Currency Hedging for International Portfolios

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Abstract

This paper examines the risk minimizing motives for adding currency hedges to international portfolios. It will be examined what amount of hedging is most profitable under passive hedging strategies. The passive hedging strategies that will be used are: no hedging, full hedging, universal and optimal hedging. This research analyzes the impact of hedging on the risk and return of investments in three markets; the United States, France and Japan. The viewpoint of a European investor using forward contracts to hedge is taken.

We combine the log excess return on a foreign stock index with a position of size 'X' in the pseudo log return on a forward contract. Also the optimal hedge ratio is determined.

It can be concluded that hedging would be most profitable in small amounts for the period 2001 until 2011. These results are the same in the United States and in Japan for the both of them the optimal amount is around the 35 percent. All hedging strategies are more profitable than the unhedged alternative, where full hedging yields the best returns in our sample.

Contents

Abstract **2**

Chapter 1: Introduction and Problem Formulation **4**

Chapter 2: Prior Research **7**

Chapter 3: Methodology **12**

Chapter 4: Empirical Findings **15**

Chapter 5: Summary and Conclusions **18**

Chapter 6: Literature **19**

Appendix A **20**

Chapter 1: Introduction and Problem Formulation

Investors can potentially improve the risk-adjusted performance of their portfolios by investing internationally. This is confirmed by asset pricing models and multi-factor models (like CAPM for example); they suggest that investors should hold global portfolios (thereby diversifying their risk). Empirically, many authors have documented the gains from international diversification of investment portfolios. It is argued that since differences exist in levels of economic growth and timing of business cycles among various countries, international portfolio diversification can be used as a means of reducing risk at a given level of return (e.g. Ang and Bekaert (2002)). When investing internationally one has to hold an investment denominated in foreign currency. This gives rise to another risk for investors, namely currency risk. An investors' home currency (euro) can appreciate against a foreign currency (dollar), meaning that you get more dollars for each euro or it can depreciate, which works the other way around.

The academic finance literature has explored a number of reasons why investors might want to hold foreign currency. These can be divided into risk management demands and speculative demands. One type of risk management demand arises if there is no domestic asset that is riskless in real terms, for example because only nominal bills are available and there is uncertainty about the rate of inflation. In this case, the minimum-variance portfolio may contain foreign currency (Adler and Dumas 1983). This effect can be substantial in countries with extremely volatile inflation, such as some emerging markets, but is quite small in developed countries over short time intervals. If domestic inflation-indexed bonds are available however, they are riskless in real terms and thus drive out foreign currency from the minimum-variance portfolio.

Another type of risk management demand for foreign currency arises if an investor holds other assets for speculative reasons, and foreign currency is correlated with those assets (an investor who wishes to hold a globally diversified equity portfolio for example). If the foreign currency excess return on foreign equities is negatively correlated with the return on the foreign currency, then an investor holding foreign equities can reduce portfolio risk by holding a long position in foreign currency. So when the foreign currency depreciates (return on the foreign currency decreases) a long position is the most attractive. An unhedged position in international equity corresponds to a long position in foreign currency equal to the equity holding, while a fully hedged position corresponds to a net zero position in foreign currency. Therefore, speculative demands result from positive expected excess returns on foreign currency over domestic safe assets. This paper focuses on the risk management demands from investors who want to minimize their risk and in which ways this can be achieved.

It has been demonstrated by Eun and Resnick (1988) that exchange rate uncertainty is a largely non-diversifiable factor adversely affecting the performance of international portfolios. Fortunately,

investors need not forgo the opportunities offered by foreign investments just because of exchange rate risk. Using currency hedging as a defense tool is a good way to keep the amount of loss at a minimum when dealing with international investment opportunities. By employing this approach, it is possible to engage in investment opportunities that would otherwise be considered too volatile for the investor to consider. With currency hedging investors can fix an exchange rate at a present value for future operations in foreign currency, avoiding market fluctuations that could otherwise affect their income. The currency hedging provides them with the financial certainty that is needed to make transactions in foreign currency.

Traditionally to hedge currency risk forward rates, currency futures and options have been used. Forward contracts are customized (legal) agreements between two parties to fix the exchange rate for a future transaction. Because of the shortcomings of the forward market, specifically the need and the difficulty in finding a counter party, the futures market came into existence. The futures market basically solves some of the shortcomings of the forward market.

A currency futures contract is an agreement between two parties – a buyer and a seller – to buy or sell a particular currency at a future date at an exchange rate that is agreed upon today. Futures contracts have a lot of the same characteristics as forward contracts. However, futures contracts are much more liquid, it is liquid because it is traded in an exchange – the futures market. Futures contracts are also legal contracts like forward contracts, but the obligation doesn't have to be fulfilled before the expiry of the contract by making an opposite transaction. Since futures contracts have the effect of amplifying profits (or losses) these contracts are also much used for speculative reasons. An example of using futures is the following: when the U.S. dollar depreciates against the euro, a European investor generally would be better off by investing in futures, thereby offsetting the losses he or she would otherwise have suffered (because the price was locked in by the futures contract).

Finally, investors can use option to hedge currency risk. A currency option may be defined as a contract between two parties – a buyer and a seller – whereby the buyer of the option has the right but not the obligation, to buy or sell a specified currency at a specified exchange rate, at or before a specified date, from the seller of the option. Call options give the buyer the right to buy a specified currency at a specified exchange rate, at or before a specified date. Put options on the other hand give the buyer the right to sell a specified currency at a specified exchange rate, at or before a specified date. Call options are used if the risk is an upward trend in price and put options are used if the risk is a downward trend in price. So when the foreign currency depreciates, you would have lost money, this loss can be offset by buying a put option.

Currency forward and futures contracts allow the firm or investor to lock in a future exchange rate; currency options allow them to insure themselves against the exchange rate moving beyond a certain level (upward or downward). Also in options there is neither initial margin nor daily variation margin since the position is not marked to market. This could potentially provide significant cash flow

relief to traders. Also, with the use of forward contracts, the buyer must go through with the contract, even if the spot rate at maturity is worse than agreed upon. Because options are much more flexible compared to forwards or futures, they are thus more expensive, their price is therefore a disadvantage of using options.

This paper examines the risk minimizing motives for adding currency hedges to international portfolios. Similar research has been performed by Glen and Jorion (1993), but they used another dataset (1970 – 1990). This paper will try to replicate some of their results using a new sample data set (2001 – 2011). The research done by Glen and Jorion (1993) was before the introduction of the euro, therefore the results of this paper could add to the results that they found. This papers' problem statement is: *'Does currency hedging improve the performance of international portfolios and if so what is the optimum amount of hedging'?* We will only use passive hedging strategies in our research, the passive hedging strategies that will be used are: no hedging, full hedging, universal hedging and optimal hedging. This papers' research question is '*How do the traditional passive hedging strategies perform empirically'?* A relatively large dataset is needed because correlations between currencies and equities are not stable over time.

The impact of hedging on the risk and return of equity investments in three markets is analyzed; the United States, France (European investor) and Japan. We will add currency hedges to a predetermined stock position. Excess returns (log returns) and standard deviations will be measured and it will be examined what the optimal amount of hedging is. Comparisons are made between each of the hedging strategies and the unhedged option. This allows conclusions to be drawn as to whether hedging is better than remaining unhedged and also as to which passive hedge, if any, is the better one (no hedging, full hedging , optimal hedging or universal hedging).

The general approach that is taken is as follows. The composition of the portfolio of risky assets that maximizes the Sharpe-ratio (the ratio of excess return to risk) is examined. Focus is on the improvement in the Sharpe ratio that occurs when adding currency hedges to a portfolio of stocks. To do this the risk free rate has to be estimated, this is computed as the monthly return on the shortest bill from the ECB with no less than one month to maturity. This information is obtained from the website of Kenneth French. Also the foreign risk-free rates are estimated. The passive benchmarks are taken to be the standard performance indices for international portfolios. The stock index data are collected from 'DataStream' as well as the exchange rates, interest rates and return indices of the countries used in this paper. Exchange rates and country stock index returns are collected from the Morgan Stanley Capital International (MSCI) World Index via DataStream. The exchange rates used represent end of day mid rates.

Chapter 2: Prior Research

The issue of how to manage the currency risk associated with a portfolio of international securities has generated considerable interest in recent years. Studies by Perold and Schulman (1988) and Thomas (1989) showed that the risk/return tradeoff offered by U.S. government securities could be improved by diversifying into a portfolio of foreign government bonds. Also, international portfolio selection strategies designed to control both estimation and exchange risks almost consistently outperform the U.S. domestic portfolio in out-of-sample periods (Eun and Resnick 1988). In addition are hedged foreign bonds usually less volatile than similar-maturity U.S. Treasury bonds (Thomas 1989). Black (1989) has shown that each party in a currency trade can simultaneously perceive positive returns. In addition Campbell et al. (2010) highlight that the demand for currency generated by this effect is quite small in practice given the high volatility of currencies. But still, a U.S. investor can perceive a positive expected excess return on euro's over dollars, while a European investor can at the same time perceive an expected excess return on dollars over euros.

Currency hedging only approximates real exchange rate hedging. But most changes in currency values, at least in countries with moderate inflation rates, are due to changes in real exchange rates. Thus currency hedging will normally be a good approximation to real exchange rate hedging (Black 1995). This makes data collection and evaluation in our research easier.

The current research covers a lot of hedging strategies, in our research we focus on passive hedging strategies. A passive strategy of hedging currency risk embedded in foreign equity or bonds could enhance the risk-return trade-off from international investments compared to never hedging. The objective of a passive currency hedge is risk reduction, it is designed to reduce or remove currency risk from an internationally invested portfolio. The investor can choose to remove a certain fixed percentage of a portfolio's currency exposure through hedging. The investor then makes sure that the hedge ratio is maintained close to the target level, whilst reducing operational risk and minimizing transaction costs.

One passive strategy is to always use forward contracts to hedge exchange risk, a second is to use protective puts to hedge the exposure. An advantage of the second strategy is that a put does not have to be exercised when it is unfavorable to do so. Thus a protective put strategy can be classified as an ex post hedging decision, meaning that the investor does not need to decide whether to hedge until after the benefit has been determined. However, using protective puts does require paying a premium, whereas no upfront cash flow is required when hedging via the forward market. When exchange rate risk is hedged with forward contracts, the risk-return relationship is very much improved over unhedged international portfolio investment for bond portfolios and stock and bond

portfolios, but only minimal improvement is obtained for stock portfolios (Eun and Resnick 1994). This confirms the results found by Glen and Jorion (1993).

Passive currency hedges are not always profit maximizing, this is because of inefficiencies like long term trends and market shocks. This characteristic, combined with the high liquidity and low transaction costs of many currencies, makes active currency hedging an attractive option. Accordingly, rather than run a persistent passive hedge, it might be more appropriate to be selective in determining when to hedge and in which currencies to hedge. The objective of an active currency hedge is to replace random currency risk with managed currency risk. Whilst active currency hedging allows for return enhancement, its main focus is risk management; but 'smart' risk management, as opposed to a consistently applied passive hedge ratio. It is designed to manage currency risk exposure with the objective of protecting the investor from depreciating foreign currencies but allowing the investor to benefit from exposure to appreciating foreign currencies. An active trading strategy based upon simple technical trading rules can often produce profits solely from taking positions in foreign exchange (Dooley and Shafer 1983; Seeney 1986; Levich 1989).

At last it is possible to implement a selective hedging strategy; research shows that selective hedging may produce superior investment performance. Selective hedging involves the practice of making investments that reduce risk to part of the investors' portfolio, but not the whole portfolio. Alternatively, selective hedging may involve making offsetting investments on the whole portfolio, but only at certain times. Selective hedging carries higher risks than other hedging strategies, simply because it leaves some of the investors' investments unhedged. Eun and Resnick (1997) introduced the distinction between passive and selective hedging. They discuss the literature concerning the forward rate being an unbiased predictor of the future spot and the subsequent literature identifying the risk premium in the forward rate that makes them in fact biased estimators. They also review Messe and Rogoff's (1983) work on the efficiency of the random walk[1] that showed it superior to, or at least the equal to, any forecasting technique as offering a selective hedge indicator. The implication being that the current spot is the best indicator of the future spot.

Eaker and Grant (1990) used the selective strategy and found it produced superior results to always hedging. This contradicts earlier research by Glen and Jorion (1993) who found that selective strategies offered no improvement over a fully hedged strategy for a portfolio of the world bond or world stock index. A more recent study by Morey and Simpson (2001) also concludes that for a twelve month time period the selective strategy gives the best result. In addition, they note that in all cases the unhedged strategy performs better than the always hedge strategy.

Levich and Lee (1993) argue that the greatest investment-opportunities are present if investors are

[1] Random walk is a mathematical formalization of a trajectory that consists of taking successive random steps. This theory when applied in this context suggests that today's spot rate is the best forecast of the future spot rate.

not restricted in their ability to over-hedge in currencies where they hold long positions in bonds. They conclude that active currency risk management, based on a simple application of technical trading signals, can substantially improve the risk return opportunities for investors in comparison to passive currency strategies. Levich and Lee (1993) also show that technical trading rules are most useful to investors with the flexibility to take both long and short currency positions.

Current literature covers a great deal about passive, active and selective hedging, but which strategy performs best is still a topic of discussion. The focus of our research is on passive hedging, the next section will give an explanation about universal hedges (also passive hedges).

Black (1989) derived a universal hedge ratio in which each investor, regardless of nationality, takes the same position when hedging the exchange risk from investing in foreign equities of all countries. The necessary assumptions are that all investors have the same risk tolerance and that the national wealth of each country is equal to the country's stock market capitalization.

Currency hedging can be done for stocks as well as bonds; Black's universal hedging formula for stocks suggests 100 percent hedging for foreign bonds. Any foreign bonds that are held unhedged can be counted as part of the total exposure to foreign currency risk. The less is hedged into foreign bonds, the more the foreign stocks should be hedged, at least in the long run.

Adler and Prasad (1992) criticize Blacks' assumptions as being unrealistic. As an alternative, they propose the minimum variance hedge ratios that result from regressing the world market portfolio or any national stock market portfolio on third currencies. Jensen's inequality[2] guarantees that the hedge ratios will be the same for each national investor regardless of their currency.

This paper will also examine the optimal hedging amount. According to Anderson and Danthine (1981), the optimally hedged portfolios yielded better but not a statistically significant improvement in performance.

There has been some research into whether or not the investment horizon of an investor would change the optimal hedging amount. Froot (1993) argued that investors with an investment horizon of several years would be naturally hedged against exchange rate fluctuations. Consequently, only investors who are sensitive to short-term volatility over a quarter or a year should hedge currency risk. A limitation of his research is that his data set spans the period prior to the current regime of free-floating exchange rates. More recent research by Schmittmann (2010) finds that the case for hedging is generally not decreasing with an increasing investment horizon. While in some cases hedging becomes less effective in reducing risk at investment horizons of up to five years, there are also cases where over-hedging, i.e. shorting a currency, is the optimal risk minimizing strategy.

[2] The implication for hedging is that investors in every country can simultaneously perceive positive expected excess returns on foreign currencies over their own domestic currencies.

Research by Campbell et al. (2010) discovered that the U.S. dollar and the euro have moved against world equity markets over the period 1975 to 2005. Therefore they suggest that risk-minimizing equity investors should seek exposure to these currencies. For bonds full hedging tends to be optimal, which confirms the results found by Black (1995). They also found that many currencies, in particular the Australian dollar, Canadian dollar, Japanese yen and British pound are positively correlated with world stock markets. The implication for risk-minimizing international equity investors is that they can minimize their equity risk by taking short positions in the Japanese yen and long positions in the U.S. dollar or the euro for example.

To measure the improvements of hedging, this paper measures the excess returns on stocks. The study of Bekaert and Hodrick (1992) concludes that there is now considerable evidence that excess returns on a variety of assets are predictable. In foreign exchange markets, predictable returns have been documented using the forward premium as a predictor. These results could be used for investors investing in currencies for speculative reasons but also for active hedges. Tryon (1997) and Bilson (1981) pioneered use of the forward premium in investigations of the efficiency of the foreign exchange market. More recent studies have found the forward rate to contain a risk premium that is time varying as well as the expectations component. Thus, it is now generally agreed that forward prices are not unbiased predictors. An alternative model is that spot exchange rates follow a pure random walk. According to this model, the best estimate of next period's rate is the current spot exchange rate. Also Eun and Resnick (1988) found evidence that exchange rate changes can contribute to the variance of dollar returns (for an U.S. investor) through not only its own variance but also its covariance with the local stock market returns. The exchange rate movements are thus reinforcing rather than offsetting the stock market movements, resulting in a greater variance.

Much of the hedging literature processed so far focuses on hedging currency risk. However, evidence on the failure of the uncovered interest rate parity (Fama (1984) and Engel (1996)) suggests that currency excess returns are not always zero. Hedging currency risk is not the only reason for investors to hold foreign currency; another reason is for speculative purposes. The research mentioned above found that currencies of countries with low interest rates tend to not appreciate as much as suggested by the parity condition. The opposite holds for currencies of countries with high interest rates. This effect is behind the global currency carry trade where investors borrow in a low yielding currency and lend the proceeds in a high yield currency. Hedging currency risk associated with foreign investments removes these carry trade profits for investors from low interest rate currencies while it may enhance the returns to high interest rate currency investors.

The dataset that will be used in the paper includes data from a financial crisis; the effect of a crisis could have an impact on currency hedging. Exchange rates are determined by the demand and supply of currency. This in turn is caused by numerous factors, such as exporters, foreign investors,

speculators and bankers. In times of crisis it would be expected that exports decrease and the same holds for investments by foreign investors; these factors will affect the exchange rates depending on which direction they take. A financial crisis in general can cause a much greater volatility and lack of liquidity in many debt-related and equity-related financial markets.

In addition Campbell et al. (2010) showed that currencies, particular the U.S. dollar and currencies with low unconditional average interest rates such as the Japanese yen have tended to strengthen against other currencies during stock market declines. This confirms the attractiveness of these currencies as hedges for equity investors.

Schmittmann (2010) however found that the euro, which has tended to move against equity markets up to the crisis, became extremely pro-cyclical falling along with equity markets. Investors who would have sought exposure to the euro based on historical evidence would have incurred substantial currency losses in addition to losses on their other assets.

Chapter 3: Methodology

In this research we look at different passive hedging strategies. We will compare no hedging, full hedging, universal and optimal hedging. We will combine the log excess return on a foreign stock index with a position of size 'X' in the pseudo log return on a forward contract. Here 'X' is 0 in case of not hedging, 0,5 for universal hedging and 1 for full hedging. The optimal hedging amount is also filled in but has to be calculated first, using a regression analysis. In the calculations performed, the standpoint of a European investor is taken. We make use of log returns which makes the use of statistical analysis easier; we will demonstrate the principle of log returns first.
A one period simple return is the relative change in net asset price over one period from time t_{-1} to time t. The one period simple return is defined by:

$$1 + R_t = S_t/S_{t-1} \tag{1}$$

Where R_t is said to be the net one period simple return. A multi-period return is the return on an asset that is held for more than one period. A multi-period simple return over k time periods is defined as:

$$1 + R_t[k] = S_t/S_{t-k} \tag{2}$$

This is also known as a compound return, we use this because we measure the returns from multiple months. $R_t[k]$ is called the k-period simple net return and is given by:

$$R_t[k] = (S_t - S_{t-k})/S_{t-k} \tag{3}$$

A continuously compounded return is defined as the natural logarithm of the simple return of the asset and is given by:

$$\begin{aligned} r_t &= \ln(1+R_t) \\ &= \ln(S_t/S_{t-1}) \\ &= \ln(S_t) - \ln(S_{t-1}) \end{aligned} \tag{4}$$

This is the difference between the natural log of the assets price at time t and the natural log of its price at the previous step in time. Log returns have some favorable properties for statistical analysis. Now that log returns are explained, we can continue with the calculations used in our paper.
Another variation on a return is what is called an excess return. The excess return at time t is the difference between the assets return and that of another reference asset, in our case a riskless asset, where r_{0t} is the log return of the reference asset.

Log Excess Return at time t: $z_t = r_t - r_{0t}$ (5)

In order to calculate excess returns we need to know the stock returns. To do so we use the so-called 'Total Return Index (RI)' from 'DataStream', this gives the value of an investment in a stock, while reinvesting any cash dividends in the same stocks. We start by calculating the log returns from the Total Return Index in yen or dollar and the log returns from this total return index calculated in our home currency (euro).

$$\text{Ln}\,(RI_{t+1}/RI_t) \tag{6}$$

Next the log return on the exchange rate measured in € per yen or dollar has to be determined.

$$r_{s,t+1} = \ln\,(S_{t+1}/S_t) \tag{7}$$

In order to perform the necessary calculations the log risk free returns in the domestic currency and in the investors' home currency have to be calculated as well.

$$\text{Ln}\,(1+r_f/100)*100 \tag{8}$$

Assuming that there are no arbitrage opportunities, the following relation holds for the forward rate.

$$F_t = [S_t/(1+r^{EU})](1+r^{\text{US or Japan}}) \tag{9}$$

Where S_t is the spot rate (number of dollars or yen you can get today for €1) and F_t is the forward rate (the forward dollar/euro or yen/euro exchange rate).
With this information the pseudo log return on a forward contract to buy 1 yen or dollar can be calculated (these variables can be added and subtracted since they are log returns).

$$\begin{aligned} z_{f,t+1} &= \ln\,(S_{t+1}/F_{t+1}) \\ &= r_{s,t+1} + r_{f,t}^{\text{(Japan or U.S.)}} - r_{f,t}^{\text{Europa}} \end{aligned} \tag{10}$$

European returns are the same as the Japanese or American returns plus the return on the exchange rate minus the return on forward contracts.

$$r_{t+1}^{EU} = r_{t+1}^{\text{Japan or U.S.}} + r_{s,t+1} - z_{f,t+1} \tag{11}$$

Combining these equations we get the following European (€) excess log return on a fully hedged position in Japan or in the United States:

$$\begin{aligned} r_{t+1}^{EU} - r_{f,t}^{EU} &= r_{t+1}^{\text{Japan or U.S.}} + r_{s,t+1} - z_{f,t+1} - r_{f,t}^{EU} \\ &= r_{t+1}^{\text{Japan or U.S.}} + r_{s,t+1} - (r_{s,t+1} + r_{f,t}^{\text{Japan or U.S.}} - r_{f,t}^{EU}) - r_{f,t}^{EU} \\ &= r_{t+1}^{\text{Japan or U.S.}} - r_{f,t}^{\text{Japan or U.S.}} \end{aligned} \tag{12}$$

We estimate optimal hedge ratios for French, Japanese and US investors investing in foreign equity markets through the use of a regression analysis. In this model β represents the optimal hedge ratio. We assume the model to be:

$$_{(\text{Excess})}R^{€}_{t+1,\,\text{US or Japan}} = \alpha + \beta * Zf^{€}_{t+1} + e$$

To calculate the unhedged, fully hedged, universally hedged and optimally hedged excess returns we need to change our position 'X' in the forward contract (from equation 9) in 0, 1, 0.5 and β respectively for the hedging strategies mentioned here.
For example; an unhedged position in the United States corresponds to $r_{t+1}^{U.S.} - r_{f,t}^{EU}$, whereas a fully hedged position corresponds to $(r_{t+1}^{U.S.} - r_{f,t}^{EU}) - (\underline{1}*Z_{f,t+1})$.

In the results section we measure the returns (hedged, unhedged, universal and optimal) and also perform some test statistics like the mean return of the foreign index in euro, the standard deviation of the foreign index, the Sharpe ratio, the average return on the home currency and the respective standard deviation and Sharpe ratio from that currency.

In its standard form the Sharpe ratio provides a risk adjusted performance measure.

$$S^f = \frac{R_i^f - R_f^f}{\sigma_i^f} \qquad S^d = \frac{R_i^d - R_f^d}{\sigma_i^d}$$

This means that you take the difference of the return of portfolio I during the time period and the risk-free rate at the time and divide this result by the standard deviation of the rate of return for portfolio I during the time period, you thereby obtain the 'Sharpe measure'.
The Sharpe ratio explains whether a portfolio's returns are due to smart investment decisions or a result of excess risk. The Sharpe ratio displays the return above the risk free return per unit of risk taken. This measurement is very useful because although one portfolio or fund can achieve higher returns than its peers, it is a better investment if those higher returns do not come with too much additional risk. The greater a portfolio's Sharpe ratio, the better its risk-adjusted performance has been. A negative Sharpe ratio indicates that a riskless asset would perform better than the security being analyzed.

In order to perform the research we used the MSCI country return indices denoted in local currency and denoted in euro (investors' home currency). We gathered the exchange rate data and the risk free rates from both the local and the home currency from 'DataStream'. With these variables we can calculate the excess returns in the way described above.

Chapter 4: Empirical Findings

After gathering the necessary data and having applied the formulas in the methodology section, we obtain the following results on passive hedges. Below the statistics of different passive hedges are presented. We start the table by presenting the return on the return index in yen/dollar and denominated in euro. After that some statistics are presented; the exchange rate over the period, the return on the exchange rate and the return on forward contracts. To conclude the table the correlation between returns in Japan and the United States are calculated.

Table 1: Sample statistics	**Japan**	**United States**	**EU**
Return from return index in yen or dollar	(0,31)	0,10	-
Standard Deviation RI in yen or dollar	*5,66*	*5,30*	-
Return from return index in euro	(0,29)	(0,17)	-
Standard Deviation RI in euro	*5,32*	*5,08*	-
Return on yen or dollar	0,025	(0,268)	-
Standard Deviation Return on yen or dollar	*3,50*	*3,20*	-
Currency Futures Return	(0,131)	(0,431)	-
Standard Deviation Futures Return	*3,52*	*3,21*	-
Mean Risk-Free Rate	0,01	0,21	0,16
Standard Deviation Risk-Free Rate	*0,01*	*0,16*	*0,14*
Average Exchange rate	0,00772 euro/yen	0,82523 euro/dollar	-

* The returns are monthly returns in %

When we examine this table we can see that the returns in the United States in dollar are positive while they are not when measured in euro. The returns in Japan are negative in both yen and euro. The average return on the dollar is negative, whereas the return on the yen is positive. For both countries the futures currency return is negative, but in the United States this amount is about three times larger than in Japan.

The mean risk-free rate in Japan is low when compared to the United States or Europe, whereas the risk-free rate in the United States and Europe are very similar.

The exchange rate indicates that the euro is on average worth more than the dollar and yen.

In the next table we have calculated some correlations between returns in the United States and in Japan, since these correlations could have an impact on the investors' portfolio.

Table 2: Correlations between returns in the United States and in Japan

Unhedged returns	0,587
Fully hedged returns	0,625
Universally hedged returns	0,603
Optimally hedged returns	0,596

Excess returns in Japan and the United States are all positively correlated, indicating that when excess returns in the United States go up, it is likely that they will go up in Japan as well. These high correlations can cause higher volatility in an investors' portfolio, this is the case when an investor is long in both JPY/EUR and USD/EUR for example.

Below the results of hedging are presented; the different portfolios that combine the futures return with the foreign equity return. The standard deviation and Sharpe ratios are calculated as well. The way in which the portfolios are composed and the Sharpe ratio is calculated are described in chapter three.

Table 3: Average monthly excess return (%) from different passive hedges and some statistics[1]

	Japan	United States
No Hedge[2]	(0,454)	(0,331)
Standard Deviation No Hedge	5,33	5,09
Sharpe Ratio No Hedge	(0,085)	(0,065)
Full Hedge[2]	(0,323)	(0,114)
Standard Deviation Full Hedge	5,66	5,33
Sharpe Ratio Full Hedge	(0,057)	(0,021)
Universal Hedge	(0,389)	(0,222)
Standard Deviation Universal Hedge	5,21	4,96
Sharpe Ratio No Hedge	(0,075)	(0,045)
Optimal Hedge[3]	(0,408)	(0,249)
Standard Deviation Optimal Hedge	5,18	4,94
Sharpe Ratio Optimal Hedge	(0,079)	(0,050)

(1) Results are obtained from monthly observations from a European perspective and presented in percentages

(2) From the perspective of an American investor investing in the Japanese yen, the excess returns are unhedged (0,186) and fully hedged (0,323) with standard deviations of 5,56 and 5,66 respectively. From the perspective of a Japanese Investor, investing in the United States dollar the excess returns are unhedged (0,356) and fully hedged (0,114) with standard deviations of 6,09 and 5,33 respectively.

(3) The optimal hedge ratio from a European perspective is obtained from a regression analysis and is 0,351 for Japan and 0,378 for the U.S. for more information see Appendix A

From table 3 it can be concluded that full hedging was on average more profitable than not hedging or any of the other alternatives. In addition, all hedges are better than remaining unhedged, which is also confirmed by the Sharpe ratios.

The optimal hedge ratio suggests that the optimal amount should be more around no hedging than around full hedging. The (un)hedged returns in Japan are somewhat lower than the (un)hedged returns in the United States. The Sharpe ratios are negative, indicating that on average the investment underperformed risk-free investment. From the American point of view, investing in Japan is more profitable unhedged while equally risky and profitable when fully hedged as was the case with a European investor. From the Japanese point of view, investing in the United States is very similar to the European standpoint, unhedged returns are more negative and the standard deviation is larger.

When looking at the sample statistics of the regression in Appendix A, it would appear that the model is significant for both Japan and the United States (the null hypothesis of no predictive value is rejected with an F-test). The variable Zf_{t+1} is individually significant at a 95% confidence level for both countries (p-value is smaller than 0,05).
Also, in figure 1 and figure 2 it stands out that the r-square is low. The variance explained by the model is only 5,4 percent in the Japan model and 5,7 percent in the U.S. model. The beta that we calculated is the optimal hedge ratio which is 0,351 and 0,378 for Japan and the United States respectively.

Some limitations to our research are that we only use data from the last eleven years and we look at three countries only. We use passive strategies only, while active strategies could be used as well. In addition we only use equity data, while research indicates that bond hedging strategies are different from those of equities, so for a deeper understanding of hedging these could be included as well. Future research could investigate the difference between (hedged) returns from equities and bonds, use active strategies as well and include more countries.

Chapter 5: Summary and Conclusions

In this paper we examined if currency hedging improved the performance of international portfolios and what, if so, the optimal amount of hedging is. We will examine what amount of hedging is most profitable under passive hedging strategies. The passive hedging strategies that will be used are : no hedging, full hedging and optimal hedging. This papers' research question is '*How do the traditional passive hedging strategies perform empirically?'* We used monthly data from France, Japan and the United States from the period 2001 until 2011.

From the different hedging strategies examined, full hedging appears to be most profitable, followed by universal and optimal hedging. No matter what hedging strategy was chosen, all strategies yielded better results than the unhedged alternative. The optimal hedging amount is around the 35 percent for both the United States and Japan. In addition investors would be better of investing in risk-free investments, since these returns would appear to be better than those of 'normal' investments in the sample used.

The high correlations between returns in Japan and the United States have some important implications for hedging since these could increase the volatility of an investors' portfolio.

In the research of Glen and Jorion the volatility of returns in the United States is lower than the volatility of returns in Japan. In our research we find similar results, although the volatility is higher than in the previous research of Glen and Jorion. Another difference between the results found by Glen and Jorion and this research is that the returns are lower. These results are in line with recent research by M. Schmittmann (2010) in which a larger time span and more countries are used. Their research too concludes that the returns in recent years have lowered.

Chapter 6: Literature

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Appendix A

Figure 1: Sample Statistics pertaining to optimal hedging in Japan

Regression Statistics	
Multiple R	0,23211521
R Square	0,053877471
Adjusted R Square	0,046543187
Standard Error	5,203887464
Observations	131

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	198,9323062	198,9323062	7,345976336	0,007635969
Residual	129	3493,377372	27,08044474		
Total	130	3692,309678			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0,408081777	0,454980835	-0,896920806	0,371431986
Zf_{t+1}	0,351370876	0,12964059	2,710346165	0,007635969

Figure 2: Sample Statistics Pertaining to Optimal Hedging in the United States

Regression Statistics	
Multiple R	0,238175967
R Square	0,056727791
Adjusted R Square	0,049415603
Standard Error	4,961659278
Observations	131

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	190,9863899	190,9863899	7,757978014	0,006153999
Residual	129	3175,7301	24,61806279		
Total	130	3366,71649			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0,248735712	0,43450161	-0,572462117	0,568005306
Zf_{t+1}	0,378169035	0,135772462	2,785314706	0,006153999