

Table 2: Summary Statistics of Hedge Fund Research Indices

Strategy	t	$\overline{X_i}$	$\overline{X_{ni}}$	$\overline{X_i - X_{ni}}$	s_i	s_{ni}	s_{i-ni}
Composite	-1.371	0.22	0.28	-0.06	1.58	1.65	0.55
Event Driven	-3.361	0.21	0.46	-0.25	1.84	2.02	1.05
Equity Hedge	-5.212	0.11	0.48	-0.37	2.23	2.57	0.99
Emerging Markets	-0.912	0.51	0.53	-0.02	2.75	3.25	1.26
Macro	-2.329	0.07	0.28	-0.21	1.89	1.35	1.23
Relative Value	-4.400	0.14	0.45	-0.31	1.99	1.47	0.98

As presented in Table 2, the summary statistics indicate that the non-investable indices of all strategies for Hedge Fund Research outperform the investable indices. All indices give positive average performances. Especially for both indices of Emerging Markets, the average monthly returns are the highest among all as well as the highest standard deviations. Regarding the t-statistics, over half of the strategies are significantly different from zero: Event Driven, Equity Hedge, Macro and Relative Value. Equity Hedge has the lowest t-value -5.212, implying the relatively considerable difference.

SECTION 2. FACTORS IN RETURN DIFFERENCES

After having an overview of the performance divergence between the non-investable and investable indices, I attempt to discover the underlying factors that lead to the difference. For the sake of evaluating the performance differences, I use the Carhart four-factor model to see the exposure to the common risk factors for monthly return differences. Mathematically, it can be illustrated as:

$$R_i - R_{ni} - R_{ft} = \alpha + \beta_{MKT}(R_m - R_{ft}) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{UMD}UMD_t + \epsilon_t$$

where R_i stands for the monthly return on investable indices at time t, R_{ni} stands for the monthly return on non-investable indices at time t, $(R_m - R_{ft})$ is the excess return on market, HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios, and UMD is the momentum factor, which is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios.

Table 3 and 4 provide the regression results of Credit Suisse Indices and Hedge Fund Research Indices. Overall, most of the return differences are generally exposed to the market risk factor, for both Credit Suisse and HFR Indices, except for Event Driven, Multi-Strategy for Credit Suisse, Composite and Macro for Hedge Fund Research. Among them, the return differences of Managed Futures for Credit Suisse, Event Driven, Equity Hedge and Emerging Markets for HFR have negative correlations with the market factor. In terms of Credit Suisse, some strategies are negatively related to the value risk, size risk and momentum factors, whereas Event Driven has a positive correlation with

the momentum factor. Regarding Hedge Fund Research Indices, a number of strategies have exposures to the size and value factors, while some of them have positive correlations and others have negative correlations. Most strategies are exposed to the momentum factor as well, yet Relative Value has a negative correlation. Nevertheless, the adjusted R-squares indicate that those factors can scarcely explain the return distinction between the non-investable and investable indices, none of which is above 0.2 for Credit Suisse Indices and none of which is above 0.3 for Hedge Fund Research Indices.

Table 3: Carhart Four-Factor Regression Results of Return Difference (Credit Suisse)

Carhart four−factor Regression Results of Return Difference (Credit Suisse)

	Dependent variable:									
	Composite	Convertible Arbitrage	Dedicated Short Bias	Emerging Markets	Event Driven	Fixed Income Arbitrage	Global Macro	Long/Short Equity	Managed Futures	Multi−Strategies
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MKT	0.064***	0.072***	0.177***	0.109***	0.011	0.055**	0.154***	0.042**	−0.042***	0.016
	(0.010)	(0.019)	(0.040)	(0.024)	(0.014)	(0.024)	(0.032)	(0.017)	(0.014)	(0.018)
SMB	−0.031*	−0.011	−0.143**	−0.068	0.033	0.023	−0.051	0.010	−0.026	−0.080**
	(0.017)	(0.033)	(0.070)	(0.043)	(0.025)	(0.042)	(0.057)	(0.030)	(0.025)	(0.033)
HML	−0.023	−0.050*	−0.049	−0.043	0.012	−0.016	−0.026	−0.052*	−0.008	0.009
	(0.015)	(0.029)	(0.063)	(0.038)	(0.022)	(0.037)	(0.050)	(0.027)	(0.022)	(0.029)
MOM	−0.004	−0.022	−0.018	−0.022	0.036**	−0.055**	−0.052	−0.021	−0.030**	0.016
	(0.010)	(0.018)	(0.036)	(0.024)	(0.014)	(0.024)	(0.032)	(0.017)	(0.014)	(0.018)
Constant	−0.365***	−0.300***	−0.110	−0.256***	−0.320***	−0.491***	−0.610***	−0.279***	−0.083	−0.363***
	(0.039)	(0.073)	(0.147)	(0.095)	(0.055)	(0.093)	(0.127)	(0.067)	(0.055)	(0.072)
Observations	193	193	146	193	193	193	193	193	193	193
Adjusted R^2	0.185	0.087	0.115	0.100	0.023	0.080	0.143	0.044	0.054	0.016

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4: Carhart Four-Factor Regression Results of Return Difference (Hedge Fund Rese)

Carhart four-factor Regression Results of Return Difference (Hedge Fund Research)

	Dependent variable:					
	Composite	Event Driven	Equity Hedge	Emerging Markets	Macro	Relative Value
	(1)	(2)	(3)	(4)	(5)	(6)
MKT	0.003	−0.034*	−0.071***	−0.080***	−0.007	0.060***
	(0.011)	(0.018)	(0.017)	(0.023)	(0.023)	(0.018)
SMB	0.037*	−0.045	−0.067**	0.007	0.008	−0.045
	(0.020)	(0.032)	(0.029)	(0.040)	(0.041)	(0.031)
HML	−0.006	−0.122***	0.016	0.065*	0.012	−0.101***
	(0.017)	(0.028)	(0.026)	(0.036)	(0.036)	(0.027)
MOM	−0.011	0.004	0.037**	0.052**	0.057**	−0.044**
	(0.011)	(0.018)	(0.016)	(0.023)	(0.023)	(0.018)
Constant	−0.119**	−0.361***	−0.407***	−0.041	−0.304***	−0.483***
	(0.046)	(0.071)	(0.065)	(0.090)	(0.090)	(0.069)
Observations	156	193	193	192	193	193
Adjusted R^2	0.020	0.171	0.218	0.104	0.023	0.112
Note:						*p<0.1; **p<0.05; ***p<0.01

Concerning the alpha returns, for Credit Suisse Indices, all return differences give significantly negative excess returns except for Dedicated Shor Bias and Managed Futures. The differences of most of the strategies for Credit Suisse possess approximately -0.3% excess returns, while since the data used in the regression are monthly returns, the excess returns are roughly -3.6% per annum. The difference of Global Macro has the lowest excess return -0.6%, which is -7.2% on an annual basis. Concerning Hedge Fund Research Indices, only Emerging Markets has an insignificant result. The differences of most of the strategies for Hedge Fund Research have lower excess returns, which are around -0.3% to -0.4% per month and -3.6% to -4.8% per annum. The difference of Relative Value has the lowest alpha return -0.48%, which is -5.76% on an annual basis. The results show that excess returns are lower in investable indices relatively to the excess returns in non-investable indices. Namely, the performance differences between the non-investable and investable indices are

considerable. The investable indices seem to underperform the non-investable indices significantly.

SECTION 3. FACTOR IN PERFORMANCES OF INVESTABLE INDICES

One might wonder whether investable indices themselves would produce positive excess returns. Hence, I run the same regression on the monthly returns on investable indices to see whether the outcomes would be dissimilar. In order to recognize whether investable indices give investors positive alpha returns, and whether the performances are exposed to those common risk factors, the constructed model can be represented as follow:

$$R_i - R_{ft} = \alpha + \beta_{MKT}(R_m - R_{ft}) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{UMD}UMD_t + \epsilon_t$$

where $R_i - R_{ft}$ is the excess return of the monthly return on the investable indices. As suggested in Table 5 and 6, the performances of investable indices are all exposed to the market risk factor, whereas the Dedicated Short Bias strategy for Credit Suisse are negatively correlated to the market factor. All of the beta coefficients of the market factor are significant at 5 percent confidence level. For Credit Suisse, a number of strategies have exposure to the other three factors. The correlations with HML are negative, while the correlations with other two factors vary from strategies. On the other hand, none of the strategies for Hedge Fund Research is exposed to the size factor. The correlations with the value factor are negative as well. More importantly, the adjusted R-squares are much higher in comparison to the previous results, especially for Hedge Fund Research Indices, indicating that the returns of investable indices can be explained by the common risk factors to some extent.

Table 5: Regression Results of Monthly Returns on Investable Indices (Credit Suisse)

Regression Results of Monthly Returns on Investable Indices (Credit Suisse)

	Dependent variable:									
	Composite	Convertible Arbitrage	Dedicated Short Bias	Emerging Markets	Event Driven	Fixed Income Arbitrage	Global Macro	Long/Short Equity	Managed Futures	Multi-Strategies
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MKT	0.363***	0.314***	−0.536***	0.551***	0.354***	0.237***	0.343***	0.482***	0.125**	0.260***
	(0.022)	(0.041)	(0.069)	(0.047)	(0.028)	(0.035)	(0.047)	(0.023)	(0.055)	(0.028)
SMB	−0.038	−0.012	−0.627***	−0.092	0.104**	−0.029	−0.117	0.036	−0.173*	−0.086*
	(0.040)	(0.073)	(0.119)	(0.083)	(0.050)	(0.062)	(0.083)	(0.041)	(0.098)	(0.050)
HML	−0.054	−0.168***	0.073	−0.108	0.061	−0.010	−0.046	−0.138***	−0.102	−0.060
	(0.035)	(0.064)	(0.108)	(0.073)	(0.044)	(0.055)	(0.073)	(0.036)	(0.086)	(0.044)
MOM	0.032	−0.118***	0.055	−0.033	0.068**	−0.097***	−0.011	0.033	0.156***	0.033
	(0.022)	(0.041)	(0.061)	(0.047)	(0.028)	(0.035)	(0.047)	(0.023)	(0.055)	(0.028)
Constant	−0.205**	−0.150	−0.239	−0.070	−0.166	−0.304**	−0.252	−0.170*	0.009	−0.100
	(0.088)	(0.161)	(0.252)	(0.183)	(0.111)	(0.138)	(0.184)	(0.092)	(0.217)	(0.111)
Observations	193	193	148	193	193	193	193	193	193	193
Adjusted R^2	0.613	0.327	0.508	0.470	0.539	0.301	0.236	0.732	0.070	0.309

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6: Regression Results of Monthly Returns on Investable Indices (Hedge Fund Research)

Regression Results of Monthly Returns on Investable Indices (Hedge Fund Research)

	Dependent variable:					
	Composite	Event Driven	Equity Hedge	Emerging Markets	Macro	Relative Value
	(1)	(2)	(3)	(4)	(5)	(6)
MKT	0.281***	0.306***	0.428***	0.465***	0.124***	0.281***
	(0.018)	(0.023)	(0.023)	(0.035)	(0.034)	(0.029)
SMB	0.016	0.060	0.050	−0.055	−0.057	−0.017
	(0.033)	(0.041)	(0.041)	(0.062)	(0.060)	(0.051)
HML	−0.037	−0.081**	−0.048	0.007	−0.049	−0.100**
	(0.028)	(0.036)	(0.036)	(0.055)	(0.053)	(0.045)
MOM	0.004	−0.012	0.020	−0.011	0.116***	−0.074**
	(0.018)	(0.023)	(0.023)	(0.035)	(0.034)	(0.029)
Constant	−0.092	−0.170*	−0.361***	0.048	−0.148	−0.216*
	(0.075)	(0.091)	(0.090)	(0.138)	(0.133)	(0.113)
Observations	156	193	193	192	193	193
Adjusted R^2	0.680	0.556	0.703	0.544	0.092	0.425
Note:						*p<0.1; **p<0.05; ***p<0.01

In terms of the excess returns, we still observe negative alpha returns. One-third of the strategies for Credit Suisse and half of the strategies for Hedge Fund Research have significantly negative excess returns. There are also positive excess returns reported in the tables, Managed Futures for Credit Suisse and Emerging Markets for Hedge Fund Research, yet none of them is statistically significant. Regarding Credit Suisse, the performance of Fixed Income Arbitrage possesses the lowest excess return -0.304%, which is approximate -3.65% on annual basis. Similarly, the performance of Equity Hedge for Hedge Fund Research has the lowest excess return -0.361%, which is approximate -4.33% on annual basis. As opposed of alpha returns of the previous results, the negative excess returns imply that investable indices are not well-performed.

Last but not least, I analyze the effect of the performances of non-investable indices on the performances of their investable counterparts by introducing the monthly returns on non-investable indices as an extra factor into the Carhart four-factor model. Mathematically, the model is constructed as:

$$R_i - R_{ft} = \alpha + \beta_{MKT}(R_m - R_{ft}) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{UMD}UMD_t + \beta_{ni}(R_{ni} - R_{ft}) + \epsilon_t$$

where $(R_{ni} - R_{ft})$ is the excess return of the monthly return on the non-investable counterparts. The results are represented in Table 7 and 8.

Table 7: Regression Results Adding Performance of Non-Investable Indices (Credit Suisse)

	Dependent variable:									
	Composite	Convertible Arbitrage	Dedicated Short Bias	Emerging Markets	Event Driven	Fixed Income Arbitrage	Global Macro	Long/Short Equity	Managed Futures	Multi–Strategies
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MKT	0.050***	0.017	0.217***	0.057*	0.012	0.063**	0.090**	0.136***	−0.042***	0.018
	(0.014)	(0.020)	(0.059)	(0.032)	(0.020)	(0.027)	(0.035)	(0.029)	(0.014)	(0.024)
SMB	−0.035**	−0.015	−0.115	−0.069	0.030	0.016	−0.034	0.012	−0.031	−0.084**
	(0.017)	(0.030)	(0.075)	(0.042)	(0.025)	(0.042)	(0.055)	(0.029)	(0.024)	(0.033)
HML	−0.018	−0.021	−0.052	−0.032	0.016	−0.013	−0.015	−0.068***	−0.005	0.012
	(0.015)	(0.027)	(0.063)	(0.037)	(0.022)	(0.037)	(0.048)	(0.026)	(0.021)	(0.029)
MOM	−0.004	0.002	−0.020	−0.019	0.038***	−0.055**	−0.062**	−0.007	−0.027*	0.018
	(0.010)	(0.017)	(0.035)	(0.024)	(0.014)	(0.024)	(0.031)	(0.016)	(0.014)	(0.018)
Broad(Composite)	1.040***									
	(0.036)									
Broad(Convertible Arbitrage)		1.216***								
		(0.040)								
Broad(Dedicate Short Bias)			1.060***							
			(0.062)							
Broad(Emerging Markets)				1.112***						
				(0.048)						
Broad(Event Driven)					0.991***					
					(0.041)					
Broad(Fixed Income Arbitrage)						0.947***				
						(0.064)				
Broad(Global Macro)							1.325***			
							(0.085)			
Broad(Long/Short Equity)								0.781***		
								(0.054)		
Broad(Managed Futures)									0.993***	
									(0.019)	
Broad(Multi–Strategies)										0.985***
										(0.062)
Constant	−0.263***	−0.205***	0.003	−0.160*	−0.215***	−0.382***	−0.588***	−0.173***	0.022	−0.256***
	(0.037)	(0.066)	(0.146)	(0.093)	(0.054)	(0.094)	(0.123)	(0.063)	(0.054)	(0.073)
Observations	193	193	146	193	193	193	193	193	193	193
Adjusted R^2	0.929	0.886	0.840	0.863	0.888	0.677	0.667	0.872	0.943	0.706

Note: *p<0.1; **p<0.05; ***p<0.01

Table 8: Regression Results Adding Performance of Non-Investable Indices (Credit Suisse)

	Dependent variable:					
	Composite	Event Driven	Equity Hedge	Emerging Markets	Macro	Relative Value
	(1)	(2)	(3)	(4)	(5)	(6)
Mkt	0.081***	0.053**	0.028	0.070**	−0.019	0.012
	(0.013)	(0.027)	(0.032)	(0.027)	(0.025)	(0.023)
SMB	0.030*	−0.020	−0.047	−0.013	0.008	−0.055*
	(0.016)	(0.031)	(0.029)	(0.034)	(0.041)	(0.030)
HML	−0.014	−0.109***	0.006	0.051*	0.020	−0.097***
	(0.014)	(0.027)	(0.025)	(0.030)	(0.036)	(0.027)
MOM	−0.006	0.001	0.035**	0.036*	0.055**	−0.035**
	(0.009)	(0.017)	(0.016)	(0.019)	(0.023)	(0.017)
HFRI(Composite)	0.714***					
	(0.034)					
HFRI(Event Driven)		0.738***				
		(0.059)				
HFRI(Equity Hedge)			0.797***			
			(0.055)			
HFRI(Emerging Markets)				0.721***		
				(0.035)		
HFRI(Macro)					1.071***	
					(0.071)	
HFRI(Relative Value)						1.206***
						(0.065)
Constant	−0.076**	−0.234***	−0.314***	0.059	−0.203**	−0.412***
	(0.038)	(0.068)	(0.062)	(0.076)	(0.090)	(0.068)
Observations	156	193	193	192	193	193
Adjusted R^2	0.918	0.757	0.859	0.860	0.585	0.795
Note:						*p<0.1; **p<0.05; ***p<0.01

Concerning Credit Suisse indices, as shown in Table 7, we can notice that the exposures to the market factor reduce, and that the beta coefficients of the performances of corresponding non-investable indices are generally 1. Assuming that the performances of the investable indices have the similar exposure to the risk factors as the performances of the non-investable indices, the beta coefficients suggest that the investable indices take roughly same amount of risk as their benchmark, yet they eventually produce less returns. Comparably, for Hedge Fund Research, as shown in Table 8

the beta coefficients of the performances of corresponding non-investable indices are generally 0.8. Notably, there are five strategies for Credit Suisse and two strategies for Hedge Fund Research possessing beta coefficients over 1, indicating that the investable indices of those strategies take even more risk than their non-investable benchmarks while they yield less returns. That is to say, the significantly negative alpha returns imply that the investable indices are less efficient.

CHAPTER 5. CONCLUSION

First of all, I discover that the non-investable indices generally outperform investable indices and that the performance distinction varies from strategies to strategies. From the visualized cumulative returns, we can observe the extent of difference are various. Liquidity and redemption might give possible reasons why the return differences exhibit, whereas these two characteristics cannot explain the overall results. The expectation is that strategies which provide higher levels of liquidity and with shorter time horizons would have smaller return differences and vice versa. Notwithstanding, the expectation is not consistent with the visualized results. Additionally, the performances of both indices were struck during the crisis periods — the financial crisis and COVID-19. Both non-investable and investable indices performed worse during those periods. Liquidity, redemption, and time horizons of strategies might be possible reasons why the drops in investable indices are even larger. Furthermore, I dig into the t-test to see whether the distinction is statistically different from zero. Once again, the average performances give us evidence that non-investable indices are superior to investable indices, except for Dedicated Short Bias for Credit Suisse. The t-statistics indicate that performance differences of half of the strategies for Credit Suisse and two-third of the strategies for Hedge Fund Research are significantly different from zero.

Secondly, I delve into the factors that can possibly give rise to the return differences. By utilizing the Carhart four-factor model, the exposures to the four common risk factors are suggested. What I observe is that the performance differences are generally exposed to the market risk factor. There are still a number of strategies exposed to the size, value, and momentum factors. More importantly, the significantly negative alpha returns are suggested in most strategies. The negative excess returns of performance differences imply that investable indices suggest substantial distinction from their corresponding non-investable indices. Nevertheless, the low adjusted R-squares indicate that those factors cannot well explained the performance differences between investable and their benchmark indices. Overall, none of the adjusted R-squares is above 0.3.

Last but not least, I probe into the factors in monthly returns on investable indices, and further dig into the effect of the performances of non-investable indices on their investable counterparts. The former result indicates that the performances of investable indices all have exposures to the market factor, whereas the Dedicated Short Bias strategy for Credit Suisse is negatively correlated to the market factor. One-third of the strategies for Credit Suisse and half of the strategies for Hedge Fund Research possess negative excess returns. However, the elaboration is different from previous results. The significantly negative alpha returns indicate that investable indices on their own do not perform well. The beta coefficients of performances of non-investable indices are presented in the latter result. Assuming that investable indices have similar exposures to the risk factors as their corresponding non-investable indices, the beta coefficients are generally 1 for Credit Suisse Indices, suggesting that the investable indices take the same amount of risk as their benchmarks. Moreover, the beta coefficients of several strategies are above 1, suggesting that those investable indices take even more risk than their benchmarks. Notwithstanding, the significantly negative alpha returns imply that the investable indices achieve less returns even taking same amount or more risk than their benchmarks.

APPENDIX

As reported in MarketWatch in December 2008, the Credit Suisse Hedge Fund Index was hit by the scandal involving Bernard Madoff. The index fell 4.15% in November 2008, leaving it down 19% so far in 2008. Equity Market Neutral Hedge Funds tracked by the index slumped more than 40%. The main reason is that three funds invested money with Madoff – Kingate Global Fund Ltd., FairField Sentry Ltd. and Rye Select Broad Market Portfolio Ltd. Returns from those funds are reported together in the Credit Suisse Hedge Fund Index.

The Madoff investment scandal was a major case of stock and securities fraud discovered in late 2008. In December of the year, the former NASDAQ chairman and founder of the Wall Street firm Bernald L. Madoff Investment Securities LLC, admitted that the wealth management arm of his business was an elaborate multi-billion-dollar Ponzi scheme.

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