OPTIMAL PORTFOLIO CONSTRUCTION BY MIXING HEDGE FUND

by

Nan Yang
Bachelor of Business Administration, Nankai University, 2013

and

Xiangyu Cui
Bachelor of Economics, Tianjin University of Finance and Economics, 2013

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN FINANCE

In the Master of Science in Finance Program
of the
Faculty
of
Business Administration

© Nan Yang and Xiangyu Cui

SIMON FRASER UNIVERSITY

Term Fall Year 2014

Approval

Name: **Nan Yang and Xiangyu Cui**

Degree: **Master of Science in Finance**

Title of Project: **Optimal Portfolio Construction by Mixing Hedge Fund**

Supervisory Committee:

         _____

         Peter Klein
         Senior Supervisor
         Professor

         _____

         Jijun Niu
         Second Reader
         Associate Professor

Date Approved: _____

Abstract

The returns of the hedge fund are declining in recent years, accompanying with the impact of the financial crisis in 2008. There will be a question that whether the hedge fund can still be used to blend in a conventional portfolio to improve the performance. Our paper focuses on the comparison analysis and does the basic asset allocation for the hedge fund and traditional portfolio. We analyze the risk-adjusted returns for conventional assets of US Equities, EAFE Equities, US Bonds and International Bonds as well as the hedge fund. Finally we find that, under current market condition, hedge fund is still an ideal alternative asset for the choice of the portfolio to increase the risk-adjusted return level.

Keywords: Hedge Fund; Conventional Assets; Asset Allocation; Sharpe Ratio; CAPM

Acknowledgements

Table of Contents

1: Introduction

"Hedge fund", which was first created by Alfred Winslow Jones in 1949 has been originally used as a means of reducing the risk of an investment, which have a wide variety of strategies with the evolution of the hedge fund market.

In the 1990s, there was a widely held belief that hedge fund has excessive market risk while at the same time producing superior return performance according to Fung and Hsieh (1997) or Liang (1999). Therefore, investors especially the aggressive ones were more inclined to holding the portfolios, which include hedge funds and structured products rather than the plain-vanilla stock and bond portfolio. The research by Lamm (1999) also mentioned that the hedge fund offered the superior risk-adjusted returns due to several reasons. The lack of transparency in the hedge markets, the limited ability to absorb large amount funds in the market, the limited number of investors and the lower liquidity comparing with other financial products all contributed to the good performance of hedge fund. In conclusion, the small size and low cash inflow resulted in the superior returns of hedge fund in the past.

However, the hedge fund market grows steadily in recent years. As a general indicator of scale, the industry has managed around $2.38 trillion at its peak in 2014 (Hedge Fund Research Inc. global report). In this way, the return of the hedge fund will experience a declining trend with the increased cash inflow to the market. What's more, with the change of the securities and hedge fund market in recent years, especially after the financial crisis in 2008, there is the necessity to do the analysis to see whether the hedge fund can still improve the performance and give some basic ideas about the optimization of the asset allocation between the hedge fund and the conventional assets. So there is the question that is it still feasible to combine the hedge fund with the conventional assets to form a satisfying portfolio for the investors now?

We do the analysis based the Lamm (1999), we improved his paper by updating the data to August 2014 as well as some extension analysis about the optimization of the portfolio and the five-strategy hedge fund in asset allocation. The topic of the paper is to analyze the risk and return of the hedge fund as well as the traditional assets (equities market, bonds market and cash). Furthermore, the portfolio of the hedge fund and conventional

1

assets will also be analyzed and the asset allocation will be done using optimization to compare the performance after adding the hedge fund into the portfolios. With the growth of the hedge fund, there are various strategies in the hedge fund market that we will use to blend into the conventional portfolio. So the optimization between the different hedge fund strategies and the conventional assets will also be done in the paper. The basic analysis about necessity of different strategies of hedge fund could be observed.

2: Literature Review

With the increase categories of the securities and financial instruments, there are more and more choices for the investors to expect the return on their portfolio. In this way, the asset allocation between the financial products is necessary and important to guide the investors for their expected return. Brinson, Hood, and Beebower (1986) examined empirically the effects of investment policy, market timing and security selection on the return of total portfolio. They first demonstrated the magnitude of asset allocation policy in determining active performance.

With the increase use of hedge fund, more and more analysis has been done related to the hedge fund issues. The research about the evaluation of the return of the hedge fund and conventional assets as well as the asset allocation between some traditional assets and hedge fund has been done in the past years using the different models according to their assumptions. Lamm (1999) has done an overall comparison of hedge fund and five-class conventional assets and analyzed to find that the use of hedge fund can improve the risk-adjusted return level of the conventional portfolio, which has given a basis for others to do the further optimization of the asset allocation. There was the conclusion that the hedge fund can be an added to the investments of conventional portfolios to significantly improve the portfolio performance in a risk and reward context. After this, several papers have analyzed the optimal asset allocation between several asset classes and the hedge fund. Amenc and Martellin (2002) analyzed the optimization of hedge fund in the portfolio with the benchmark index (S&P 500) using an estimator of the covariance structure of hedge fund index returns. The out-of-sample performance of an improved estimator of the covariance structure of hedge fund index returns is evaluated, focusing on the optimal portfolio selection. The paper strongly indicated that to include an optimal amount of hedge funds in an investor portfolio could potentially generate a dramatic decrease in the portfolio volatility on an out-of-sample basis, which verified the conclusion of the Lamm (1999). Later Boyle and Liew (2007) also did the optimal asset allocation between the hedge fund and the benchmark index (S&P 500) using the regime-switching framework, which is a different way with the Amenc and Martellin. This paper discussed the asset allocation decision of an investor who is considering investing in hedge funds. They developed a simple procedure that helped to make the decision about the asset allocation given the assets consist of a core

equity portfolio, the risk-free asset, and a hedge fund. A regime-switching framework was used to model the joint returns of the hedge fund and the equity market. In the same year, with the non-normal properties of the hedge fund, Apopova, Morton, and Yau (2007) did a research about the asset allocation between the hedge fund and benchmark-related investments using a new stochastic programming model to calculate the optimal portfolio. This article introduced this model, which incorporated Monte Carlo simulation and optimization to examine the effects on the optimal allocation to hedge funds with benchmark related investment objectives such as expected shortfall and semi-variance. The paper concluded a result that a substantial allocation (approximately 20%) to hedge funds is justified. For the years before 2008, hedge fund has been proved to be an ideal alternative for the portfolio construction according the several papers above.

However, there is a serious financial crisis, which has a profound effect on the economy environment and securities market all over the world. Under this circumstance, equities and bond market as well as the hedge fund market have changed a lot. Billio, Getmansky, and Pelizzon (2009) analyzed that the financial crises made average volatility and correlation of hedge fund strategy returns increase. Hedge fund managers reduce market exposures during the periods of high volatility. Several other persons such as Black, Brassil and Hack (2010) have also analyzed the impact of the financial crisis on the equities and bond markets. These papers showed that the financial crisis has changed the returns and risks factors of all the markets all over the world. Due to the big change of the markets, a question that whether the hedge fund will still improve the performance of the conventional assets will be raised due to the new scenario of the economy today?

In our paper, we will do the analysis using the same approach of Lamm (1999). This paper that proved the feasibility and use of the hedge fund into the portfolio gave the basis for the asset allocation analysis of other papers afterwards.

Lamm (1999) found that investors' interest in "alternative assets" increased tremendously in 1990s due to the expectation for superior risk-adjusted returns of the investments. In 1990s, the hedge fund industry has attracted institutions and individual investors who initially invested in one or several hedge funds to spread their exposure over a number of hedge fund managers. The increased investment of hedge fund has produced diversification benefits, accompanying with more stable returns at lower risk. In his paper, in

4

addition to the hedge fund, he also analyzed the five-class assets for securities markets: US Equities, EAFE Equities, US Bonds, International Bonds and Cash. For hedge funds, he divided them into the main five strategies to analyze: Relative Value Hedge Fund Strategy, Event-driven Hedge Fund Strategy, Equity Hedge Fund Strategy, Global Hedge Fund Strategy as well as Short-selling Hedge Fund Strategy.

After determining the assets classes that he need to do the analysis, He did the following analysis. First, he calculated the risks and returns as well as the efficient frontier for the five-strategy hedge funds. Therefore with the historical monthly returns of the hedge fund, the asset allocation of the different strategies of the hedge fund could be observed and the overall hedge fund return and risk could be calculated which would be used to blend into the conventional portfolios. Then he would like to calculate the risks and returns for the conventional assets. In this process, he reengineered the returns for these equities and bonds from the current market capitalizations given the historical risks and correlations, which was obtained from the historical monthly returns. From his research, he found that the efficient frontier of the hedge fund dominated the efficient frontier of conventional assets at all risk levels. According to his analysis, although the reported returns of the hedge funds were accurate, they were likely biased upward because individual hedge funds were added to databases only when they have a demonstrated record of success. So there was the related data bias called backfill bias, which assumed that hedge funds that failed were largely excluded from reported returns by data vendors. What's more, the survivorship bias was also exposed to the hedge fund based the assumption that firms that fail are often dropped from existing data bases, creating even more potential for upward bias. He was also concerned about another fact that the cash inflow into the hedge fund would increase tremendously with the evolution of the hedge fund industry. In this way, the hedge fund would not provide such a superior return and there was indeed a statistically significant negative trend in hedge fund returns according to the TASS data. So he drew a conclusion that the hedge fund should not be invested at 100% with all funds. It should be blended into the conventional portfolios with its overvalued returns.

According to the analysis he did in the above steps, he did the final step of the paper. Because of the issue of the hedge fund survivorship bias and the declining trend, he decided to produce the efficient portfolio by combining hedge funds with the traditional assets under

various hedge fund returns assumptions. He set a range of returns for the hedge fund while holding the same volatility and correlation. By analyzing the efficient portfolios table, he found that the hedge fund could be invested in lieu of the bonds in the portfolios as a complement to equities. After the comparison analysis between the hedge fund and the conventional assets, he believed that the hedge fund played an important role in the portfolio construction and the superior returns on the risk-adjusted basis by blending the equities and the hedge fund. During 1990s, the hedge fund was a conservative but quite good investment choice for all the investors. For aggressive investors, they could hold portfolios with hedge fund with its superior returns if the survivorship bias was small. For conservative investors, the hedge fund was also advised because of the function to reduce risk. His conclusions were also consistent with the investor behavior they observed in 1990s. Some aggressive small institutions and high net worth individuals made about 40% asset allocations to the hedge fund, and the balance was exposed to equities. On the other hand, the conservative investors held few hedge funds. In this way, they may be significantly underexposed to hedge funds.

The Lamm (1999) gave the basic conclusion of the necessity and use of the hedge funds for the other papers in 1990's market condition. Because of the change of the markets after the financial crisis, we need to check the result given the new economy environment nowadays. In order to check the conclusion of the Lamm (1999), we will use the same approach. The approach is the "mean-variance" approach accompanying with the efficient frontier that can gives us a direct image about the performance of the portfolio, which is appropriate for the comparison between the conventional assets and hedge fund. This approach for asset allocation was raised by Markowitz (1952) who came up with the "expected returns-variance of returns" rule (E-V rule). The procedure aims for maximizing expected return for some level of risk, or minimizing risk for a given return. Another reason for us to use this approach is to get a comparable result to check the accuracy of the conclusion of Lamm (1999) nowadays.

Due to the current market condition as well as the dramatic increase of cash inflow into the hedge fund market, the hedge fund can't offer the superior returns as 1990s did as we mentioned before. In this way, hedge fund may not dominate the conventional assets nowadays. So the further asset allocation analysis needs to be done to observe whether the

hedge fund could increase the risk-adjusted returns of the portfolios. In addition to the Lamm (1999), we will also do some further basic analysis about the optimal portfolio of the hedge fund and conventional assets. What's more, we will also do another extension in the analysis about the different strategies of the hedge fund. By doing the asset allocation between the traditional assets and the five different hedge fund strategies, the importance and necessities of the different strategies could be also analyzed.

3: Hedge Fund

3.1 Background

Hedge fund is always recognized as an alternative investment vehicle and a free-for-all pooled investment way which is privately structured, managed by investment professionals, used by high-net-wealth people and not widely available to the low-income people. Few regulations allow hedge funds to achieve "alpha" no matter the market goes up or down. Due to their private feature, hedge funds have fewer limitations on the usage of leverage, short selling, and derivatives than more regulated conventional investment vehicle such as mutual funds. This allows for investment strategies that differ significantly from traditional non-leveraged, long-only strategies.

Traditionally, rich persons have been the largest investors in hedge funds. Latterly, however, more and more institutional investment put money into hedge according to Rajnish (2011).

In 1990s, the hedges funds had small amount cash inflow to the hedge fund market, which results in the superior returns. However, according to the latest HFR Global Hedge Fund Industry Report (Hedge Fund Research Inc.), hedge fund industry capital finished the quarter at $2.38 trillion (Figure 1). In the last five years the number of hedge funds has increased by at least 155%.

Figure 1 Hedge Fund Asset under Management from 2004 to 2014
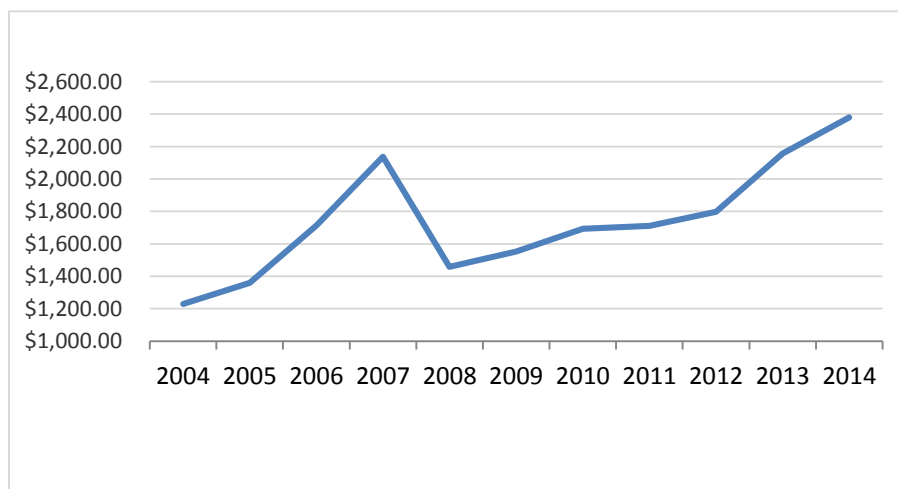
Source: Hedge Fund Research Inc.

According to the historical returns of the hedge fund for past ten years, we can see that 2008 was essentially a lowest return year and the asset under management declined sharply as well, constituting the only such poor performance year reported due to the severe and unprecedented global financial crisis.

However, with the increase of the amount of funds into the hedge fund market, the declining trend of the return of the hedge fund has been realized in recent years. We found that, comparing with the returns in 1990s, the performance of hedge fund has decreased to a lower level. Therefore, it is necessary for us to verify the use of the hedge fund into the conventional portfolio and make a comparison with the results in Lamm (1999).

3.2 Data

The data of hedge funds we used comes from the Lipper Tass Database, which includes 277 hedge fund indices, 5902 actively reporting individual hedge funds and funds of hedge funds and 13909 graveyard funds that have closed, liquidated or not continue to report for any reason. The number of individual hedge funds is based on the database file released on Oct. 21, 2014.

In Lamm (1999), the data he used provided by Evaluation Associates, Inc. (EAI). Lamm (1999) thinks that the return and risk profile is confirmed using alternative data available from TASS. A study based on TASS was done by Brown, Goetzmann, and Park (1998). Therefore, we think it is reasonable for using TASS data in our paper.

We conducted our research at index level and used nine hedge fund index databases. We use the Dow Jones Credit Suisse Hedge Fund Indices, which have been used in Rajnish (2011). The data we used in this paper included the NAV's and monthly returns of nine hedge fund indices over the last 10 years from Jan 2004 to Aug 2014. The monthly returns were altered into yearly returns to study the yearly performance of the hedge fund indices. The nine hedge funds were: Dow Jones Credit Suisse Convertible Arbitrage Hedge Fund, Dow Jones Credit Suisse Dedicated Short Bias Hedge Fund, Dow Jones Credit Suisse Emerging Markets Hedge Fund, Dow Jones Credit Suisse Equity Market Neutral Hedge Fund, Dow Jones Credit Suisse Event Driven Hedge Fund, Dow Jones Credit Suisse Fixed Income Arbitrage Hedge Fund, Dow Jones Credit Suisse Global Macro Hedge Fund, Dow

Jones Credit Suisse Long/Short Equity Hedge Fund, and Dow Jones Credit Suisse Hedge Fund.

Following the categories of hedge funds in Lamm (1999) and in order to make a rational comparison, we make some editions for the indices of hedge fund and combined convertible arbitrage hedge fund and fixed income arbitrage hedge fund to get the index of relative value hedge fund, global macro hedge fund and emerging markets hedge fund to get the index of global asset allocators, and long/short equity hedge fund and market neutral hedge fund to get the index of global asset allocators. The classification is based on the definition of hedge funds with different strategies in Lamm (1999).

The overall hedge fund returns and volatility were calculated using the nine hedge fund indices and were compared with the returns of US equities, EAFE equities, US bond, and International bond. The correlation and covariance between the hedge fund indices and with the US equities, EAFE equities, US bond, and International bond index were also calculated in our paper in order to do the analysis the optimization between hedge funds and conventional assets.

3.3 Five Strategies of Hedge Fund

Nowadays, hedge fund has a large pool of financial instruments, taking the long or short position by trading, to hedge the exposure to the market or make profit by arbitrage. In this way, hedge fund employs dynamic investment strategies designed to find unique opportunities in the market and then actively trade their portfolio investments in an effort to maintain high and absolute returns. In the market, there are more than 30 investment strategies. To analyze the performance of the hedge fund more efficiently, we divided the hedge fund into five strategies, which is in the same way with Lamm (1999). In Lamm (1999), he gave the definition of five hedge fund strategies: "1. Relative Value: managers primarily execute market-neutral strategies that combine long positions offset in whole or part by short positions. These could be in equities, convertibles versus common equity, yield-curve arbitrage, or even in commodities. 2. Event-Driven: managers primarily employ merger and acquisition or bankruptcy arbitrage. 3. Equity Hedge: managers engage in classic hedge fund activity where long positions are offset by short positions, except that there is typically a long bias. 4. Global asset allocators: take leveraged long or short positions in virtually any financial product in any market. 5. Short-Sellers: sell short equities that are

expected to decline in price." The classification and inclusions of these five hedge fund strategies are described below.

Relative Value Hedge Fund mainly includes: 1. Convertible Arbitrage Hedge Fund: The convertible bond can be regarded as a fixed-income security that has embedded equity call option. The convertible arbitrage hedge fund is a market-neutral investment strategy that involves the simultaneous purchase of the convertible securities and the short sale of common shares that underlie the convertible. 2. Fixed Income Arbitrage Hedge Fund: This hedge fund attempts to exploit pricing inefficiencies in fixed income markets by combining long/short positions of various fixed income securities. Its arbitrage income comes from volatility arbitrage, mortgage arbitrage, swap spread arbitrage, capital structure arbitrage and yield curve arbitrage. Thus the fixed income arbitrage hedge fund has very low correlation with the stock market and bond market.

Event Driven Hedge Fund has the same definition as Lamm (1999), which includes: 1. Distressed Securities Hedge Fund: The hedge managers for this hedge fund invest in the securities of the companies in distressed situation such as bankruptcy or restructure. The prices of these securities fall in anticipation of financial distress when the holders choose to sell and there is a lack of buyers. The hedge manager often choose to invest in distressed securities for this hedge fund by purchasing at a discounted price and expecting the potential return in the future to offset the risk. 2. Merger/Risk Arbitrage Hedge Fund: This hedge fund makes efforts to exploit the profit when the ownership of the company changes. During the merger and acquisition, the manager generates the return by longing on the target company and shorting the stock of acquiring company.

Equity Hedge Fund often maintains both the long and short position in equity securities and equity derivatives. It includes two sub-classes: 1. Equity Market Neutral Hedge Fund: for this hedge fund, the managers often select the various securities with similar market value, similar beta in the similar industry to purchase or sell in an effort to make the net exposure close to zero to reach the dollar neutrality. In this way, the hedge fund can obtain continuous profit however the market changes. 2. Long/Short Equity Hedge Fund: This is different from market neutral hedge fund because the goal of long/short hedge fund is not to reach neutrality. The hedge fund focus on equity long/ short position and adjust the position due to movements of the market, starting with the fundamental analysis of the

11

individual companies as well as the research on risk and opportunities of its industry, competitors and overall environment.

Global Asset Allocator Hedge Fund can be divided into two streams: 1.Global Macro Hedge Fund: This is the most widely used and famous hedge fund. The hedge fund managers set this strategy according to the overall macroeconomics environment. Global macro hedge fund can profit from the change of interest rates, stock market, foreign exchange rates and commodity prices etc. by taking the position. The return of this hedge fund strategy is highly correlated with return level of stock market and bond market with the high leverage ratio. 2. Emerging Market Hedge Fund: This hedge fund invests a major share of portfolio in securities of companies or the sovereign debt of developing or "emerging" countries. The emerging market hedge fund is sensitive to the political and economic factors, which is not market neutral with high risk.

Dedicated Short Bias Hedge Fund is to gain the return by maintaining the net short exposure (more dollars short than long) in the securities. The hedge fund managers often borrow the securities, which are overvalued from the brokers and short, and sell them on the market. When the real value of the securities is realized and the price of the securities fall, the manager can buy the securities to repay for the brokers. In this way, the net return due to the price discrepancy has been obtained for this hedge fund. In our paper, we treated it as "Short-Sellers" in Lamm (1999).

 In order to make a good comparison with Lamm (1999), in our paper we keep the same name of each of hedge fund strategy as used in Lamm (1999), which included "Relative Value", "Event-Driven", "Equity Hedge", "Global Asset Allocators", and "Short-Sellers".

3.4 Hedge Fund Efficient Frontier and Analysis

Our data on hedge funds shows that returns of the overall hedge fund averaged 6.23% in past ten years with an annualized volatility of 5.56%. This is better than other assets as well as slightly superior to equities and bonds on a risk-adjusted basis. Compared with the return and volatility of hedge funds in 1990s, which are 16.5% and 3.4%, the return of hedge funds from 2004 to 2014 has decreased significantly and its volatility has increased mainly due to the bad performance of hedge fund in 2008 and 2011. The return of hedge fund in 2008 is almost negative 20%, and the poor performance of hedge fund showed again

in 2011 (Figure2). Figure 2 was constructed by converting the monthly return of hedge fund into the yearly return from 2004 to 2014. The yearly return of hedge fund is estimated based on the first eight months in 2014. We calculated the average of the first eight monthly return and then multiplied the average by 12 to get the estimated yearly return.

In the past ten years, the decline of return of hedge fund from 15% to 5%. Thus, at a certain degree, the prediction that hedge fund would have a declining trend of the return in Lamm (1999) was proved correctly. One possible explanation for this trend is the more and more money was invested in hedge fund, which result in the dramatic increase of cash inflow to the hedge fund market (Figure 1). According to Lamm (1999), we also produce the polynomial trend using the historical returns of the hedge fund, which shows a probable trend for the hedge fund performance. As there is no declining trend as 1990s, we use another range set for the alternative hedge fund returns in scenario analysis .The analysis will be discussed in the following "scenario analysis" part in our paper.

Figure 2
Modest Decline in Hedge Fund Returns 2004-2014

Return

Polynomial trend
$y = -5E-10x^3 + 7E-05x^2 - 2.6577x + 3593$
$R^2 = 0.03$
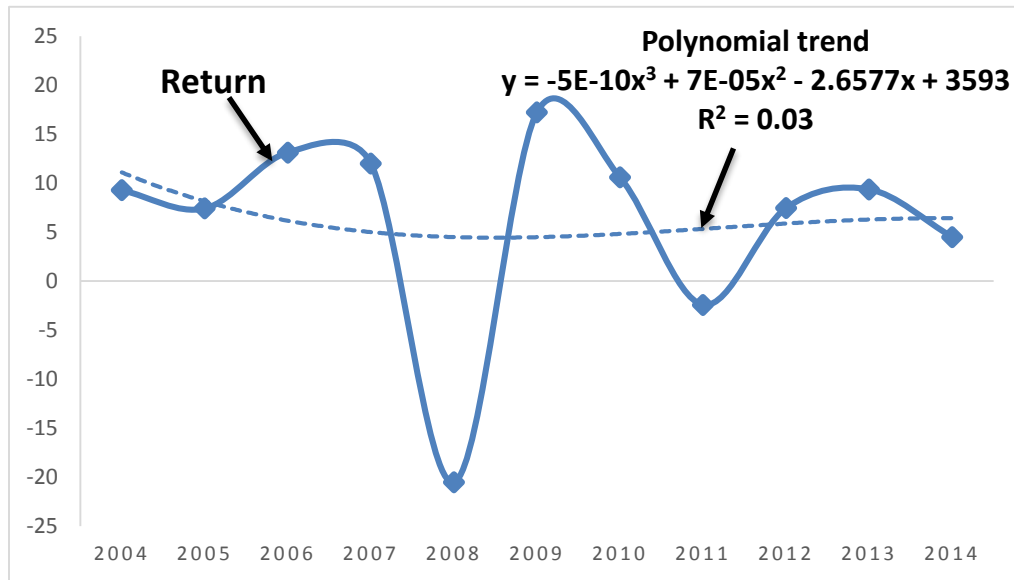
*The yearly return of 2014 is estimated based on the monthly return of first eight months in 2014.
Source: Lipper Tass Hedge Fund Database

As we discussed above, hedge fund strategies are consisting of a variety of flavors and formats. Many data suppliers and consultants use ten or more descriptive strategies to segment the industry. Even though the trend of return of overall hedge fund has been declining, diverse hedge fund styles produce different risk and return characteristics. For instance, hedge funds that primarily sell short show statistically varying risk, return, and correlation profiles from global macro style. The same is not false for other hedge fund strategies. The relative richness of performance data on different strategies permits the construction of efficient hedge fund frontiers using standard Mean-Variance analysis. This analysis produces efficient combinations of strategies that represent optimal hedge fund portfolios. In this way, people could design fund of hedge funds that have bigger risk and return profiles. What is more, this analysis can be used to decide which diverse hedge fund strategies may be added to stock and bond portfolios.

Figure 3
Hedge Fund Efficient Frontier
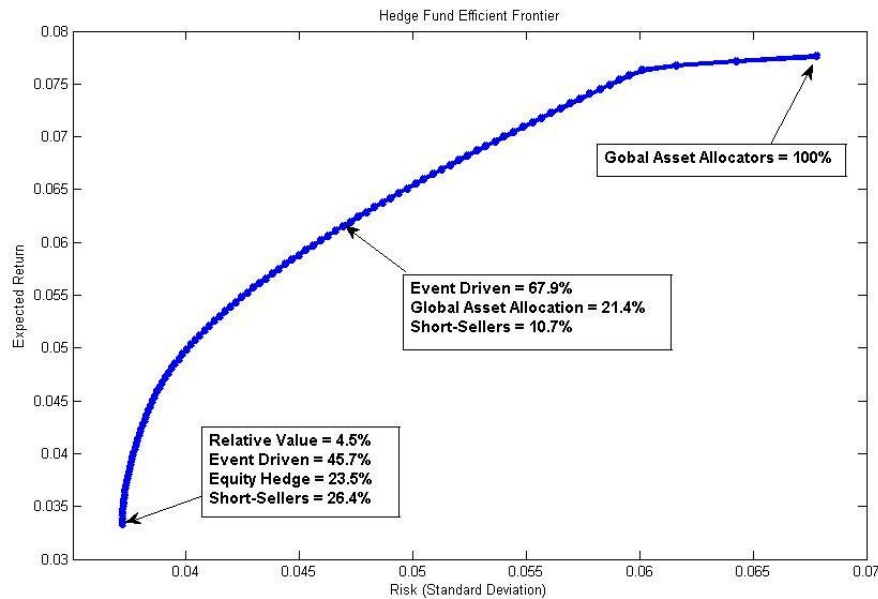
Hedge Fund returns, risks, and correlations used to generate the efficient frontier of hedge fund are historical based on Lipper Tass monthly data of hedge fund indices from January 2004 to August 2014.

We use the historical returns of the indices from Lipper Tass Database mentioned before to calculate the returns and volatility of the five strategies of hedge fund. We also calculate the covariance matrix for the five strategies. These returns and covariance are used to produce the efficient frontier of Figure 3.

The result of generating the efficient frontier for hedge fund strategies (Figure 3) indicates that the most aggressive optimal portfolios assign high weightings to event driven and global asset allocators. Short-sellers and equity hedge managers produce more conservative risk-adjusted returns. 14 optimal portfolios with different risk and return profiles consisting of hedge funds with different strategies are displayed in Table 1. The maximum return and risk of all portfolios on efficient frontier is 7.76% and 6.78%. In this portfolio, only global asset allocators' hedge funds are included. The minimum return and risk of all portfolios on efficient frontier is 3.33% and 3.72%. This portfolio with minimum risk includes relative value, event driven, equity hedge, and short-sellers hedge funds. The global asset allocators' hedge funds are excluded in this portfolio. Then we get a general conclusion. For the aggressive investors, they should put 100% investment into global asset allocators' hedge funds. For the investors who have a neutral risk tolerance, their portfolio consists of 67.9% event-driven hedge funds, 21.4% global asset allocation hedge funds, and 10.7% short-sellers hedge funds. For the most conservative investors, they should add 4.5% relative hedge fund into their portfolio, increase the weight of short-sellers to 26.4% and that of equity hedge to 23.5%, and decrease the weight of event driven hedge funds to 45.7%. Based on our efficient frontier analysis, conservative investors should assign large weights to equity hedge and short-sellers managers and commit smaller percentages of funds to other hedge fund strategies.

Compared with Lamm (1999), the weight of equity hedge and relative value decreased in all portfolios. The performance of portfolios with hedge funds had a worse performance in past ten years then 1990s. We found that short-sellers still have produced very poor negative returns. It has lower correlation with the other hedge funds than 1990s, thus we think it can be used to reduce risk of portfolio more efficiently.

Table 1

Selected Portfolio on Hedge Fund Efficient Frontier (%)

Portfolio Return	Portfolio Risk	Relative Value	Event Driven	Equity Hedge	Global Asset Allocators	Short-Sellers
		-------------------------- Allocation ---------------------------				
3.33	3.72	5	46	23	-	26
3.67	3.73	3	55	17	-	25
4.01	3.77	-	62	11	3	24
4.35	3.82	-	67	3	8	22
4.69	3.90	-	69	-	11	20
5.03	4.02	-	69	-	13	18
5.37	4.19	-	69	-	16	15
5.72	4.39	-	68	-	19	13
6.06	4.62	-	68	-	21	11
6.40	4.88	-	68	-	24	8
6.74	5.17	-	67	-	27	6
7.08	5.48	-	67	-	29	4
7.42	5.80	-	67	-	32	1
7.76	6.78	-	-	-	100	-

In order to evaluate the performance of the five hedge fund indices, Sharpe ratio was also used in our paper (Table 2). The Sharpe Ratio, or Sharpe Index, measures the excess return per unit of risk in an investment asset or a trading strategy. The Sharpe Ratio is defined as:

$$\text{Sharpe Ratio} = \frac{E(\bar{r}_p - \bar{r}_f)}{\hat{\sigma}_p}$$

Where $\bar{r}_p$ is the asset return, $\bar{r}_f$ is the risk free rate of return, $E(\bar{r}_p - \bar{r}_f)$ is the expected value of the excess of the asset return over the riskless return, and $\hat{\sigma}_p$ is the standard deviation of the excess return. The Sharpe Ratio is used to characterize how well the return of an asset rewards the investor for the risk taken.

By comparing the Sharpe Ratio of five hedge funds with different strategies with those in 1990s, we found that the Sharpe Ratios of all hedge funds are lower than the number in Lamm (1999), especially, the hedge fund with relative value strategy and that of hedge fund with equity hedge. The Sharpe Ratio of hedge fund with relative value strategy in Lamm (1999) was 5.9, however, the Sharpe Ratio of hedge fund with relative value strategy in our paper is only 0.64. The Sharpe Ratio of hedge fund with equity hedge strategy in Lamm (1999) was 2.7, the Sharpe Ratio of hedge fund with equity hedge strategy in our paper is only 0.83. Therefore, we think this provided a good explanation why the weight of hedge fund with equity hedge strategy and hedge fund with relative value strategy are decreased in all portfolios consisting of hedge funds. The main reason for this large decrease of the Sharpe ratio of hedge funds is attributed to the large decrease of the return of the hedge fund.

Table 2
Returns, Volatility and Correlations for Various Hedge Fund Strategies (%)

	Relative Value	Event-Driven	Equity Hedge	Global Asset Allocators	Short-Sellers
Return	4.42	7.53	6.3	7.76	-6.77
Risk	6.87	6.12	7.52	6.75	14.74
Sharpe Ratio	0.64	1.23	0.83	1.14	-0.45
	-------------------------------- Correlation --------------------------------				
Relative Value	1				
Event-Driven	0.68	1			
Equity Hedge	0.65	0.9	1		
Global Asset Allocators	0.72	0.77	0.83	1	
Short-Sellers	-0.35	-0.59	-0.68	-0.42	1

Source: Lipper Tass Database begins January 2004 through August 2014

4: Conventional Assets

To compare with the hedge fund, the conventional assets should be analyzed as well. To give a more adequate view of the securities market, the conventional asset classes should conclude a wide variety of the securities in a worldwide area. In this way, the equities markets, bonds markets and cash returns (3-month treasury bills rate) should be considered in several regional markets, such as US, EAFE and international. In this way, the overall performance of the conventional assets could be obtained and is more reasonable to compare with the whole hedge fund market.

4.1 Methodology

Having established the basic behavioral characteristics of the hedge fund portfolios, we determine the optimum asset allocation for portfolios of conventional assets and compare them to the hedge fund. First, we need to calculate the conventional portfolios using the traditional assets. Then we inquire to what extent hedge fund assets should be blended with the conventional assets to produce optimum portfolios.

For the analysis of the asset allocation of conventional portfolios, the assumptions underlying are critical to any conclusions reached. In this paper, we include five categories of conventional assets to analyze: US Equities, EAFE Equities, US Bonds, International Bonds, and Cash. This is a simple, well-diversified global portfolios that includes the key asset classes employed by most investment managers, which is appropriate and complete for the overall performance of the conventional assets.

4.2 Data

Chopra, Vijay, and Ziemba (1993) have shown that the return assumptions are the most critical component in asset allocation. Therefore, the appropriate expected returns of conventional assets should be gained instead of the historical returns. To simplify the process and remove subjectivity from the analysis, we reengineer expected returns given current market capitalizations combined with historical volatilities and correlations as Lamm (1999) did. Lamm (1999) didn't specify the model he used. The alternative models that can be used for the reengineering the returns are Black Litterman model and CAPM model. According to Idzorek (2005), it showed that the CAPM model relative to the market

capitalization-weighted portfolio using the implied beta could get the identical implied returns of the conventional assets with the Black Litterman Model. In this way, we decide to use the CAPM model instead of the Black Litterman model for reengineering to simplify the process.

We use the index as the proxy which can represent each securities market: US Equities: Russell 3000; EAFE Equities: MSCI EAFE Index; US Bonds: Barclays Capital US Bond Index; International Bonds: Barclays Capital Bond Global Index. We take the following steps to get the implied returns for the conventional assets from reengineering.

First, we calculate the monthly returns for each index as well as the historical volatilities. Then we use the current market-cap for each index to calculate the weights for each asset-class, in this way, the monthly return of market-cap portfolio could be calculated. With the volatilities of each asset-class as well as the covariance matrix of the traditional assets and the market portfolio, the implied betas for each asset could be calculated. Finally, taking the parameters into the CAPM model, the implied returns for the traditional assets will be obtained in Table 3. The expected return of the market-cap portfolio is regarded as the market return and the three-month Treasury bill rate is used as the risk-free rate. The calculation method we used is given Idzorek (2005). The beta we calculate by using the formula below has the same value as the beta given by regression method for the conventional assets.

$$E(r_j) = r_f + \left[E(r_m) - r_f\right]\beta_j$$

$$\beta_j \equiv \frac{\text{cov}(\tilde{r}_j, \tilde{r}_m)}{\sigma_m^2}$$

Where:

r_j: Implied return for conventional asset j

r_f: Risk free rate(3-month Treasury bill rate)

$E(r_m)$: Expected market return

β_j: Beta for conventional asset j

4.3 Results and Analysis

Table 3 shows the risks, returns and correlation matrix for the conventional assets and the overall hedge funds, which has several changes comparing with those in 1990s. The result of reengineering returns produces the situation that reflects the current market environment in the following aspects.

The US yield curve has changed a lot in the recent decades where the risk-free rate (three-month treasury bills rate) is really low now (Table 3) comparing with the 5% rate in 1990s, the reason for which is the impact of the financial crisis in 2008. After the financial crisis, the investors are rushing to the safety of US Treasury securities. During the credit crisis, the yield on the two-year Treasury Bonds fell from more than 5% to less than 1%. Yields on shorter term Treasuries fell even further. Here we use the three-month Treasury bill rate as the risk free rate, which is only 0.0285%. The dramatic decrease in the rate is related to the increase number of the investors.

Meanwhile the bonds markets have lower returns and risks comparing with those of 1990s. For the whole economic market, the decrease of the returns and risks of the bond market is also related to the investors' preference, similar with the treasury bonds. Due to the unstable performance of the economic environment, especially the equities market, investors feel safer to invest into the financial instruments that have lower risk. In this way, the bond is more preferred by the investors comparing equities market. The increase cash inflow to the bond markets comparing with the markets of 1990s, leads to the decrease of the returns. In this context, international bonds are less attractive with a lower Sharpe ratio, which is the same with the situation in 1990s. For the worldwide bond markets, US bond market has a better performance than the international market.

On the other hand, the equities markets have a higher risk and returns comparing with the 1990s. In my opinion, the performance of the equity markets is related to the investors' confidence. Because of the unstable performance of the equities market, especially affected by the financial crisis in 2008, the investors are less interested in the equities investments. When the economies enter into recession, many firms made less profit or even loss so they didn't have the ability to give the returns to the investors. The negative signal the firms gave to the investors leads to the decrease of share price in the recession period. For the several years after 2008 till now, the market is in the recovery period, and the firms begin

20

to give the good responses to the market with the recovery of the share price. However, as we mentioned before, the investors have less interest in the equities market comparing with the 1990s. Many of them lose the confidence in the equity market. The decrease of cash inflow will impact the return of the equity market. And the volatility of the equity market is higher than 1990s due to the unstable market condition, especially during the 2008. The EAFE Equities have a higher returns and Sharpe ratio than the US Equities, which is also the same with the situation in 1990s.

Table 3
Asset Class Returns, Risk and Correlation Assumptions

	US Equities	EAFE Equities	US Bonds	International Bonds	Hedge Funds*	Cash
Implied returns	13.24	17.9	3.35	3.29	6.23	0.03
Excess returns	13.21	17.87	3.32	3.26	6.2	0
Risk	13.03	15.98	3.65	3.77	5.56	0
Sharpe ratio	1.01	1.12	0.91	0.86	1.12	0
	------------------------------ *Correlation* ------------------------------					
US Equities	1					
EAFE Equities	0.86	1				
US Bonds	-0.09	0.01	1			
International Bonds	0.07	0.21	0.84	1		
Hedge Funds	0.27	0.24	-0.28	-0.12	1	
Cash	0	0	0	0	0	1

*The return of hedge fund is historical return

Implied returns for US Equities, EAFE Equities, US Bonds, and international bonds above are reengineered from current market capitalizations given historical risks (monthly trailing standard deviation) and correlations. Hedge fund returns, risks and correlations are historical based on TASS Database monthly from 2004 through August 2014.

Table 4 shows the efficient frontier for the conventional assets where the EAFE equities and US bonds weights more. And asset allocation is tilt to EAFE for more risky portfolios. The investment for cash is quite low due to the very low US yield in recent years. The asset allocation to the EAFE is still large, which is the same with the 1990s. However, the weight to the US bonds has increased accompanying with the decreased weights to US Equities. The US Equities market is influenced the most in the financial crisis, which reduce the motivation of the investors to make investments into it. The international bonds still an unattractive market for the investors, especially in recent years. For the investors who would like to invest into the bond market, the US bond may be a better choice for them due to the higher Sharpe ratio we calculated in Table 3.

In 1990s, when we compare the efficient frontier of the hedge fund with that of the conventional portfolios, we found that the performance of the hedge fund dominates that of conventional portfolios. However, with the declining performance of the hedge fund due to the evolution of the hedge fund market as well as the declining trend, the performance of the hedge fund has changed a lot. So in our paper, when we compare the hedge fund efficient frontier (Table 1) with the efficient frontier for traditional assets (Table 4), we find that the hedge fund cannot dominate the conventional portfolio any more as 1990s. So investing in 100% hedge fund is definitely not a good choice any more. But the Sharpe ratio of the hedge fund is slightly higher than the five-class traditional assets. What's more, if one believes that hedge funds offer at least several percentage points of excess return, we can easily conclude that they should play an important role in portfolios. The excess return for the hedge fund is 6.20% (Table 3), which is high. In this way, we would like to regard the hedge fund as another alternative asset class to blend into the conventional portfolio in order to check the efficient frontier for the new portfolios.

Table 4
Efficient Frontier for Traditional Assets (%)

Portfolio Return	Portfolio Risk	US Equities	EAFE Equities	US Bonds	International Bonds	Cash
		------------------------------ *Allocation* ------------------------------				
0.03	0.00	-	-	-	-	100
1.40	0.94	3	3	17	-	78
2.78	1.89	6	5	34	-	56
4.15	2.83	8	8	50	-	34
5.53	3.77	11	10	67	-	12
6.90	4.75	11	17	72	-	-
8.28	5.93	9	28	63	-	-
9.65	7.25	6	39	55	-	-
11.03	8.63	3	51	46	-	-
12.40	10.06	-	62	38	-	-
13.78	11.52	-	72	28	-	-
15.15	12.99	-	81	19	-	-
16.53	14.48	-	91	9	-	-
17.90	15.98	-	100	-	-	-

Figure 4
Optimal Conventional Portfolio
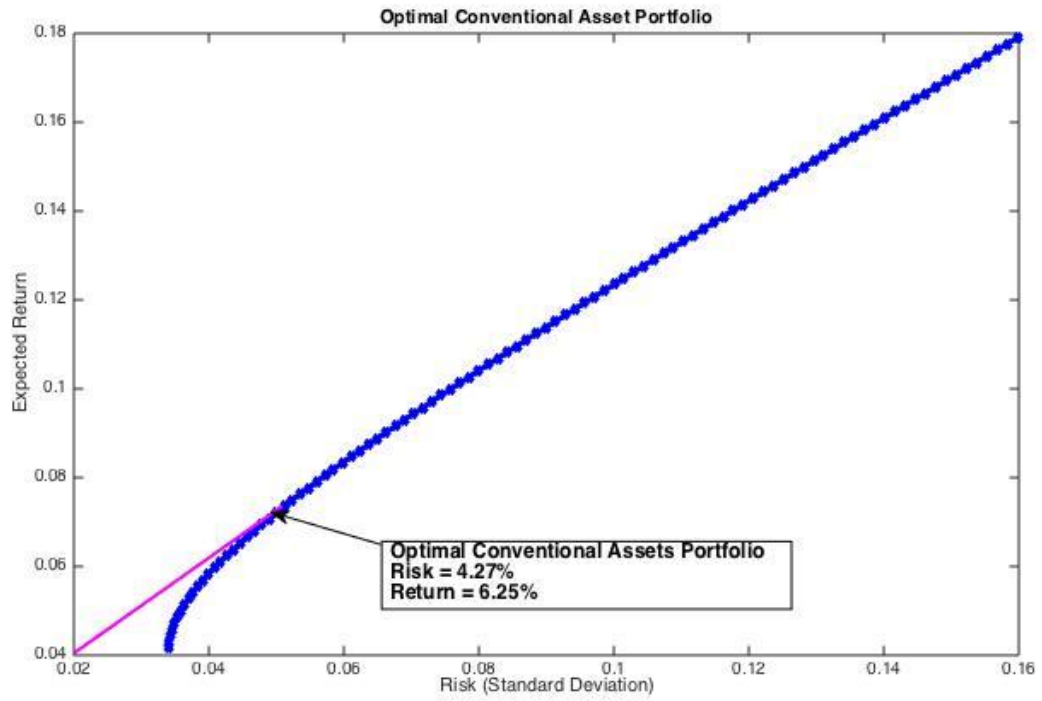
Conventional assets returns, risks, and correlations in Table 4 are used to generate the efficient frontier of conventional portfolios.

5: Comparison Analysis

After the "mean-variance" analysis of the hedge fund and conventional assets, we need to blend the hedge fund into the portfolio as an alternative asset class to check whether the performance of the new portfolio improve that of conventional portfolios. We use the returns and risks of the five conventional assets and hedge fund as well as the covariance between them, therefore, the efficient frontier and optimal portfolio could be observed. This part is an extension of Lamm (1999) by doing the asset allocation and determines the optimal portfolio on the efficient frontier between the conventional assets and hedge fund.

5.1 Optimization of the Portfolio with the Hedge Fund

As we analyzed before, although the hedge fund can't dominate the traditional assets, it still is an alternative asset class that could be blended into the conventional portfolio. In this way, we need to use the data to check whether the hedge fund can improve the performance of the overall portfolio by the quantitative analysis using the optimization method. This is an extension of Lamm (1999), which wasn't done because of the fact that the hedge fund dominates the conventional assets. There is no need to do the analysis to check the importance of the hedge fund to blend into the conventional portfolios. Instead, due to the data bias as well as the declining trend, the hedge fund returns may be overvalued. In this way, he did the scenario analysis to do the asset allocation under alternative hedge fund returns directly, which we will do the same analysis in section 6.

We did the asset allocation with the same approach with the other analysis above. After we blend the overall hedge fund into the conventional portfolios, we do the asset allocation between the traditional five-class assets and the hedge fund. Then we can also get the efficient portfolio as well as the optimal portfolio from the optimization. In order to check the performance of the portfolios by adding the overall hedge fund, we compare the efficient frontier of the conventional portfolios and the portfolios with the hedge fund (Table 4 and Table 5). We can get the following results from the tables and figures.

First, from these two tables of the efficient portfolios, we could find that the risks of the portfolios decrease on all levels of the return of the portfolios. When we compare the optimal portfolios, the optimal one in Figure 5 also has a higher risk-adjusted return comparing with the optimal conventional portfolio in Figure 4. Therefore, we could find that on the

condition of the current market environment accompanying with the decreased return of the hedge fund, it can still be used to improve the performance of the portfolio as an alternative asset class. The use of the hedge fund can effectively decrease the risk for the same portfolio returns. Comparing with the conclusions of the Lamm (1999) that the hedge fund could provide superior returns for the portfolios than the other conventional assets, the use of the hedge fund now focus more on reducing the risk for the given level of the returns instead of providing the higher excess returns. In Lamm (1999), the hedge fund is appropriate and advised for all kinds of investors including the aggressive investors and conservative investors because the hedge fund can both provide the higher returns for risk-preferring investors as well as reduce the risk for the conservative investors. Nowadays, the hedge fund is more advisable for the conservative investors who care more about the portfolios risk.

Table 5
Efficient Frontier for portfolio of conventional assets and hedge fund (%)

Portfolio Return	Portfolio Risk	US Equities	EAFE	US Bond	International Bond	Hedge Fund	Cash
				-- *Allocation* --			
0.03	0.00	-	-	-	-	-	100
1.40	0.73	1	1	14	-	9	75
2.78	1.46	2	2	28	-	18	49
4.15	2.20	3	3	42	-	27	24
5.53	2.93	4	5	55	-	36	-
6.90	3.92	1	16	44	-	39	-
8.28	5.17	-	26	33	-	42	-
9.65	6.54	-	35	21	-	44	-
11.03	7.97	-	44	10	-	46	-
12.40	9.44	-	53	-	-	47	-
13.78	10.98	-	65	-	-	35	-
15.15	12.59	-	76	-	-	24	-
16.53	14.26	-	88	-	-	12	-
17.90	15.97	-	100	-	-	-	-

Then, when analyze the specific asset allocation between the asset classes, we could find that international bond is still an unattractive investment choice for the investors, just as the results of Lamm (1999). EAFE Equities still has a large weight and important role in the portfolios. Especially for aggressive investors who pursue the higher returns of the portfolios, the weight of the EAFE will be larger comparing to the other assets because of the higher returns of the EAFE Equities. On the other hand, when we analyze other asset classes, we

found that the weight and use of the US bond has been increased accompanying with the decrease investment in US Equities. This is consistent with the results of conventional assets that we have mentioned before. The US bond becomes a good investment choice in recent years especially after the financial crisis because of the conservative attitude of investors. Especially for conservative investors, the US bonds accompanying with the hedge fund would be a primary choice for investing. In all, the use of the hedge fund to blend into the conventional portfolios is still useful and effective despite of the decreasing performance of the hedge fund in recent decades, especially after the financial crisis. By the way, after comparing the Table 4 and Table 5, the blend of the hedge fund into the portfolio has made the corresponding slightly decrease in weight of the US bonds and cash. Recalling the conclusions in Lamm (1999), the hedge fund can be invested in lieu of bond and cash to blend with the equities into the portfolio. This result is related to and similar with the conclusion of Lamm (1999). The hedge fund can have the similar function with bond and cash; however, the role of the bond has changed. The bond market is important in the market condition, which cannot be replaced by the current hedge fund with the decreased performance.

Finally, when we analyze the optimal portfolio, we find that Figure 5 shows the optimal portfolio, which has the overall hedge fund. This optimal portfolio has a much better performance on risk-adjusted basis than the conventional portfolio. In this way, the necessity of the hedge fund in the portfolio has been verified.

Figure 5
Optimal portfolio of conventional assets and overall hedge fund.
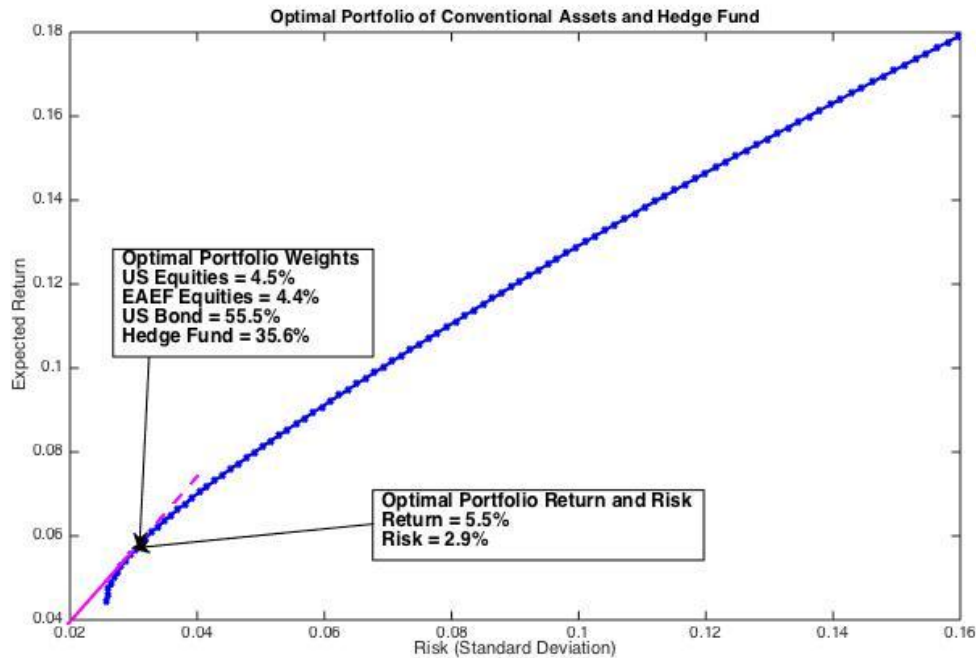
5.2 Optimization of the Portfolio with Five-Strategies Hedge Fund

After we have confirmed the use of the hedge fund is efficient to improve the performance of the portfolio, we do a further analysis of the asset allocation between the conventional assets and the five-strategy hedge fund. In this way, the choice of the different strategies of the hedge fund could be observed to get the optimal portfolio.

This is a totally new extension based on the Lamm (1999), focusing on the further analysis of the different strategies of hedge fund. With the evolution of the hedge fund market, hedge funds employ dynamic investment strategies designed to find unique opportunities in the market and then actively trade their portfolio investments in an effort to maintain high and absolute returns. For the investors, the choice of the specific hedge fund to blend into the portfolios may also be important and advisable when making the investment decisions. The approach to analyze the different strategies choice of the asset allocation is the same with the above one. We also do the asset allocation to get the efficient portfolios and determine the optimal portfolio on the efficient frontier. Different from adding the overall hedge fund input,

29

we do the asset allocation between ten asset classes, including the five conventional assets as well as the five hedge fund strategies.

When we compare the efficient frontier of the portfolio (Table 6) and the efficient frontier of the conventional portfolio in Table 4, we could also find that the risk decrease more effectively on all levels of the returns of the portfolios, which decrease the risk even more than the overall hedge fund because the diversification benefits with the various asset classes. Therefore, although the performance of the overall hedge fund as well as the five hedge fund strategies have decreased, the hedge fund market still provides the opportunities for the investors to improve their risk-adjusted returns. In this way, the hedge fund market still play a necessary and important role in the asset allocation of portfolios.

When we turn to the optimal portfolio, we analyze the Figure 6. The Figure 6 shows the optimal portfolio, which has the different weights to different hedge fund strategies. By comparing this optimal portfolio with the conventional portfolio (Figure 4), the performance could be also improved on the risk-adjusted basis. The necessity of the hedge fund in the portfolios has been verified again with the five strategies.

Figure 6
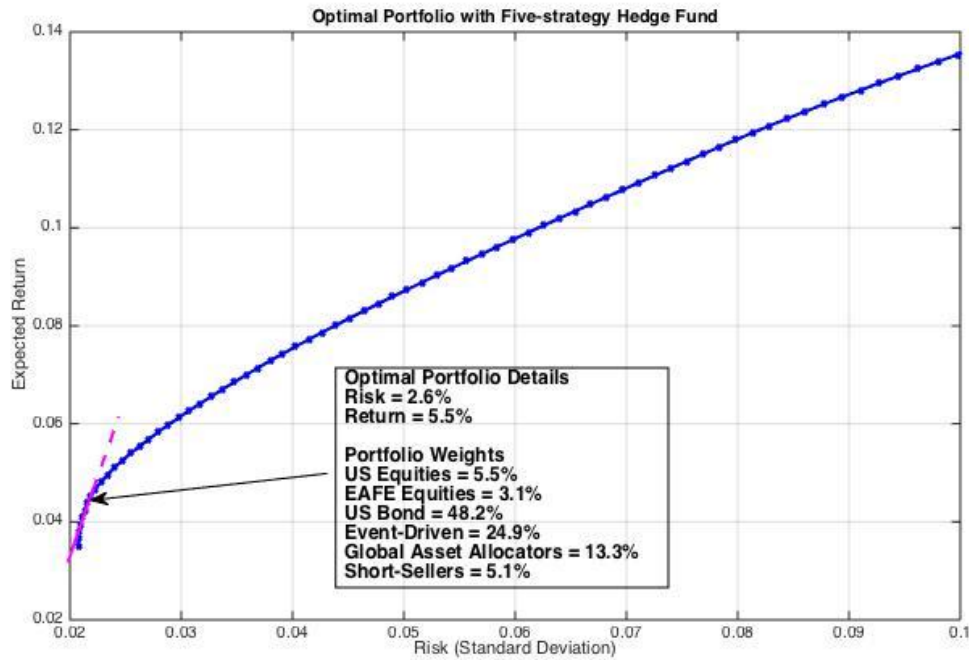*Optimal portfolio with five-strategy hedge fund*

Table 6 Efficient Portfolio of conventional assets and five-strategy hedge fund(%)

Portfolio Return	Portfolio Risk	US Equities	EAFE Equities	US Bond	International Bond	Relative Value	Event Driven	Equity Hedge	Global Asset Allocators	Short-Sellers	Cash
					----------- *Allocation* -----------						
0.03	0.00	-	-	-	-	-	-	-	-	-	100
1.40	0.65	2	-	13	-	-	7	-	3	2	73
2.78	1.30	3	1	26	-	-	14	-	7	3	46
4.15	1.95	5	1	39	-	-	20	-	10	5	19
5.53	2.62	5	3	48	-	-	25	-	14	5	-
6.90	3.51	2	11	45	-	-	23	-	18	-	-
8.28	4.62	-	20	33	-	-	25	-	22	-	-
9.65	5.88	-	28	19	-	-	27	-	26	-	-
11.03	7.21	-	35	6	-	-	29	-	30	-	-
12.40	8.63	-	46	-	-	-	21	-	33	-	-
13.78	10.27	-	59	-	-	-	5	-	36	-	-
15.15	12.07	-	73	-	-	-	-	-	27	-	-
16.53	13.98	-	86	-	-	-	-	-	14	-	-
17.90	15.97	-	100	-	-	-	-	-	-	-	-

5.3 Comparison analysis of portfolios with overall hedge fund and with five-strategy hedge fund

From the analysis above, we have observed that both the overall hedge fund and the five-strategy hedge fund can improve the performance of the conventional portfolios and get higher returns on risk-adjusted basis. Based on the conclusions, we will compare the use of overall hedge fund and the use of five-strategy hedge fund for the further analysis. When we compare the Table 5 and Table 6 as well as the Figure 5 and Figure 6, we can get the following results.

First, when we compare the table 5 and table 6, we can see the risks of the portfolios with five-strategy hedge fund is even smaller than the portfolios with the overall hedge fund on all levels of the return. What's more, we can also observe that the optimal portfolio with five-strategy hedge fund has a smaller risk with the same return than the optimal one with overall hedge fund. In this way, we could know the five-strategy hedge fund with different weights comparing with the overall hedge fund can improve the performance of the conventional portfolios better.

Then, after we get conclusions that the five-strategy hedge fund can improve the performance better, we can further analyze the asset allocations between the different strategies of the hedge fund. The overall hedge fund index reflects the weights for different strategies in the current hedge fund market. According to Ineichen (2012), for the current market, the weights for the five strategies are: Relative Value 18%, Event-driven 13%, Equity Hedge 34%, Global Asset Allocator 33% and Short-sellers 2%. We can see from Table 6 that the equity hedge fund and global hedge fund play the most important role in the portfolios comparing with other strategies, which are advised to invest for almost all levels of risk. Therefore, the use of five-strategy hedge fund can help emphasize the use of these two hedge fund strategies in order to improve the performance better than the overall hedge fund.

Finally, we can find that with the current hedge fund distribution of different strategies, the hedge fund market can provide the investors more opportunities to optimize the portfolio with the large weights of these two hedge fund strategies.

5.4 Scenario Analysis

Lamm (1999) did the scenario analysis. He thinks that the overestimation of the return of hedge fund is significant to be concerned due to the survivorship of data. So he used reducing returns of hedge funds from 5.5% to 12.5% and analyzed the impact of that on portfolios. Following Lamm (1999), we also did the scenario analysis to see the asset allocation between the hedge fund and the conventional assets by using alternative returns of hedge fund from 5% to 12%.

The performance of the hedge fund has decreased a lot in past ten years, which is impacted by the financial crisis as well as the declining trend that is made in 1990s. However, the economy environment is in the recovery period. As mentioned in section 3, we calculate the returns of the overall hedge fund are 6.23% while the hedge fund has experienced the decrease of the returns for recent decades. We need to analyze the asset allocation under different circumstances for hedge fund, so we decide to make a scenario analysis to do the asset allocation between the hedge fund and the conventional assets given the range of return from 5% to 12%, which indicates the probability that the performance of the hedge fund will increase in the recovery period. We set different portfolio returns to see the corresponding asset allocation, which are shown in Table 7.

In this way, we could find that the weights of the hedge fund will increase if the performance of them could be improved. On all levels of the prospective hedge fund returns, the hedge fund is still useful to optimize the portfolios. The international bond is still the unattractive asset class for the investors no matter the performance of the hedge fund. For the same level of the hedge fund returns, the aggressive investors prefer to invest more in EAFE for higher returns while the conservative investors would like to invest more in hedge fund on a risk-adjusted basis accompanying with a small portion of US bond, which is similar with the analysis mentioned before.

Table 7
Efficient Portfolios under Alternative Hedge Fund Returns (%)

Return	Risk	US Equities	EAFE Equities	US Bond	International Bond	Hedge Fund	Cash
				Asset Allocation			
				---- *12%* ----			
4.50	1.64	1	1	27	-	27	44
8.97	3.34	-	5	39	-	56	-
13.43	6.40	-	24	-	-	76	-
				---- *11%* ----			
4.50	1.74	1	1	30	-	28	40
8.97	3.66	0	8	34	-	59	-
13.43	7.40	0	35	-	-	65	-
				---- *10%* ----			
4.50	1.85	2	2	33	-	29	35
8.97	4.05	-	11	29	-	60	-
13.43	8.30	-	43	-	-	57	-
				---- *9%* ----			
4.50	1.98	2	2	36	-	30	31
8.97	4.50	-	15	25	-	60	-
13.43	9.06	-	50	-	-	50	-
				---- *8%* ----			
4.50	2.12	3	2	39	-	30	26
8.97	5.00	-	21	23	-	57	-
13.43	9.69	-	55	-	-	45	-
				---- *7%* ----			
4.50	2.26	3	3	43	-	30	21
8.97	5.50	-	26	24	-	50	-
13.43	10.23	-	59	0	-	41	-
				---- *6%* ----			
4.50	2.42	4	4	47	-	29	17
8.97	5.95	-	31	29	-	40	-
13.43	10.68	-	62	0	-	38	-
				---- *5%* ----			
4.50	2.58	5	4	50	-	27	13
8.97	6.29	-	35	37	-	28	-
13.43	11.04	-	67	12	-	22	-

5.5 Findings

If one believes that the hedge funds offer at least several percentage points of excess return above treasury rates, we can easily conclude that they should play an important role in portfolios. Despite of the current market condition and the declining performance of the hedge fund, we find the hedge fund is still a critical asset to improve the performance on conventional portfolios, especially decreasing the portfolio risks. Therefore, the hedge funds constitute a conservative investment on the risk and return basis.

These findings are different from the results in the past that the hedge fund could be blended with both the equities and bonds instead of blending the equities by replacing the bonds. This is related to the unstable stock market performance after 2008, which leads to diversifying the investment choice. In addition, unlike 1990s, the hedge fund may be not attractive to the aggressive investors who pursue the higher returns. But for conservative investors, they would be best advised to increase their holdings of hedge funds to reduce risk.

6: Conclusion

  Portfolios of hedge funds represent an important alternative asset class that has gained prominence in the past decades. However, for the decade we analyzed from 2004-2014, a severe financial crisis has occurred which has a profound impact on the worldwide economy environment including all kinds of securities markets. What's more, the significant increase cash inflow into the hedge fund market has also decreased the returns of the hedge fund. In this way, the important role of the hedge fund in the portfolio should be verified given the declining performance in recent years.

  After we analyzed the performance of conventional assets and hedge funds respectively, we found that the hedge fund cannot dominate the conventional assets any more. However, the hedge fund is still an ideal asset-class to blend into the conventional portfolios. In this way, we do the asset allocation and determine the optimal portfolio with the hedge fund. According to the results, we find that even under such conditions, the hedge fund can still improve the risk-adjusted performance of the portfolios, which makes it still a critical alternative asset to invest. We also analyze the different hedge fund strategies when blending into the conventional portfolios and find that the event-driven hedge fund and the global hedge fund play an important role in the construction of the portfolios, which is supported by the increasing share in the hedge fund market.

  In conclusion, the hedge fund is still important and ideal to blend into the conventional portfolios to improve the risk-adjusted returns. This is true especially for the conservative (conservative) investors, for whom the hedge fund should be used as a diversification instrument.

7: Appendix

7.1 MATLAB Code:

```matlab
% Author: Xiangyu Cui
% Student ID. No.: 301235497
% Date: Dec.,2014
% For Final Project Figure1

clear all
close all
clc
format compact

% Loading Return Time Series
data = xlsread('FiveSubHFRt.xlsx');
RetTS = data(:,:).*12;
[ExpRet,ExpCov] = ewstats(RetTS(:,:));


% Number of portfolios
NumPorts = 100;
NumPortsN = 14;

% Displaying the efficient frontier
frontcon(ExpRet,ExpCov, NumPorts);

% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet,ExpCov, NumPortsN)
PortWts100 = PortWts.*100

% Author: Xiangyu Cui
% Student ID No.: 301235497
% Date: Dec., 2014
% For Final Project Table 1

clear all
close all
clc
warning off
format compact

% Setting Expected Return of Five Hedge Funds
ExpRet5 = [0.0442   0.0753  0.0630  0.0776  -0.0677];

% Setting Expected Covariance
ExpCov5 = [0.0047   0.0029  0.0034  0.0033  -0.0036
0.0029  0.0037  0.0041  0.0032  -0.0053
0.0034  0.0041  0.0057  0.0042  -0.0075
0.0033  0.0032  0.0042  0.0046  -0.0042
-0.0036 -0.0053 -0.0075 -0.0042 0.0217];

% Number of portfolios
```

37

```
NumPorts = 14;
NumPortsC = 100;
% Setting asset bounds
AssetBounds5 = [0, 0, 0, 0, 0 ;
                1, 1, 1, 1, 1 ];

% Calculating Portfolio risk, return and weights
frontcon(ExpRet5, ExpCov5, NumPortsC, [], AssetBounds5)
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet5, ExpCov5, NumPorts,
[], AssetBounds5);

PortReturnAdj = PortReturn.*100
PortRiskAdj = PortRisk.*100
PortWtsAdj=PortWts.*100
% Author: Xiangyu Cui
% Student ID. No.: 301235497
% Date: Dec.,2014
% For Final Project Figure 9

clear all
close all
clc
format compact

% Asset Class: US Equities, EAFE Equities, US Bonds, Int Bonds

ExpRet = [0.1324 0.1790 0.0335  0.0329];
ExpCov = [0.0169740975611511     0.0179  -0.0004 0.0003
0.0179  0.0255401451757507   0.0001   0.0013
-0.0004 0.0001   0.00132963778797048      0.0012
0.0003   0.0013   0.0012   0.00142006669263504];

% Number of portfolios
NumPorts = 100;

% Displaying the efficient frontier
frontcon(ExpRet,ExpCov, NumPorts)

% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet,ExpCov, NumPorts);

% Setting current 3 month T-bill rate as riskless asset rate
RisklessRate = 0.0003;
BorrowRate = 0.0003;

% Assuming risk adversion of an average Canadian investor
RiskAversion = 3;

% Displaying the efficient frontier
portalloc(PortRisk, PortReturn,
PortWts,RisklessRate,BorrowRate,RiskAversion);

% Giving the optimal portfolio data
```

```
  [RiskyRisk, RiskyReturn, RiskyWts, RiskyFraction,
OverallRisk,OverallReturn] ...
      = portalloc(PortRisk, PortReturn,
PortWts,RisklessRate,BorrowRate,RiskAversion)


 ExpRet5 = [ExpRet 0.0003];
 ExpCov5 = [ExpCov zeros(4,1);zeros(1,5)];


[PortRisk5risky, PortReturn5risky, PortWts5risky] =
frontcon(ExpRet5,ExpCov5, [], 0.0625)
% Author: Xiangyu Cui
% Student ID. No.: 301235497
% Date: Dec.,2014
% For Final Project Figure4

clear all
close all
clc
format compact


% Asset Class: US Equities, EAFE Equities, US Bonds, Int Bonds, HF


ExpRet = [0.1324    0.1790  0.0335  0.0329 0.0624];
ExpCov = [0.0170    0.0179  -0.0004 0.0003  0.0020
0.0179  0.0255  0.0001  0.0013  0.0022
-0.0004 0.0001  0.00133     0.0012  -0.0006
0.0003  0.0013  0.0012  0.0014  -0.0002
0.0020  0.0022  -0.0006 -0.0002 0.0031 ];

% Number of portfolios
NumPorts = 100;


% Displaying the efficient frontier
frontcon(ExpRet,ExpCov, NumPorts)


% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet,ExpCov, NumPorts);


% Setting current 3 month T-bill rate as riskless asset rate
RisklessRate = 0.0003;
BorrowRate = 0.0003;


% Assuming risk adversion of an average Canadian investor
RiskAversion = 3;


% Displaying the efficient frontier
portalloc(PortRisk, PortReturn,
PortWts,RisklessRate,BorrowRate,RiskAversion);


% Giving the optimal portfolio data
  [RiskyRisk, RiskyReturn, RiskyWts, RiskyFraction,
OverallRisk,OverallReturn] ...
      = portalloc(PortRisk, PortReturn,
PortWts,RisklessRate,BorrowRate,RiskAversion)
```

```matlab
 ExpRet6 = [ExpRet 0.0003];
 ExpCov6 = [ExpCov zeros(5,1);zeros(1,6)];


[PortRisk5risky, PortReturn5risky, PortWts5risky] =
frontcon(ExpRet6,ExpCov6, [], 0.0546)
% Author: Xiangyu Cui
% Student ID No.: 301235497
% Date: Dec., 2014
% For Final Project Table 4

clear all
close all
clc
warning off
format compact

%% Question 1
data = xlsread('return for asset allocation.xlsx');



% Setting Expected Return of Five Conventional Assets
ExpRet5 = [0.1324   0.1790  0.0335  0.0329  0.0003];

% Setting Expected Covariance
ExpCov5 = [0.0169740975611511   0.0179  -0.0004 0.0003  0.0000
0.0179  0.0255401451757507  0.0001  0.0013  0.0000
-0.0004 0.0001  0.00132963778797048     0.0012  0.0000
0.0003  0.0013  0.0012  0.00142006669263504     0.0000
0.0000  0.0000  0.0000  0.0000  0];

% Number of portfolios
NumPorts = 14;

% Setting asset bounds
AssetBounds5 = [0, 0, 0, 0, 0 ;
                1, 1, 1, 1, 1];

% Calculating Portfolio risk, return and weights %?????Function
frontcon(ExpRet5, ExpCov5, NumPorts, [], AssetBounds5)
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet5, ExpCov5, NumPorts,
[], AssetBounds5);

PortReturnAdj = PortReturn.*100
PortRiskAdj = PortRisk.*100
PortWtsAdj=PortWts.*100

% Author: Xiangyu Cui
% Student ID No.: 301235497
% Date: Dec., 2014
% For Final Project Table5

clear all
close all
```

```matlab
clc
warning off
format compact

%% Question 1
data = xlsread('return for asset allocation.xlsx');



% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet6 = [0.1324   0.1790  0.0335  0.0329 0.0624 0.0003];

% Setting Expected Covariance
ExpCov6 = [0.0170    0.0179  -0.0004 0.0003  0.0020  0
0.0179  0.0255  0.0001  0.0013  0.0022  0
-0.0004 0.0001  0.00133     0.0012  -0.0006 0
0.0003  0.0013  0.0012  0.0014  -0.0002 0
0.0020  0.0022  -0.0006 -0.0002 0.0031  0
0   0   0   0   0   0];

% Number of portfolios
NumPorts = 14;

% Setting asset bounds
AssetBounds6 = [0, 0, 0, 0, 0, 0 ;
                1, 1, 1, 1, 1, 1];

% Calculating Portfolio risk, return and weights %?????Function
frontcon(ExpRet6, ExpCov6, NumPorts, [], AssetBounds6)
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet6, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturnAdj = PortReturn.*100
PortRiskAdj = PortRisk.*100
PortWtsAdj=PortWts.*100
% Author: Xiangyu Cui
% Student ID. No.: 301235497
% Date: Dec.,2014
% For Final Project Figure5

clear all
close all
clc
format compact

% Asset Class: US Equities, EAFE Equities, US Bonds, Int Bonds, 5 HFs

ExpRet = [0.1324    0.1790  0.0335  0.0329 0.0442   0.0753   0.0630
0.0776  -0.0677];
ExpCov = [0.0170     0.0179  -0.0004 0.0003  0.0027  0.0019   0.0025
0.0014  -0.0041
0.0179  0.0255  0.0001  0.0013  0.0022  0.0020  0.0028  0.0017  -0.0029
-0.0004 0.0001  0.0013  0.0012  -0.0008 -0.0006 -0.0007 -0.0007 0.0001
0.0003  0.0013  0.0012  0.0014  -0.0004 -0.0003 -0.0003 -0.0003 0.0005
0.0027  0.0022  -0.0008 -0.0004 0.0047  0.0029  0.0034  0.0033  -0.0036
0.0019  0.0020  -0.0006 -0.0003 0.0029  0.0037  0.0041  0.0032  -0.0053
```

```
0.0025   0.0028   -0.0007 -0.0003 0.0034   0.0041   0.0057   0.0042   -0.0075
0.0014   0.0017   -0.0007 -0.0003 0.0033   0.0032   0.0042   0.0046   -0.0042
-0.0041 -0.0029 0.0001   0.0005   -0.0036 -0.0053 -0.0075 -0.0042 0.0217];


% Number of portfolios
NumPorts = 100;


% Displaying the efficient frontier
frontcon(ExpRet,ExpCov, NumPorts)


% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet,ExpCov, NumPorts);


% Setting current 3 month T-bill rate as riskless asset rate
RisklessRate = 0.0003;
BorrowRate = 0.0003;


% Assuming risk adversion of an average Canadian investor
RiskAversion = 3;


% Displaying the efficient frontier
portalloc(PortRisk, PortReturn,
PortWts,RisklessRate,BorrowRate,RiskAversion);


% Giving the optimal portfolio data
 [RiskyRisk, RiskyReturn, RiskyWts, RiskyFraction,
OverallRisk,OverallReturn] ...
     = portalloc(PortRisk, PortReturn,
PortWts,RisklessRate,BorrowRate,RiskAversion)

 ExpRet10 = [ExpRet 0.0003];
 ExpCov10 = [ExpCov zeros(9,1);zeros(1,10)];


[PortRisk5risky, PortReturn5risky, PortWts5risky] =
frontcon(ExpRet10,ExpCov10, [], 0.0514)
% Author: Xiangyu Cui
% Student ID No.: 301235497
% Date: Dec., 2014
% For Final Project Table6


clear all
close all
clc
warning off
format compact


% Setting Expected Return of Five Conventional Assets and 5 Hedge Funds
ExpRet10 = [0.1324   0.1790   0.0335   0.0329 0.0442   0.0753   0.0630
0.0776   -0.0677 0.0003];


% Setting Expected Covariance
ExpCov10 = [0.0170   0.0179   -0.0004 0.0003   0.0027   0.0019   0.0025
0.0014   -0.0041 0
```

```
0.0179  0.0255  0.0001  0.0013  0.0022  0.0020  0.0028  0.0017  -0.0029
0
-0.0004 0.0001  0.0013  0.0012  -0.0008 -0.0006 -0.0007 -0.0007 0.0001
0
0.0003  0.0013  0.0012  0.0014  -0.0004 -0.0003 -0.0003 -0.0003 0.0005
0
0.0027  0.0022  -0.0008 -0.0004 0.0047  0.0029  0.0034  0.0033  -0.0036
0
0.0019  0.0020  -0.0006 -0.0003 0.0029  0.0037  0.0041  0.0032  -0.0053
0
0.0025  0.0028  -0.0007 -0.0003 0.0034  0.0041  0.0057  0.0042  -0.0075
0
0.0014  0.0017  -0.0007 -0.0003 0.0033  0.0032  0.0042  0.0046  -0.0042
0
-0.0041 -0.0029 0.0001  0.0005  -0.0036 -0.0053 -0.0075 -0.0042 0.0217
0
0   0   0   0   0   0   0   0   0   0];

% Number of portfolios
NumPorts = 14;

%
AssetBounds10 = [0,0,0,0,0,0,0,0,0,0;
                 1,1,1,1,1,1,1,1,1,1];


% Calculating Portfolio risk, return and weights %?????Function
frontcon(ExpRet10, ExpCov10, NumPorts, [], AssetBounds10)
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet10, ExpCov10, NumPorts,
[], AssetBounds10);

PortReturnAdj = PortReturn.*100
PortRiskAdj = PortRisk.*100
PortWtsAdj=PortWts.*100
% Author: Xiangyu Cui
% Student ID No.: 301235497
% Date: Dec., 2014
% For Final Project T7 Sensitivity Analysis

clear all
close all
clc
warning off
format compact

%% 12%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet612 = [0.1324    0.1790  0.0335  0.0329 0.12 0.0003];

% Setting Expected Covariance
ExpCov6 = [0.0170   0.0179  -0.0004 0.0003  0.0020  0
0.0179  0.0255  0.0001  0.0013  0.0022  0
-0.0004 0.0001  0.00133     0.0012  -0.0006 0
0.0003  0.0013  0.0012  0.0014  -0.0002 0
```

```matlab
0.0020  0.0022  -0.0006 -0.0002 0.0031  0
0   0   0   0   0   0];

% Number of portfolios
NumPorts = 5;

% Setting asset bounds
AssetBounds6 = [0, 0, 0, 0, 0, 0 ;
               1, 1, 1, 1, 1, 1];

% Calculating Portfolio risk, return and weights %?????Function
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet612, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturn12 = PortReturn.*100
PortRisk12 = PortRisk.*100
PortWts12=PortWts.*100

%% 11%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet611 = [0.1324     0.1790  0.0335  0.0329 0.11 0.0003];

% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet611, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturn11 = PortReturn.*100
PortRisk11 = PortRisk.*100
PortWts11 =PortWts.*100

%% 10%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet610 = [0.1324     0.1790  0.0335  0.0329 0.10 0.0003];

% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet610, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturn10 = PortReturn.*100
PortRisk10 = PortRisk.*100
PortWts10=PortWts.*100

%% 9%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet69 = [0.1324  0.1790  0.0335  0.0329 0.09 0.0003];

% Calculating Portfolio risk, return and weights
```

```matlab
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet69, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturn9 = PortReturn.*100
PortRisk9 = PortRisk.*100
PortWts9=PortWts.*100

%% 8%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet68 = [0.1324  0.1790  0.0335  0.0329 0.08 0.0003];

% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet68, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturn8 = PortReturn.*100
PortRisk8 = PortRisk.*100
PortWts8 =PortWts.*100

%% 7%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet67 = [0.1324  0.1790  0.0335  0.0329 0.07 0.0003];

% Calculating Portfolio risk, return and weights
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet67, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturn7 = PortReturn.*100
PortRisk7 = PortRisk.*100
PortWts7 =PortWts.*100

%% 6%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet66 = [0.1324  0.1790  0.0335  0.0329 0.06 0.0003];


% Calculating Portfolio risk, return and weights %?????Function
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet66, ExpCov6, NumPorts,
[], AssetBounds6);

PortReturn6 = PortReturn.*100
PortRisk6 = PortRisk.*100
PortWts6 =PortWts.*100

%% 5%

% Setting Expected Return of Five Conventional Assets with Hedge Fund
ExpRet65 = [0.1324  0.1790  0.0335  0.0329 0.05 0.0003];

% Calculating Portfolio risk, return and weights
```

```
[PortRisk, PortReturn, PortWts] = frontcon(ExpRet65, ExpCov6, NumPorts,
[], AssetBounds6);


PortReturn5 = PortReturn.*100
PortRisk5 = PortRisk.*100
PortWts5 =PortWts.*100
```

8: Reference

Lamm Jr., R. M. (1999), Portfolios of Alternative Assets: Why Not 100% Hedge Funds, *The Journal Of Investing, 87-97*

Chopra, Vijay, and William Ziemba. (1993), The Effect of Errors in Means, Variance, and Covariance on Portfolio Choices, *Journal of Portfolio Management, 51-58*

Crerend, William J. (1998), Fundamentals of Hedge Fund Investing

Fung, William, and David A. Hsieh. (1997), Empirical Characteristics of Dynamic Trading Strategies: The Case of Hedge Funds, *The Review of Economic Studies, 275-302*

Lamm, R. McFall, Jr. (1998), Asset Allocation Implications of Inflation-Protection Securities, *Journal of Portfolio Management, 1998, 93-101*

Noël Amenc and Lionel Martellini (2002), Portfolio Optimization and Hedge Fund Style Allocation Decisions, *Journal of Alternative Investments, 7-20*

Phelim Boyle and Sun Siang Liew (2007), Asset Allocation with Hedge Funds on the Menu, *North American Actuarial Journal, 1-21*

Ivilin Apopova,David P. Morton, Elmir Apopova, and Jot Yau (2007), Optimizing Benchmark-Based Portfolios with Hedge Funds, *Journal of Alternative Investments, 35-55*

Thomas M. Idzorek (2012), A Step-By-Step Guide to the Black-Litterman Model, *Forecasting Expected Returns in the Financial Markets Book.*

Aspadarec, Waldemar (2013), Investment performance of hedge funds, *Folia oeconomica Stetinensia, Vol/Issue: 13 (1), 174-185*

Aggarwal, Rajnish (2011), *Global Journal of Finance and Banking Issues, Vol/Issue: 5 (5), 25-37* Robust Reverse Engineering of Cross-Sectional Returns and Improved Portfolio Allocation Xiaohui Ni, Yannick Malevergne, Didier Sornette, Peter Woehrmann (2011), Performance Using the CAPM, *The Journal of Portfolio Management Vol/Issue: 37 (4), 76-85*

Martin Eling,Roger Faust (2010), The performance of hedge funds and mutual funds in emerging markets, *Journal of Banking & Finance, Volume 34, Issue 8, 1993–2009*

Roll, R (2010), The Market Portfolio May be Mean/Variance Efficient After All, *Review of Financial Studies, 2464-2491*

Kapoor, Amitesh (2012), Performance Comparison of Canadian Hedge Funds and Mutual Funds. *IJBMT, Vol. 2, Issue 8.*