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European Investor Currency Hedging: Forwards or Options in International Portfolios

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Abstract

The hedging effectiveness of currency forward contracts and currency put option for three different portfolios—Portfolio of Emerging Markets, Portfolio of Developed Countries, and the International Portfolio—are examined from the viewpoint of European investors. European Union (EU), United States (US), United Kingdom (UK), Switzerland (SF), Sweden (SE), Denmark (DK), Norway (NK), and Japan (JAP) are considered in the developed countries. China (CH), India (IN), Malaysia (MA), and Thailand (THAI) are the emerging markets in this study. And a combination of these two groups, which formed an international portfolio, is studied as well. As the data of the stock returns, bond returns, and exchange rate returns exhibit asymmetrical characteristics, the downside risk measurement methodology Conditional Value-at-Risk (CVaR) is applied. The significance of the hedging instrument contributes to the portfolio performance in reducing the risks and enhancing the returns simultaneously has been confirmed in all portfolios. In the Portfolio of Emerging Markets, the hedging strategy with 10% strike price put option yield a better result. While under the Portfolio of Developed Countries, although hedging with the 10% strike price put option yields the highest portfolio return, the uncertainty and fluctuant in returns is much lower in 5% option. In the portfolio of internationally diversified investment, there is no clear conclusion of which hedging instrument is over performing the other. The 5% strike price put option yields a much higher portfolio return. However, the higher return accompanied with higher risks.

Key words: international portfolio currency hedging, hedging instruments, currency forward contracts, currency put options, optimal portfolio, CVaR

Contants

1. Introduction

The benefits of international portfolio diversification have been recognized for decades. When diversifying their portfolios internationally, investors are inevitable exposed to exchange risks. Investing in the international stock markets without hedging currency risks might be suboptimal. Further, the extent of investors exposing to the currency risks without hedging in the portfolio depends on both the currencies position and the size of the investment, which might result large unfavorable lose (Roon, Nijman, and Werker, 2003). Therefore, in order to reduce the risks generated by multi-currencies, some hedging techniques should be applied. However, in practice, the foreign currency is not directly hold by many investors, which might because the character of the currency is the asset with high volatility and low average return, while in the meantime, investors mostly hold indirect positions in foreign currency (Campbell, Medeiros, and Viceira, 2010).

In order to hedge the currency risks, different types of derivatives with the currency as the underlying asset are applied in international portfolio optimization problem. There are three main points need to be figure out when dealing with the international investment. First, the viewpoint of the investor, this is to determine the main currency in your portfolio which you want to hedge the depreciation of. Second is to determine the methodology used in choosing the optimal portfolio and third, the assets from which markets to be included in the portfolio.

1.1 The Point of View of Investor

In the international portfolio diversification context, most previous literatures investigated the portfolio return from the view of an U.S. investor. Lessard (1973) examined the portfolio diversification benefits in investing in Latin American countries from the point of view of a U.S. investor. From a set of empirical results, he found that to diversify the investment into different countries can generate much better return than simply invest in a single country. Roon, Nijman, and Werker (2003) investigated whether hedging exchange risk via currency forwards improves the international portfolio performance from a U.S. investor viewpoint. Their results suggested that using currency forwards against exchange rate risks does not significantly increase the portfolio return however hedging through the interest rate spread can improve the portfolio performance. Topaloglou, Vladimirou, and Zenios (2011) constructed the portfolio from the viewpoint of a U.S. investor to examine which currency hedging tools, forwards or options, grants a better portfolio returns. They found that rather than hedging against currencies, using options to control the market risk generating more profits.

The number of studies on the extent of international portfolio management is mostly from the viewpoint of U.S. investors. However, for the most recent Euro crisis last for several years, it is important for European investors to diversify their investment portfolio internationally in order to reduce currency risks. There is one paper (Maurer

and Valiani, 2004) has been examined on this issue but the basement currency is German Mark (the dominance currency in the continental Europe before Euro introduced). Maurer and Valiani (2004) studied the performance of multicurrencies portfolio consisting the stock indices and bonds from five developed countries hedged with options against hedged with forwards. They found that portfolio with European in-the-money put option outperform the portfolio hedged with forwards contract and suggested that European put in the money option might be used instead of the forwards. Caporin, Martin, and Serrano (2014) investigated the portfolio performance by using currency futures to hedge the exchange risks from the point of view of a Euro-based investor. And they concluded that the portfolio with dynamic covariance models perforce better in hedging. Based on the Maurer and Valiani (2004), this paper is going to examine the effectiveness of different currency hedging instruments, forwards and options, from the perspective of a European investor.

1.2 Donwside Risk Measurement

Since Markowitz (1952) introduces the mean-variance framework to explore the optimal portfolio selection, this method has been commonly used in international investment diversification. Roon et al. (2003) tested the portfolio hedging performance in mean-variance and non-mean-variance cases. They draw the conclusion under mean-variance approach and the investor with power utility that to improve performance, the portfolio should be hedged by interest rate spread rather than currency forwards. Bugar and Maurer (2002) employed the mean-variance framework for different hedging strategies. Interestingly, for the international investment diversification, it betters more for the emerging European investor (Hungarian investor) than for the viewpoint of an investor from the developed European country (Germany).

However, the traditional mean-variance framework for portfolio maximization has some specific requirements. One is that the return should be symmetric distribution and another is that the utility function for investors should be quadratic (Maurer and Valiani, 2004). These assumptions are not empirically necessary correct in practice. The characteristic of the options pay-off is non-linear and exhibits apparent asymmetric in the distribution of returns (Bookstaber, and Clarke, 1985). Further, Sarin and Weber (1993) criticized on the inappropriate of the quadratic utility function as it indicates the absolute and relative risk aversion is increasing while the marginal utility of wealth is decreasing. As these assumptions under the mean-variance framework are critical, this paper is going to apply conditional Value-at-Risk (CVaR) to study the shortfall-risk involves in the asset allocation for a rational investor. By applying CVaR, shortfall-risk measurement, a coherent risk measurement that is not only to measure the asymmetric probability in asset returns but also with attractive properties like convexity (Pflug, 2000). In addition, minimizing CVaR gives the investors an opportunity to deal with a large-scale portfolio optimization problem as it solves a convex programming problem (Rockafellar and Uryasev, 2000, 2002).

1.3 International Portfolio

Previous literatures either studied the portfolio diversification benefits in Emerging markets or in developed markets. For example, Li et al. (2003) take the point of view of a U.S. investor demonstrated that the benefits from the international portfolio diversification. They found that even with the international market integration, investing in emerging markets subject to short-sale constraints can still benefit the U.S. investors. Madura and Tucker (1992) examined investing in some major developed equity markets can be benefit from currency risks hedging. Their results demonstrated that the negative covariance between foreign currency and their local stock markets is adversely affecting the hedging performance.

In the context of detecting the hedged portfolio performance by dividing the portfolio into emerging markets and established one, Hauser et al. (1994) examined to what extend the hedging portfolio is affected by different risk level. While Garibaldi and Soenen (2000) investigated the significance of hedging currency risk in international portfolios contribute to the incremental of portfolio returns by dividing the portfolio in emerging markets and developed countries. However, non-of them examined whether the different hedging instrument will perform the same effectiveness in different markets. If the emerging markets portfolio can be better hedged by currency forward contracts will forward be outperform put options in the developed countries portfolio?

This study is going to investigate from the perspective of a European investor, which currency hedging instrument, forwards or options, is more effective in their international investment. The optimal asset allocation will be obtained by mean-CVaR method. In precise, I compare three portfolios performances of the unhedged one, the one hedged with currency forwards, and the one hedged with European put option to figure out which hedging tool is more preferable. The first portfolio is mainly included the stocks and bonds returns from Emerging markets (China, India, Malaysia, and Thailand). The second portfolio consists the equity and bonds returns from the Developed countries (UK, US, Sweden, Norway, Denmark, Switzerland, and Japan). The third portfolio is a combination of the first two to construct a portfolio that is internationally diversified. By comparing the performance of currency hedging by forward contracts and European put options in these three different portfolios, to the best of my knowledge, this is the first paper to investigate the effectiveness of currency hedging instruments in different type of markets might be different.

The remaining part of this paper is organized as follows. Section 2 gives the basic theoretical background and previous studies that examine the effectiveness of the currency hedging instrument in international portfolio. Section 3 briefly explains the international asset allocation in emerging countries and in the Scandinavian markets. Section 4 presents the selected dataset and the preliminary analysis. Section 5 describes the methodology used for currency hedging by forwards and options respectively. Section 6 presents and analyzes empirical results and the conclusion of this paper is summarized in Section 7.

2. Theoretical Background and Literature Review

The indirect positions of foreign currencies can be achieved through different derivatives. Futures, forwards, swaps, options and many other complex financial instruments are frequently used when investors pretend to control or manage risks exposures to exchange rates (Broll, Wong, and Zicha, 1999). Among all these derivatives, forwards and options are most commonly actively used when investors trying to hedge risks exposure to exchange rates.

2.1 Currency Forwards

A foreign currency forward contract is a binding contract that obligates two parties either to make (sell, short position) or take (buy, long position) a foreign currency payment at a certain rate at some time in the future and the payment time has been specified when the contract has made (Hodrick, 1987). Forwards contract have some advantages, one of them is that it helps to ensure the stability of payment at the end of the transaction to both parties to receive the exact amount of money regardless the exchange rates fluctuations (Siddaiah, 2010). The disadvantage of foreign currency forwards contract is that it prevents the extra gain from the favorable movement in exchange rate for investors although the contract limits the losses results from the unfavorable exchange rate fluctuation.

Several previous literatures evidenced that adding currency forwards contract into investment can improve the portfolio performance. Eun and Resnick (1988) stated that the fluctuations in exchange rate impacts adversely on the international portfolio performance, and this fact is non-diversifiable to a large extent. Therefore, to reduce this multicurrency risks, they examined the performance of international portfolios, the unhedged one against the one hedged currency risks by unitary forward hedge strategy and concluded that the hedged portfolio has a better performance in reducing the volatility in portfolio returns. Glen and Jorion (1993) analyzed the portfolios performance of a globally diversified one and the one includes forward contracts over 1974 to 1990. The empirical results show that the performance has statistically significant improved of the hedged portfolio with foreign currency forward contracts compared with the unhedged one. Larsen and Resnick (2000) investigated the portfolio performance under different strategies—unhedged international portfolio, hedged with forward contracts, hedged with universal regression hedge ratios, and the one hedged with Black's universal hedge ratio. They concluded that the unitary hedging strategy with forward contracts outperform the others.

2.2 Currency Options

A currency option is a financial derivative that gives the right but not the obligation to the holder, either to buy or sell the currency at a predetermined exchange rate for a given period of time. In order to obtain this buy or sell right, the holder should pay a premium at first (Siddaiah, 2010). There are two types of options, currency call option and currency put option where the call option gives the investor the right to buy and

the put option gives the right to sell. Similarly to forward contracts, the currency exchange rate for options is also pre-specified. Further, there are two categories of options on the financial market at the moment which are American options, gives investors the right during a certain period of time that can be exercised before the exercise date, and European options, which gives the investors to exercise the right on a specific date, the exercise date.

Although options required the holder to pay a non-recovered premium no matter what circumstance is following, the effectiveness of options in hedging currency risks have been proofed by previous literatures. Ware and Winter (1988) concluded that the currency options can be included in the portfolio when the aim is to hedge economic exposures. They stated that even forward market are enable to hedge the transactions exposure in the case of multicurrency, options are more preferable than other currency derivatives in hedging economic risk. Conover and Dubofsky (1995) examined the effectiveness of investment strategies by including different American options (currency spot options and futures options). The outcome is that put options on futures are generally better performed in hedging than other options such as call on futures options and put on spot currencies options. However, options are not always dominated the performance in currency hedging comparing the portfolio returns with other derivatives. Hsin, Kuo, and Lee (1994) investigated whether the currency future contracts performs better than currency options. Their results indicated that futures contacts contribute more to the portfolio returns when comparing with currency options under synthetic futures. Further, futures contracts are also outperform options when the delta and delta-gamma hedging strategy applies. Therefore, they concluded that futures contracts can be treated as a better hedging instrument than options.

2.3 Comparison between Forwards and Options

The key difference between a forward contract and an option can be seen from the definition for these two hedging products. The option gives the investor the right not the obligation to trade while the forward contract is a legally binding agreement, which must be traded.

Another major difference is that option requires a premium whereas in the case of forward contract, the investor pays nothing. As the option gives the financial decision makers either to exercise the option or not, in order to obtain this flexible right in the trade, the premium is required to buy an option. However investors made them under an obligation when they enter a forward contract. There is no cost for entering this obligation.

Finally, as investors can choose either to exercise the option or not at the maturity, option eliminates the downside risk but maintaining the potential profit simultaneously. While in the forward contracts, as the exchange rate is predetermined, the downside risks are exist and can be unlimited. Therefore, forward contracts are seemed to be a more rigid hedging instrument comparing to options.

3. International Asset Allocation

In this section, the historical background of the emerging countries and the Scandinavian markets are described, which includes a particular focus on the cornerstone of the important role of these two types of market played in international investment diversification.

3.1 Emerging Countries

The integration and international correlation among the global markets is changing over time, especially being influenced by the major events, i.e. the financial crises. The investor nowadays might not only allocate their assets domestically but also internationally in order to minimize the risks by maximizing the portfolio returns.

When investing in the emerging markets, the cost of capital is the first consideration. In the past, the developing countries did not open their financial system to foreign investors, the capital cost is so high (Bekaert and Harvey, 2000). However, after the liberalizations in emerging equity markets, there is a substantial decrease in the capital cost of investment in the emerging markets due to the local market returns are correlated with the world market portfolio by sharing the risk premium (Edison and Warnock, 2004).

Thus, for the investment decision maker, developed countries are not mainly considerable and favorable markets under the high degree of global integration with the fast development of emerging markets and their significantly increasing role in the global economy. One reason is that the currency risks from the local market might affect the pricing of other assets internationally. In this case, the exchange rates volatility from emerging markets might affect both the equity stocks prices in emerging economies and in developed countries. Therefore, for an investor aim to diversify the portfolio risk by investing internationally should consider the currency risks in both markets in order to avoid unnecessary losses caused by exchange rates fluctuations.

Carrier, Errunza, and Majerbi (2006) examined whether the currency risks in emerging economies will affect the prices of equities in those markets and will further spills over this effect into developed countries. If this statement holds, especially for the currency volatility from developing countries impact on the equity prices of developed markets it will result in an unfavorable position for an European international investor without hedging the currency risks from emerging markets against Euros. Their results confirm the hypothesis in their paper, which means that the global market assets are related to the currency risk premia in emerging economies. Moreover, the outcomes in their paper indicated that the currency risks in emerging markets are not priced by the specific risks in those countries, which means the emerging economies currency risks are related to the international equity market. This might be further explained as that when there is a large fluctuation in world equity

market, i.e. U.S. subprime crisis and the recent Euro crisis, the currency risks in emerging markets are being affected. Therefore, for rational financial decision makers, the exchange rates fluctuations in these countries should be taken into consideration when they construct their investment portfolio.

3.2 The Scandinavian Markets

The empirical literatures measured the investment in developed countries are mainly focus was on US and in the central Europe, some researchers also concern about the market in Japan as well as Canada. In the Scandinavian[1] market's context, there is rarely been pay attention to.

The markets within Nordic region are often small and open economy, however, these small economies performs better in the stable of currency during the 2008 financial crisis as well as the recent Euro crisis. Take Sweden as an example, Öberg (2009) stated that although Sweden economy is highly impacted by the international equity markets fluctuation and affected by the global crisis, the Swedish banks have not encounter funding problems. In another word, Swedish Krona performs relatively stable than other currencies in the word. Even though Sweden has the ability to control the fluctuation in financial system generated by the world financial crisis, it does not imply that this economy is isolated from the global market. In contrast, Sweden is highly dependent on the world events. The dependency of Swedish economy on the international market can be evidenced by how much do the imports and exports are proportional to the country's total resources. For Sweden, the percentage of exports to total balance of resources has increased almost 20 percent in the past two decades (Öberg, 2009).

The integration and the dependency of the Scandinavian markets with the global financial markets can be further evidenced by my thesis for the first year. In my first thesis, I tested the mean and volatility spillover effects from the US and the aggregate European stock markets into individual Scandinavian equity markets are investigated by applying an EGARCH volatility-spillover model. My results suggested that in these Nordic countries, the European effects are least significant. In Denmark and Norway, the local effects are most essential, followed by the US effects whereas the world influences is most significant in Sweden. With the high correlation of the world economy and given the relative stable currency, Nordic countries can be treated as an ideal place for international investors to hedge against exchange rates fluctuations. Therefore, this region could be seen as a "safe harbor" and should be taken into consideration for investors who would like to hedge the currencies risks exposures to the international investment.

[1] The Scandinavian market here refers to the market of Sweden, Norway, and Denmark, as Finland has join the EMU and change its currency into Euro, this paper does not include Finland within the Scandinavian market.

4. Data Description and Preliminary Analysis

4.1 Data Description

The data employed in this paper are monthly equity and government bond indices from two groups, developed and emerging markets. European Union (EU), United States (US), United Kingdom (UK), Switzerland (SF), Sweden (SE), Denmark (DK), Norway (NK), and Japan (JAP) are considered in the developed countries. China (CH), India (IN), Malaysia (MA), and Thailand (THAI) are the emerging markets in this study. And a combination of these two groups, which formed an international portfolio, is studied as well. All the prices are in local currencies and all these data are available from Datastream.

Portfolio performance is measured monthly as well. The advantage of applying this lower frequency data (compared to the daily or weekly one) is that it avoids the non-synchronous trading problem. The trading hours are different among all selected countries. Therefore, higher frequency data might generate the asymmetric information sharing issue. To examine the portfolio performance, the portfolio values, spot exchange rates, one-month currency forward rates, and one-month put options are considered. The time period in this paper begins from January 2003 to December 2013. Since Euro has been introduced in January 1, 2002, this study is set the beginning date to be January 2003, which gives sometimes for the major European currencies to be fully replaced by the Euro.

The price indices for equity, government bond, and exchange rate are translated into log returns here. The currency forwards are contracts for the other 11 currencies with respect to the Euro with a maturity of one month. In the case of currency put options, as the result of no data available on Datastream, I am going to calculate the price of European put option based on the model applied by Garman and Kohlhagen (1983).

4.2 Preliminary Analysis

The summary statistics of stock returns for these 12 countries are presented in Table 4.1 while the statistics of bond returns are summarized in Table 4.2.

For each country, there are 124 observations. The average monthly returns are all positive and fall within a range from 0.24% in Japan to 1.30% in India. Interestingly, the average returns for emerging markets are generally outperforming their developed counterparts. The standard deviation ranges from 0.0452 in Malaysia to 0.0840 in India. From the above figures we can see that although Malaysia provides the most attracting average return but it associated with the highest volatility in returns. None of the Skeweness of these twelve indices is equal to zero and none of the Kurtosis follows normal distribution.

Table 4.1—Descriptive statistics of all monthly Stock Returns

Stock Index Excess Returns	MEAN	Std. Dev.	Skew	Kurt	J-B	P-Value
EU	0.0045	0.0668	-1.2793	7.0333	117.8751	0.0000
US	0.0047	0.0527	-2.1774	15.7868	942.7495	0.0000
UK	0.0038	0.0519	-1.9353	11.6988	468.3668	0.0000
SF	0.0038	0.0570	-1.3788	8.5529	198.6010	0.0000
SE	0.0069	0.0606	-1.6543	7.5651	164.2313	0.0000
DK	0.0095	0.0614	-1.3319	10.4188	321.0277	0.0000
NK	0.0078	0.0736	-1.4853	8.6488	210.4574	0.0000
JAP	0.0024	0.0655	-1.0348	7.2733	116.4762	0.0000
CH	0.0112	0.0831	-0.4829	4.6638	19.1223	0.0000
IN	0.0130	0.0840	-0.6080	6.8756	85.2456	0.0000
MA	0.0075	0.0452	-0.3149	4.1275	8.6174	0.0135
THAI	0.0112	0.0758	-1.0361	7.4094	122.6387	0.0000

Notes: The Table contains summary statistics of monthly stock returns. The first four moments (average returns—MEAN, standard deviation—Std. Dev., skewness—Skew, and kurtosis—Kurt) are given. The third (skewness) and forth (kurtosis) central moments of returns can provide the information of the distribution of the series under examined. The excess kurtosis is equal to zero when the time series is normally distributed. JB (Jarque-Bera) test and the P-Value for this test is to test the normality of the returns.

The negative skewness illustrates that all the data are left skewed and the positive excess kurtosis indicates that the tails for these time series are fatter than those normally distributed ones (Maurer and Valiani, 2004). The non-normal distribution of these twelve data sets is further confirmed by the Jarque-Bera test as the probability to accept the null hypothesis of normal distribution are equal to zero (with MA being the exception), which means the rejection of normal distribution. In the case of Malaysia, we cannot reject the normal distribution of stock returns at 10% significance level.

Compared Table 4.2 with Table 4.1, we can see that the general return for stock markets are higher than for the bond markets for all countries. The government bond returns are positive for most countries except for Thailand and for Malaysia and fall within a range from -0.12% in Malaysia to 0.25% in Norway. The results are consistent with the expectation as high risk gives high returns (in stock markets, where bond markets with low volatility provide lower returns). The standard deviation ranges from 0.0124 in Japan to 0.0826 in Thailand. None of the Skeweness of these twelve indices is equal to zero and none of the Kurtosis follows normal distribution. However, we cannot reject the null hypothesis of J-B test for normal distribution of the bond returns in EU, UK, Switzerland, Sweden, Denmark, Norway, and Thailand.

Table 4.2—Descriptive statistics of all monthly Bond Returns

Bond Index Excess Returns						
	MEAN	Std. Dev.	Skew	Kurt	J-B	P-Value
EU	0.0025	0.0175	-0.2433	2.4793	2.6242	0.2693
US	0.0018	0.0231	0.2831	5.0292	22.9307	0.0000
UK	0.0022	0.0173	-0.0198	2.7295	0.3861	0.8244
SF	0.0013	0.0146	-0.2810	3.2161	1.8730	0.3920
SE	0.0019	0.0172	0.0926	2.6709	0.7366	0.6919
DK	0.0023	0.0183	-0.1054	2.6088	1.0203	0.6004
NK	0.0025	0.0191	0.0101	3.0388	0.0099	0.9951
JAP	0.0011	0.0124	-1.4019	7.2745	135.0163	0.0000
CH	0.0002	0.0556	-0.0921	6.8354	76.1777	0.0000
IN	0.0017	0.0425	-0.0270	5.8041	40.6407	0.0000
MA	-0.0012	0.0554	0.7685	6.3534	70.3058	0.0000
THAI	-0.0004	0.0826	0.0541	3.8514	3.8060	0.1491

Notes: The Table contains summary statistics of monthly bond returns. The first four moments (average returns—MEAN, standard deviation—Std. Dev., skewness—Skew, and kurtosis—Kurt) are given. The third (skewness) and forth (kurtosis) central moments of returns can provide the information of the distribution of the series under examined. The excess kurtosis is equal to zero when the time series is normally distributed. JB (Jarque-Bera) test and the P-Value for this test is to test the normality of the returns.

In addition, the summery statistics of foreign exchange rates with respect to Euro are illustrated in Table 4.3. From the results we can see that only UK and Switzerland are not following the normal distribution at 1% significance level. Further, we reject the null hypothesis for Sweden and Norway for being normally distributed at the significant level of 5% and Denmark at 10%. For the rest countries we do not reject the normally distributed hypothesis.

To use the mean-variance framework to optimize the portfolio returns should fulfill the requirement that the return distribution is symmetric and investors follow quadratic utility function (Maurer and Valiani, 2004). In our case, for most countries in stock, bond and foreign exchange returns, the distributions are leptokurtic, they are not symmetric distributed. If the mean-variance framework used here, it would lead to a biased result in this study. Therefore, the mean-CVaR framework is going to be applied.

Table 4.3—Descriptive statistics of all monthly Currency Exchange Rate Returns

Currency Exchange Rate Returns						
	MEAN	Std. Dev.	Skew	Kurt	J-B	P-Value
US	0.0021	0.0311	-0.0802	2.8335	0.2763	0.8710
UK	0.0023	0.0219	0.5055	4.0574	11.0570	0.0040
SF	-0.0015	0.0202	0.7991	10.4500	299.9628	0.0000
SE	-0.0007	0.0172	-0.2286	4.1650	8.0924	0.0175
DK	3.22E-05	0.0007	0.3228	3.7083	4.7455	0.0932
NK	0.0001	0.0212	0.0188	4.1233	6.5263	0.0383
JAP	0.0004	0.0362	-0.3001	3.7123	4.4821	0.1063
CH	-0.0002	0.0301	-0.0695	2.8515	0.2137	0.8986
IN	0.0031	0.0304	-0.0994	2.7633	0.4937	0.7812
MA	0.0003	0.0276	0.2279	2.8483	1.1921	0.5510
THAI	-0.0011	0.0279	0.2783	3.1865	1.7802	0.4106

Notes: The Table contains summary statistics of monthly exchange rate returns. The first four moments (average returns—MEAN, standard deviation—Std. Dev., skewness—Skew, and kurtosis—Kurt) are given. The third (skewness) and forth (kurtosis) central moments of returns can provide the information of the distribution of the series under examined. The excess kurtosis is equal to zero when the time series is normally distributed. JB (Jarque-Bera) test and the P-Value for this test is to test the normality of the returns.

5. Methodology: Downside Risk Framework in International Asset Allocation

5.1 Portfolio Optimization with CVaR[2]

When investors invest internationally, it refers to that they allocate their asset to construct a portfolio that assigned the optimal weights to different assets within the portfolio in order to obtain the expected return but with the minimum risks. In terms of minimizing the risks, downside risk measurement is prevalent, which is to capture the negative returns. Conditional Value-at-Risk is one of the most commonly used method in measuring the downside risk which was developed based on the traditional Value-at-Risk by Rockfeller and Uryasev (2000). The CVaR is referred to expected shortfall (ES) as well because it is defined as given the certain confidence level and time span, it captures the conditional expectation of the loss over VaR (Yao et al., 2013).

[2] The estimation results under CVaR framework was done by the Matlab program and the codes for CVaR framework is available in Appendix.

CVaR overcomes the limitations of lack in subadditivity and convexity in VaR. Due to CVaR includes the property as measuring convexity, it is also refers to a convex risk measurement, which is easier in mathematical computation (Yao et al., 2013). Further, CVaR framework does not requires the measured asset returns to be normally or symmetrically distributed. It can deal with the asymmetric asset return distribution and particularly good at dealing with the asset returns with heavy-tail, which is the case in this study[3] (Huang et al., 2008). In addition, minimizing CVaR gives the investors an opportunity to deal with a large-scale portfolio optimization problem as it solves a convex programming problem (Rockafellar and Uryasev, 2000, 2002).

The following steps are given for deriving the CVaR mathematically (Rockafellar and Uryasev, 2002):
For a certain time period t, the loss of a portfolio is denoted as $f(x,S)$, where x is the decision variable and S is the random variable with a probability density $p(S)$, which is without loss of generality. For a given portfolio x, the loss threshold is denoted as α, and the cumulated distribution of the loss probability not exceed this threshold is as follow:

$$\psi(x,\alpha) \stackrel{\text{def}}{=} \int_{f(x,S)\leq\alpha} p(S)dS \tag{1}$$

$\psi(x,\alpha)$ is everywhere continuous with respect to α when there is no loss jumps in the probability distribution.

Based on the above loss probability distribution, VaR for portfolio x with a certain confidence level β during this time period t is given by:

$$VaR_\beta(x) \stackrel{\text{def}}{=} min\{\alpha \in \mathbb{R}: \psi(x,\alpha) \geq \beta\} \tag{2}$$

Since $\psi(x,\alpha)$ is everywhere continuous by assumption, then we have:

$$p\left(f(x,S) \leq VaR_\beta(x)\right) = \psi\left(x, VaR_\beta(x)\right) = \beta \tag{3}$$

$CVaR$ is defined as:

$$CVaR_\beta(x) \coloneqq E[f(x,S)|f(x,S) \geq VaR_\beta(x)] \tag{4}$$

$$= \frac{1}{1-\beta}\int_{f(x,S)\geq VaR_\beta(x)} f(x,S)p(S)\,\mathrm{dS}$$

According to Rockafellar and Uryasev (2002), CVaR can also be interpreted as follows:

$$CVaR_\beta(x) = \min_{\alpha\in\mathbb{R}} F_\beta(x,\alpha) \tag{5}$$

$$F_\beta(x,\alpha) \coloneqq \alpha + \frac{1}{1-\beta}\int_{S\in\mathbb{R}^N}[(f(x,S)-\alpha)^+]p(S)dS \tag{6}$$

[3] See Table 4.1-4.3 for asset returns distribution

where $(f(x,S)-\alpha)^+$ is defined as $(f(x,S)-\alpha)^+ = \max\{0, f(x,S)-\alpha\}$ for any $f(x,S)-\alpha \in \mathbb{R}$
To minimize CVaR is as follows:

Minimize

$$F_\beta\left(x, VaR_\beta(x)\right) \coloneqq VaR_\beta(x) + \frac{1}{1-\beta}\mathrm{E}[\left(f(x,S)-VaR_\beta(x)\right)^+] \quad (7)$$

$$\text{Subject to} \qquad f(x,S)-VaR_\beta(x)-\theta_n \le 0$$

$$\theta_n \ge 0, \mathrm{n} = 1,2,\dots\dots,\mathrm{N}$$

where $\theta_n = [f(x,S)-VaR_\beta(x)]^+$

Therefore, the mean-CVaR framework in portfolio optimization is derived by:

$$\text{Minimize} \qquad CVaR_{0.95}(x)$$

$$CVaR_{0.95}(x) = VaR_{0.95}(x) + \frac{1}{1-0.95}\int \max\{0, (f(x,S) - VaR_{0.95}(x)\}p(S)dS \quad (8)$$

$$\text{Subject to} \qquad \sum_{i=1}^{N} w_i E(R_i) = R_p$$

$$\sum_{i=1}^{N} w_i = 1$$

$$w_i \ge 0, i = 1,2,\dots\dots,N$$

where random variable S is equal to R_i

The unhedged portfolio return is given by:

$$\sum_{i=1}^{N} w_i R_i = R_p \quad (9)$$

where N is the number of assets within different portfolios
w_i is the weight allocated to asset i

The asset return R_i in the unhedged portfolio is as following:

$$R_i = R_{i,f} + e_f + R_{i,f} * e_f \quad (10)$$

$$e_f = \frac{(SX_{t+1}-SX_t)}{SX_t} \quad (11)$$

where $R_{i,f}$ is the rate of return of assets[4] in the local curency

e_f is the rate of appreciation/depreciation of foreign currencies against Euro

SX_t is the spot exchange rate of individual countries against Euro

From the above equation, R_i for each financial market (stocks or bonds) is converted to the same currency (Euro) and the obvious currency risks are existed. The portfolio performance is exposed to two types of risks, one is the volatility in stocks or bonds returns in individual financial markets, and the other is the currency appreciation (depreciation) of the foreign exchange rate against Euro. Therefore, the importance of hedging currency related risks to the international investors are straightforward.

5.2 Currency Hedging with Forwards

Forward currency contracts are seen as one of the most widely used currency hedging instrument by importers or exporters (Bisen, 2012). As foreign currency forward contract obligates two parties either to make (sell, short position) or take (buy, long position) a foreign currency payment at a certain rate at some time in the future and the payment time has been specified when the contract has made, this contract results in a random payoff, which not requires a certain amount of initial investment. Due to the payoff from currency forward contracts is not fixed, it is not possible to calculate the return produced by this contract. However, for international investor who intends to use this instrument to hedge exchange rates volatilities, it is possible to compare the portfolio returns that involve or not involve forward contracts (Glen and Jorion, 1993). Therefore, in this case, the single asset return with forward contracts is as follow:

$$R_i^f = R_{i,f} + e_f + R_{i,f} * e_f + h_i(f_p - e_f) \quad (12)$$

$$f_p \text{ (forward premium)} = \frac{Forward\ Price(F)}{Spot\ Price\ (SX)} \text{-1} \quad (13)$$

where R_i^f is the return with forward contracts

h_i refers to the hedge ratio

The short position in forward contracts is considered in this paper to hedge against the currency (Euro) risk.

5.3 Currency Hedging with Put Options

To achieve the same goal as in the hedging with forward contracts strategy, I am going to take long position in European put options to against Euro depreciation.

[4] Here assets refers to stock equities and bonds, where R_i is computed for the stock returns and bond returns separately in the individual country in order to allocate different weights to stock market and bond market even for the same country.

However, there is no data available for currency put options on Datastream. The following pricing model for European currency options (based on Garman and Kohlhagen, 1983) is applied. This method assumes that the underlying asset—foreign currency exchange rates—follows a geometric Brownian motion (GBM) and the price for the put option is given by:

$$P_t = -SX_t * \exp\left(-r_f(T-t)\right) * N(-d_1) + K * \exp\left(-r(T-t)\right) * N(-d_2) \quad (14)$$

$$d_1 = \frac{\ln\left(\frac{SX_t}{K}\right) + r - r_f(T-t)}{\sigma\sqrt{T-t}} + \frac{1}{2} * \sigma\sqrt{T-t} \quad (15)$$

$$d_2 = \frac{\ln\left(\frac{SX_t}{K}\right) + r - r_f(T-t)}{\sigma\sqrt{T-t}} - \frac{1}{2} * \sigma\sqrt{T-t} \quad (16)$$

where P is the European put option price

SX_t is the spot exchange rate at time t

r_f is the risk free rate (here is one-month Euro interest rate) in local currency

r is the risk free rate in foreign currencies (the one-month interest rate in foreign currencies)

$T-t$ is the time to maturity, in this case is equal to one month

σ is the volatility of log return on spot exchange rates

K is strike price of put option

Based on the above equations, P is the price of European currency put option measured in Euro. It refers to the price need to be paid by selling one unit of the foreign currency exchange rate on the predetermined strike price at maturity time T.

One remaining unknown data for the above formulas is the strike price, *K*. The strike price can be difference for different put options (at-the-money put option, in-the-money put option, and out-of-the money option). In this paper, only the in-the-money put option is going to be investigated as investors would not take position in the other two types of put options when they can trade the currency in spot market, which do not require a premium to be paid. Therefore, at-the-money and out-of-the money put options can be treated as the trading in spot exchange market, which is still expose to the currency risks. For this reason, only in-the-money currency put option is considered.

The strike price for the in-the-money put option is arbitrarily build up to be 5% and 10% higher than the corresponding spot exchange rate at the beginning of each month (Maurer and Valiani, 2004).

The payoff of the put option is given by $\max[(K-SX), 0]$. Therefor the return for put option and the single asset return with put options are as follow:

$$R_0^p = \frac{(\max[(K-SX),0] - P)}{P} \quad (17)$$

$$R_i^o = R_{i,f} + e_f + R_{i,f} * e_f + R_0^p * h_i \quad (18)$$

where R_i^p is the return of the put option

R_i^o is the individual asset return with currency put option

h_i is the hedge ratio (the same as in the forward contracts hedging strategy)

5.4 Hedge Ratio Determination

Hedge ratio has been early suggested by Black (1990). In his paper, the optimal hedge ratio is universal for all investors with the assumption that different financial decision makers have the same level of risk tolerance. Based on his assumption and combined with the IAPM, the hedge ratio will be close to unity when investors have low risk tolerance, which is seeking for pure risk minimization. The hedge ratio is equal to zero when investors are with logarithm utility functions. While the hedge ratio can even be negative for less risk-averse decision makers.

In this thesis, I am going to follow the definition of hedging mentioned in Anderson et al. (2001), where the hedge instruments (here refers to the forward contracts) are sued to improve the portfolio performance by either minimize the risk or maximize the return. The hedge ratio is determined to achieve this risk-return characteristic. There is no speculation position on forward contracts in this paper like many regulated institutional investors (pension funds, mutual funds, and insurance companies) did, the restriction on the hedge ratio is that

$$0 \leq h_i \leq 1$$

There are five hedge ratios considered in this paper, 0.2, 0.4, 0.6, 0.8, and 1.0. When hedge ratio equals to 1.0, we say that it is the unitary hedge ratio. Even the unitary hedge ratio cannot yield out the optimal portfolio (because it is not consider the correlations between exchange rates and individual asset returns, which is to say the exchange rates and single asset returns are uncorrelated), it is considered here as it would have lowered risk irrespective it would have less return (Glen and Jorion, 1993).

Within these five hedge ratios, the one that produces maximum Conditional Sharpe Ratio and give the lowest Conditional Value-at-Risk (CVaR) would be treated as the optimal hedge ratio[5].

[5] This method is followed by Glen and Jorion, 1993. In their paper, they maximize Sharpe Ratio instead of Conditional Sharpe Ratio. As this paper focused on the downside risk, Conditional Sharpe Ratio is applied.

5.5 Portfolio Selection

After applying the mean-CVaR framework, there are several selected portfolios on the efficient frontier. The optimal portfolio for each strategy is based on the minimum-risk portfolio (MRP) criterion (Maurer and Valiani, 2004).

In order to determine effectiveness of each strategy, the Conditional Sharpe Ratioc(CSR) is calculated. Conditional Sharpe Ratio measures risk adjusted return by capturing only downside risk. Since we are using mean-CVaR efficient frontiers, Sortino Ratio is more appropriate in this thesis. The one with the highest CSR would be considered the most effective strategy to hedge currency risk in international portfolio with asset denominated in currencies of foreign countries.

The Conditional Sharpe Ratio (CSR) is given by:

$$\frac{\mathrm{R}_p - r_f}{CVaR} \tag{19}$$

where R_p is the portfolio return

r_f is the target return, here refers to the risk free asset (one month interest rate)

$CVaR$ is the standard deviation of the portfolio return[6]

6. Empirical Results

In this section, the *Portfolio of Emerging Markets* is firstly examined to test the effectiveness of different financial derivatives (forwards and options) in hedging currency risks over the full sample period (from Jan 2003 to Dec 2013). Subsequently, the impact from these two instruments on the portfolio performance has been investigated by testing the *Portfolio of Established Markets*. Further, in order to estimate the hedging efficiency of forwards and options in internationally diversified investment, the *International Portfolio* is formed. In addition, each strategy will yield different composition for portfolio construction, the investment weight for different stock markets and bonds markets are presented for different optimal portfolio under each market as well.

6.1 Portfolio of Emerging Markets

The results for three different hedging strategies—the unhedged one, the one hedged with forward, and the one hedged with options for different strike prices—are presented in Table 6.1.1 to 6.1.4 below:

[6] As the portfolio return is measured under the mean-CVaR framework, here I use CVaR in Conditional Sharpe Ratio to represent the standard deviation.

Table 6.1.1—Optimal Portfolio for Emerging Markets under the Unhedged Strategy

Unhedged Strategy				
Portfolio Return	Risk Free Rate	Excess Return	Portfolio CVaR	CSR
0.40%	0.03%	0.37%	**1.45%**	**25.81%**

Table 6.1.2—Optimal Portfolio for Emerging Markets Hedged with Forwards

Hedged with Forwards					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	0.41%	0.42%	0.43%	0.44%	0.45%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	0.38%	0.39%	0.40%	0.41%	0.42%
Portfolio CVaR	1.59%	**1.50%**	1.62%	1.63%	1.64%
CSR	24.08%	**26.23%**	24.89%	25.26%	25.76%

From the two tables above we can see that a hedge ratio of 0.4 yield the optimal portfolio for forward contracts among the other hedging ratio (0.2, 0.6, 0.8, and 1.0) as it gives the lowest portfolio CVaR, 1.50%, but together with the highest CSR, 26.23%. The interpretation of this result is that with a 0.4 hedge ratio of the optimal portfolio in forward contracts, it is the portfolio with the lowest volatility (standard deviation) but with the highest returns. Further, although the volatility in the hedging portfolio with forwards is slightly higher than the hedged one, the effectiveness of adding currency forward contracts can be evidenced by the increase in portfolio returns from 25.81% (in unhedged portfolio) to 26.23%.

The results for hedging effects with European Put Options but with a different strike price are summarized below:

Table 6.1.3—Optimal Portfolio for Emerging Markets Hedged with Option with a 5% strike price

Hedged with Option Strike Price at 5%					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	1.58%	2.83%	4.08%	5.32%	6.58%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	1.55%	2.80%	4.05%	5.29%	6.55%
Portfolio CVaR	**3.95%**	7.74%	11.52%	15.30%	19.08%
CSR	**39.13%**	36.16%	35.13%	34.59%	34.30%

The optimal hedged ratio for a 10% strike price European Put Option is similarly to the one hedged with forwards, which is 0.4, whereas it is different for a put option with a 5% strike price, which is optimally hedged at h=0.2. These two optimal hedge

ratio was selected based on they are giving the lowest CVaR but together with the highest CSR. Compared the statistics given by these two strike price, 5% gives a higher CSR (39.13%) than the 10% one (34.83%). However, the volatility in returns is much larger in the one with higher CSR, 3.95%. The volatility in 10% strike price put option is quite smaller than the 5% one, which is only 1.55%, a slightly higher than the CVaR under the unhedged strategy and the strategy hedged with forwards. Although the unhedged portfolio, the portfolio hedged with forwards, and the portfolio hedged with 10% strike price put option are similarly in portfolio CVaR, the option hedging yields a much higher CSR than the others, which is nearly 10% higher than the other two.

Table 6.1.4—Optimal Portfolio for Emerging Markets Hedged with Option with a 10% strike price

Hedged with Option Strike Price at 10%					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	0.41%	0.57%	0.49%	0.53%	0.45%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	0.38%	0.54%	0.46%	0.50%	0.42%
Portfolio CVaR	2.43%	**1.55%**	1.67%	1.79%	1.90%
CSR	15.79%	**34.83%**	27.69%	28.05%	22.22%

Table 6.1.5—Weights Allocation for Portfolio of Emerging Markets

	Stock Markets				
Portfolio Weights	EU	India	Malaysia	Thailand	
Unhedged Strategy	0.00%	7.61%	7.29%	1.95%	
Hedging with Forwards (h=0.4)	0.00%	2.06%	13.70%	0.41%	
Put Option with 5% Strike Price (h=0.2)	6.01%	0.00%	7.78%	0.00%	
Put Option with 10% Strike Price (h=0.4)	**96.67%**	0.00%	0.00%	0.00%	
	Bond Markets				
Portfolio Weights	China	EU	India	Thailand	Malaysia
Unhedged Strategy	0.00%	**72.13%**	5.99%	5.02%	0.00%
Hedging with Forwards (h=0.4)	0.00%	**66.70%**	16.67%	0.47%	0.00%
Put Option with 5% Strike Price (h=0.2)	0.00%	**82.58%**	0.00%	0.00%	3.63%
Put Option with 10% Strike Price (h=0.4)	0.71%	2.63%	0.00%	0.00%	0.00%

Note: To save place, for those countries that the stock markets and bond markets are allocated with 0 weights are not presented here

In the portfolio of emerging markets, the 10% strike price put option performs the best in hedging effectiveness. Although the volatility in 10% option is slightly higher than the portfolio hedged with forwards or 5% strike price option, the portfolio CSR of 10% option is considerable larger than the other two hedging instruments.

The portfolio composition under each hedging strategy is different. For the portfolio invested in emerging markets, the Euro Bonds occupied the most heavy weights in three out of four different strategies—the unhedged one (72.13%), the forward hedging one (66.70%), and the 5% strike price put option hedging one (82.58%)—the put option hedging with 10% strike price is being the exception, which only allocates 2.63% in Euro Bonds. However, for the 10% strike price hedging strategy, the vast majority of the assets are also invested within Euro markets but in the stock markets, which the weight is 96.67%. The reason for this kind of result that most investors are going to invest within Euro markets no matter under which kind of hedging strategy might be that investors are all tend to be risk-averse. They prefer to allocate their assets in the home currency in order to avoid the fluctuation in return due to expose to the exchange risks.

Under the unhedged strategy, the asset invest in stock markets are larger than the bond markets in three emerging countries—India, Malaysia, and Thailand. For Malaysia, there is no investing in the bond markets at all. One interesting result is that there is no investment in both stock market and bond market in China at all. On the surface, this result might be astonishing, as China plays a more and more important role in the international economic market in the recent year. However, as the currency policy in China has not been changed, which is to say that it is not the floating exchange rate in China, therefore, the risks in currency is even higher than the other countries, which might result no investment in China at all.

In the portfolio hedged with forwards, the amount of money invested in bond markets in India and Thailand is higher than those invested in the stock markets, which is opposite to the unhedged portfolio. Whereas, it is the same that the Euro bond occupied the most weights of the investment.

In terms of hedging with put option, the construction for different strike price differs a lot. In the 5% option portfolio, the Euro stock market together with the Euro bond market accounts for nearly 90% of the total investment. The rest of the portfolio is invested in Malaysia only, 7% in stock market and 3% in bond market. When it comes to the portfolio with 10% strike price, there is a tiny amount of money invest in Chinese stock market, which has not been found under the other hedging strategies. But in the bond markets, 10% option portfolio only invests in the Euro bond for 2.63%.

6.2 Portfolio of Established Markets

The statistics of the portfolio of Developed Countries for three different hedging strategies are summarized in Table 6.2.1 to 6.2.4.

Table 6.2.1—Optimal Portfolio for Developed Countries under the Unhedged Strategy

Unhedged Strategy				
Portfolio Return	Risk Free Rate	Excess Return	Portfolio CVaR	CSR
0.32%	0.03%	0.29%	**2.40%**	**12.20%**

Table 6.2.2—Optimal Portfolio for Developed Countries Hedged with Forwards

Hedged with Forwards					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	0.32%	0.33%	0.33%	0.35%	0.36%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	0.29%	0.30%	0.30%	0.32%	0.33%
Portfolio CVaR	1.27%	1.28%	1.29%	1.30%	**1.23%**
CSR	23.07%	23.08%	23.44%	24.54%	**27.05%**

The hedging effectiveness of forward contracts in the portfolio of developed countries is much obvious than in the portfolio of emerging markets. The portfolio CVaR is 2.40% in the unhedged portfolio only gives a CSR in 12.20%. While under the hedging strategy with currency forward contracts, the portfolio CVaR is 1.23% but the CSR is 27.05%. This can be interpreted as when including the forwards in the portfolio consists the stock markets and bonds markets from developed countries, the volatility in returns can be reduced in some extend and the expected return will increase to a satisfied level. In another word, the risk-return characteristic focused on minimizing risk and maximizing returns can be better captured when the portfolio is with forward contracts than without.

As the optimal hedge ratio in this case is 1.0, it indicates that fully hedge the currency risk with forwards is the optimal strategy for investors. This result is contradictory with previous theory suggested by Glen and Jorion (1993). They stated that when hedge ratio equals to 1.0, we say that it is the unitary hedge ratio. Due to the unitary hedge ratio does not consider the correlation between the exchange rates and other assets, they believe that this hedge ratio cannot yield out the optimal portfolio but will lower the risk within the portfolio together with a lower return compared with the other hedge ratios. We can see from Table 6.2.2, the optimal portfolio with 1.0 hedge ratio does lower the risks compared with the other ratios and the unhedged portfolio, but with the sample data of this study, the unitary hedge ratio also gives the highest CSR among the other hedging ratios when hedged with forwards.

Table 6.2.3—Optimal Portfolio for Developed Countries Hedged with Option with a 5% strike price

Hedged with Option Strike Price at 5%					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	0.78%	0.53%	0.78%	1.03%	1.27%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	0.75%	0.50%	0.75%	1.00%	1.24%
Portfolio CVaR	**1.76%**	2.52%	2.27%	3.02%	3.77%
CSR	**42.73%**	19.78%	32.90%	32.94%	32.95%

Table 6.2.4—Optimal Portfolio for Developed Countries Hedged with Option with a 10% strike price

Hedged with Option Strike Price at 10%					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	3.33%	3.32%	4.97%	6.61%	8.25%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	3.30%	3.29%	4.94%	6.58%	8.22%
Portfolio CVaR	**11.56%**	19.95%	34.66%	46.21%	28.88%
CSR	**28.53%**	16.49%	14.25%	14.24%	28.48%

For the portfolios hedging with put option, both 5% strike price and 10% strike price are optimally hedged with 0.2 hedging ratio. Unlike the hedging strategy in Emerging markets, which is the 10% strike price put option outperforms the other hedging instruments, the 5% put option performs best in the portfolio with developed countries. The 10% strike price option yields a 11.56% portfolio CVaR and a 28.53% CSR. Whereas the 5% strike price put option only have 1.76% in portfolio CVaR but gives 42.73% in CSR. The volatility in the portfolio of established markets hedged with 5% strike price option is much lower than the 10% one and the difference in CSR is quite large between these two strike prices as well.

In the portfolio of established markets, the 5% strike price put option performs the best in hedging against currency risks. Although the volatility in 5% option is slightly higher than the portfolio hedged with forwards, it is much lower than the unhedged portfolio and the portfolio under the hedging strategy with 10% strike price put option (1.76% CVaR in 5% option, 1.23% in forwards, and 2.40% under unhedged strategy, 11.56% in 10% option). The portfolio CSR of 5% option is considerable larger than the other two hedging instruments, which is 42.73% in 5% strike price option and 27.05%, 28.53% in forwards and 10% option respectively.

Table 6.2.5—Weights Allocation for Portfolio of Developed Countries

	Stock Markets				
Portfolio Weights	Denmark	Japan	Sweden	Norway	US
Unhedged Strategy	8.29%	0.93%	4.48%	0.00%	0.00%
Hedging with Forwards (h=1.0)	4.75%	1.97%	6.05%	0.00%	0.00%
Put Option with 5% Strike Price (h=0.2)	0.00%	0.00%	0.00%	0.00%	0.00%
Put Option with 10% Strike Price (h=0.2)	26.45%	0.00%	0.00%	11.14%	0.56%
	Bond Markets				
Portfolio Weights	EU	Norway	Sweden	UK	
Unhedged Strategy	29.55%	13.38%	28.65%	14.72%	
Hedging with Forwards (h=1.0)	29.11%	12.05%	26.16%	19.91%	
Put Option with 5% Strike Price (h=0.2)	88.59%	0.00%	11.41%	0.00%	
Put Option with 10% Strike Price (h=0.2)	61.85%	0.00%	0.00%	0.00%	

Note: To save place, for those countries that the stock markets and bond markets are allocated with 0 weights are not presented here

Within this portfolio, the asset allocation becomes less and less diversified from the unhedged portfolio, hedging with forwards, to the option hedging portfolios. The unhedged portfolio gives similar weights in bond markets but different in stock markets. In total, the portfolio invests in seven different assets, four of them are from the bond markets. It gives more or less equal weight in Euro bond and Sweden bond for 29% and the almost equal weight for Norway and UK bond markets (14%) as well. While in the stock markets, only Denmark, Sweden, and Japan are invested with weights 8.29%, 4.48%, and 0.935, respectively.

Similar to the unhedged strategy, the portfolio hedged with forwards also better diversified in different assets. It is invested in the same assets as the unhedged portfolio but not given that even allocation. In bond markets, it is still Euro bond accounts for the most amount of investment, 29.11%, followed by Sweden bond, 26.16%. While the British bond market gained more asset in forwards hedging portfolio for 19.91% and 12.05% is allocated in Norway bond. In stock markets, Sweden now occupies more weights than Denmark, 6.05% against 4.74%, Japanese stock is still the least investment asset.

In the case of hedging with put option, the portfolio with 5% strike price is the least diversified portfolio where the number of assets invested is shrinking into just two, the 10% option portfolio is slightly better with four assets included in the portfolio. 5% option portfolio allocates all the assets within bond market without any stock markets. For Euro bond, it gives a weight of 88.59% and the rest 11.41% is invested in Sweden bond market. The portfolio of 10% strike price is slightly better in diversification, at least there are both stocks and bonds within the portfolio. It give 26.4% in Denmark stock market, 11.14% in the stock market of Norway and further, it is the only one that invests in the US (with 0.56% allocates in the US stock market). The rest of the portfolio is invested in Euro bond (61.85%).

6.3 International Portfolio

The statistics of the portfolio of Internationally Diversified Investment for three different hedging strategies are summarized from Table 6.3.1 to 6.3.4.

Table 6.3.1—Optimal Portfolio for Internationally Diversified Investment under the Unhedged Strategy

Unhedged Strategy				
Portfolio Return	Risk Free Rate	Excess Return	Portfolio CVaR	CSR
0.55%	0.03%	0.52%	**2.43%**	**21.37%**

Table 6.3.2—Optimal Portfolio for Internationally Diversified Investment Hedged with Forwards

Hedged with Forwards					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	0.41%	0.42%	0.45%	0.44%	0.48%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	0.38%	0.39%	0.42%	0.41%	0.45%
Portfolio CVaR	2.44%	2.45%	2.46%	2.47%	**1.56%**
CSR	15.68%	16.03%	16.99%	16.77%	**29.18%**

It is obvious from the above two tables, the portfolio performance for one hedged with currency forwards is better than the one under the unhedged strategy. The volatility in unhedged portfolio is 2.43% while it is only 1.56% under the one hedged with forwards. Further, the portfolio with forward contacts yields a better CSR, 29.18%, than the unhedged one (21.37% in CSR).

Table 6.3.3—Optimal Portfolio for Internationally Diversified Investmetn Hedged with Option with a 5% strike price

Hedged with Option Strike Price at 5%					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	2.79%	5.28%	7.76%	10.25%	12.73%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	2.76%	5.25%	7.73%	10.22%	12.70%
Portfolio CVaR	**6.11%**	15.16%	19.29%	30.21%	37.73%
CSR	**45.18%**	34.60%	40.09%	33.83%	33.66%

In terms of hedge ratio, the result in the international portfolio is similar to the one in the portfolio of developed countries, which are both optimal at the unitary hedge ratio (h=1.0). It indicates that fully hedge the currency risk with forwards is the optimal strategy for investors. We can see from Table 6.3.2, the optimal portfolio with 1.0 hedge ratio does lower the risks compared with the other ratios (0.2, 0.4, 0.6, and 0.8) and the unhedged portfolio, but with the sample data of this study, the unitary hedge ratio also gives the highest CSR among the other hedging ratios when hedged with forwards

Table 6.3.4—Optimal Portfolio for Internationally Diversified Investmetn Hedged with Option with a 10% strike price

Hedged with Option Strike Price at 10%					
Hedge Ratio	h=0.2	h=0.4	h=0.6	h=0.8	h=1.0
Portfolio Return	3.33%	3.32%	4.97%	6.61%	8.25%
Risk Free Rate	0.03%	0.03%	0.03%	0.03%	0.03%
Excess Return	3.30%	3.29%	4.94%	6.58%	8.22%
Portfolio CVaR	**9.54%**	19.08%	28.62%	38.16%	47.70%
CSR	**34.55%**	17.26%	17.25%	17.25%	17.24%

For the portfolios hedging with put option, both 5% strike price and 10% strike price are optimally hedged with 0.2 hedging ratio. However, the results are not that clear in the internationally diversified portfolio than the portfolio of emerging markets or developed countries. For the portfolios hedged with put option, the 5% strike price portfolio performs better both in the volatility and returns. The portfolio CVaR is smaller in the 5% strike price option (6.11%) than in the 10% one (9.54%). The CSR is higher in 5% option (45.18% compared 34.55% in 10% strike price option) as well. When comparing the volatility of the portfolio hedged with 5% option with the unhedged one or the one hedged with forwards, hedging with option is much more volatile with a portfolio CVaR of 6.11% (2.43% and 1.56% in the unhedged and hedging with forwards portfolios respectively). Whereas with the large portfolio return volatility, the 5% strike price put option yields a considerable large CSR (45.18%) than the other portfolios (21.37% under no hedging strategy and 29.18% for forwards hedging).

In the portfolio of internationally diversified investment, the best hedging strategy is depends on the risk preference of different investors. For risk averse decision makers, they might prefer the lowest volatility in returns with an acceptable CSR, which is the strategy hedging with currency forward contracts. For risk neutral investors, they might go for the largest portfolio CSR but with the acceptable volatility in returns, which will go for the strategy hedging with 5% strike price put option.

The international portfolio is supposed to be well diversified among the emerging and established markets, however, the results for different hedging strategies do not seem to support this intuitive.

Under the unhedged portfolio, as there is no hedging instrument applied, and if the investors invested quite internationally, they will expose to large currency risks. Therefore, the high weight invested in the Euro stock and Euro bond markets are expected. However, the results showed that unhedged portfolio is more internationally diversified than the other three hedged portfolios. There is only 45.37% is allocated in Euro bond market and no investment in Euro stock is suggested by mean-CVaR framework. The portfolio does invest both in emerging and established markets although for the vast majority of the asset are invested in developed markets. Both the

stock market and bond market in Indian are included in the portfolio for a weight of 4.66% and 1.62% respectively. The other emerging countries selected are the stock market of Malaysia (with 3.39%) and the bond market in Thailand (6.59%，which is considerably high in this case).

Table 6.3.5—Weights Allocation for International Portfolio

	Stock Markets						
Portfolio Weights	EU	Denmark	Sweden	India	Malaysia	Norway	US
Unhedged Strategy	0.00%	6.66%	2.55%	4.66%	3.39%	0.00%	0.00%
Hedging with Forwards (h=1.0)	0.00%	9.75%	8.19%	0.00%	1.07%	0.00%	0.00%
Put Option with 5% Strike Price (h=0.2)	0.00%	0.00%	0.00%	0.00%	20.65%	0.00%	0.00%
Put Option with 10% Strike Price (h=0.2)	47.34%	0.00%	0.00%	0.00%	1.91%	22.50%	1.04%
	Bond Markets						
Portfolio Weights	EU	Norway	UK	India	Thailand	Sweden	US
Unhedged Strategy	45.37%	13.77%	15.40%	1.62%	6.59%	0.00%	0.00%
Hedging with Forwards (h=1.0)	40.85%	6.05%	18.39%	12.88%	2.83%	0.00%	0.00%
Put Option with 5% Strike Price (h=0.2)	78.87%	0.00%	0.00%	0.00%	0.00%	0.48%	0.00%
Put Option with 10% Strike Price (h=0.2)	27.18%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%

Note: To save place, for those countries that the stock markets and bond markets are allocated with 0 weights are not presented here

In the portfolio hedging with currency forward contracts, the weights are not differed far away from those in the no hedging strategy. The total investment in stock markets has been slightly increased where the increase comes from more weights on Denmark and Sweden but reducing the weights for Malaysia and India (the weights allocated to India stock markets is zero under the forward hedging strategy). It is interesting that in the bond markets, the investment in Norway has been reduced but a significant increase of the weights is assigned to the India bond market (12.88% in India bond compared to 1.62% under the unhedged portfolio). This might suggest that the trend of Norway koruna against Euro is on the opposite way of the India Rupee against Euro, which is to say the fluctuation in these two exchange rates can be offset to some extent.

Under the hedging strategy with put options, the asset allocation for international portfolio is quite similar to the portfolio of developed countries with both the 5% strike price put option and 10% strike price. The results indicated that the portfolio of 5% strike price put option is the least diversified one, which only invested in the Malaysia stock market (20.65%) and the Euro bond market (78.87%). The potfolio

with 10% strike price performs better in diversified asset allocation. It gives 47.34% in Euro stock market and invested in the stock markets in Malaysia and Norway as well. The 10% option portfolio is the only one that invests in the US market for international portfolio under different strategies (1.04% in US stock and 0.02% in US bond).

6.4 Comparing Hedging Effectiveness under Different Strategies

The results from three different portfolio—Portfolio of Emerging Markets, Portfolio of Developed Countries, and the International Portfolio—proofed that either when currency forward contract or currency put option is added in the portfolio, the performance is better yield than the unhedged one.

Table 6.4.1—Hedging Effectiveness of Portfolio of Emerging Markets

	Portfolio Return	Excess Return	CVaR	CSR
Unhedged	0.40%	0.37%	1.45%	25.81%
Forward Hedging	0.42%	0.39%	1.50%	26.23%
5% Option Hedging	1.58%	1.55%	3.95%	39.13%
10% Option Hedging	**0.57%**	0.54%	1.55%	**34.83%**

In the Portfolio of Emerging Markets, the hedging strategy with 10% strike price put option yield a better result. Compare the portfolio of 10% option with the unhedged one, there is a 0.17% increase while a 0.10% decrease in CVaR (the volatility), which confirms that the hedging instrument contributes to the portfolio performance in reducing the risks and enhancing the returns simultaneously.

Table 6.4.2—Hedging Effectiveness of Portfolio of Developed Countries

	Portfolio Return	Excess Return	CVaR	CSR
Unhedged	0.32%	0.29%	2.40%	12.20%
Forward Hedging	0.36%	0.33%	1.23%	27.05%
5% Option Hedging	**0.78%**	0.75%	1.76%	**42.73%**
10% Option Hedging	*3.33%*	3.30%	*11.56%*	28.53%

Under the Portfolio of Developed Countries, although hedging with the 10% strike price put option yields the highest portfolio return (3.33% compared to the one with forwards, 0.78%), the uncertainty and fluctuant in returns is much higher than the rest strategies, which is 11.56% compared with the others around 2%. Therefore, the better strategy in giving a higher returns but not volatile a lot in returns come from the one hedging with 5% option.

Table 6.4.3—Hedging Effectiveness of the International Portfolio

	Portfolio Return	Excess Return	CVaR	CSR
Unhedged	0.55%	0.52%	2.43%	21.37%
Forward Hedging	**0.48%**	0.45%	1.56%	**29.18%**
5% Option Hedging	**2.79%**	2.76%	6.11%	**45.18%**
10% Option Hedging	3.33%	3.30%	9.54%	34.55%

In the portfolio of internationally diversified investment, the conclusion of which hedging instrument is over perform the other is controversial to make. The 5% strike price put option yields a much higher portfolio return, 2.79%, compared with 0.48% comes from the forward hedging strategy. However, the higher return accompanied with higher risks. The volatility in 5% option is 6.11%, which is 4.55% higher than the one in forwards hedging. Thus, for risk averse decision makers, they might prefer the lowest volatility in returns with an acceptable CSR, which is the strategy hedging with currency forward contracts. For risk neutral investors, they might go for the largest portfolio CSR but with the acceptable volatility in returns, which will go for the strategy hedging with 5% strike price put option.

7. Concluding Remarks

In this paper, the hedging effectiveness of currency forward contracts and currency put option for three different portfolios—Portfolio of Emerging Markets, Portfolio of Developed Countries, and the International Portfolio—are examined from the viewpoint of European investors. The data employed in this paper are monthly equity and government bond indices from two groups, developed and emerging markets. European Union (EU), United States (US), United Kingdom (UK), Switzerland (SF), Sweden (SE), Denmark (DK), Norway (NK), and Japan (JAP) are considered in the developed countries. China (CH), India (IN), Malaysia (MA), and Thailand (THAI) are the emerging markets in this study. And a combination of these two groups, which formed an international portfolio, is studied as well. As the data of the stock returns, bond returns, and exchange rate returns exhibit asymmetrical characteristics, the downside risk measurement methodology Conditional Value-at-Risk (CVaR) is applied. The study contains the data from 1st January 2003 to 31st December 2013.

The significance of the hedging instrument contributes to the portfolio performance in reducing the risks and enhancing the returns simultaneously has been confirmed in all portfolios. In the Portfolio of Emerging Markets, the hedging strategy with 10% strike price put option yield a better result. While under the Portfolio of Developed Countries, although hedging with the 10% strike price put option yields the highest portfolio return, the uncertainty and fluctuant in returns is much lower in 5% option.

In the portfolio of internationally diversified investment, there is no clear conclusion of which hedging instrument is over performing the other. The 5% strike price put option yields a much higher portfolio return. However, the higher return accompanied with higher risks. Thus, for risk averse decision makers, they might prefer the lowest volatility in returns with an acceptable CSR, which is the strategy hedging with currency forward contracts. For risk neutral investors, they might go for the largest portfolio CSR but with the acceptable volatility in returns, which will go for the strategy hedging with 5% strike price put option.

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Appendix

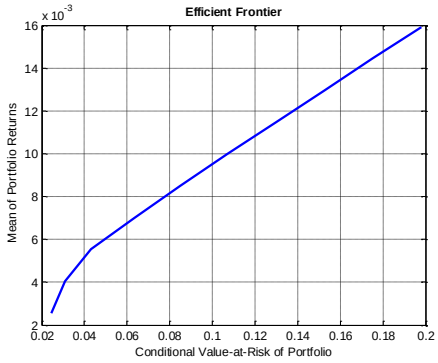
The MATLAB Code for CVaR framework:

```
pmcw = PortfolioCVaR;
pmcw = pmcw.setScenarios(FRD);
pmcw = pmcw.setDefaultConstraints;
pmcw = pmcw.setProbabilityLevel(0.95);
[lb, ub, isbounded] = pmcw.estimateBounds;
pwgtf = pmcw.estimateFrontier;
disp (pwgtf);
pmcw.plotFrontier
```

Portfolio Efficient Frontier Figures:

Portfolio of Emerging Markets:

Unhedged Portfolio



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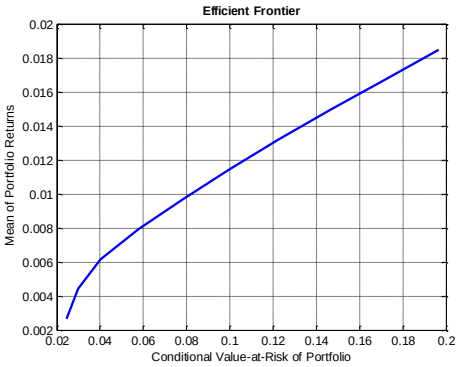

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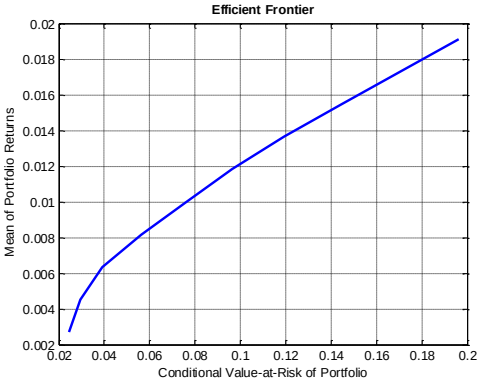

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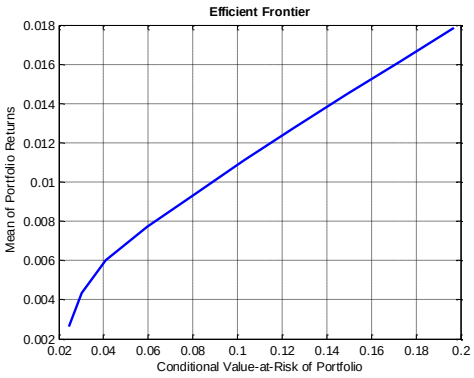

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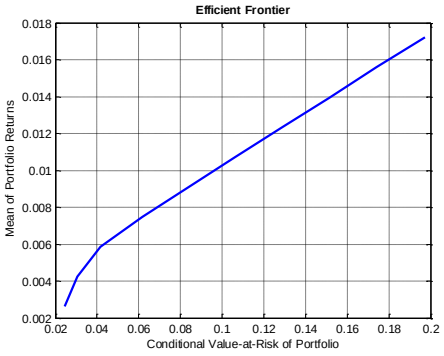

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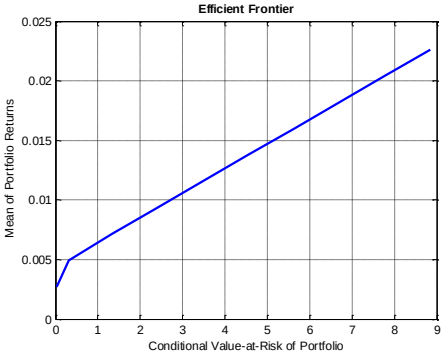

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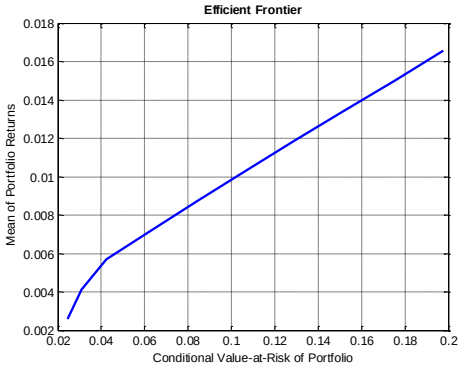

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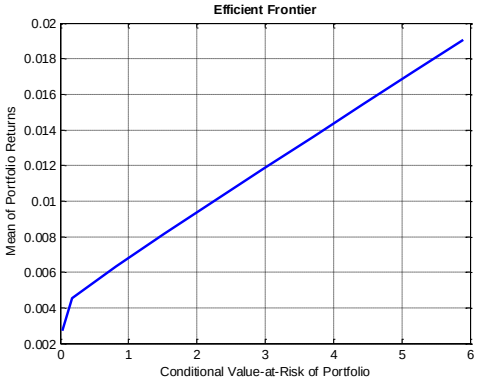

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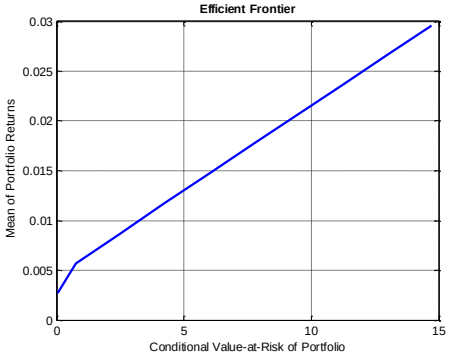

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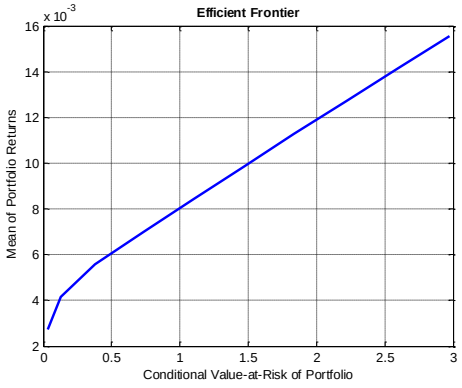

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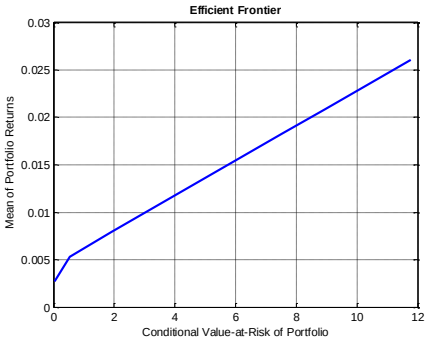
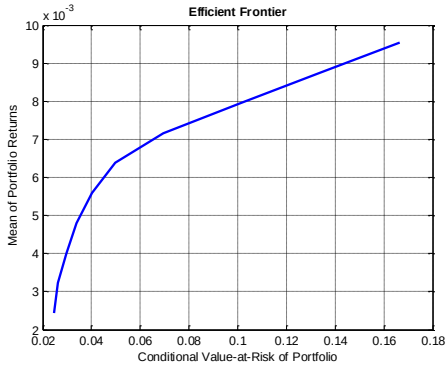


Portfolio of Developed Markets

Unhedged Portfolio



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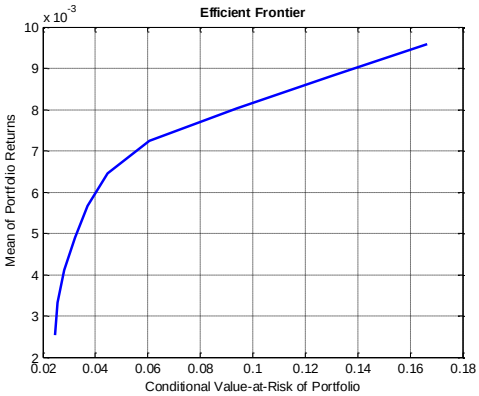

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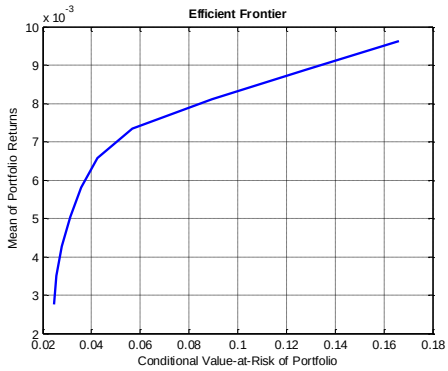

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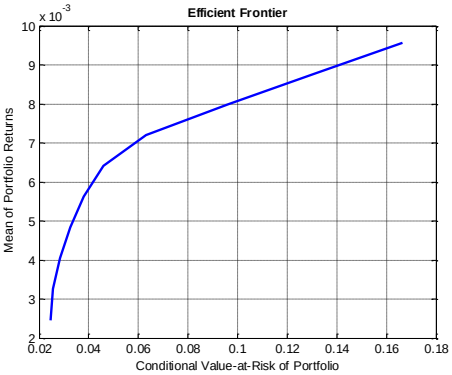

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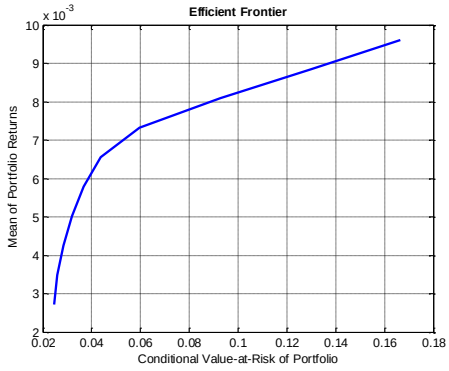
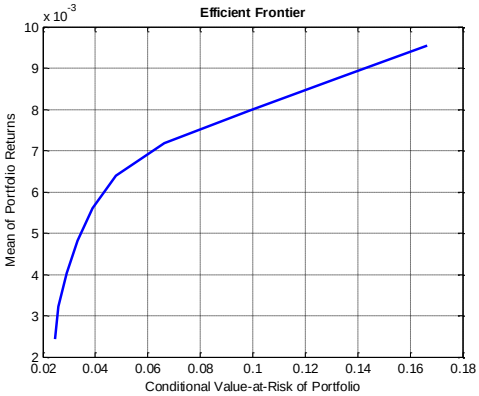
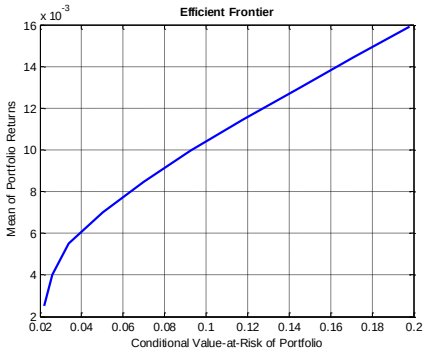


Forward Hedging h=0.2

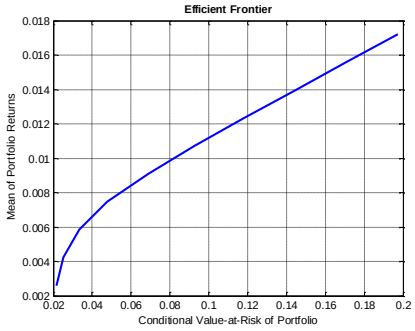


International Portfolio

Unhedged portfolio



Forward Hedging h=0.4



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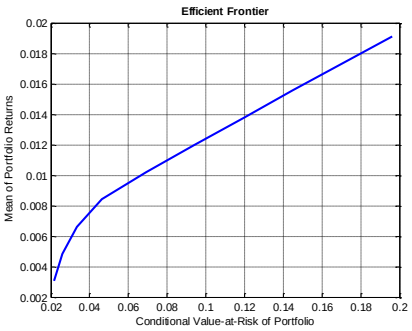

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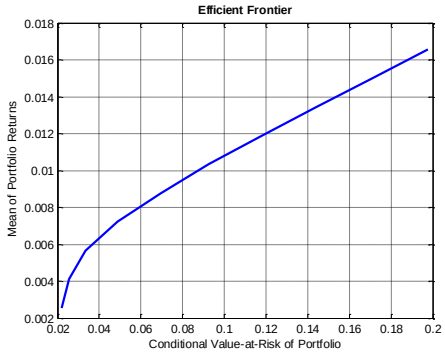
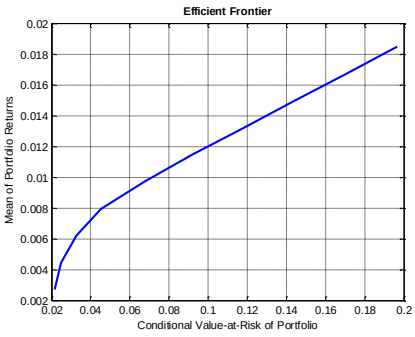
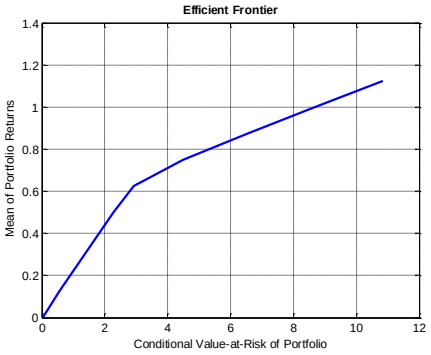


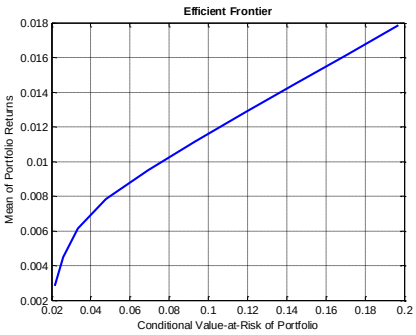
Forward Hedging h=0.8



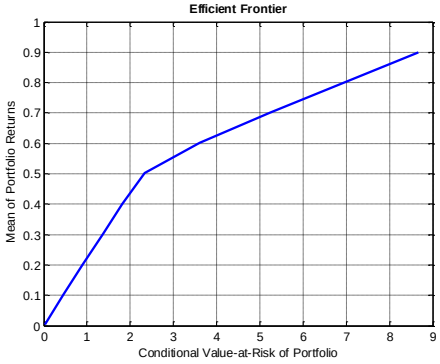
5% Option Hedging h=1.0



Forward Hedging h=0.6



5% Option Hedging h=0.8



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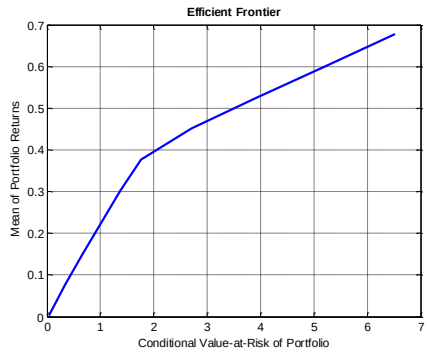

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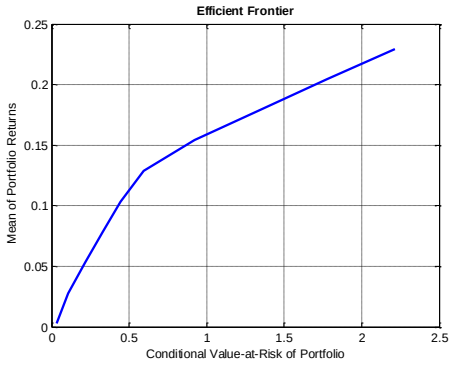

5% Option Hedging h=0.4