THE EFFECT OF ALTERNATIVE INVESTMENT IN HEDGE FUNDS

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Abstract

Given that there is a growing emphasis in the field of alternative investment, this paper studies the effect of alternative investment in hedge funds and tests whether hedge funds that take positions in non-standard asset classes outperform hedge funds that take positions only in equity and fixed income securities. The Fung and Hsieh (2004) seven-factor model is used to analyse the hedge fund returns. The seven-factor model is first tested with a substitute factor as the original factor data ceased to exist by 2007, then is extended to cover 2000-2006, 2007-2010, 2011-2015 period to examine its explanatory power, and finally used to obtain the alpha return of the hedge funds. The alpha return will be separated into two groups, with verse without alterative investment exposure. The alphas are tested to see if there is any difference between the two groups. An empirical comparison base on pure return will also be presented. We observe that the funds which have weights in non-standard assets earned a statistically significant excess alpha than the funds without exposure during the 2007 to 2010 period. It is possible that funds with investment in the non-standard assets could outperform those without exposure in future financial crisis.

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Introduction

For institutional investors, there is a growing investment trend of increasing portfolio weight in the non-standard asset classes such as commodity, currency and property. As early as 1990s, Lamm (1999) had found that non-standard assets, also known as "alternative investment assets", have tremendously attracted investors' interests because of investors' expectation of those assets' excellent risk-adjusted returns as well as diversification benefits. Swensen (2009) points out that institutional investors "investing only a small amount in traditional choices like U.S. equities and bonds, and devoting a more significant portion of the portfolio to a class of non-traditional assets known as alternative assets" included oil, gas and commodities. With a long period of history, hedge fund is one of the most important alternative investment asset classes. The flexible investment strategies and advanced management of hedge fund has continuously attracted investors' preferences. As asset under management is boosting among those years, like most institutional investors, hedge fund has also increased exposure in other non-standard asset classes. According to the Lipper TASS database, 48% hedge funds have portfolio weight in the typical non-standard asset classes at January of 2015.

So whether hedge funds with exposure with non-standard asset classes would beat those funds without weight in non-standard asset classes is an interesting topic to discuss, as it could help those high-net wealth investors or institutional investors to make better decision when choosing hedge funds. This article apply William Fung and David A. Hsieh's seven-factor model (2004) to analyse individual hedge funds returns and test if

hedge funds with exposure with non-standard asset classes will outperform those without non-standard asset classes. The hedge fund data source is from the Lipper TASS database and Wharton Hedge Fund Research Database. Seven-factor data are found through ThomsonOne.com Investment Banking' database, official U.S. Federal Reserve website and David A. Hsieh's Data Library.

We will divide our test into three steps: first we will replicate and extend the William Fung and David A. Hsieh's seven-factor model to the year 2015 and test if it could still give good explanation of the hedge fund returns in recent years. Next we will modify the seven-factor model and add dummy variable of non-standard assets to test if non-standard asset classes allows funds generates a statistically significant alpha over the funds that only invest in traditional assets. We decided to split the time series data into 3 periods of pre-crisis, during crisis and post-crisis because of financial crisis' unique characteristics and their influence with asset returns. We also do the empirical test by compare cumulative return of the two group of hedge funds, one group is funds with non-standard assets class exposure and another is funds only invest in the traditional assets. The empirical test analysis is showed in the Appendix.

We construct the reminder of our paper as follows: Section 2 gives the literature review and Section 3 makes an introduction of the Non-standard Assets, followed by the Section 4 of the review of Hedge Fund. Section 5 and Section 6 separately describe the data and research methodology. Then analysis of test results in Section 7. In Section 8 we make our conclusion.

Literature review

Leitner, Mansour and Naylor (2007) pointed that "Interest in alternative assets has gained increasing momentum" before financial crisis. Rosen (2015) demonstrates that despite the risk exposure of non-standard assets, the upside potential of them attracted increasing number of institutional investors. This is proved by the fact that in 2009, among all the university endowments, 90 percent held unconventional assets.

There are several precedent literatures that have done series of empirical tests with the non-stand assets and their influence with the portfolio returns. For non-standard asset of Property, research findings designate that it is possible to included REITS with stocks in the portfolios holdings to reduce risk exposure (Kuhle, 1987; Chen et al., 2005;). In addition, Bhuyan, Kuhle, Al-Deehani and Mahmood indicate that the equity EREITs provides diversification benefits and helps investors earn return from real estate investments without directly investing in properties. For non-standard assets as commodity, Bessler and Wolff (2015) prove that through most asset allocation strategies, if adding physical commodity and energy to a traditional stock and bond held portfolio, the performance will be greatly improved.

There are also numerous empirical research focus on the exploring risk factor that could explain hedge fund returns. The most famous model is the Fama-French (1993) three-factor model and further four-factor model (2013) and five-factor model (2015) to describe general investment returns. Harvey-Siddique (2000) developed a two-factor model, an asset pricing model that incorporates conditional skewness. Their model

validate the intuition that if systematic skewness existed in asset returns, to accepting the risk, rewards should be included in the expected returns. Ding and Shawky (2007) improve performance estimates with traditional performance measures by using three-factor models along with the two factor model which incorporates skewness. They conclude that "all hedge fund categories achieve above average performance when measured against an aggregate market index." Fung and Hsieh (2004) proposes a model of hedge fund returns that is similar to models based on arbitrage pricing theory, with dynamic risk-factor coefficients. For diversified hedge fund portfolios (as proxied by indexes of hedge funds and funds of hedge funds), the seven ABS factors can explain up to 80 percent of monthly return variations.

Some trading strategies could also give good explanations of hedge fund performance. In 1997, Fung and Hsieh observe that hedge funds differentiate themselves from mutual funds because of their dynamic trading strategies, Fung and Hsieh further clarified five main investment styles in hedge funds. This clarification provided a basic framework for any further analysis on hedge fund investment styles.

The 2007-2009 Financial crisis deeply impact the world economy and all the securities market were influenced. The underlying market condition changed significantly during the financial crisis and correlation between majority of the assets classes increased, thus the portfolio performance were greatly influenced. Billio, Getmansky, and Pelizzon (2009) clarify that average volatility and correlation between different hedge fund strategy returns surged with the impact of the financial crisis. Due to high volatility of the market, some hedge fund managers decreased their market exposure (Ben-David, Franzoni & Moussawi, 2011). On the other hand, some researchers such as Black, Brassil

and Hack (2010) focus on analysing the impact of the financial crisis on the traditional asset class markets of stock and bond. Both research support that financial crisis greatly changes the risk and return factors among each market around the world. Thus there is the necessity for us to divide our research into three period of pre-crisis period, during-crisis period and post-crisis period and test how financial crisis influence the hedge fund returns.

The papers discussed above inspire us to verify and extend the time period of the Fung and Hsieh (2004) seven factor model to analyse the hedge fund returns and add innovation of whether hedge fund with weight in the non-standard assets outperform those funds without non-standard assets exposure.

Defining Non-standard assets

Characteristics

Generally alternative investments differ from conventional investments (stock, bond and cash). There are several categories of alternative investments: Hedge funds, Private Equity, Real Estate, Commodities, and Currencies. They all show different characteristics with the traditional assets and some alternative investment assets are also known as non-standard assets. Non-standard assets have the characteristics of low correlations with the traditional assets, which resulted in reduced portfolio risk after including alternative investments in the portfolio. Non-standard assets also have higher than average return than the traditional investments. Thus, adding non-standard assets to a portfolio with only conventional assets may increase expected returns. The reason for the higher returns is to compensate for the fact that non-standard assets are less efficiently priced and illiquid. The higher return could also cause by the fact that some non-standard assets often use leverage and thus increase both the return and risk

Hedge Fund

Background

Hedge fund is a well-known vehicle of alternative investment and it is generally privately held and managed by some of the most outstanding investment managers. Those managers use more flexible investment strategies than the traditional investment managers. As there are less regulations for hedge funds, the funds attempted to generate "alpha" during both recession and market boom. Compared with the conventional investment institutions, e.g. mutual funds, the less regulation has provided hedge funds managers with fewer limitations in regard to using leverage, holding long and short positions, utilizing derivatives and putting weight on illiquid assets. The illiquid assets covers property, commodity and currencies and are generally categorized as the non-standard assets.

The investors of hedge funds traditionally are those people with high net wealth, whom typically have the largest capital invested under hedge funds. Lower income groups are not broadly available to invest in hedge funds. Recently year, Rajnish (2011) point out that increasing number of institutional investors such as university endowments and pension funds have put assets under hedge fund management.

Recent years sees a trend of increasing asset under management of hedge funds. In 1990s, hedge funds had noticeable performance without big amount of asset under management. According to the latest Hedge Fund Research data, the whole industry

capital of hedge fund in the latest quarter was $2.38 trillion, and has increased 160 percent in just five years.

During the financial crisis, the hedge fund industry recorded the lowest return in the year 2008, with the AUM declined severely simultaneously. The unprecedented and serious destress of financial crisis contributed to the lowest return in 2008 and the overall returns rebounded after the financial crisis. While the rate of return increase post financial crisis is not parallel with the growth rate of industry capital, the hedge fund industry return shows the declining trend. Thus there is a necessity to check the validity of the William Fung and David A. Hsieh's seven-factor model and test if it adapt to the circumstance change of hedge funds.

Hedge fund trading strategy

At the present time, hedge funds are skilled at utilizing a series of financial instruments such as holding the long/short position to make profit by arbitrage and hedge away the market risk. Hedge funds apply dynamic investment strategies which seek distinctive investment opportunities in the market and then dynamically trade their investment portfolios with the effort to track high and absolute returns.

Different hedge fund employ various trading strategies, and there existed more than 30 different investment strategies. According to the Hedge Fund Research, Inc., there are four main classifications of hedge fund strategies: "1. Event-Driven strategies: typically based on corporate restructuring or acquisition that creates profit opportunities for long and short positions in commend equity, or debt of a specific corporation. 2. Relative Value: involve buying a security and selling short a related security with the goal of profiting when a perceived pricing discrepancy between the two is resolved. 3.

Macro strategies: based on global economic trends and events and may involve long or short positions in equities, fixed income, currencies, or commodities. 4. Equity hedge fund strategies: seek to profit from long or short positions in publicly traded equities and derivatives with equities as their underlying assets." The classification and inclusions of these hedge fund strategies are described below.

Event Driven mainly includes: "1. Credit Arbitrage Strategies employ an investment process designed to isolate attractive opportunities in corporate fixed income securities; 2. Distressed Restructuring Strategies which employ an investment process focused on corporate fixed income instruments, primarily on corporate credit instruments of companies trading at significant discounts to their value at issuance or obliged (par value) at maturity as a result of either formal bankruptcy proceeding or financial market perception of near term proceedings. 3. Merger Arbitrage strategies which employ an investment process primarily focused on opportunities in equity and equity related instruments of companies which are currently engaged in a corporate transaction. "Equity Hedge: Equity Hedge strategies maintain positions both long and short in primarily equity and equity derivative securities. 1. Equity Market Neutral strategies employ sophisticated quantitative techniques of analysing price data to ascertain information about future price movement and relationships between securities, select securities for purchase and sale. 2. Fundamental Value strategies which employ investment processes designed to identify attractive opportunities in securities of companies which trade a valuation metrics by which the manager determines them to be inexpensive and undervalued when compared with relevant benchmarks. 3. Fundamental Growth strategies employ analytical techniques in which the investment thesis is predicated on

assessment of the valuation characteristics on the underlying companies which are expected to have prospects for earnings growth and capital appreciation exceeding those of the broader equity market. 4. Short-Biased strategies employ analytical techniques in which the investment thesis is predicated on assessment of the valuation characteristics on the underlying companies with the goal of identifying overvalued companies. 5. Multi-Strategy: Investment Managers maintain positions both long and short in primarily equity and equity derivative securities."

Macro: "1. Active Trading strategies utilize active trading methods, typically with high frequency position turnover or leverage; these may employ components of both Discretionary and Systematic Macro strategies." 2. Trading strategies related to Commodity: Commodity – Agriculture, Commodity – Energy and Commodity – Multi. 3.

Relative Value: "1. Fixed Income - Asset Backed includes strategies in which the investment thesis is predicated on realization of a spread between related instruments in which one or multiple components of the spread is a fixed income instrument backed physical collateral or other financial obligations (loans, credit cards) other than those of a specific corporation. 2. Fixed Income - Convertible Arbitrage includes strategies in which the investment thesis is predicated on realization of a spread between related instruments in which one or multiple components of the spread is a convertible fixed income instrument. Volatility strategies trade volatility as an asset class, employing arbitrage, directional, market neutral or a mix of types of strategies, and include exposures which can be long, short, neutral or variable to the direction of implied volatility, and can include both listed and unlisted instruments."

Risk and Return Characteristic

It has been proven that hedge fund can obtained better than the traditional global equities in the downside markets and lagged the returns of the traditional equities in the upside markets. Among different time periods, different hedge fund strategies have the best performance. Because of the great amount of strategies utilized, hedge fund can run into problems with its performance due to over diversification with other alternative investment asset classes. Less than perfect correlation with global equity returns could offer some diversification benefits. However, during financial crisis the correlation tend to increase.

William Fung and David A. Hsieh (2007) had done research to see the risk in hedge fund strategies and they have obtained evidence from long/short equity hedge funds. They concluded that "There is no evidence of a negative effect of fund size on managers' ability to deliver alpha. In addition, non-factor related returns, or alpha, are positively correlated to market activity and negatively correlated to aggregate short interest. In contrast, equity mutual funds and long-bias equity hedge funds have no significant, persistent, non-factor related return. Expressed differently, L/S equity hedge funds, as the name suggests, do benefit from shorting. Besides differences in risk taking behaviour, this is a key feature distinguishing L/S funds from long-bias funds."

In this paper, we have examined the influences of non-standard assets classes by cumulative return of the funds with exposure to alternative investment with the cumulative return of the funds without exposure. The returns examined include types of

return: absolute cumulative return stated in monthly term and risk adjusted return which is the monthly return adjusted for the monthly volatility. Every single fund's return are calculated and then sorted into high to low order. The returns are further divided into 5 quantiles and then split into 2 groups: one for hedge funds without investment to non-traditional asset classes and one with. Lastly, we studies the percentage composition of each of groups (relative to the group's own total number of funds) to the theoretical 20% composition. The process is repeated for three time periods that included pre-financial crisis era, during financial crisis era and post financial crisis era. The comparison result are presented in the Appendix of this paper. As we can see funds that invests in non-traditional asset classes only performed over and above the funds that did not have exposure during the financial crisis periods both in the absolute return and risk adjusted return basis. The fact that alternative investments, as demonstrated in Appendix, does not help funds with them to generate better risk adjusted return compare to the funds that does not venture into the non-traditional investment world is an interesting phenomenon. In this paper, we will use the seven-factor model by Fund and Heish (2004) to examine the alpha between funds with exposure to non-standard asset classes and funds without exposure and see how well the two groups of hedge funds did in terms of alphas.

Data

We obtain hedge fund data from Lipper TASS, a widely used database for the academic and empirical studies of hedge fund. The Lipper TASS provides the monthly returns of individual hedge funds as well as the net assets under management reported in US dollars. The hedge funds in the TASSS database can be divided into eleven categories according to their investment strategies which included Dedicated Short Bias, Equity Market Neutral, Fixed Income Arbitrage, Convertible Arbitrage, Multi-Strategy Long/Short Equity Hedge, Equity Market Neutral, Managed Futures, Event Driven, Global Macro, Emerging Markets, and Funds of Hedge Funds. Also the individual hedge fund could be classified based on their exposure of asset classes. There are three major Non-standard asset classes the funds involved with: Commodities, Currencies, and Properties. And each major Non-standard asset class covers several sub asset classes. The category of Commodities includes sub classes of Agriculturals, BaseMetals, Commodity, Energy, ExchangeTraded, Forwards, Futures, Indices, Metals, Options, OTC, Physical, PreciousMetals and Softs. Currencies category is constituted of Currency, ExchangeTraded, Forwards, Futures, HedgingOnly, Options, OTC, Spot and Swaps. The category of Properties includes OtherAssets and Property. In our analysis, we combine some non-standard sub asset class into 1 overall sub asset class as there is overlapping quality existed.

William Fung and David A. Hsieh (2004) used an equally weighted average return of all hedge funds in the TASS database (TASSAVG) to represent overall hedge

fund returns. They constructed the equal weighted index of TASSAVG from all the live funds from TASS database. Generally there are three different ways to construct investable index (equally weighted, price weighted, or value weighted).

For this article, we will follow Fung and Hsieh (2004)'s strategy to construct our three equal weighted index of TASS. The first is TASSAVG (noNS+NS) index, an equally weighted average return of all individual hedge funds in the TASS database and covers all funds that have exposure with non-standard assets and funds without non-standard assets exposure. Another is the TASSAVG_noNS index, a constructed equal weighted hedge fund index which have no weight in non-standard assets. Last the TASSAVG_NS index is the equal weighted fund index that have exposure with non-standard assets.

Since we will utilize the Fung and Hsieh (2004) seven-factor model to do the analysis of the hedge fund returns, the accuracy of the seven factor data is extremely significant for our regression. We have found the Fung and Hsieh (2004) seven-factor model data from the database below: The data for S&P500 index, Russell 2000 indexes, Wilshire Small Cap 1750 index and Wilshire Large Cap 750 index are accessible through 'ThomsonOne.com Investment Banking' database. The bond data for the 10 year U.S. treasury yield and Moody's Baa yield can be found on the official U.S. Federal Reserve website. The trend following straddle portfolio return data are updated and archived online at the 'David A. Hsieh's Data Library'. We also find the data of HFRFOF index from the Wharton Hedge Fund Research Database.

Methodology and Results Analysis

Seven-Factor Model

In this paper, we used the seven-factor model by Fung and Hsieh (2004) to analyse the performance of hedge funds. The original seven factors in the model include two equity-oriented risk factors, two bond-oriented risk factors and three trend-following risk factors.

$$r_{i,t} = \alpha_i + \beta_{i1} MKT_{i,t} + \beta_{i2} SMB_{i,t} + \beta_{i3} 10YrY_{i,t} + \beta_{i4} CredSpr_{i,t} + \beta_{i5} tfBd_{i,t} + \beta_{i6} tfFX_{i,t} + \beta_{i7} tfComm_{i,t} + \varepsilon_{i,t}$$

We kept the factors same as per Fund and Heish's model. The equity-oriented factors account for the market effect (*MKT*) and size effect (*SMB*) of the U.S. equity market. The *MKT* factor is the monthly return on the S&P 500 index. The *SMB* factor is monthly change of Wilshire Small Cap 1750 index return less Wilshire Large Cap 750 index return. However, due to the fact that both of the Wilshire indexes ceased to exist as of August of 2006, we have opted to use it as the *SMB* factor only for the purpose of replicating the original results. We will use the monthly difference between Russell2000 index return and S&P 500 index return as the *SMB* factor for our own analysis. The bond-oriented factors capture the bond effect (*10YrY*) and credit spread effect (*CredSpr*) on the U.S. bond market. The *10YrY* factor is the monthly change, at month end, of the 10-year U.S. treasury yield while the *CredSpr* factor is the monthly difference between the Moody's Baa yield and the 10-year U.S. treasury yield. The trend following factors

attempts to examine effect of trending dynamic trading strategies. The three factors is for bond trend, currency trend and commodity trend. The factors are the monthly return of a portfolio of lookback straddles future on their respective underlying asset. Lastly, r denotes either the monthly return of the hedge fund index or the monthly return of the hedge fund and ε represent the error term of the regression.

Model Test on the Seven-Factor Model

In the first step, model tests on the seven-factor model were conducted. Two sets of data were used for the assessment: the HFRI Fund of Funds Composite Index (HFRFOF) and the constructed TASSAVG index. The *SMB* factor used for first set of tests in this step will be the base on the Wilshire indexes, and the regression will be perform over the same time periods as the original paper's with the intent to replicate the original paper result as closely as possible. A small modification to the *SMB* factor will be introduced later in this step. The regression statistics prior and post modification will be compared and analysed.

Regression with the HFRFOF Index

Our regression results of HFRFOF index against the seven hedge fund risk factors are presented in Table 1. The R^2 of our analysis resemble that of the R^2 statistics of Fung and Hsieh's: Fund and Hsieh's R^2 statistics for HFRFOF index are 0.55, 0.69 and 0.80 respectively for the time period 01/1994 – 12/2002, 01/1994 – 09/1998 and 04/2000 – 12/2002. The actual result are presented under model A, B and C in Table 1. Although the estimated coefficients of the regression differs by 0.001 – 0.05 in our tests, but the significance level on the factor coefficients are fairly consistent. The R^2 statistics of regression measures the "goodness" of the fit and here can be interpreted as the percentage of variation of index return explained by the seven risk factors. R^2 statistics by itself may be a non-reliable measure of the explanatory power for multi-factor regression model. This is due to the fact that R^2 almost always increases as more independent variables are added to the model, even if the new variables is not statistically significant. The adjusted R^2 statistics adjusts the R^2 statistic based on the number of independent

variables in the model and is a more reliable measure of fit. We can spot that the adjusted R^2 of our results are very strong and close the R^2, which suggest that the Seven-Factor model can describe a substantial part of the systematic risk of typical hedge fund portfolios in those periods.

SMB factor Substitution

One thing we observed in the study is that, the two Wilshire indexes used in original *SMB* factor (*SMB* original) are dead indexes; the data available on those particular indexes ends on August of 2006. Consider our paper's investigation time frame is up until January 2015, it is essential find a suitable substitute for the *SMB* factor with obtainable data all the way to 2015. We have chosen to use the monthly return difference between Russell 2000 index and S&P 500 index as the new *SMF* factor (*SMB* new). Since the Russell 2000 index measures the performance of small-cap segment of the U.S. equity universe and S&P 500 index is an U.S. stock market index based on the market capitalization of 500 large companies listed on NYSE or NASDAQ, it looks like a good representation of the size effect in the U.S. equity market. The results from regression (1) – (3) in Table 1 are generated with the original *SMB* factor while the results from regression (4) – (6) are regressed with the new *SMB* factor. As we can see, the R^2 and adjusted R^2 statistics for the regression with the new *SMB* factor are analogous to the statistics from the regression with the original *SMB* factor. Combine with that fact that the significance level of the factor coefficients from the new *SMB* factor are very similar to that of the original factor regression, it can be concluded the new *SMB* is a decent substitute of the original factor and will not undercut the integrity of the Seven-Factor model.

Table 1. Regression of HFRFOF index on Seven Hedge Fund Risk Factors

	Fung & Hsieh's original result			Replicate HFRFOF result			HFRFOF result with the new *SMB* factor		
	(A)	(B)	(C)	(1)	(2)	(3)	(4)	(5)	(6)
	1994~2002	1994~1998	2000~2002	1994~2002	1994~1998	2000~2002	1994~2002	1994~1998	2000~2002
MKT	0.2153	0.3242	0.1730	0.2142***	0.3178***	0.1696***	0.2169***	0.3228***	0.1702***
	(0.0287)**	(0.0453)**	(0.0293)**	(0.0285)	(0.0453)	(0.0298)	(0.0289)	(0.0453)	(0.0285)
SMB (original)	0.2256	0.1779	0.1497	0.2269***	0.1773**	0.1632***			
	(0.0362)**	(0.0662)**	(0.0363)**	(0.0359)	(0.0655)	(0.0372)			
SMB (new)							0.1906***	0.1464*	0.1449***
							(0.0312)	(0.0570)	(0.0300)
10YrY	− 1.5644	− 1.1171	− 2.7080	-1.4972*	-1.0040	-2.6360***	-1.5743*	-0.9994	-2.7021***
	(0.6540)**	-0.9495	(0.6326)**	(0.6437)	(0.9468)	(0.6176)	(0.6490)	(0.9569)	(0.5850)
CredSpr	− 2.9639	− 6.6649	− 2.1305	-2.9515*	-6.1545**	-2.2141*	-3.2466**	-6.3910**	-2.3386*
	(1.1919)**	(2.2477)**	(0.9816)*	(1.1834)	(2.2780)	(1.0075)	(1.1856)	(2.2995)	(0.9469)
tfBd	− 0.0152	− 0.0105	− 0.0068	-0.0194*	-0.0151	-0.0082	-0.0181*	-0.0148	-0.0061
	(0.0073)*	-0.01064	-0.0060	(0.0077)	(0.0110)	(0.0073)	(0.0078)	(0.0110)	(0.0069)
tfFX	0.0070	0.0065	0.0031	0.0080	0.0076	0.0047	0.0073	0.0073	0.0027
	-0.0067	-0.0074	-0.0069	(0.0066)	(0.0074)	(0.0069)	(0.0067)	(0.0075)	(0.0067)
tfComm	0.0190	0.0271	0.0356	0.0204*	0.0285*	0.0305*	0.0200	0.0290*	0.0281*
	(0.0104)*	(0.0138)*	(0.0128)**	(0.0100)	(0.0137)	(0.0113)	(0.0101)	(0.0139)	(0.0109)
Constant	0.0047	0.0019	0.0021	0.0049***	0.0021	0.0018	0.0051***	0.0020	0.0019
	(0.0012)**	-0.0017	-0.0013	(0.0013)	(0.0018)	(0.0013)	(0.0013)	(0.0018)	(0.0012)
Observations				108	57	33	108	57	33
R^2	0.55	0.69	0.8	0.563	0.695	0.795	0.555	0.691	0.813
Adjusted R^2				0.532	0.652	0.738	0.523	0.647	0.760

Standard errors in parentheses for model 1-6

** p < 0.05, ** p < 0.01, *** p < 0.001*

Regression with the TASSAVG index

The constructed TASSAVG index is fabricated from equally weighting the average return of all hedge funds in the Lipper TASS Academic Hedge Fund Database. We have use the 'live research file for March 2015 Revised' dataset. It contains individual hedge fund data up to January of 2015, thus allowing us to back test the TASSAVG index for all three of the test periods. Evidently, result of the TASSAVG index against the seven hedge fund risk factors in Table 2 differs from Fung and Hsieh's result in their 2004 paper. Fund and Hsieh's R^2 statistics for TASSAVG index are 0.73, 0.46 and 0.71 respectively for the time period 01/1994 – 12/2002, 02/1995 – 09/1998 and 04/2000 – 12/2002, which are found in Table 2 and 4 of their paper. In particular the R^2 statistics and adjusted R^2 statistics for time period 1994 to 2002 in our study is only 0.46 and 0.43 respectively. The two equity market factors' coefficient remain at the same significance while the bond factors dwindled in their power of significance. The trend following factors significance varies time period to time period compare to the original output. The analysis yield closer estimation in the two sub-period compare to the overall time period. The deviation of outcomes is most likely owing to the difference in composition of index since Fund and Hsieh created their version of the TASSAVG index using the TASS database ending March 2003.

A number of hedge funds have been added and few have dropped out of the 2015 version of the TASS database. Out of the total of 5612 funds, 2841 new hedge funds have been newly introduced to the database since 2003. 455 of the 2841 funds have been removed by 2015, leaving 2386 new funds in the TASS database. In addition, 279 funds that existed prior to 2003 have purged from the database by 2015. Considering the TASSAVG index excludes fund of funds, 1896 funds must be excluded as they have

exposure in other funds. Furthermore, 1623 out of the remaining useable 3716 funds has incomplete data regarding either performance detail or asset details; this cuts the number of fund available for examination down to 2093.The data has survivorship bias, which explains why 1623 funds out of the 3716 non-fund-of-fund funds have incomplete data. Moreover, when the 2417 new funds enter the database, their past performance history is also added, which creates instant-history bias. A typically fund that joins the database would have a successful record in its incubation period since funds with relatively poor performance would cease to operate. Therefore, when a data vendor backfills the fund's performance, there is an upward bias in its return. Consequently, because of the composition difference and the biases associated with data and composition, the model produced less explanatory power with our TASSAVG data compare to the original result.

Similar to the tests on HFRFOF index, we have perform the tests with the new *SMB* factor on the TASSAVG index. In Table 2, (1) – (3) are result completed with the original *SMB* factor and (4) – (6) are result done with the new *SMB* factor. As we can see, the R^2 and adjusted R^2 statistics for the regression with the new *SMB* factor are analogous to the statistics from the regression with the original *SMB* factor. For the TASSAVG, we can draw the conclusion that substituting the new *SMB* will not distort the effectiveness of model on the TASSAVG. However, we have to keep in mind that, while the Seven-Factor model does explain close to half of the systematic risk, it did not perform as well it was intended for the TASSAVG index in all tested time period.

Table 2. Regression of TASSAVG index on Seven Hedge Fund Risk Factors

	(1) *1994~2002*	*(2)* *1994~1998*	*(3)* *2000~2002*	*(4)* *1994~2002*	*(5)* *1994~1998*	*(6)* *2000~2002*
MKT	0.2262***	0.2607***	0.1993***	0.2282***	0.2663***	0.1997***
	(0.0327)	(0.0681)	(0.0321)	(0.0330)	(0.0682)	(0.0320)
SMB (original)	0.1931***	0.1664	0.1861***			
	(0.0412)	(0.0986)	(0.0401)			
SMB (new)				0.1608***	0.1291	0.1574***
				(0.0357)	(0.0858)	(0.0337)
10YrY	-1.7086*	-2.0694	-1.8088*	-1.7751*	-2.0200	-1.9209**
	(0.7381)	(1.4255)	(0.6657)	(0.7426)	(1.4395)	(0.6572)
CredSpr	-2.7818*	-5.9132	-0.9888	-3.0431*	-6.1057	-1.2177
	(1.3570)	(3.4298)	(1.0861)	(1.3565)	(3.4589)	(1.0638)
tfBd	0.0004	0.0062	-0.0013	0.0015	0.0066	0.0013
	(0.0089)	(0.0165)	(0.0078)	(0.0089)	(0.0166)	(0.0077)
tfFX	0.0097	0.0011	0.0164*	0.0092	0.0010	0.0144
	(0.0076)	(0.0112)	(0.0075)	(0.0077)	(0.0112)	(0.0075)
tfComm	0.0247*	0.0458*	0.0144	0.0243*	0.0459*	0.0119
	(0.0115)	(0.0206)	(0.0122)	(0.0116)	(0.0209)	(0.0122)
Constant	0.0125***	0.0110***	0.0087***	0.0126***	0.0109***	0.0089***
	(0.0015)	(0.0026)	(0.0014)	(0.0015)	(0.0027)	(0.0014)
Observations	108	57	33	108	57	33
R^2	0.464	0.412	0.791	0.456	0.405	0.792
Adjusted R^2	0.426	0.327	0.732	0.418	0.320	0.734

Standard errors in parentheses
* *p < 0.05,* ** *p < 0.01,* *** *p < 0.001*

Testing Non-standard Asset Classes Influence with Hedge Fund Returns

Splitting TASSAVG into 2 more index for 1994 to 2002

In order to examine the effect of alternative investment on hedge fund, the hedge funds are further split into 2 categories: ones with exposure only to the traditional asset classes like equity and fixed income and ones with exposure to the non-standard asset classes. Out of the useable 2093 funds, 1089 (or 52%) funds lack non-standard asset exposure and will be grouped under into the TASSAVG_noNS index and the other l004

(or 48%) will be group under the TASSAVG_NS index. The regression is ran with the new *SMB* factor as it has been established previously that the new *SMB* factor is essentially just as good as the original *SMB* factor. For the full test period of 1994 to 2002, it seem to have similar explanatory power for the TASSAVG_NS and TASSAVG index. However, we can observe that the seven-factor model is mixed in its explanatory power when we split the full period into two sub periods. For the TASSAVG_noNS, a trimmed down version of the seven-factor model is used. Considering the TASSAVG_noNS index has no exposure to alternative investment, we can safely to remove the commodity trend following factor, *tfComm* and the currency trend following factor, *tfFX*. The modified models explanatory power for the TASSAVG_noNS index is very high for the 2000-2002 period but is questionable in the 1994-1998 period. For the overall full period, the explanatory power is similar to that of the TASSAVG and TASSAVG_NS index.

Table 3. Regression of the three TASSAVG index on Seven Hedge Fund Risk Factors

	TASSAVG			TASSAVG_noNS			TASSAVG_NS		
	(1) 1994~2002	(2) 1994~1998	(3) 2000~2002	(4) 1994~2002	(5) 1994~1998	(6) 2000~2002	(7) 1994~2002	(8) 1994~1998	(9) 2000~2002
MKT	0.2282***	0.2663***	0.1997***	0.3374***	0.3229*	0.2962***	0.1392***	0.2329***	0.1062*
	(0.0330)	(0.0682)	(0.0320)	(0.0516)	(0.1219)	(0.0320)	(0.0342)	(0.0562)	(0.0436)
SMB (new)	0.1608***	0.1291	0.1574***	0.2019***	0.1565	0.2184***	0.1318***	0.1384	0.1009*
	(0.0357)	(0.0858)	(0.0337)	(0.0561)	(0.1492)	(0.0335)	(0.0369)	(0.0707)	(0.0459)
10YrY	-1.7751*	-2.0200	-1.9209**	-1.0870	-1.6399	-1.3929*	-2.2935**	-1.9191	-2.4128*
	(0.7426)	(1.4395)	(0.6572)	(1.1663)	(2.5204)	(0.6572)	(0.7683)	(1.1858)	(0.8951)
CredSpr	-3.0431*	-6.1057	-1.2177	-3.1441	-6.1061	-2.4013*	-2.7462	-5.1875	0.1619
	(1.3565)	(3.4589)	(1.0638)	(2.1258)	(6.0345)	(0.9720)	(1.4035)	(2.8493)	(1.4489)
tfBd	0.0015	0.0066	0.0013	-0.0160	-0.0189	-0.0122	0.0135	0.0197	0.0154
	(0.0089)	(0.0166)	(0.0077)	(0.0139)	(0.0279)	(0.0077)	(0.0092)	(0.0137)	(0.0105)
tfFX	0.0092	0.0010	0.0144				0.0183*	0.0064	0.0266*
	(0.0077)	(0.0112)	(0.0075)				(0.0079)	(0.0093)	(0.0102)
tfComm	0.0243*	0.0459*	0.0119				0.0497***	0.1031***	0.0153
	(0.0116)	(0.0209)	(0.0122)				(0.0120)	(0.0172)	(0.0166)
Constant	0.0126***	0.0109***	0.0089***	0.0124***	0.0111*	0.0081***	0.0128***	0.0107***	0.0092***
	(0.0015)	(0.0027)	(0.0014)	(0.0023)	(0.0047)	(0.0013)	(0.0015)	(0.0022)	(0.0019)
Observations	108	57	33	108	57	33	108	57	33
R^2	0.456	0.405	0.792	0.411	0.242	0.907	0.403	0.622	0.594
Adjusted R^2	0.418	0.320	0.734	0.382	0.168	0.890	0.362	0.567	0.480

** $p < 0.01$, *** $p < 0.001$

Extension of the Seven-factor model to the period of 2000 to 2015

We further test the William Fung and David A. Hsieh (2004) seven-factor model using the data from the Lipper TASS database for the period of 2000 to 2015. By making Regression of TASSAVG index on seven Hedge Fund risk factors, we could get the result of whether the model still valid during this period. Due to the financial crisis influence with the market, we have splitted our regression with three period: Pre-crisis period, During-crisis period and Post-crisis period. We categorized the period of Pre-crisis from the year March 2000 to December 2006, the period of During-crisis from January 2007 to December 2010, and Post-crisis from January 2011 to January 2015. Considering the influence of both Global Financial Crisis (begin from 2007) and European sovereign debt crisis (2010), we divide during-crisis period from 2007 to 2010. The regression would show the level of validation of the seven-factor model among different time period. Below is the result analysis.

Pre-Crisis period Analysis

Table 4 shows the summary statistics of our pre-crisis period regressions of the three equal weighted TASS index using the William Fung and David A. Hsieh (2004) seven-factor model. TASSAVG (noNS+NS) is an equally weighted average return of all individual hedge funds in the TASS database (TASSAVG) and covers all funds that have exposure with non-standard assets and funds without non-standard assets exposure. TASSAVG_noNS is the constructed equal weighted hedge fund index which have no weight in non-standard assets. TASSAVG_NS is the equal weighted fund index that have exposure with non-standard assets.

The statistics clearly shows that from April 2000 to December 2006, the William Fung and David A. Hsieh's seven-factor model gives good explanation for the returns of

the TASSAVG (nNS+NS) index as its adjusted R^2 is 0.589. The trimmed down factor model also offers good explanations for TASSAVG_noNS index as the adjusted R^2 is 0.804. The seven-factor model is extremely valid for the index without non-standard assets exposure. However, the seven-factor model could not give very strong explanation for the TASSAVG_NS index, with only a R^2 of 0.332 and an adjusted R^2 of 0.278.

The first column of Table 4 shows the regression of the TASSAVG (noNS+NS), index with both non-standard and traditional asset classes. The two equity ABS factors (*MKT* and *SMB*) are very significant for the pre-crisis period. While exposure to Bond-oriented factors of *10YrY* and *CredSpr* are insignificant during this period. It is observed that TASSAVG exposure to all the tree trend-following factors of FX, Bond and Commodity are statistically significant. These observations confirms William Fung and David A. Hsieh's observation that, "on average, hedge fund portfolios have systematic exposures to directional equity as well as systematic exposures to long–short equity". However, interest rate bets and credit spread bets are not as statistically significant as previously. It seems an investor can achieve an overall alpha of over 97 bps every month. The average monthly alpha improved from 78 bps (alpha from William Fung and David A. Hsieh's finding from 1994 to 2002) to 97 bps

Table 4. Regression of the three TASSAVG index (March 2000 - December 2006)

	(1)	(2)	(3)
	TASSAVG	TASSAVG_noNS	TASSAVG_NS
MKT	0.2098***	0.3123***	0.1107*
	(0.0344)	(0.0280)	(0.0485)
SMB (new)	0.1987***	0.2478***	0.1616**
	(0.0379)	(0.0303)	(0.0534)
10YrY	-1.3011*	-0.8560	-1.7002*
	(0.5420)	(0.4394)	(0.7643)
CredSpr	-1.4531	-1.7356*	-0.8621

	(1.0773)	(0.8510)	(1.5190)
tfBd	-0.0005	-0.0036	0.0043
	(0.0085)	(0.0069)	(0.0120)
tfFX	0.0173*		0.0269**
	(0.0068)		(0.0095)
tfComm	0.0197*		0.0299*
	(0.0089)		(0.0126)
Constant	0.0097***	0.0085***	0.0108***
	(0.0012)	(0.0010)	(0.0017)
Observations	81	81	81
R^2	0.625	0.816	0.380
Adjusted R^2	0.589	0.804	0.321

Standard errors in parentheses
* p < 0.05, ** p < 0.01, *** p < 0.001

During-Crisis period Analysis

Table 5 provide the regression results of the TASSAVG (noNS+NS), the TASSAVG_noNS, and the TASSAVG_NS on the seven hedge fund risk factors for the period of financial crisis from January 2007 to December 2009. It shows that ABS factor model regressions remain valid for the TASSAVG (noNS+NS) and TASSAVG_noNS, as their adjusted R^2 (0.755 and 0.867) improves when comparing with the Pre-crisis period. ABS seven-factor model also works better for the TASSAVG_NS index, with its R^2 statistic (0.560) over the 0.50 mark and enhanced adjusted R^2 (0.483). The ABS factor model gives better explanation of the returns of hedge funds within non-standard assets exposure during crisis period than the previous period. The overall improvement of the three indexes' adjusted R^2 illustrates that the ABS factor model is more valid in the crisis period. An investor following this model during crisis could get more accurate insights of hedge fund returns. The three indexes show very similar ABS factor exposure. It is noticeable that for the crisis period, *MKT* factor remained highly significant for the three indexes' returns. Exposure to Bond-oriented factors of *10YrY* and *CredSpr* are still not

significant during financial crisis period and SMB factor's level of significant drops surprisingly compared with the prior period. While the other three ABS factors are significant during this period as illustrated in Table 5. This could be explained by the view that financial crisis simultaneously influence different markets, resulting in increased correlations between different asset classes and tightening interactions between different ABS factors. Looking through the alpha of the TASSAVG index, it drops from 97 bps of prior period from to 87 bps, which is consistent with the history record of decreasing hedge fund return during financial crisis.

Table 5. Regression of the three TASSAVG index (January 2007 - December 2010)

	(1) TASSAVG	(2) TASSAVG_noNS	(3) TASSAVG_NS
MKT	0.2809***	0.3395***	0.2127***
	(0.0428)	(0.0386)	(0.0515)
SMB (new)	-0.1697*	-0.1472*	-0.1884
	(0.0780)	(0.0702)	(0.0939)
10YrY	-0.0180	-0.4523	0.3857
	(0.7634)	(0.6719)	(0.9183)
CredSpr	-2.6972***	-3.7313***	-1.6825
	(0.7146)	(0.5760)	(0.8596)
tfBd	0.0014	-0.0134	0.0150
	(0.0159)	(0.0133)	(0.0191)
tfFX	-0.0075		-0.0143
	(0.0124)		(0.0150)
tfComm	0.0118		0.0313
	(0.0162)		(0.0195)
Constant	0.0087***	0.0077***	0.0098***
	(0.0019)	(0.0017)	(0.0023)
Observations	48	48	48
R^2	0.791	0.881	0.560
Adjusted R^2	0.755	0.867	0.483

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Post-crisis Analysis

Table 6 contains our regression results of the Post-crisis period for the TASSAVG (noNS+NS), the TASSAVG_noNS, and the TASSAVG_NS index. We surprisingly observed that for the most recent years, the validity of William Fung and David A. Hsieh's seven-factor model dramatically decrease. This circumstances showed directly from the column three of Table 6, the result of TASSAVG_NS index that equally weighted constructed of the individual funds that have weight in the non-standard asset classes. The adjusted R^2 drops intensively from 0.483 of crisis period to almost non-

existent during post-crisis period. Thus the ABS factor model could not be a good reference to understand and analyse the returns of the TASSAVG_NS index. While adjusted R^2 level of TASSAVG (noNS+NS) and the TASSAVG_noNS index result are still acceptable for us to analyse hedge funds exposure to various ABS factors.

According to the Table 6, the TASSAVG (noNS+NS) and the TASSAVG_noNS indexes have statistically insignificant betas for the equity ABS factor of *MKT and SMB.* And their exposure to the fixed income ABS factor of *10YrY* is also still insignificant. While their exposure to the trend-following factors of FX, Bond and Commodity are significant after financial crisis. When comparing the alphas of the two indexes, the value of the intercept terms are quite small when compared with both the pre-crisis period and during-crisis period, with only 45 bps for the TASSAVG index and 15 bps for the TASSAVG_noNS. This illustrates the further declination of hedge fund returns after financial crisis. We consider that the William Fung and David A. Hsieh's seven-factor need some improvements to give better explanation for the return of funds with non-standard asset classes.

Table 6. Regression of the three TASSAVG index (January 2011 - January 2015)

	(1) TASSAVG	(2) TASSAVG_noNS	(3) TASSAVG_NS
MKT	0.1863	0.3846***	-0.0090
	(0.1078)	(0.0921)	(0.1887)
SMB (new)	0.1485	0.1510	0.1571
	(0.1293)	(0.1132)	(0.2263)
10YrY	-0.2421	-1.3188	0.9243
	(1.5435)	(1.3656)	(2.7011)
CredSpr	-4.2495	-3.7491	-4.6350
	(2.4441)	(2.1604)	(4.2771)
tfBd	-0.0053	-0.0121	0.0095
	(0.0218)	(0.0170)	(0.0382)
tfFX	-0.0018		-0.0179
	(0.0163)		(0.0286)
tfComm	0.0146		0.0427
	(0.0176)		(0.0308)
Constant	0.0045	0.0015	0.0070
	(0.0030)	(0.0026)	(0.0052)
Observations	49	49	49
R^2	0.334	0.568	0.114
Adjusted R^2	0.220	0.518	0.037

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

After comparing the model validity during the different time period, we concluded that it is still available for us to use the seven-factor model to continuously test the non-standard influence with the hedge fund returns.

Testing Non-standard Asset Classes Influence for 2000 to 2015

We continue to test the non-standard assets' influence on hedge fund return by performing t-test on alphas of the individual funds. In this step, each funds are fitted with the modified seven-factor model as funds would have different betas. T-tests were performed to verify whether the alpha is statistically between hedge funds with only exposure to traditional asset class (group 0) and hedge funds with exposure to both

traditional and alternative asset class (group 1). The null hypothesis for the two sided t-test tests whether the two alpha are the same. The tests will be conducted over the same three time periods mentioned in the extension of seven-factor model: March 2000 to December 2006, January 2007 to December 2010 and January 2011 to January 2015. The regression equation used is the modified seven-factor model, with *tfFX* factor and *tfComm* factor removed. The reason for excluding the trend following currency and commodity factor is that both currency and commodity is a non-standard asset class, we do not want to systematically account for return from them.

During the first time period of interest (2000-2006), the t-test showed inconclusive result. That is, we cannot reject the null hypothesis even at 5% significance that the alpha is different in the 2 subset of hedge funds. There is limited benefit in diversifying into the non-traditional in the pre-financial crisis period.

Table 7: Two-sample t test with unequal variances from March 2000 – December 2006

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	491	.0095455	.0008257	.018297	.0079231	.0111679
1	473	.0113551	.0012475	.0271316	.0089038	.0138065
combined	964	.0104334	.0007429	.0230644	.0089756	.0118912
diff		-.0018096	.001496		-.0047461	.0011269

diff = mean(0) - mean(1) t = -1.2096
Ho: diff = 0 Satterthwaite's degrees of freedom = 823.855

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.1134 Pr(|T| > |t|) = 0.2268 Pr(T > t) = 0.8866

As for the financial crisis phase (2007 - 2010), the t-test showed promising results. We are able to reject that two-sided test beyond the significance level of 1%; that is the alpha between hedge funds with only exposure to the traditional asset class (group 0) and hedge funds with exposure (group 1) is difference. In fact, according the one sided

t-test, it is statistically significant that the alpha of hedge with alternative asset exposure (group 1) is better than the funds in group 0. It can be concluded that investing in alternative class lessen the blow of the Subprime Mortgage crisis and the European Solvent Debt crisis.

Table 8: Two-sample t test with unequal variances from January 2007 – December 2010

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	851	.0085542	.0003724	.0108649	.0078232	.0092852
1	794	.0099729	.0003943	.0111102	.0091989	.0107469
combined	1645	.009239	.0002713	.0110035	.0087068	.0097711
diff		-.0014187	.0005424		-.0024825	-.0003548

diff = mean(0) - mean(1) t = -2.6156
Ho: diff = 0 Satterthwaite's degrees of freedom = 1629.31

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0045 Pr(|T| > |t|) = 0.0090 Pr(T > t) = 0.9955

For the period following the two financial crisis, diversification effect of the non-standard asset class is again mixed. The t-test could not reject the hypothesis of that the alpha between the two group of hedge fund are same. Although the one-sided t-test with alternative hypothesis for higher alpha in group 1, the group with investment in non-standard asset class, did strength compare to the pre-crisis from 0.1134 (table 7) to 0.0746(table 9), we still cannot reject the null hypothesis and accept this alternative hypothesis of better group 1 alpha in a statically significant way. Keep in mind that this can be partially due to the reason that the seven factor model fails to systemically explain the return of hedge funds with non-standard asset exposure well, thus the model alpha not as reliable. As explained in the model extension step for the post crisis period, the adjusted R^2 drops to almost non-existent during post-crisis period for funds categorized under group 1.

Table 9: Two-sample t test with unequal variances from January 2011 – January 2015

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	1089	-.000702	.0007469	.0246477	-.0021675	.0007636
1	1004	.0314446	.022255	.7051723	-.0122271	.0751164
combined	2093	.0147186	.0106857	.4888628	-.0062371	.0356743
diff		-.0321466	.0222676		-.0758429	.0115496

diff = mean(0) - mean(1) t = -1.4437

Ho: diff = 0 Satterthwaite's degrees of freedom = 1005.26

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0746 Pr(|T| > |t|) = 0.1491 Pr(T > t) = 0.9254

Conclusion

In this paper, we have used the seven-factor model by Fung and Hsieh (2004) to examine the alpha of hedge funds. The hedge funds tested omitted fund of funds as Fung and Heish's model excludes them. Base on the data of non-fund-of-fund hedge funds, the analysis demonstrated that while there are significant number of hedge funds that invested in alternative investment (1004 out of 2093 funds or 48%), the investment benefit of alternative asset class such as commodity, FX and real-estate is almost non-existential during normal economic condition. Funds that invest in non-standard asset classes did benefit from holding them during the financial crisis. We observe that the funds which invested in non-standard assets earned a statistically significant excess alpha over the funds that did not have exposure during the 2007 to 2010 period. Furthermore, according to the empirical test, funds without exposure to non-standard asset classes did exhibited higher tendency to underperform in ordinal ranking of fund performance relative to the whole TASS hedge fund universe. Thus, it is possible that funds with investment in the non-standard assets could outperform those without exposure in future financial crisis.

Appendix

Empirical test of hedge fund performance

Methodology

In the empirical testing step, the emphasis is on the returns. Cumulative return from hedge funds that has no non-standard asset exposure (group 0) and hedge funds that has exposure to non-standard asset (group 1) are compared. The cumulative return are obtained via geometric method to take account the compounding effect of returns. Two type of return are compared here: absolute return and risk adjusted return. For the absolute return, it is simply the cumulative return of the period; it is converted into a monthly return for ease of comparison as not every single fund exists for the full duration of the testing periods. For the risk adjusted return, it is the absolute return divided by the monthly standard deviation of the return.

We order all the hedge fund returns into ascending order and divided them into the 5 equal quantiles. Then, funds are split into two groups. The percentage of number of fund in each group relative to the total number of fund in that particular group is produced. Theoretically, each quantile should have a percentage of 20%. We will compare the percentages to see which group of hedges fund has higher portion in the best and worst performing quantiles. A lower quantile correspond to lower return and a higher quantile correspond to higher return. The empirical test will be conducted over the period of March 2000 to December 2006, January 2007 to December 2010 and January 2011 to January 2015, same as per the pervious step's tests.

This step excluded 15 funds as there are missing monthly return data during their reporting periods. Those fund are removed to as gap in return can cause biased in the final cumulative return and the standard deviation. 10 of the funds removed are hedge fund without exposure to non-standard asset class and the remaining 5 are funds with exposure.

Empirical Test Results

We can observe from figure 1 that during that 2000 to 2006 period, group 0 (funds with no exposure to non-standard asset class) has more percentage of the fund in the higher quantile relative to the lower quantile than the group 1 (fund with exposure to non-standard asset class), especially in a risk adjusted basis. The percentage composite for group 0 in quantile 3 4 5 are all above the theoretical 20% mark. This suggest that historically speaking, the in terms of returns, group 0 funds are more likely to place in the better return quantile than those from group 1.

In figure 2, the situation improves for group 1 funds. There are less percentage of the funds in the lower quantile (quantile 1 and 2). Group 0 funds on the other hand, had its percentage above 20% in the quantile 1 and 2, therefore making it more likely to underperform compare to the funds categorized under group 1. This illustrates that during the financial crisis period, hedge fund that has alternative investment benefited from the diversification of the non-traditional investment and thus are less probable to be placed in the lower quantile.

After the financial crisis period, the benefit of alternative investment seem to disappear again, in fact invest in alternative seem to seem to be dragging the hedge fund performance. Group 0 funds as a whopping 24% composition in the fifth quantile, well

above the theoretical 20% mark while group 1 funds has higher weights in the lower performance quantile. Thus, hedge funds with alternative investment exposure seem to have higher likelihood have lower ordinal ranking in terms of fund returns compared the funds that do not the exposure.

Figure 1: Performance of Hedge funds (2000-2006)

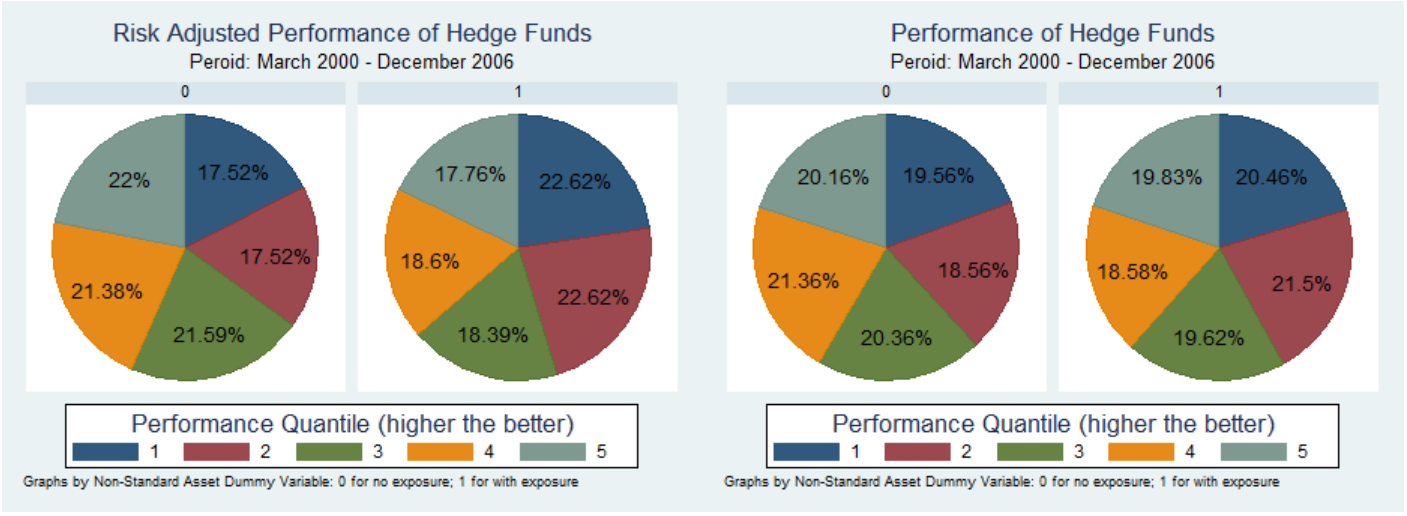


Figure 2: Performance of Hedge funds (2007-2010)

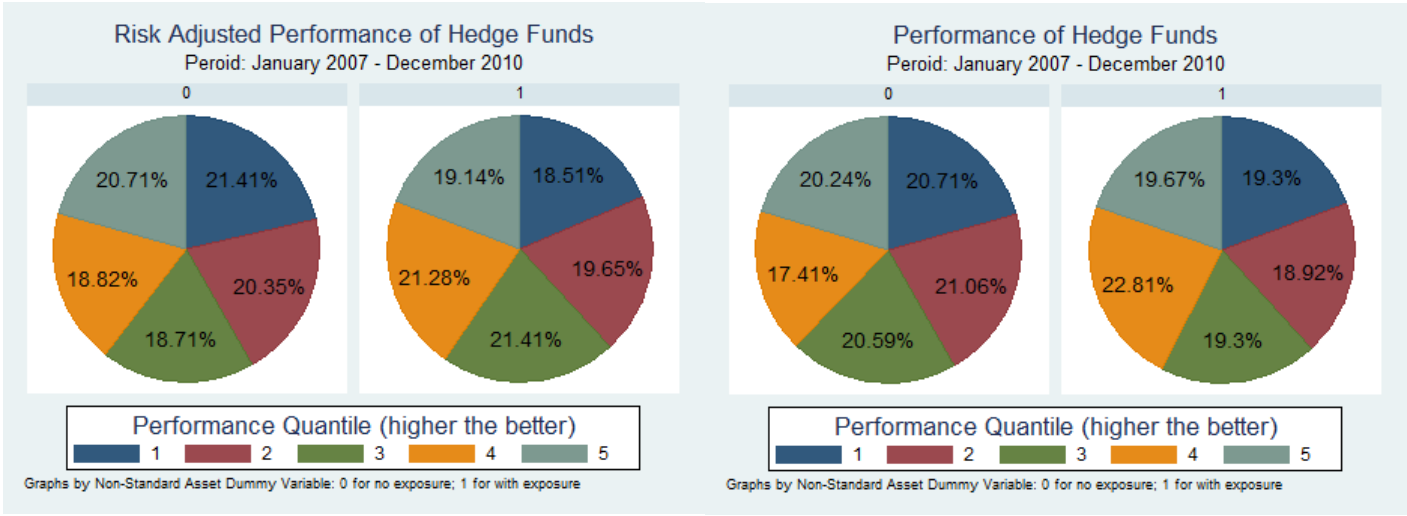
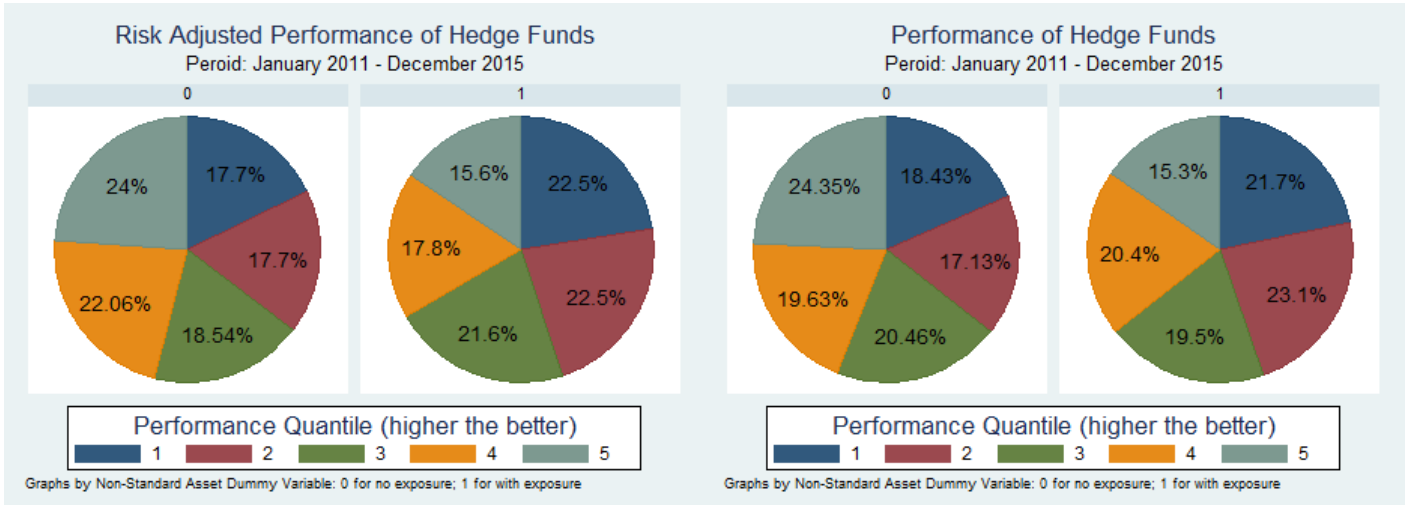


Figure 3: Performance of Hedge funds (2007-201



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