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Department of Banking & Financial Management

26

THESIS

INTERNATIONAL BOND PORTFOLIOS:

TO HEDGE OR NOT TO HEDGE?

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To Mary and my parents

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CONTENTS

1. MOTIVATION

This thesis, as the title suggests is motivated by the fact that the hedging decision is a rather controversial matter, which cannot get a clear answer. Yet, the decision" ***To Hedge or not to Hedge?"*** is very important to thousands of investors and asset managers. With the thesis and the attendant empirical work, we shall try to shed some light on aspects of the extensive debate in the existing literature.

The hedging motivation differs from investor to investor across the world. In the literature it has been almost exclusively analyzed from the perspective of the US investor. This study also analyzes it from the perspective of the European investor and the Japanese investor.

The decision to hedge or not to hedge has grown in significance lately as the international capital has progressively become more mobile. Because of eliminations of the government's prohibitory the motivation for an international investment is being more and more stronger. As a result, investors are exposed not only to the interest rate risk but to foreign exchange risk as well. The latter, additionally, appears to be more pronounced compared to the former.

Hedging exchange rate risk is easier said than done. This has to do with the many aspects of the decision. Namely, should we make full or partial hedging? Is there any optimal hedge ratio? Should we face hedging as a passive strategy or an active one? Should we buy a particular foreign asset from a particular country or we must diversify in several countries? Or finally should we hedge at all?

Recognizing the difficulties inherent in these aspects, we do not aim at giving a universal answer about hedging policy, something many prominent scholars have not accomplish so far. We do hope, however, to check and give some reliable explanations about the existing findings in the literature. We also hope to propose the best hedging strategy for our sample, which consists of bond portfolios from G7 countries for the period. The yardstick to evaluate

our proposal is attaining higher return with lower risk using a foreign bond portfolio than using a domestic one.

The purpose is to attain better return and a remarkable risk reduction of investing internationally.

Specifically, we shall examine whether and how much

- Currency hedging provides a very good risk reduction in a foreign bond portfolio

Additionally, we aim at

- Generating insights about hedging international bond portfolios
- Examining if a hedge ratio of one gives the maximum risk reduction
- Showing the benefits of active currency hedging
- Calculating the optimal hedge ratio from the perspective of the three major overseas investors (US, EUROPEAN, JAPANESE)

To this goal, we shall construct two benchmark bond portfolios using government bonds from G7 countries and we take the view of US, European and Japanese investor.

The two portfolios will be created as follow

a) Equally –weighted with readjustment every period

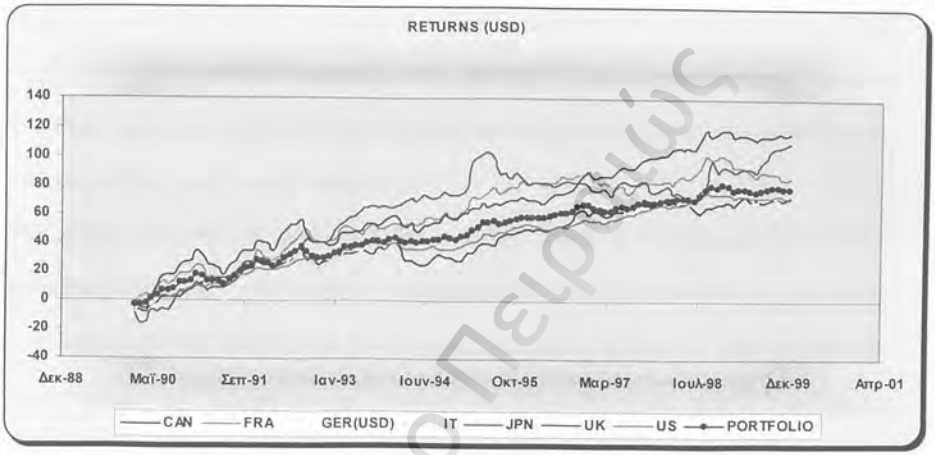
b) Optimal portfolio with rolling estimation period

After the construction of portfolios we will search for the optimal hedge ratio from 0 (zero) to 1 (one)

As a foretaste, we present an equally weighted portfolio in US dollars without hedging, where we can realize the benefits from diversification.

Figure 1

Cumulative bond returns and equally weighted portfolio return (in local terms)



Sample Period (01/01/1990-01/01/2000)

From the above figure we see the risk reduction from the diversified portfolio than the separated bonds. Comparing bonds we see that the greater return we obtain from investing totally in the Japanese index while we obtain the less from the German and Canadian. Our unhedged diversified portfolio provides an average of separated returns and a remarkable risk reduction (smooth line). With our methods we will try to reduce risk from our proper mixed portfolio without sacrificing return and give some credible answers to some points of the existing literature.

2. LITERATURE REVIEW

2.1 THE ISSUES

A lot of academics and distinguished practitioners have written extensively on currency hedging and currency risk management issues. Before we begin to present some of the most important papers, it is appropriate to present some general principles that pertain to the currency hedging decision and controversy.

The major motivation of currency hedging foreign bonds is to minimize risk without sacrificing return. This in the literature is called as a "free lunch" and it is a very controversial matter without a very clear answer. So with hedging one may succeed in being exposed only in interest rate risk avoiding foreign exchange risk. But is there, and what is it, an optimal hedge ratio? Is it different from one? This question arises from the different correlations of bonds from different countries and the covariance between bond returns and currency returns. A great role has also played by the fact that the exchange rate between two countries say, dollar versus mark, has not exactly the same return as the exchange rate between Mark versus dollar. This phenomenon so-called Siegel's Paradox is quite clear from the literature as a major factor of having a hedge ratio different than one.

Another aspect is that the expected returns on hedged and unhedged bonds should be the same or quite similar in the long run assuming there is no risk premium embedded in forward exchange rates. The key to this argument is that, from the perspective of long run policy, investors should think of currency hedging as having zero expected return. There in lies the free lunch we mentioned before. On average, currency hedging gives you substantial risk reduction at no loss of expected return. The expected return on unhedged foreign bonds would be greater than the expected return on hedged foreign bonds only if the expected average appreciation of the relevant foreign currency versus the domestic one consistently exceeded

the average forward premium of these currencies versus the domestic currency. But if one faces the opposite side, he is exposed in currency risk that leads to capital loss. This kind of risk wants to eliminate through currency hedging as well.

Moreover, there are different views on hedging strategies because of investors all over the world, who have different consumption and inflation standards and different risk tolerance. These strategies are the passive hedging, which means that they want to hedge their portfolios from the beginning to the end of their investment without changing any parameters of hedging. Passive hedging should be 100% of portfolio hedged; or a part of it, leaving the opportunity to get some benefits if the exchange rates move in their favor minimizing a part of risk and facing less loss if the exchange rate does not move on their side.
In contrast to the passive hedging there is the active currency management, which give the investor the opportunity to adjust his part of hedging using technical trading rules and statistical tools. Finally there are a lot of people who never hedge, refusing to pay the cost of hedging and believing that the asset allocation to international diversification is strong enough to minimize the bulk of risk, leaving some window to obtain some extra returns from the exchange rates movements.

To close, we present some key elements of the existing literature:

- Currency hedging provides a very good risk reduction in a foreign bond portfolio
- The impact from currency hedging to the expected return is little because of low transaction costs
- Hedging currency policy is better for long-term investment because of zero-expected currency returns
- A hedge ratio of one does not give necessarily the maximum risk/return trade off
- There are covariances between exchange rate movements and security returns
- Diversification provides also a good risk reduction

- Currency hedging is a free lunch
- The hedge ratio should be less than one because of Siegel's Paradox
- The optimal hedge ratio depends on investor's risk tolerance
- Passive hedging as the proper strategy
- Active currency management using technical trading rules
- Active currency management should be used because the forward rate is not a good predictor of future spot rate
- The optimal hedge ratio lies between 0,30 and 0,77
- There are high correlations between bonds and currencies
- Hedging decision is a very controversial matter

2.2. EXISTING LITERATURE

From the extensive literature on currency hedging we will discuss those more appropriate for the study at hand.

Andre F. Perold and Evan C. Schulman (1998) suggest that currency hedging provides a very good risk reduction in a foreign bond or equity portfolio. Currency hedging has a low impact to the expected return because of low transaction costs.

Hedging currency policy is better for long-term investments because for such investments currency hedging is a zero-expected return.

At this point lies the currency hedging free lunch. The point is that on average, this policy gives to an international investor substantial risk reduction at no loss of expected return.

A hedge ratio of one does not give necessarily the maximum risk reduction but it does eliminate the bulk of risk. If the hedge ratio of one were the appropriate ratio then we would not count the co variances between exchange rates movements and security returns.

The measure this effect they compare the historical volatilities between hedged and unhedged portfolios. The first observation is that, on unhedged basis, foreign stock and bond markets are much riskier than the respective US markets while hedged are less risky. In this study is obvious the percentage risk reduction of hedging.

Observing expected returns from currency hedging they say that there is a premium, which depends on the risk aversion of markets participants and on the covariance structure of international security returns, exchange rate movements and price deflators. There is no ground that this premium will always be positive or negative. In addition they found that currency expected return in long run is insignificantly different from zero. Because of the co variances between securities return [(1+c) local terms] and the exchange rates (1+x) the hedged return should be the following:

Hedged return (with periodic rebalancing) = $(1+c) * (1+f) * (1+\sigma_{cx})$

Where (1+f) is the forward rate measured by the interest rate parity and $(1+\sigma_{cs})$ is the covariance between the securities return and exchange rate returns.

The more frequent the rebalancing the more precise the above equation. So the conclusion is that one should hedge actively with a proper ratio different than one having in mind that transactions costs in this market are very low.

Keeping in mind these precious conclusions and remarks from the above paper we used some thoughts from Haim Levy and Zvi Lerman about "The Benefits of International Diversification in Bonds" where there is an examination of international diversification in bonds for some institutional investors that are confined (either by policy or by regulation) to holdings in the bond market. The sample is 1960-1980 from the database published by Ibbotson, Carr and Robinson. During that period the US stock market dominated the US bond market in terms of risk-adjusted returns. The gain from international diversification was substantial giving the opportunity to a US investor to earn more than double from a US bond portfolio. For investors not confined to bonds the gains are more impressive.

The article focuses on three issues.

- To what extent can international diversification among bonds produce returns in excess of those available from investment only in domestic bonds?

- Is it possible to construct internationally diversified bond portfolios that will outperform stock portfolios, despite the relatively low mean returns of bonds compared with stocks?
- What is the impact of diversification on portfolios made up of bonds and stocks from various markets?

Examining the mean return and standard deviation of international portfolios of stocks or bonds of the target countries they conclude that bonds are on the whole less risky than stocks. The standard deviation of bond returns in any particular market is usually lower than the standard deviation of the stock returns in that market. The comparison of risk/return of stocks and bonds in several markets is from the US investor's point of view.

Black (1989) "Universal Hedging: Optimizing Currency Risk and Reward in International Equity Portfolios" argues that for reasons based on the characteristics of percentage relationships among asset and currency returns and most importantly on the structure of the global capital asset pricing model, that there exists a single, universal currency-hedge ratio that should be applied to all cross-border positions in the absence of specific information and conviction to the contrary. Yet, Setting aside the highly restrictive assumptions on which the universal hedge calculation is based, the value of the universal hedge ratio is a function of several unstable observed variables. As a consequence, the value of the hedge ratio can vary considerably over time. In examples Black provides, the appropriate ratio ranges from a low of 0.30 to a high of 0.77.Although changing parameters affect many hedging decisions that are based in part on historical relationships, the impact of these instabilities is probably more obvious and more troubling in the universal currency-hedge case than in most others.

More particularly Black in this article suggests how investors can increase their return by holding foreign stock in addition to domestic ones. They can also gain by taking the appropriate amount of exchange risk. The writer makes some assumptions. First, investors see the world in light of their own consumption goods, and count both risk and expected return when figuring their optimum hedges. In addition investors share common views on stocks and currencies, and

that markets are liquid and there are no barriers to international investing. Taking these assumptions the writer derives a formula for the optimal hedge ratio.

The formula requires three basic inputs: a) the average across countries of the expected returns on the world market portfolio (μ_m); b) the average across countries of the volatility of the world market portfolio (σ_m); c) the average across all pairs of countries of exchange rate volatility (σ_c). These values can be easily estimated from historical data.

More over the formula depends on three rules: 1) hedge your foreign equities 2) hedge equities equally for all countries. 3) Don't hedge 100% of your foreign equities. A great advantage of this method is that applies not only to a US investor but also to every investor who holds foreign assets.

The formula is presented with the following expression:

$$\frac{\mu_m - \sigma_m^2}{\mu_m - \frac{1}{2} * \sigma_c^2}$$

Analyzing the three rules above the writer supports his opinion on hedging because it reduces risk for both sides that hold foreign assets. Thus for the writer currency hedging provides a "free lunch". The hedge should be less than one because of Siegel's paradox.

Finally the answer to the question "why universal Hedging?" lies in how exchange rates reach equilibrium. In equilibrium prices will adjust until everyone is willing to hold all stocks and until someone is willing to take the other side of every exchange rate contract.

As Black mentioned above the formula is based on historical data the universal hedging formula assumes that you put into the formula your opinions about what investors around the world expect for the future. So with a given level of volatility they can maximize the expected portfolio return taking the proper mix.

At this point it should be mentioned that the formula assumes that investors hedge real (inflation-adjusted) exchange rates changes, not changes due to inflation differentials between countries. To the extent that currency changes are the result of changes in inflation the formula is only an approximation.

The formula also assumes that the real exchange rate between two countries is defined as the relative value of domestic and foreign goods.

Black in a follow up paper "Equilibrium Exchange Rate Hedging that published in the Journal of Finance in July 1990, tries to link the universal hedge ratio formula with the Capital Asset Pricing Model making remarks for the Siegel's Paradox as well. Using some rather tedious algebra he derives the ratio of exchange risk (hedge ratio) to the market risk.

Siegel's Paradox makes investor to want a positive amount of exchange risk. When average risk tolerance is the same across countries every investor will hold the same mix of market risk (through the word market portfolio of all assets) and exchange risk (in a diversified basket of foreign currencies). In fact the ratio of exchange risk to market risk is equal to the average investor's risk tolerance.

The ratio of exchange risk to market risk can be written as depending on an average of world market risk premium, an average of world market volatilities, and an average of exchange rates volatilities.

The investor's problem is to minimize

$\sigma_i^2 = w_{im}^2 \sigma_{im}^2 - 2w_{im} \Sigma_j w_{ij} \sigma_{ijm} + \Sigma_{jk} w_{ij} w_{ik} \sigma_{ijk}$

to conclude to the final equation

$1-\lambda = (\mu_m - \sigma^2_m) / (\mu_m - 0.5\sigma_e^2)$.

The ratio λ has two roles: λ is the world average risk tolerance, and $1-\lambda$ is the total short position that each investor holds in currencies to hedge his asset portfolio.

The conclusion is that optimal hedging depends on this average of investor risk tolerances. In addition we can note that the short position in each currency depends on the wealth and risk tolerance of investors in that currency. It does not depend on the distribution of asset locations across countries or any means, variances, or co variances except certain average means and variances. In equilibrium, though, the optimal portfolio for any investor is a mix of the market portfolio with borrowing and lending.

Because of Siegel's Paradox the optimal amount of exchange rate hedging is always less than 100%.

Yet, Solnik in "Currency Hedging and Siegel's Paradox on Black's Universal Hedging Rule" (1993), claims that, in an international multi-currency context, with non-stochastic inflation, equilibrium asset pricing models dictate that all investors should hold a combination of their national risk-free bill and the world market portfolio partly hedged against currency risk. He attempts to show that the equilibrium hedge ratio is not universal and depends on investors' preferences and relative wealth. The objective is to provide a simple, but hopefully clarifying, discussion of equilibrium currency hedging. More specifically this article attempts to clarify the hedging implications of the simple international asset-pricing model, assuming non-stochastic inflation and a constant investment opportunity set. The complete derivations of the equilibrium investment and hedging rules are obtained in four steps.

In step 1 the optimal asset demand of an investor j with a wealth W_j and a risk tolerance of λ_j can be decomposed as a combination of $(1-\lambda_j) W_j$ invested in his risk free bill and of $\lambda_j W_j$ invested in a portfolio including all assets (stocks and bills). This portfolio is often called a log portfolio because it would be the portfolio held by investor with a logarithmic utility function (risk aversion $\lambda_j = 1$). This separation theorem applies to all investors using the same currency as a unit of measure. But investors from different countries use different units of measure.

In step 2 a logarithmic investor does not care about the currency used to measure returns since consumption price levels separate out in a logarithmic objective function and have no influence on investments decisions. The implication is that each investor combines his national risk free bill with the common log portfolio.

In step 3 constrained aggregate asset demands to be equal to asset supplies. The aggregate demand for stocks must be equal to the world market portfolio, while the aggregate demand for each national bill must be equal to zero (no net borrowing / lending in each currency). Hence aggregate wealth is equal to the aggregate stock market capitalization M.

We have

$$M_i = \Sigma_j \lambda_j W_j x_j = xi\ (\Sigma_j \lambda_j W_j) = xi\ \lambda\ W$$

Since M=W xi= $M_j/\lambda m$

Where λ is the average risk tolerance of all investors, weighted by their wealth.

In step 4 the bill in currency (i) is risk free only for investors of that country and for the others is a component of the log portfolio. If we denote y_i the weight of bill I in the log portfolio we finally get

$y_i = -(1-\lambda_i) W_i/\lambda M$.

A short position in a bill in currency I can be interpreted as a currency hedge in that currency, since a forward foreign currency contract is equivalent to going short in the foreign bill and long for the same amount, in the domestic bill

$h_i = (1-\lambda_i) W_i / M_i$

This means that the equilibrium hedge ratio in currency (i) is a function of the relative wealth and risk aversion of investors from country i.

The global hedge ratio will be equal for all currencies only in the unrealistic case where all investors have the same risk tolerance λ and where there is no foreign investment

$h = 1-\lambda$.

In addition the article mentions the Siegel's Paradox which can be illustrated by the observations that if the dollar goes up by 10% against the British Pound then the British Pound goes down by only 9.1% against the dollar. Siegel's Paradox can be expressed as

$\mu(S) + \mu(1/S) = \sigma^2(S) \neq 0$.

Some conclusions of this finding can be expressed as follows:

The equilibrium hedging policy is invariant to the nationality of investor and the hedge ratio is equal to 1-λ

The amount of foreign currency hedging does depend on the nationality of the investor.

The equilibrium hedge ratio for stocks of country (i) depends on net foreign investment by investors for country (i) and their risk tolerance.

If λ_i is greater than one, investors (i) will borrow in their own currency and foreigners will provide lending. There will be a negative hedge of currency (i) or rather a speculative demand for currency (i), because of high-expected return on the bill of country (i).

A global hedge ratio lesser than one is explained by the dual role played by national bills as a risk-free asset for its nationals and a foreign currency hedging device (short position) for all other investors. This is explained, considering the following equation:

$h = -(\Sigma_i * y_i)/(\Sigma_i * x_i) = 1-\lambda.$

As can been seen the global hedge ratio $1-\lambda$ does not depend on the exchange rate variance and hence on the extent of the deviation caused by Siegel's Paradox. Black (1990) already made this point but without drawing any inferences. The log portfolio contains only two assets: the market portfolio with weight $1/\lambda$ and the risk free asset with weight $1-\lambda/\lambda$. Using Black's definition of hedging, the hedge ratio is still equal to $1-\lambda$, although no exchange risk or Siegel's Paradox are present.

To summarize, currency hedge ratios are on the average less than one to compensate the demand for risk-free assets.

Among the first to write about active currency management were Richard M. Levich and Lee R. Thomas in their article published in Financial Analysts Journal in September-October 1993 titled "The Merits of Active Currency Risk Management: Evidence from International Bond Portfolios" where they tried to link their job with Fisher Black's. More particularly they accepted the existence of the optimal hedge ratio but they tried to present that neither the hedging strategy, nor the hedge ratio must be the same during the investment period but they should change according to some trading rules that they present as follow.

This article is actually a new statistical procedure which tests for weak –form efficiency in the foreign exchange futures markets. Their finding are implications for at two groups of investors (1) return-seeking investors considering foreign exchange as a separate class and (2) international portfolio investors deciding whether or not to hedge the foreign exchange rate exposures embedded in their non dollar investments. For both types of investors this article suggests an active currency risk management based on technical rules and signals with selective hedging against the traditional passive strategies "always hedge" or "never hedge". The collected data concern the period 1976-1990 for the following currencies: (DEM, GBP, CHF, JPY, CAD)

The writers have chosen to use futures prices rather than spot prices because changes in futures prices represent the total excess return (interest income, less the interest expense of funding a foreign currency position, plus capital gain or loss) accruing to the holder of a foreign currency. Calculating the profitability of mechanical trading rules commonly tests weak-form efficiency of the foreign exchange market.

Two kinds of trading rules have been used to this research; filter rules and moving averages crossover rules. A filter rule is defined by a single parameter f, the filter size. The technique is simple: "Buy the currency it rises by f% above its most recent through" and " sell the currency whenever it falls by f% below the recent peak". The filters, which are used, are 0.5%, 1.0%, 2.0%, 3.0%, 4.0%, 5.0%, and 10.0%. Specifying a moving average crossover rule requires two parameters: the length (L) of the longer moving average MA_L and the length (S) of the shorter moving average MA_S. An L/S moving average rule can be defined as follows: if $MA_S>MA_L$ then buy the foreign currency. If $MA_S<MA_L$ sell the foreign currency. If $MA_S=MA_L$ take no position. The moving averages, which are used, are L/S 5/1,20/5, 200/1. The transaction costs are estimated about 4 basis points for every trade. Although they are not part of the calculations they reduce the annual profit by 3.3%. In tables 1 and 2 there is the comparison between the "trading rule" and the "Buy and hold strategy". The excess return is largest using the first method rather the buy and hold strategy that gives very disappointing figures.

Moreover, according to the writers using the composite technical rule with possibility of hedging we have better results. The composite technical rule is based on the equation

$P=(N_L-N_S)*10\%$,

where N_L is the technical rules which give buy signals and N_S are the technical rules which give sell signals.

The active technical rule strategy is based in a non-parametric test motivated by the bootstrapping methodology. One cannot use a convectional t-test to measure the statistical significance because exchange rates volatility varies substantially. The rules give better results using the Sharpe ratio.

The article examines the following hedging strategies for a global bond portfolio. The passive hedging strategies "never hedge" and "always hedge" which are presented and the active strategies as the tactical hedging strategy and the currency overlay strategy.

A tactical hedging strategy is one where the percentage of currency futures to sell for currency (i), $P_{T,I}$ based on our 10 technical rules, is determined by the following formula:

$P_{T,I} = [10 - (N_{L,I} - N_{S,I})] * 10\%$ for $N_{L,I} >= 5$

$P_{T,I} = 100\%$ for $N <= 4$

Where $N_{L,I}$ and $N_{S,I}$ are the number of technical rules advocating long and short currency positions when all technical rules expect the value of FC to rise ($N_{L,I} = 10$) no hedging is recommended. But when the trading rules are evenly split ($N_{L,I} = N_{S,I} = 5$) the tactical strategy results in a 100% hedge of the currency risk in a foreign portfolio. The return on the tactically hedged portfolio R_T is simply

$R_T = R_U * (1 - P_T) + R_H - P_T$

where R_U is the return on the unhedged bond and R_H is the return on the currency hedged bond. Finally this article presents the currency overlay strategy, which is actually, a combination of two separate investments (1) a foreign currency bond position that is always hedged against currency risk and (2) a currency position governed by the composite currency trading rule

$[P = (N_L - N_S) * 10\%]$.

With this strategy at the extreme cases we have always 100% hedged position either long or short according to the trading rules. The return on the currency overlay

$R_{CO} = R_H + R_A$

where R_A is the return on the composite trading rule or

$R_A = \Sigma_t * P_t * \ln (F_{t+1} / F_t)$ and $-1.0 < P_t < 1.0$.

As we can see from the comparisons of all methods the results indicate that active hedging strategies can be very beneficial to international bond portfolio managers. Jorion's paper "Mean/Variance Analysis of Currency Overlays" (Financial Analysts Journal, 1994), implements an econometric approach of portfolio optimization using forward contracts.

Three approaches to currency management are considered in a mean/variance framework (1) a joint full-blown optimization over the underlying assets (stocks or bonds) and currencies, (2) a partial optimization over the currencies, given a predetermined position in the core bond portfolio, (3) a separate optimization over currencies and bonds. The writer compares the portfolio allocations derived from these approaches and analyze conditions under which the second and the third approaches are globally optimal.

Approach 1 assumes that the manager has expertise in many asset classes and can structure a portfolio to account for correlations between assets and currencies.

Approach 2 (partial optimization) currencies are managed separately from the core portfolio, but the manager still controls total portfolio risk.

Approach 3 (separate optimization) currencies are managed completely independently of the rest of the portfolio, and their performance is measured against a separate benchmark-cash, for instance.

More generally, this article discusses conditions under which currency hedging adds value to global portfolios, using historical data on major stocks, bond and currency markets over the 1978-91 period and for the countries US, Japan, Germany, Britain and France.

In a mean/variance framework investors choose investments weights, w, so as to maximize an objective function that is positively related to the portfolio mean, μ_p and negatively related to the portfolio variance, σ_p^2. This tradeoff between return and risk is reflected in the function U (μ_p, σ_p^2) where p=the total portfolio, x=the underlying assets (stocks or bonds) and f= the currency forward contracts.

In approach 1 the problem is $Max_{wx,wf}$ U (μ_p, σ_p^2)

In approach 2 the problem is Max_{wx} U (μ_x, σ_x^2) & Max_{wf} U (μ_p, σ_p^2/w_x)

In approach 3 the problem is Max_{wx} U (μ_x, σ_x^2) & Max_{wf} U (μ_f, σ_f^2)

Clearly going from approach 1 to 3 is successively less optimal. Using this path we observe the loss of efficiency.

The article also mentions the zero risk premium from forwards contracts on a foreign currency is incorrect and supports the opinion that the forward premium can help in predicting expected returns on forward contracts.

From the empirical evidence for the period of 1978-91 the writer comes to some interesting conclusions about the above hedging strategies. Unhedged stocks returns appear to be positively correlated with exchange rates. Therefore optimizing currencies and underlying unhedged assets separately cannot be optimal. In contrast stock returns appear uncorrelated with currencies. Full currency hedging may be an acceptable strategy for stocks.

For bonds we observe high correlations for both unhedged and hedged returns. Partial optimization and fully hedging must be sub optimal for international bonds.

There is not statistical evidence that currencies add value to the global equity portfolios.

Fixed-income portfolios benefit much more than equity portfolios from the management of currencies.

Given the high correlation between bonds and currencies these two asset classes must be managed together. This is why, in practice, currency overlays are only applied to equity portfolios.

Finally as is written above the forward premium is a good predictor of expected returns in forward contracts. So using forward contracts the writer presents the method of active hedging which gives the best Sharpe ratio compared with passive strategies of fully hedged or unhedged positions.

Simulated results over the 1978-91 period indicate that overlay management can add value to global equity and bond portfolios. It cannot enhance performance by as much as an integrated approach to currency management.

Finally to present a spherical solution about which is the best portfolio we used the paper of Gary Gastinau "The Currency Hedging Decision. A Search for Synthesis and Asset Allocation" which is published in 1995.

The major starting point of this finding is that there is not a prescription, which describes the decision of currency hedging but is a very controversial matter. The policy of currency

hedging cannot satisfy the demand of a simple rule but helps a manager to measure the cost of risk of a specific currency commitment. This approach is based on empirical studies and academic literature on risk management.

Real life observation is that hedging decision is a separate decision, which is taken after the asset selection. Considerable evidence also suggests that currency management is not the best place to simplify. Active currency management is stronger than the currency management and the case of active equity and fixed income management.

Having a view in the principal of Portfolio diversification we conclude that diversification reduces risk according to Markowitz opinion. It is additionally mentioned that if the correlations among the returns in each market are less than one, risks offsets from diversification can provide a more consistent return in the portfolio as a whole even if average returns remain the same.

In general the lower the intermarket correlation, the greater the potential risk and reward improvement from intermarket diversification.

Using all this literature above in addition with some more papers that we will present in the bibliography with ought detailed presentation we will give you a hint of our econometric work trying to persuade you about the value of this empirical research.

3. A FIRST LOOK OF THE DATA

The data used in this research are the J.P. Morgan government bonds indices for the G7 countries, retrieved from DataStream, for the period 1990-2000. The data pertain to the first day of the month. The purpose of our study is to construct the best portfolio from index bonds of the G7 countries. By saying the best portfolio we mean the mix of bonds, which provides the best risk/return trade off. So the unit measure of comparison will be the quotient of mean return with the standard deviation of each portfolio. The portfolio will be constructed from the point of view of three major international investors European, US, and Japanese. So we calculated the returns and standard deviation of every bond index of every G7 country. We took the exchange rate of all countries versus the German Mark the US dollar and Japanese Yen. We used the exchange rate to convert the returns of bonds from local terms to USD, DEM and JPY.

3.1 THE IMPACT OF CURRENCY FLUCTUATIONS

For an international investor the return of his bond portfolio depends upon three factors:
First from the capital gain or loss, second from interest rates, which define, bond coupons and finally, the gain or loss will cause him the foreign exchange rate volatility. From the third factor arises the basic necessity of currency hedging.
In order to have a clear view of the role of exchange rate variability we present the following tables:
The elements in tables 1-4 are average monthly returns and standard deviations in each currency.

Table 1

Bond Returns (in local currency, % monthly data)

	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
RETURN(LT)	0,7786	0,7469	0,6169	1,0515	0,5577	0,9191	0,5960
STDEV(LT)	1,6609	1,3318	1,1620	1,5780	1,4516	1,9700	1,2383
RET/ST(LT)	0,4688	0,5608	0,5309	0,6664	0,3842	0,4666	0,4813

Sample Period (01/01/1990-01/01/2000)

This table above shows us the risk, return and their quotient for bonds of the G7 countries expressed in local terms.

The best-case scenario according to the return/risk ratio that is the measure of our evaluation is the Italian bond index that provides 1.0515% (monthly average) with 1.5780% risk and the worst-case scenario is the Japanese bond index, which gives 0.5577% with a 1.4516% risk. In ratio terms we have 0.6664 for Italy versus 0.3842 for Japan. The conclusion is that Italian bond is the most attractive investment for every investor while the Japanese bond is the most unattractive one. The high volatility in the Japanese Bond can be explained by the continuous change of the Japanese interest rates the last decade.

We will show with the following tables how the risk is increasing while the return is decreasing or in rare occasions remain similar or increasing when we convert the returns in USD, DEM and JPY.

Table 2

Bond Returns (in USD, % monthly data)

	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
RETURN(USD)	0,6080	0,7015	0,5585	0,7669	0,9140	0,9648	0,5960
STDEV(USD)	2,4453	3,1210	3,1390	3,5342	3,9629	3,2738	1,2383
RET/ST(USD)	0,2487	0,2248	0,1779	0,2170	0,2306	0,2947	0,4813

Sample Period (01/01/1990-01/01/2000)

Taking account the foreign risk by expressing the bond indices in US dollars we see that the Italian bond index is almost the less attractive case with 0.7669% return and 3.5342% risk. To

be more enlightening if we see the investment from the US perspective we face 37.11% loss of return and 123.97% increase of return. This imbalance from the foreign currency impact causes the implementation of the hedging strategy.

Table 3

Bond Returns (in DEM, %monthly data)

	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
RETURN(DEM)	0,7581	0,7653	0,6169	0,8560	1,0084	1,0567	0,7352
STDEV(DEM)	4,0259	1,5032	1,1620	3,1931	3,7823	2,9853	3,0785
RET/ST(DEM)	0,1883	0,5091	0,5309	0,2681	0,2666	0,3540	0,2388

Sample Period (01/01/1990-01/01/2000)

Similar conclusions we take from the European perspective. In this table the decrease of return in the Italian bond is 18.59% and the increase of risk is 102.35%. This better situation compared to the US case may explain by the higher correlation, which has the Italian security with the German mark rather that, the US dollar. In the following table the impact of Japanese Jen shows even more dramatically decrease of return/risk ratio.

Table 4

Bond Returns (in JPY, % monthly data)

	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
RETURN(JPY)	0,3836	0,4369	0,2882	0,5274	0,5577	0,7089	0,3683
STDEV(JPY)	4,3806	3,8425	3,6922	4,7283	1,4516	4,1731	3,7354
RET/ST(JPY)	0,0876	0,1137	0,0780	0,1115	0,3842	0,1699	0,0986

Sample Period (01/01/1990-01/01/2000)

More specifically in the Italian case we have a mean return of 0.5274% per month with a risk of 4.7283%. In other words the reduction of return is 49.89% for the Japanese investor versus the local investor and the increase of risk is 199.64%. These data are reflected in the risk return ratio, which turned into 0.1115 from 0.6664 in the local case.

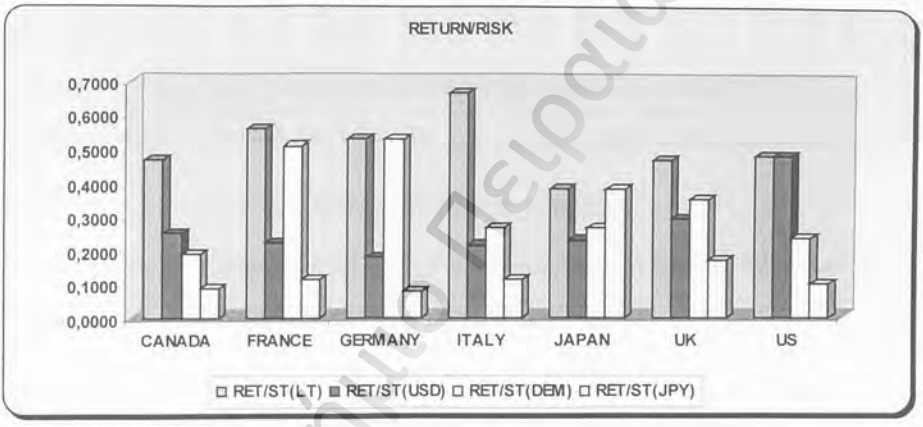
It is quite obvious from the above tables than when we convert the returns from local terms to USD, DEM and JPY the quotient is decreasing the most in JPY case. The conclusion is that

the incentive to hedge is obvious in the three cases and we face the stronger necessity in JPY case.

This conclusion can be seen with the following diagram, which presents the quotient of average monthly return to the standard deviation for every bond.

Figure 2

Mean Return/ Standard Deviation



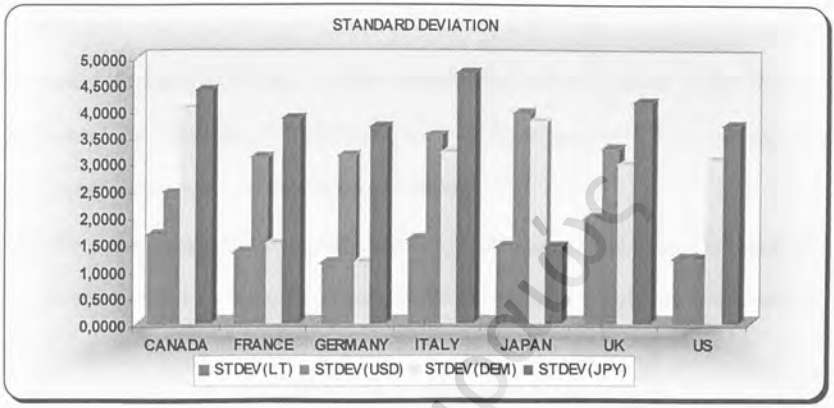
Sample Period (01/01/1990-01/01/2000)

As we can see from figure 2 the quotient in local terms is better than expressed in USD, DEM, JPY so in three cases we need to hedge.

The impact of exchange rate variability is more obvious concerning the risk for every bond, which can be seen in figure 3. The risk, which is expressed by standard deviation, increases dramatically when we take in the impact of foreign exchange variability. So the incentive to hedge is absolutely necessary to have risk reduction.

Figure 3

Bond Risk (Standard Deviation % monthly data)

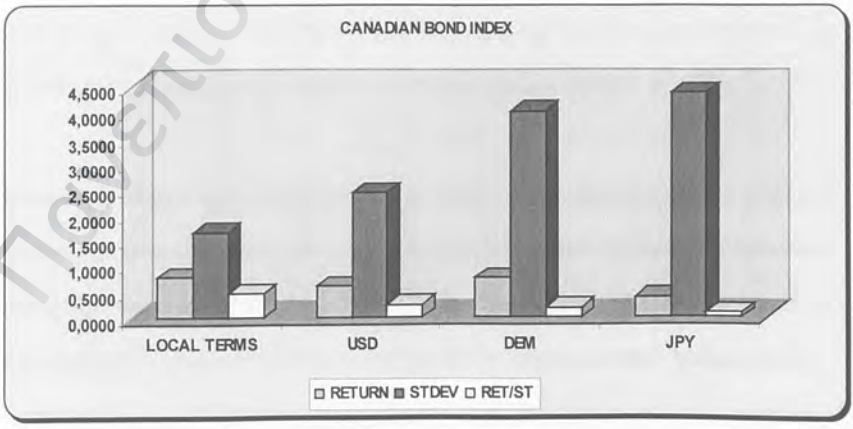


Sample Period (01/01/1990-01/01/2000)

To have a complete support to our opinion for the necessity of hedging we present one country for example Canada where we have exactly the same view.

Figure 4

Canada Bond Returns/Risks (in JPY, USD, DEM, local terms)



Sample Period (01/01/1990-01/01/2000)

From the above figure, it is clear that exchange rate volatility greatly increases the risk of our Canadian bond index. When the index is expressed in local terms (Canadian dollars) the standard deviation is 1.6609. When the bond is expressed in USD the standard deviation is 2.4453 when is expressed in DEM the standard deviation is 4.0259 and when is expressed in JPY the standard deviation is 4.3806. In other words when we take count of the foreign currency the total risk increase is 47.22% for the American currency, 142.39% for the European currency and 163.75% for the Japanese currency.

Some institutional investors may be confined (either by policy or by regulation) to accept so much risk. So the result is to choose an international diversified portfolio of bonds with a selective hedging.

However, the necessity of hedging has to do with the world macroeconomic conditions in a particular period. For example, until the early nineties most of the largest investors in the world, such as US pension funds and other major institutional investors, did not currency-hedge their international portfolios. Several explanations can be found for this policy.

International assets especially bonds represented only a tiny portion of the global portfolio of US pension funds; the impact of currency risk was thus very limited, and even beneficial, as it provided an element of diversification for domestic monetary risks. In terms of return, the US dollar was a weak currency in the seventies and eighties, so holding strong currencies such as the yen or the German mark provided additional return to the international portfolio.

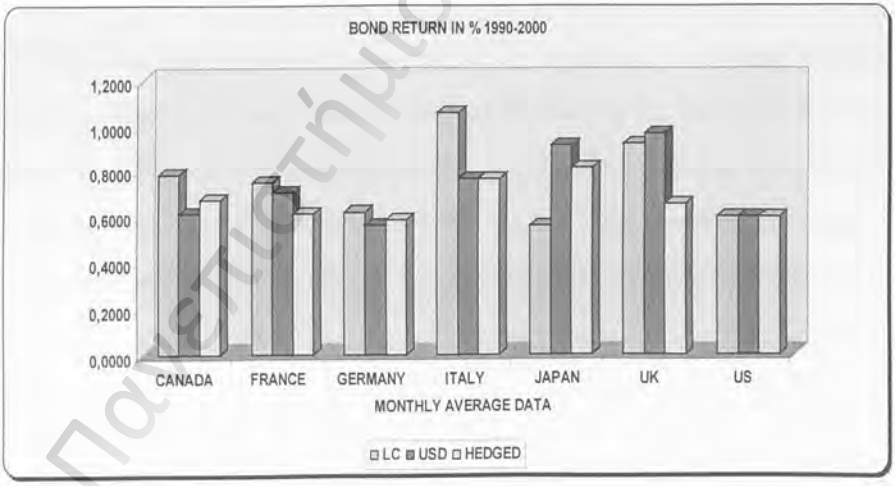
The picture has recently changed. The US dollar has been a strong currency relative to the yen and the other European currencies such as the German Mark. So the US institutional investors have drastically increased their foreign investments. The currency risk can no longer be treated as a negligible component. All this is leading for an optimal currency hedging policy.

As mentioned before, an investor in foreign markets can get two types of return. The return on a foreign investment translated into the investor's home currency. In our example if US investors buy a bond of G7 countries let's say Italy they get the Italian return on those bonds plus or minus the return of exchange rate differential between the Italian lira and the US

dollar. The option is to hedge the currency risk but the currency-hedged return differs by the local currency return by the interest rate differential between the two countries (the percentage difference between the forward and the spot exchange rates). Thus, US investors can get either the US dollar return or the currency-hedged return, and they must compare the two to evaluate the effect of the currency difference. The same point of view has the European international investor and the Japanese one. The only thing that they have to care about is the return of the domestic bond portfolio compared to the international and the interest rate differential between the two countries in order to have beneficial results either by hedging policy or by unhedged bond portfolio. The following figures provide a historical comparison of US dollar return, DEM return and JPY return compared with the local return and hedged return for the G7 countries and period 1/1/1990-/1/12000.

Figure 5

Bond returns of G7 countries in local terms, USD, USD hedged



Sample Period (01/01/1990-01/01/2000)

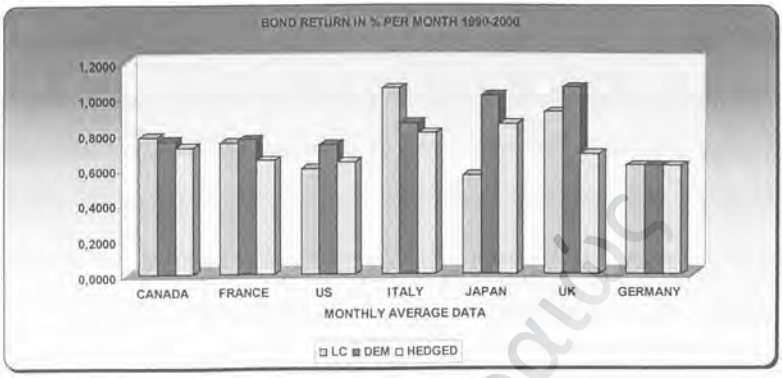
From figure 5 we have a quick look of the impact of the change in the return of every index bond we have when we take account the impact of the US dollar and the impact of hedging.

For example the monthly average return of the Italian bond index when is expressed in local currency (Italian lira) is 1.0515%. This return comes from the capital gain/loss of the Italian bond index and the coupons. When we express the Italian bond index in US dollars the monthly average return we obtain for the ten years is 0.7669%. The difference of course comes from the depreciation of the lira over time. The third return comes from hedging the lira using the one-month forward every month, which reflects to the interest rate differential between the two countries. The long run difference between not hedging and hedging is about 0.7669%-0. 7645% = 0.0024% or 2.4 basis points. Similar results we have with the under indices with a little exception to the German index where the hedged return provides a better outcome from the unhedged one 0.5787%-.05585% =0.0202% or 2.02 basis points. Here we have the "free lunch" phenomenon in currency hedging, something we have seen in the previous literature. With the term "free lunch" we mean that the benefit of reduced risk that comes from hedging does not lead to a reduction of our investment's return.

The conclusion of the above figure is that, for all investments, the difference between currency-hedged and unhedged return is rather small in the long run. So the main benefit of currency hedging will come from risk reduction. This is might be explained by the fact that exchanges rates revert to fundamentals over the long run (mean reversion). The following figure examines the European point of view as the bond indices are expressed in DEM.

Figure 6

Bond returns of G7 countries in local terms, DEM, DEM hedged



Sample Period (01/01/1990-01/01/2000)

This picture gives some evidence to our former conclusions. From the point of view of European investor the return in DEM is beneficial because of high depreciation of German Mark versus the US dollar. The latter, in the most of the cases moves to the same direction with all currencies together.

From the European perspective the exchange rate moves in favor of the investor who invests outside Europe. As can be seen this happens not only of the capital appreciation of the bond indices but from the foreign currency movements, which appreciate versus the German Mark. For example in the case of the Japanese index bond the monthly average return expressed in local terms (the Japanese yen) is 0.5577% while when we take account of the German currency we obtain an average monthly return of 1.0084% unhedged and 0.8512% hedged return. In other words from the beneficial impact of the exchange rate movement we have an 80.81% increase of return in the unhedged case and an 52.63% increase in hedged case. One should say that with the first look there is no necessity of hedging in this case thus we have so much loss of return. We could agree with that perspective but it would be wrong to agree

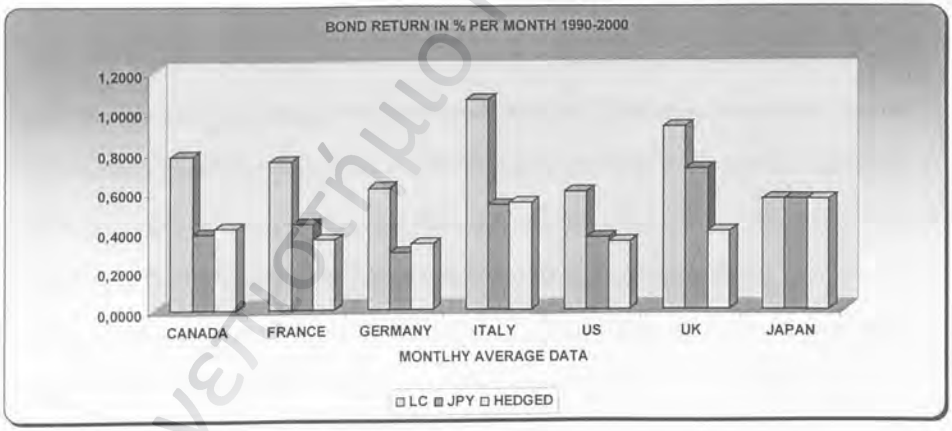
without examine the risk reduction of the hedged situation which refers to the investor's risk tolerance.

Finally in this case we come to the same conclusion that the loss of the return is little in the long run. We give the same explanation as before that the exchange rates reflect to fundamentals over the long run. (10 years period can be considered as long run period).

The third view is this one which refers to the Japanese investor following in figure 7. From the following figure that examines the Japanese investor in G7 bond indices we can conclude that for every bond index the return expressed in local terms is higher in every bond index of G7 countries versus the return that we calculate when we take the impact of the Japanese yen.

Figure 7

Bond returns of G7 countries in local terms, JPY, JPY hedged



Sample Period (01/01/1990-01/01/2000)

The higher return reduction is observed when a Japanese invests in German bond index something that was expected from the previous figure we presented and is explained of the depreciation of the German currency versus yen. The return reduction is 53.28% (from 0.6169

in local terms to 0.2882 in yen terms, average monthly) and the lower impact of yen is in case of UK bond that we have a 22.87% reduction in return.

In any case we can see that a Japanese investor because of the appreciation of yen has a very strong incentive to hedge if he wants to invest abroad, particularly in G7 bond indices.

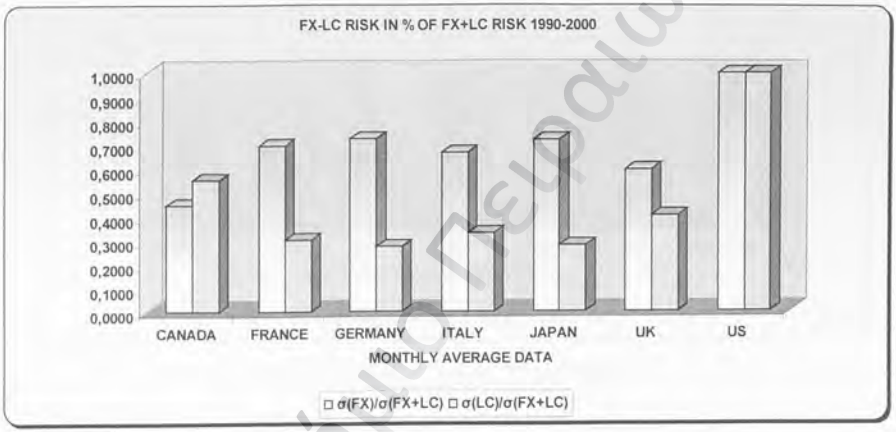
This can be seen from the higher hedged return that he obtains in every bond he invests and in some cases has "free lunch" because as we shall see with following figures in some cases faces lower risk with higher return. Finally in this case as with the previous we have mean reversion.

The impact of foreign exchange risk in a bond portfolio can be seen with the following figures.

From the following figure we can have a lot of information with the first look to support our argument that the foreign exchange risk plays a great role to an international investor. The risk from investing in foreign bonds comes from the bond prices, which reflect the interest rates changes and the exchange rates movements. With the figure below we compare the risk, which comes from the exchange rate movements of the US dollar to the other G7 currencies with the market risk expressed in local terms that reflect the interest rates risk, which faces every country. We compare the currency risk and the market risk with the sum of them because we do not want to examine the impact of correlation, something that is under examination in following rows.

Figure 8

Relative magnitude of foreign exchange risk (FX) and market risk (LC) in % of the sum of them (USD)

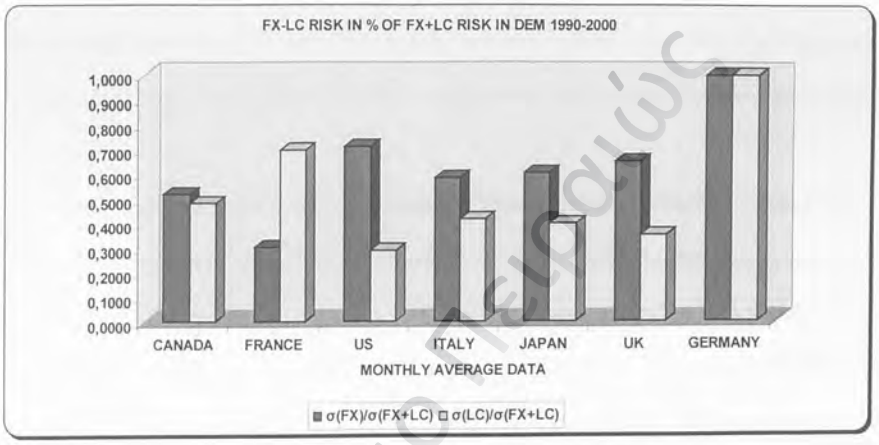


Sample Period (01/01/1990-01/01/2000)

As we said before the greater part of risk is the currency risk that ranges from 44.95% of the sum of the two risks together (market and currency risk) to 71.75% in Japan case. In all cases except Canada the percentage of foreign exchange risk to the market risk is higher and that give a very good reason of hedging. The case of Canada can be attributed to the high correlation between the Canadian and US dollar. Exactly the same view we have in cases of the European and the Japanese investor that are presented in the following figures.

Figure 9

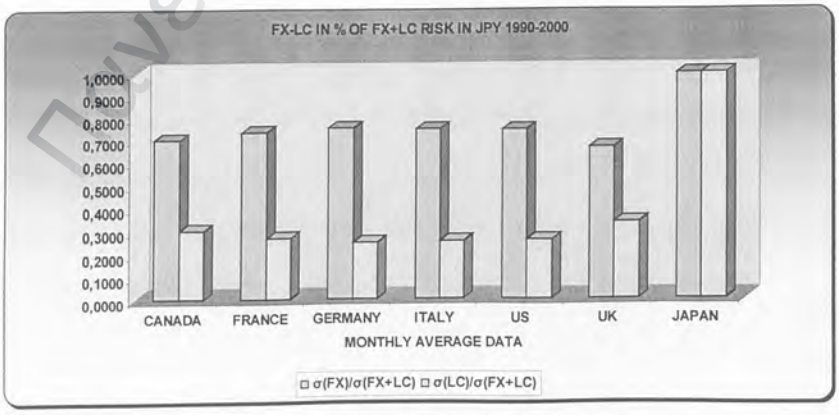
Relative magnitude of foreign exchange risk (FX) and market risk (LC) in % of the sum of them (DEM)



Sample Period (01/01/1990-01/01/2000)

Figure 10

Relative magnitude of foreign exchange risk (FX) and market risk (LC) in % of the sum of them (JPY)



Sample Period (01/01/1990-01/01/2000)

3.2 THE IMPACT OF CORRELATION

In a global investment environment we have two types of correlation that take into account for an internationally investment decision. The first type is the correlation between the security (bond index) and the exchange rate between our currency (USD, DEM, JPY) and the local currency of the bond index. (G7 countries) The second type of correlation is the intermarket correlation, the correlation between the securities of every G7 bond index. In our empirical evidence we took both of them in our account and we shall give some estimation of our finding.

The correlation coefficient has a direct impact in total risk of the portfolio. Currency risk and local market risk are not additive. The total risk for example, of the Italian bond index measured in US dollars, is equal to the local market variance (in Italian lira) plus the foreign exchange variance plus two times the correlation coefficient of the two multiplied by the standard deviation of each source of risk: the local market risk in Italian lire and the US dollar/Italian lira exchange rate risk. The equation to express the variance of Italian stock returns in US dollars is:

$$\sigma^2_{tot} = \sigma^2_{Local} + \sigma^2_{FX} + 2\rho(Local,FX)\,\sigma_{Local}\,\sigma_{FX}$$

Note that currency risk and local market risk are not additive. We can calculate the total risk by calculating the returns in local terms expressed in currency of study, but we want to mention that the correlation coefficient or covariance is in the exchange rate conversion.

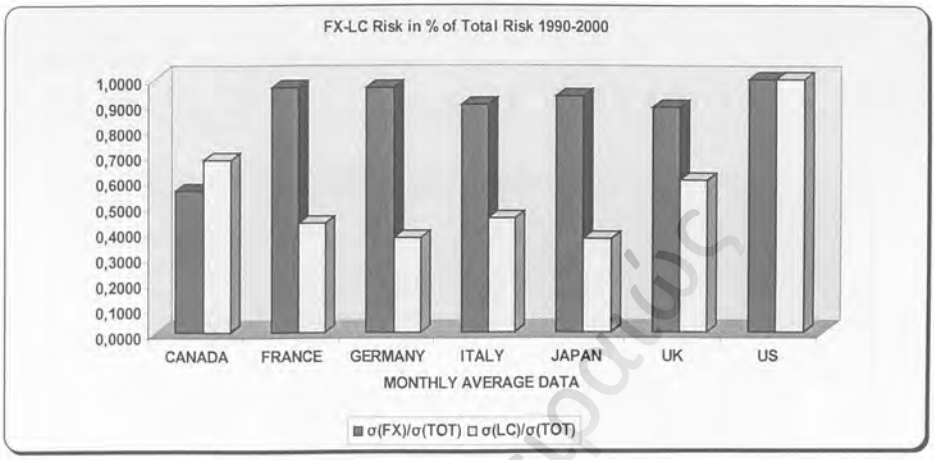
The above risks would be additive only if the correlation was equal to 1. Then the volatility in US dollars of Italian bond index would be equal $(\sigma_{Local} + \sigma_{FX})^2$ and hence $\sigma_{tot}=(\sigma_{Local} + \sigma_{FX})$.

If the correlation were equal to –1, no currency risk would exist.

The impact of correlation between the market risk and the currency risk is obvious in the following diagram:

Figure 11

Foreign exchange and market risk in % of total risk



Sample Period (01/01/1990-01/01/2000)

The percentage of foreign exchange risk and in particular the G7 currencies expressed in US dollars is for the case of Canada for example is 55.46% of the total risk and the local market risk is 67.92%. That shows that the two risks are not additive to 100% and the existence of correlation, which may have a negative sign.

In our US case the correlation between the securities (bond indices of G7 countries) and the exchange rates of G7 currencies relative to the dollar are presented in the following table.

Table 5

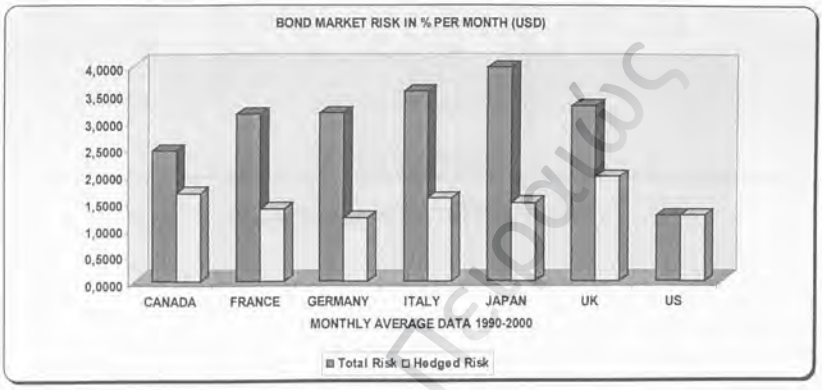
G7 cross-correlations between bond indices and currencies

	USD/CAD	USD/FRF	USD/DEM	USD/ITL	USD/JPY	USD/GBP
CANADA	**0,3071**					
FRANCE		**-0,1675**				
GERMANY			**-0,1154**			
ITALY				**-0,0310**		
JAPAN					**-0,0207**	
UK						**-0,1705**

Sample Period (01/01/1990-01/01/2000)

The only positive correlation that the Canadian index bond has, is with the USD/CAD exchange rate while in the other cases we have negative correlations with the exchange rates. This observation is a good explanation to the fact that the minimum risk reduction of hedging is in the case of the Canadian bond index.

Figure 12

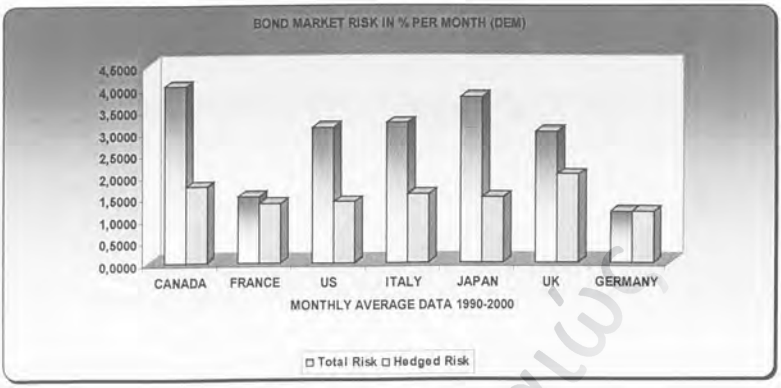


Sample Period (01/01/1990-01/01/2000)

From the above figure we notice that currency hedging leads to an impressive reduction of the initial investment's risk. This can be attributed to the fact that currency hedging eliminates the exchange risk. In some cases the risk reduction attained is accompanied with higher return from the unhedged case.

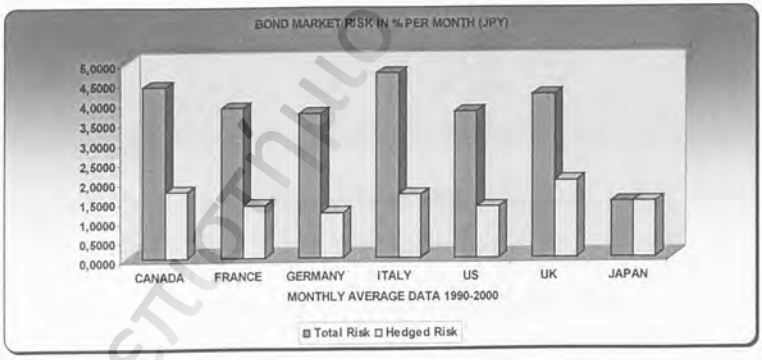
Similar view we have from the European and Japanese perspective in which we have negative correlations between currency and market. This can be seen in the following figures.

Figure 13



Sample Period (01/01/1990-01/01/2000)

Figure 14



Sample Period (01/01/1990-01/01/2000)

In addition to the correlation between currency and market, we have the intermarket correlation between securities of G7 countries. The correlations between securities of every G7 countries are expressed in the following tables. Table 6 refers to the correlations between securities of G7 countries in USD, table 7 in DEM and table 8 in JPY to cover the three perspectives of our overseas investors.

Table 6

Cross correlations between G7 bond indices in USD

CORREL (USD)	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
CANADA	1	0,0418	0,0789	0,1879	0,0780	0,3323	0,4581
FRANCE		1	0,9538	0,5782	0,3993	0,6234	0,4073
GERMANY			1	0,5433	0,4665	0,6254	0,4062
ITALY				1	0,0964	0,5679	0,2647
JAPAN					1	0,2846	0,1667
UK						1	0,4534
US							1

Sample Period (01/01/1990-01/01/2000)

Table 7

Cross correlations between G7 bond indices in DEM

CORREL (DEM)	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
CANADA	1	0,2549	0,2775	0,4264	0,3392	0,5663	0,8427
FRANCE		1	0,7758	0,3149	0,0867	0,3746	0,3740
GERMANY			1	0,1766	0,1850	0,3575	0,3352
ITALY				1	-0,0315	0,4759	0,3928
JAPAN					1	0,1840	0,3549
UK						1	0,5300
US							1

Sample Period (01/01/1990-01/01/2000)

Table 8

Cross correlations between G7 bond indices in JPY

CORREL (JPY)	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
CANADA	1	0,5587	0,5602	0,6348	0,1535	0,6928	0,8682
FRANCE		1	0,9690	0,7748	0,1919	0,7636	0,7158
GERMANY			1	0,7504	0,2409	0,7590	0,7003
ITALY				1	0,0395	0,7587	0,7000
JAPAN					1	0,1427	0,1366
UK						1	0,7345
US							1

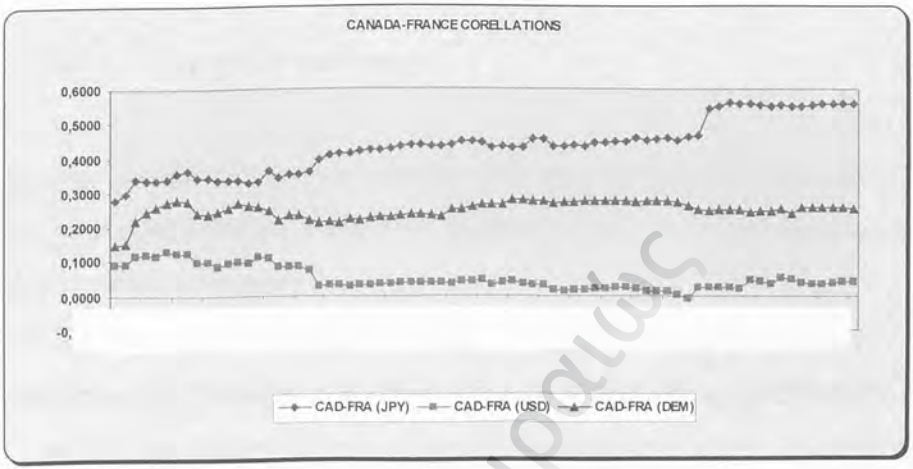
Sample Period (01/01/1990-01/01/2000)

The case for international investing has been built on the rather low correlations between national markets in local terms. If global correlations are low, spreading investing among countries allows diversification of the total risk of a portfolio and provides more opportunities to find markets that will have a large return. So from both a risk and return viewpoint, low global correlations are beneficial. Diversifying across national markets with low correlation of returns allows investors to reduce their total portfolio risk, presumably without sacrificing return. The primary motivation in holding a diversified portfolio is to reduce risk. The risk of a portfolio in terms of variability of returns will be less risky of its separate parts. Obviously the greater the number of countries, meaning the greater the number of bond indices, the less the portfolio is likely to lose of one country's misfortune.

The results of diversification depend on the return in each market and on the independence of the return across markets. If the correlations among the returns in each market are less than 1, risk offsets from diversification can provide a more consistent return in the portfolio as a whole, even if average returns remain the same. In general, the lower the intermarket correlation, the greater the potential risk and reward improvement from intermarket diversification. In the following figure, which presents Canada-France cross correlations, we have the impact of intermarket correlation in hedging of the perspective of our three investors.

Figure 13

Canada-France Rolling Cross-Correlations (in USD, DEM, JPY)



Sample Period (01/01/1990-01/01/2000)

The above figure presents the cross correlation of returns of Canadian bond index and the French bond index. The returns have been calculated for the period of ten years every first of the month starting of 1/1/1990 to 1/1/2000 in USD, DEM and JPY and allows us to have a clear view that which investor has the most beneficial result of diversification. From the above figure we see that the lower rolling cross correlations have the bond indices when are expressed in JPY. The conclusion is that the stronger incentive to hedge by diversification has the Japanese investor.

4. MAIN RESULTS

4.1 EQUALLY WEIGHTED PORTFOLIO

As foretold, the hedging decision is a very controversial matter. Our purpose is not to give a clear answer about the hedging strategy but to give some answers to the relevant questions existing in the previous literature.

With the statistical work made so far we have given some early answers to questions that we already faced in the literature and at this chapter we summarize them and try to answer some more presenting our equally weighted portfolio of bond indices of G7 countries for period 1/1/1990-1/1/2000 for the perspective of the US, European and Japanese investor.

The returns of the equally weighted portfolios for each period have been calculated under the following formula:

$$R_{EW} = (\Sigma_{i=1}^{6}\{(1+R_i)\cdot(h\cdot(1+e_{h,i})+(1-h)\cdot(1+e_i)\}+(1+R_{LB}))/7-1)$$

R_{EW} = the return of the equally weighted portfolio

R_i = the return of the i foreign bond

h= the hedge ratio

$e_{h,i}$= the hedged exchange rate return of the i foreign currency

e_i= the exchange rate return of the i foreign currency

R_{LB} = the return of the local bond

First we present our results of our equally weighted- portfolio expressed in US dollars.

Table 9

Equally Weighted Portfolio (US investor's perspective)

Average monthly data

USD HEDGE RATIOS		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	BOND US
mean	USD	0,0074	0,0074	0,0073	0,0072	0,0072	0,0071	0,0070	0,0069	0,0069	0,0068	0,0067	0,0060
stdev	USD	0,0207	0,0191	0,0176	0,0162	0,0149	0,0137	0,0126	0,0118	0,0112	0,0109	0,0109	0,0124
ratio		0,3604	0,3859	0,4145	0,4464	0,4812	0,5181	0,5548	0,5879	0,6122	0,6222	0,6147	0,4813
Total Value of 1 USD invested from 01/01/1990-01/01/2000	USD	2,3577	2,3460	2,3333	2,3198	2,3054	2,2902	2,2742	2,2573	2,2397	2,2214	2,2023	2,0220

Sample Period (01/01/1990-01/01/2000)

The above table presents the mean, standard deviation the ratio between the two of them in order to have a satisfied tool to evaluate our hedging strategy. In the last row we present the compounded return of our investment in the ten years of our data. We vary the hedge ratio from 0% to 100% in order to search for the optimal hedge ratio.

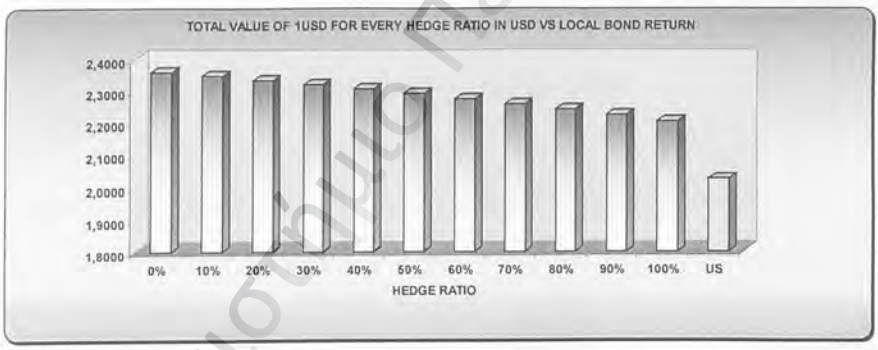
The first conclusion that can be extracted from the previous table is something that we faced before in our last chapter and is the very good risk reduction that is achieved through the currency hedging policy. From figure 13,14,15 of chapter 3 we mentioned the remarkable risk reduction for our hedged bond instead of unhedged, now we have another supportive argument from our equally weighted portfolio. So we are coming to agree with A. Perold and E. Schulman (1988) who claimed that currency hedging according to the period and the volatility of exchange rates is risk beneficial. The same view has Solnik (1998) about the beneficial risk reduction, of hedging.

To be more specific we observe for a 10.84% loss of return (from 0.0074 to 0.0068) in our fully hedged portfolio we have a 47.10% risk reduction something that give no doubt to us about the necessity of hedging in an international bond portfolio. The second point that can be observed is for the US investor is more profitable to invest outside the United States in a G7 equally weighted portfolio rather than investing in the domestic bond index. To be more accurate for the US investor, investing overseas for the study period is "free lunch" thus he

has risk reduction with an increase of return. At the point, which seems to have the optimal hedge ratio of 0.9 or 90% the US investor has from the equally weighted portfolio an increase of return of 13.90% compared with the domestic bond index and a decrease of risk of 11.90%. So we are confident that for a US investor an international bond portfolio is beneficial something that seems in the following figure:

Figure 15

Equally Weighted Portfolio (USD) vs US bond index



Sample Period (01/01/1990-01/01/2000)

As can be seen the US investor has an advantage in terms of compounded return to invest in a mix of bonds abroad rather than invest in the domestic one. This fact can be explained from the interest rate differential that US had in the study period with the other countries, which gave more returns in the other G7 countries. Another reason that supports this point of view is the fact that the US dollar during the study period faced depreciation with the most of currencies, which gave them the benefit to hold foreign securities. The last appears from the

fact that increasing the hedge ratio in benefit of risk reduction we had loss of return for the US investor who did not fully utilize the US dollar depreciation.

Similar view we have from the European perspective looking the following table:

Table 10

Equally Weighted Portfolio (European investor's perspective)

Average monthly data

DEM HEDGE RATIOS		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	BOND GER
mean	DEM	0,0081	0,0080	0,0079	0,0078	0,0077	0,0076	0,0075	0,0074	0,0073	0,0072	0,0071	0,0062
stdev	DEM	0,0194	0,0181	0,0170	0,0158	0,0148	0,0139	0,0130	0,0123	0,0118	0,0115	0,0114	0,0116
ratio		0,4193	0,4419	0,4664	0,4926	0,5200	0,5477	0,5743	0,5976	0,6149	0,6236	0,6214	0,5309
Total Value of 1 DEM	DEM	2,5633	2,5379	2,5121	2,4859	2,4592	2,4322	2,4048	2,3770	2,3490	2,3205	2,2918	2,0751

invested from 01/01/1990-01/01/2000

Sample Period (01/01/1990-01/01/2000)

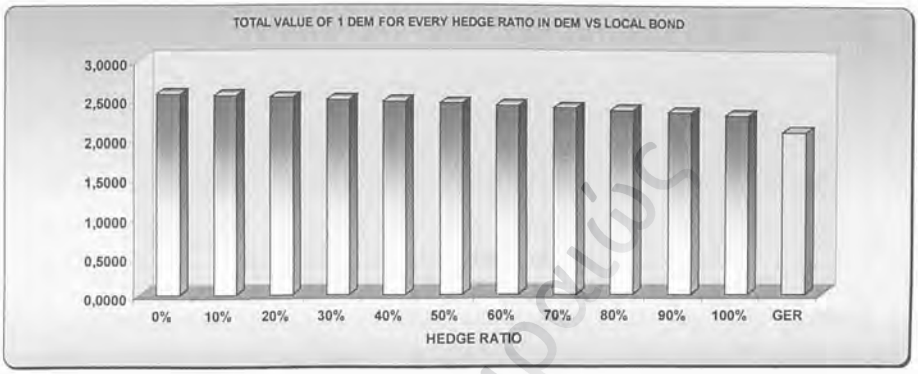
The first conclusion is that after an examination of hedge ratios between 0 and 1, the optimal case is the same with US investor 0.9 or 90%, something that made us to have some doubts about Black's optimal hedge ratio, which lies between 0.33-0.77. This observation makes us to believe for the possible existence of a universal hedge ratio but the percentage may depend on the estimated time period and the general macroeconomic conditions of this period.

The second observation is of course the risk reduction us we saw in the previous US case and the previous chapter, something that enforces our confidence about the necessity of hedging policy. To be more specific we have a risk reduction from the unhedged case to the fully hedged of 41.39% and a loss of return of only 13.14%.

To the question if the European investor has benefits of the international bond portfolio the answer is obvious with the following figure.

Figure 16

Equally Weighted Portfolio (DEM) vs German bond index



Sample Period (01/01/1990-01/01/2000

Calculating the compounded return from the above case we observe that even in the fully hedged case the equally weighted portfolio provides more return than the domestic German bond index. In terms of monthly average risk-return we have "free lunch" in the fully hedged case of 14.41% increase of return and 2.26% decrease of risk.

A third point that should be noticed is that for our long period of study (10 years) the loss of total return between the unhedged and fully hedged case is 10.51% for the whole period something that let us the right to conclude that exchange rates reverts to fundamentals in the long run (mean reversion). In addition we may agree with Perrold and Schulman that currency hedging is a better decision for long run investment period, because in long term perspective investors should think of currency hedging as having a zero-expected return.

However in the case of Japanese investor who uses the international equally weighted portfolio we do not have exactly the same point of view like the US and European perspective.

In the following table we can get a few comparative conclusions.

Table 11

Equally Weighted Portfolio (JPY)

Average monthly data

JPY HEDGE RATIOS		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	BOND JAP
mean	JPY	0,0052	0,0051	0,0051	0,0050	0,0050	0,0049	0,0048	0,0048	0,0047	0,0046	0,0046	0,0056
stdev	JPY	0,0272	0,0250	0,0228	0,0206	0,0186	0,0167	0,0149	0,0134	0,0122	0,0115	0,0112	0,0145
ratio		0,1916	0,2063	0,2233	0,2432	0,2664	0,2931	0,3231	0,3547	0,3839	0,4039	0,4074	0,3842
Total Value of 1 JPY	JPY	1,7768	1,7757	1,7732	1,7694	1,7643	1,7578	1,7502	1,7412	1,7310	1,7197	1,7071	1,9251

invested from 01/01/1990-01/01/2000

Sample Period (01/01/1990-01/01/2000)

The first conclusion that can be extracted of the Japanese perspective is that the hedge ratio is not 0.9 (90%) but almost 1 (97%). So we are a little far away from the universal hedge ratio of Fisher Black but the fact that the three hedge ratios are close to 1 generates some thoughts. The fact that the optimal hedge ratio is close to one bring us memory of Solnik (1993) who claims that currency hedge ratios are on average less than one to compensate the demand for risk free assets. In Japan case the optimal hedge ratio is too close to one (actually 0.97 with great precision) because the risk free rate is close to zero (0.25%).

In any of our three cases the hedge ratio is less than one and we are close to agreeing with Solnik that the global hedge ratio will be equal for all currencies only on the unrealistic case where all investors have the same risk tolerance something that does not exist in practice.

Another reason that the hedge ratio is not exactly one might be the Siegel's Paradox, which can be illustrated by the observation in our study that is if the Canadian dollar goes down by 17.60% the US dollar goes up versus the Canadian by 19.47%. Siegel's Paradox can be expressed as:

$\mu(S) + \mu(1/S) = \sigma^2(S) \neq 0.$

Siegel's Paradox is responsible for taking profits of carrying currency risk.

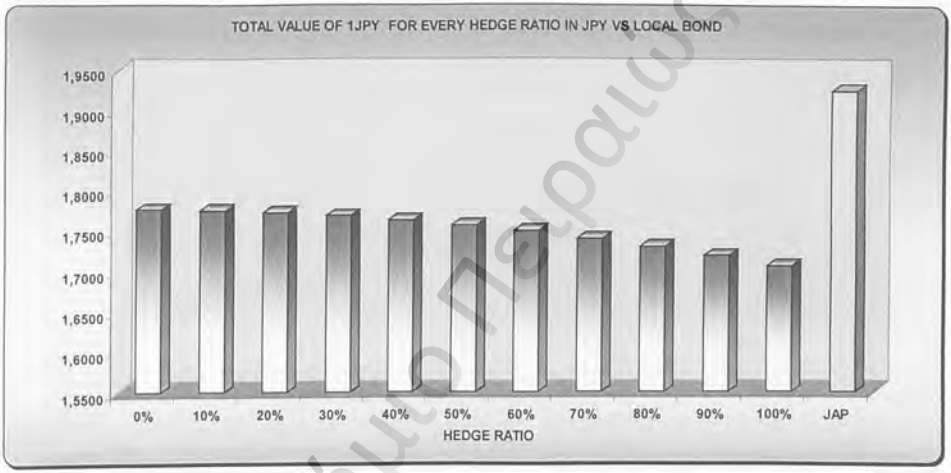
The second conclusion that we take from the Japanese case is of course that the hedging policy provides a very good risk reduction. Particularly the risk reduction of unhedged case to the fully hedged is 58.80% in addition to the loss of return, which is 12.40%. So the

conclusion is that hedging policy brings universally beneficial results in terms of risk return ratio.

However if we have a closer look to the following figure we should have a logical question.

Figure 17

Equally Weighted Portfolio (JPY) vs Japanese bond index



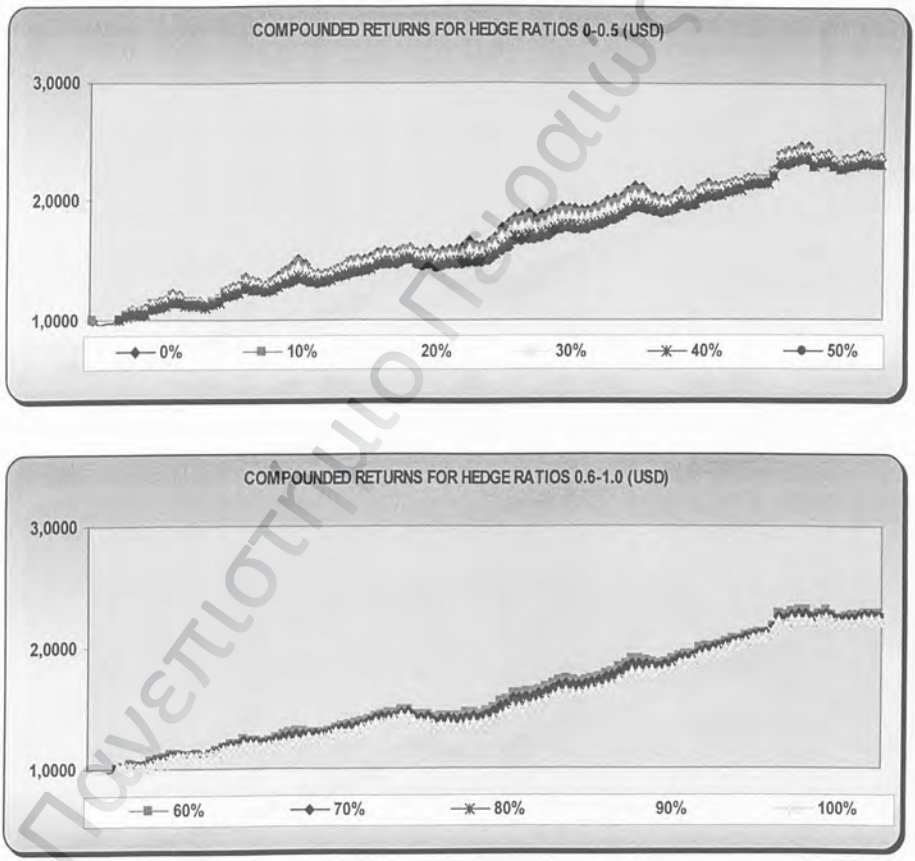
Sample Period (01/01/1990-01/01/2000)

As we can see, the return of the Japanese bond index is better enough to the return of the international equally weighted portfolio something that make us thing that the Japanese has no benefits of investing abroad rather than his own domestic bond index. This has an explanation. The international investing has to do with interest rates differential between the countries. In Japan in the recent decade, which is the study period, we faced a steep drop of the Japanese interest rates. This drop reflects to the bond prices and we have a significant increase in the Japanese bond index. In addition we had a Japanese yen appreciation. Relative to the US dollar for example in 1/1/1990 1 US dollar was equal to 143.75 Japanese yens while in 1/1/2000 the exchange rate was 1 US dollar 101.60 Japanese yens. These two factors create the fact of "home bias" in the case of Japan and unattractive the conditions for the Japanese

investor to invest abroad. The only advantage the Japanese investor faces to invest in our equally weighted portfolio is 22.78% risk reduction in comparison to the Japanese bond. Finally we present some figures of the compounded returns of our equally weighted portfolio to give some final general conclusions for the three countries.

Figure 18

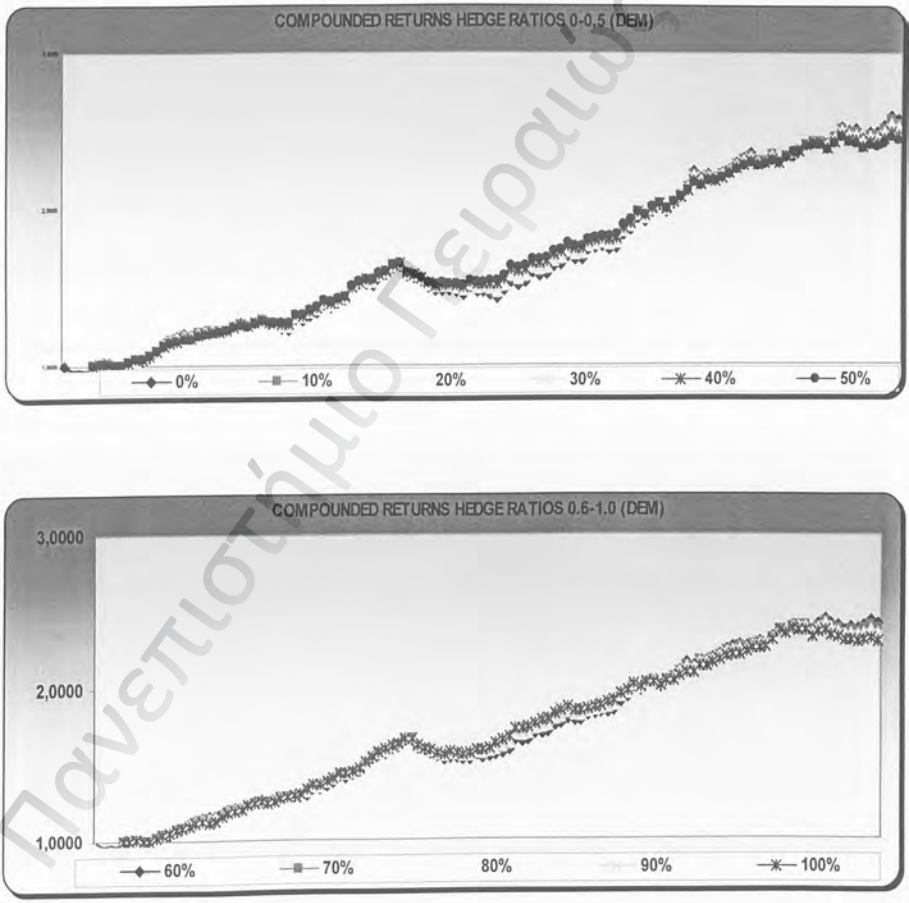
Equally Weighted Portfolio (USD) Compounded returns for hedge ratio 0-1



Sample Period (01/01/1990-01/01/2000)

Figure 19

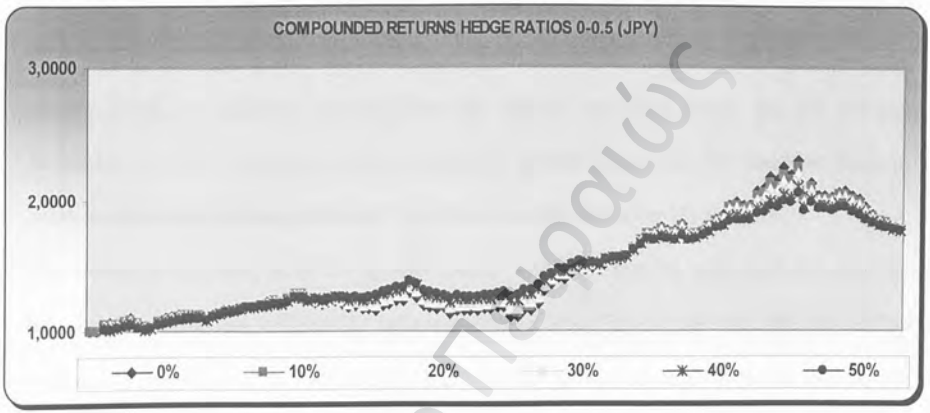
Equally Weighted Portfolio (DEM) Compounded returns for hedge ratio 0-1

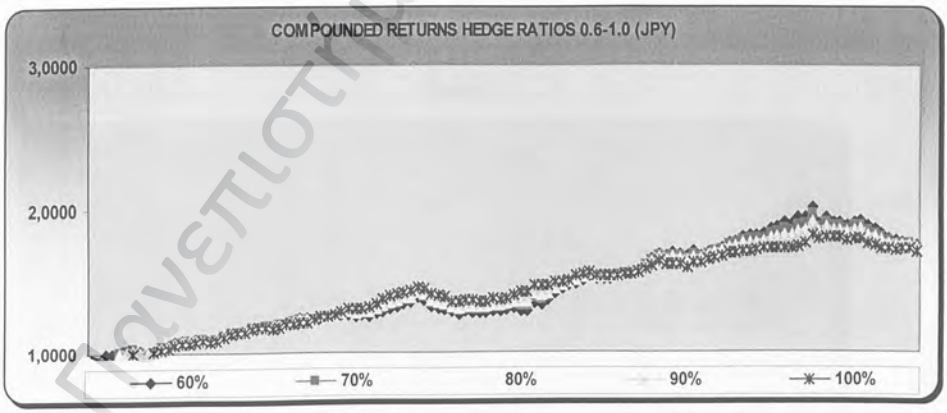


Sample Period (01/01/1990-01/01/2000)

Figure 20

Equally Weighted Portfolio (JPY) Compounded returns for hedge ratio 0-1





Sample Period (01/01/1990-01/01/2000)

From the above figures we can conclude that in all cases of our weighted average portfolio to invest in bond is rather beneficial as we take a compounded return 170.71% in the worst case

which is the Japanese one 220.23% in the US case and 229.18% in the European which is most optimistic.

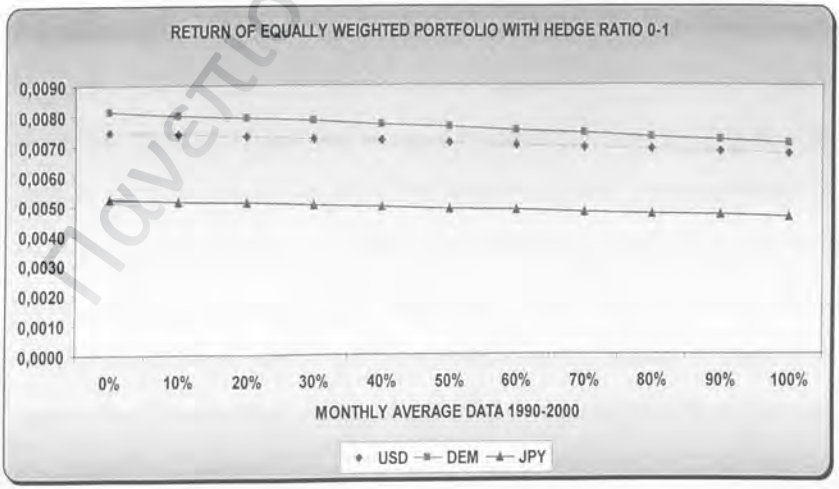
The return was rather stable in 1990-1995 without any concern of the hedge ratio. The dramatical increase of return came in 1995-1998 and that can be explained of the general world macroeconomic conditions which had a lot of growth and a interest rates cut policy.

When we increase the hedge ratio we face lower volatility of return something that is explained through the fact that the volatility of return is a product of exchange rate risk.

At this point, the Japanese investor faces the greater volatility, which has the greatest exchange rate risk. This can be seen too; from the greater hedge ratio the Japanese faces in order to reduce the exchange rate risk. The lower volatility faces the US investor.

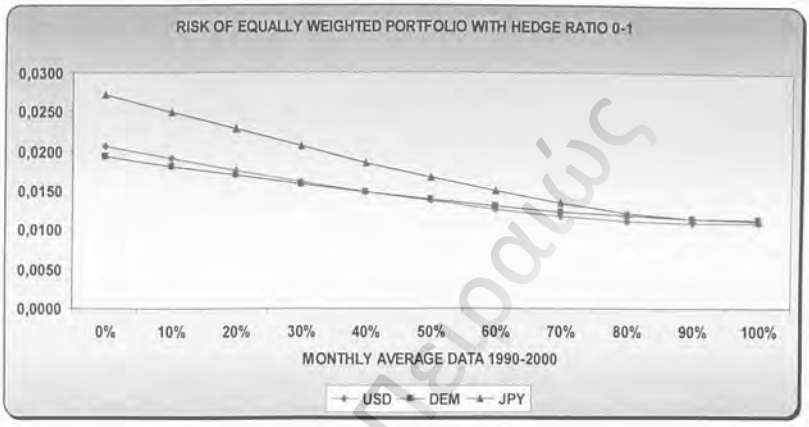
The European investor faces the greater return. This fact can be explained through the beneficial interest rate differential between Europe and US by the fact the US dollar appreciates simultaneous with the other currencies. The general conclusion for the three cases is the clear risk reduction and the little loss of return, which can be seen, in the following figures:

Figure 21



Sample Period (01/01/1990-01/01/2000)

Figure 22



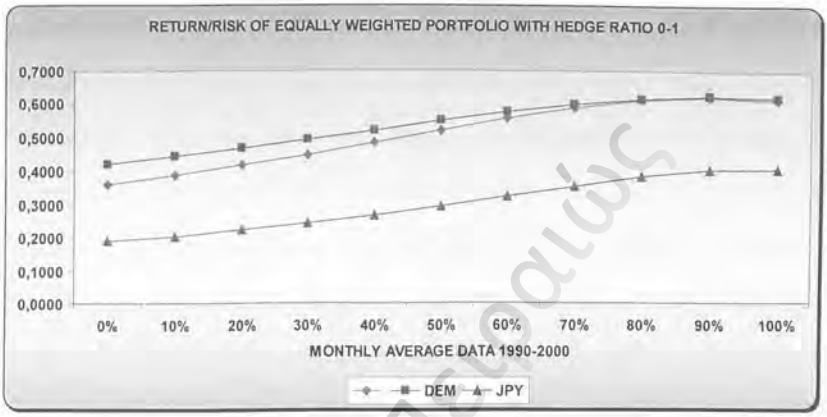
Sample Period (01/01/1990-01/01/2000)

For the hedge ratio of zero (0) we have for the US case risk of 2.07% and for hedge ratio one (1) 1.09%. It is an impressive risk reduction of 47.35%.

For the European case we have risk of 1.94% for zero hedge ratio and 1.14% for hedge ratio of one (1). The European investor faces a risk reduction of 41% lower than the US one. Finally the Japanese investor faces the greatest volatility. In zero hedging has 2.72% risk while in the fully hedged case has 1.12% standard deviation. As we expected from the previous charts and the figures of intermarket correlations we faced in the previous chapter the Japanese has the stronger incentive to hedge. In addition for the case of Japanese who face the greater volatility hedging is better for long term. The question in this case is if the Japanese would invest abroad because of home bias we described but the answer comes from any investor's risk tolerance.

The benefits of hedging in the equally weighted portfolio are clear in terms of risk/return tradeoff through the following figure. As the ratio increases gives better risk return trade off until the optimal hedged case.

Figure 23



Sample Period (01/01/1990-01/01/2000)

The optimal hedge ratio with great precision is 91% for the US investor, 94% for the European investor and 97% for the Japanese investor.

As we proved in our previous chapter there are covariances between securities and currency and between securities themselves. Something that we found in the literature is the question if the forward rate that we used to hedge is good predictor of the future spot rate?

The answer with the data we found is rather negative and here is the explanation. John Hull (1989) claims that the forward rate is a good predictor of the expected future spot exchange rate if the foreign exchange rate is uncorrelated with the interest rates. The bond prices are affected from the changes in interest rates. The conclusion is that the interest rates are correlated with the foreign currency exchange rate. That makes us to thing that the forward rate is not a good predictor of future spot exchange rate. Thus, we believe that the best hedging policy in that case is the active currency management. The only thing that we found is that in the long run the exchange rates revert to fundamentals. (Mean reversion).

4.2 OPTIMAL PORTFOLIO

In our effort to extract completed conclusions of our empirical work, we constructed an optimal portfolio. Our portfolio is based on yearly data starting from 1990. The optimization leans on 12 monthly returns for the construction of the readjustment period. Every period the weights of the portfolio are changing according to the returns of the G7 bond indices, which are the components of our investment. The goal is the maximization of return for a predetermined level of risk, which is the average standard deviation. The risk is represented by the average standard deviation of the bond indices. The optimization is based on local returns. The implementation of the hedge ratio follows the calculation of the optimal weights. As in the case of the equally weighted portfolio, we face the perspective of the three major overseas investors (US, European, Japanese). As before we present for every investor the evaluation of each portfolio by tables containing the return, the risk and their ratio, to bring out our conclusions. In addition we present the total value of one unit of currency after investing it in our portfolio for the ten years period of our study.

When we calculate the optimal weights with data for year t, to use them to construct bond portfolios for year t+1, we have in mind that the returns and the variance/covariance matrix for t will be a good estimate for those for year t+1. This hope, however, is undermined by the very high volatility of the exchange rate. Thus, making a virtue out of necessity, we calculate the optimal weights using the local currency returns.

The first table that we present in the current portfolio is the weights of our investment calculated as foretold.

Table 12

Weights of optimal portfolio calculated from local bond returns

	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	US
1990	1,04%	0,00%	0,00%	98,96%	0,00%	0,00%	0,00%
1991	19,47%	0,00%	0,00%	50,21%	0,41%	6,80%	23,11%
1992	0,00%	0,00%	0,07%	0,00%	80,55%	19,37%	0,00%
1993	0,00%	64,02%	0,00%	16,27%	0,00%	19,71%	0,00%
1994	0,00%	0,00%	78,24%	15,07%	6,69%	0,00%	0,00%
1995	48,86%	0,00%	0,00%	22,25%	19,02%	0,00%	9,87%
1996	0,00%	3,96%	0,00%	59,33%	36,71%	0,00%	0,00%
1997	0,00%	0,00%	3,08%	52,81%	44,03%	0,08%	0,00%
1998	0,00%	0,00%	0,00%	64,00%	0,00%	36,00%	0,00%
1999	14,65%	0,00%	0,00%	0,00%	38,45%	46,89%	0,00%

Sample Period (01/01/1990-01/01/2000)

We mention that the calculations of the weights of the optimal portfolio are based on Markowitz's model using MV Optimizer. Markowitz's optimization method rests upon the assumption that short selling is not permitted. Consequently all the weights that are calculated must be positive or zero.

The returns of the optimal portfolios for each period have been calculated under the following formula:

$$R_{OP} = (\Sigma_{i=1}^{6}\{w_i(1+R_i)\cdot(h\cdot(1+e_{h,i})+(1-h)\cdot(1+e_i)\}+w_{LB}(1+R_{LB}))/7-1)$$

R_{OP} = the return of the optimal portfolio

w_i = the markowitz weights for the bonds of the six foreign countries with i=1-6

R_i = the return of the i foreign bond

h= the hedge ratio

$e_{h,i}$= the hedged exchange rate return of the i foreign currency

e_i= the exchange rate return of the i foreign currency

w_{LB} = the markowitz weight for the local bond

R_{LB} = the return of the local bond

Analyzing each case separately, to be consistent with the former structure of the thesis we present the US case in the following table.

Table 13

Optimal Portfolio (USD)

USD HEDGE RATIOS		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	BOND US
mean	USD	0,0104	0,0102	0,0101	0,0099	0,0097	0,0096	0,0094	0,0093	0,0091	0,0089	0,0088	0,0060
stdev	USD	0,0236	0,0216	0,0197	0,0178	0,0161	0,0145	0,0130	0,0118	0,0109	0,0104	0,0104	0,0124
ratio		0,4402	0,4730	0,5109	0,5549	0,6054	0,6624	0,7239	0,7845	0,8337	0,8571	0,8439	0,4813
Total Value of 1 USD invested from 01/01/1990-01/01/2000	USD	3,3424	3,2967	3,2498	3,2017	3,1526	3,1023	3,0512	2,9991	2,9463	2,8927	2,8384	2,0220

Sample Period (01/01/1990-01/01/2000)

Lets us make a few comments on the comparative analysis between the results of the equally weighted and the optimal portfolio. As we can see from tables 9 and 13 the mean return on the optimal portfolio is higher than that of the equally weighted portfolio. This can be attributed to the optimized nature of the second portfolio. Similarly we notice that in all cases the risk of the equally weighted portfolio, as expressed by the standard deviation of its return, is lower than the risk of the optimized portfolio. A result that must be pointed out is the superior mean return /risk ratio, which the optimal portfolio succeeds.

The first conclusion is the same with the equally weighted portfolio. We face the remarkable risk reduction in the hedged case instead of the unhedged one. To be more specific the optimal hedge ratio lies once again between 90% and 100% as in the former case. For higher precision we mention that the hedge ratio in the US perspective is 94% instead of 91% in the equally weighted portfolio. This deference is explained by the fact that the weights of investing in US bond are zero for the most of the cases (table 10). As a result we have a

reduced possession of local (US) bond, which is translated to higher foreign exchange risk. This means that there is increased need for currency hedging.

Once again we are coming to agree with A.Perold and E Schulman (1988) who claimed that currency hedging according to the period and the volatility of exchange rate is risk beneficial. So writes Solnik in 1998.

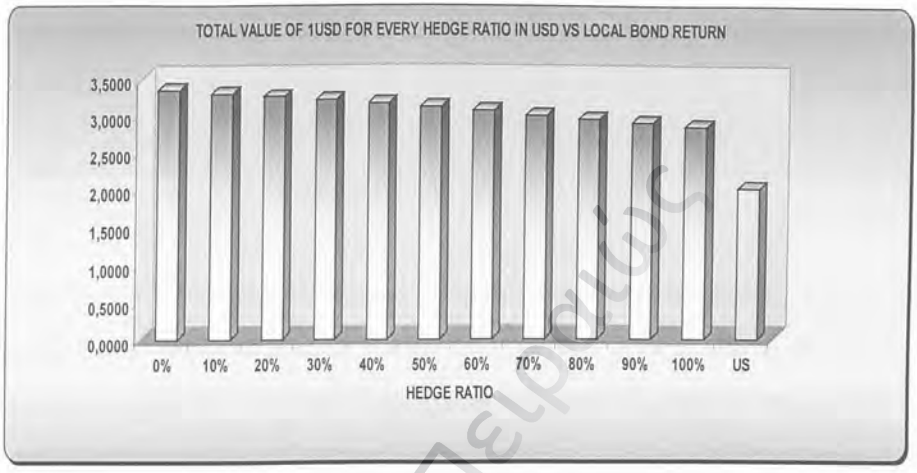
As with the equally weighted portfolio where we had a very good risk reduction of 47.10% with a loss of return of 10.84% between fully hedged and zero hedged case, we face similar results. We calculated a 15.35% decrease of return between 0% hedged and 100% and a decrease of risk of 55.35%. The most impressive result comes out from the comparison of the return/risk ratio of the equally weighted portfolio and the optimal. In the first case we have at the 90% hedged a ratio of 0.62 and in optimal we take a ratio of 0.84. Meaning a 35.5% improvement of our investment.

Once again we proved the necessity of hedging. The question is if it is worth for the US investor to invest internationally. The answer in the optimal portfolio is yes. Comparing the best case of 0.9-hedge ratio with the domestic bond index we calculate a 50.07% increase of return with a risk reduction of 15.73%. We are in front of the "free lunch" case with stronger percentages than with the equally weighted portfolio. By the term "free lunch" we mean that with higher return in the oversea portfolio than the domestic one we do not obtain higher risk that we should expected because of foreign exchange risk. Instead of that we take lower risk that brings up the magnificent impact of hedging.

The benefits of investing abroad for the US investors are presented in the following diagram:

Figure 24

Optimal portfolio (USD) vs US bond index



Sample period (01/01/1990-01/01/2000)

The total value of one (1$) dollar from the investment in the optimal portfolio give 3.34 dollars despite of 2.02 dollars that we take investing in the domestic US index. The beneficial impact is quite obvious having in mind that we have also a decrease in our average risk. The result of our dollar ten years investment in the equally weighted portfolio was 2.36. So, we a have a 65.35% benefit of our investment in the optimal portfolio rather than domestic one and 41.53% in comparison with the equally weighted.

To close the US case we conclude that we have another supportive evidence about the necessity of hedging as the obvious advantage of the US investor in the G7 bond indices. From the fundamental perspective the US investor can benefit from the interest rates differential between US and G7 countries and the depreciation of his currency versus the G7 countries.

Similar view we have examining the European perspective.

Table 14

Optimal Portfolio (DEM)

DEM HEDGE RATIOS		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	BOND GER
mean	DEM	0,0113	0,0111	0,0109	0,0107	0,0104	0,0102	0,0100	0,0098	0,0096	0,0093	0,0091	0,0062
stdev	DEM	0,0212	0,0196	0,0181	0,0166	0,0153	0,0140	0,0129	0,0119	0,0112	0,0108	0,0107	0,0116
ratio		0,5338	0,5658	0,6016	0,6414	0,6851	0,7314	0,7780	0,8204	0,8516	0,8640	0,8516	0,5309
Total Value of 1 DEM invested from 01/01/1990-01/01/2000	DEM	3,7676	3,6837	3,6002	3,5172	3,4347	3,3527	3,2714	3,1908	3,1108	3,0317	2,9533	2,0751

Sample period (01/01/1990-01/01/2000)

From the above table where are presented the mean return, the standard deviation and the ratio between the two of them, we evaluate our portfolio in DEM in order to have the European perspective. In the last row there is the total value of 1 DEM invested in our portfolio after ten years. In the last column we present the same data for the domestic German bond index.

From tables 10 and 14 we observe that the mean return on the optimal portfolio is higher than that of the equally weighted portfolio. As we have mention before this is due to the optimised nature of the second portfolio. Similarly we notice that in all cases the risk of the equally weighted portfolio, as expressed by the standard deviation of its return, is lower than the risk of the optimised portfolio. Once again one can notice the superior mean return /risk ratio, which the optimal portfolio succeeds.

Once again the beneficial risk reduction is a result of our data. In this case the hedge ratio declines from 0.94 in the equally weighted portfolio to 0.90. This can be explained from table 12. Looking at the weights, the German investor, which possesses Italian bond, faces lower exchange rate risk because of higher correlation between Italian bond and the European currency (ERM).

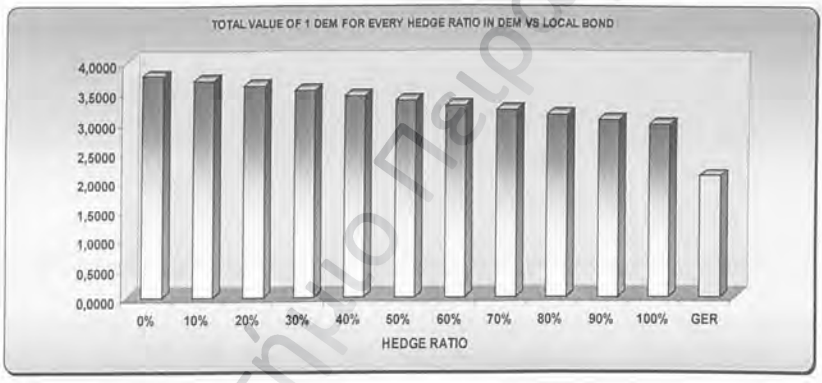
The necessity of hedging is obvious in table 10. The risk reduction between the hedged and zero hedged case is 49.55% while the loss of return is 19.52%. In comparison with the equally weighted portfolio that we had 41.39% risk reduction with a loss of return of 13.14% we see

that we sacrifice a little more return in order to succeed lower risk. But the conclusion in principal of hedging policy is exactly the same.

In order to examine if the optimal oversea portfolio is beneficial from the domestic one we present the following figure.

Figure 25

Optimal portfolio (DEM) vs German bond index



Sample period (01/01/1990-01/01/2000)

The risk, which is expressed by the average standard deviation, is less in the optimal portfolio at the optimal case of 90% hedging than the domestic German bond. In details the risk of the optimal portfolio is 0.0108 than the 0.0116 in the German bond.

As can be seen from figure 23 the value of 1 DEM when it is invested in the optimal portfolio becomes 3.76 in the unhedged case and 2.95 in the 90% hedged position versus 2.07 in the domestic bond. The benefit of the optimal portfolio is much better than the German bond. The decision between the hedged and unhedged position depends on the investor's risk tolerance. The ratio of return /risk of the two portfolios, is 0.86 for the optimal international portfolio and 0.53 for the German bond. In comparison with the equally weighted portfolio we have a ratio of 0.62 versus 0.86 in the optimal case. It is an expected outcome because for a

predetermined amount of risk, which was the average standard deviation, we tried to maximize our return.

Finally we face the Japanese point of view where here we have a different conclusion than the equally weighted portfolio. We present in the following table the Japanese data.

Table 15

Optimal Portfolio (JPY)

JPY HEDGE RATIOS		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	BOND JAP
mean	JPY	0,0088	0,0086	0,0084	0,0082	0,0079	0,0077	0,0075	0,0072	0,0070	0,0068	0,0066	0,0056
stdev	JPY	0,0307	0,0280	0,0254	0,0228	0,0203	0,0179	0,0156	0,0136	0,0120	0,0109	0,0105	0,0145
ratio		0,2879	0,3074	0,3305	0,3581	0,3913	0,4311	0,4783	0,5317	0,5851	0,6237	0,6263	0,3842
Total Value of 1 JPY	JPY	2,7177	2,6701	2,6206	2,5696	2,5170	2,4631	2,4079	2,3517	2,2945	2,2366	2,1780	1,9251

invested from 01/01/1990-01/01/2000

Sample Period (01/01/1990-01/01/2000)

With the optimal portfolio we don't have the "home bias" phenomenon that we faced at the equally weighted portfolio. In this case we see that investing abroad is rather beneficial for the Japanese investor in terms of return and risk.

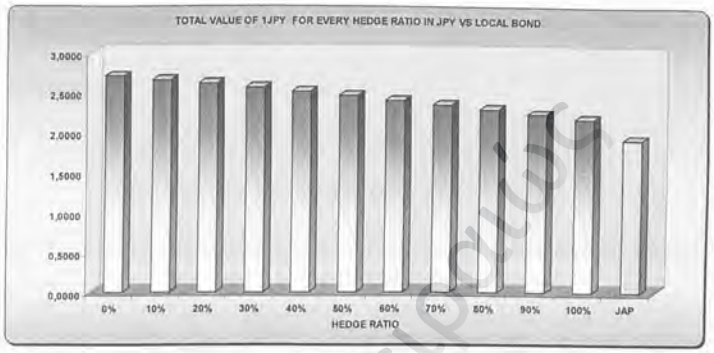
To be more precise the total value of 1 JPY investing in the optimal portfolio becomes 2.71 in the unhedged case and 2.17 in the fully hedged one versus the domestic compounded return of 1.90. Once again the conclusion that currency hedging provides remarkable results concerning the risk reduction is quite obvious in table 15. From the unhedged position to the fully hedged we have a 65.85% of risk reduction. The ratio from 0.38 in the domestic bond index becomes 0.62 in the fully hedged case of the optimal portfolio. The explanation for the Japanese investor to face more benefits of investing abroad lies in the optimization of the international portfolio.

The impact of hedging though is indisputably beneficial.

The benefits of the compounded return are seen in the following figure.

Figure 26

Optimal portfolio (JPY) vs Japanese bond index



Sample Period (01/01/1990-01/01/2000)

The comparison with the equally weighted portfolio shows that in the equally weighted case the compounded return was 1.70 in the risk less case of 100% hedged in the optimal portfolio is 2.17 .We face an increase of return of 27.6% which makes the Japanese investor to think of investing overseas.

Finally we would like to mention that in the optimal portfolio case the hedge ratio becomes 0.955 instead of 0.97 in the equally weighted portfolio. The explanation that can be given is that in the optimal portfolio case the possession of the Japanese bond is greater than the equally weighted portfolio. That indicates lower exchange rate risk.

The final conclusions concerning the three cases are about the same as in the equally weighted portfolio.

Analytically, when we increase the hedge ratio we face lower volatility of return something that is explained through the fact that the volatility of return is a product of exchange rate risk. At this point, the Japanese investor faces the greater volatility, which has the greatest exchange rate risk. This can be seen too; from the greater hedge ratio the Japanese faces in order to reduce the exchange rate risk. The lower volatility faces the US investor.

The European investor faces the greater return. This fact can be explained through the beneficial interest rate differential between Europe and US by the fact the US dollar appreciates simultaneous with the other currencies. The general conclusion for the three cases is the clear risk reduction, which shows the magnificent impact of hedging policy. The difference in return/risk between the two portfolios is presented in the following table for the best case of hedging.

Table 16

Optimal Portfolio vs Equally Weighted Portfolio at the best case of hedging

	EQUALLY WEIGHTED			OPTIMAL		
	RETURN	RISK	RATIO	RETURN	RISK	RATIO
US	0,0068	0,0109	0,6222	0,0089	0,0104	0,8571
EUROPEAN	0,0072	0,0115	0,6236	0,0093	0,0108	0,8640
JAPANESE	0,0046	0,0112	0,4074	0,0066	0,0105	0,6263

Sample Period (01/01/1990-01/01/2000)

The superiority of optimal portfolio is sustained to the maximization of return for a predetermined level of risk and the rational choice of optima's portfolio weights.

5. CONCLUSIONS

The hedging decision is indeed a very controversial matter. With the empirical work we tried to approach some points of the existing literature and give some answers. One major question is whether an investor should invest internationally or not. For a long time there was a fear that some countries might unexpectedly impose exchange controls or other government tax prohibits, freezing invested capital. The last decade the global trend has been changed. There is an effort of investment globalization and supply of rules for the international capital to become perfectly mobile around the countries. Now, which country the investor will choose, is a decision according to its risk tolerance.

From the empirical work we attained we concluded that in all cases we faced, international investing is rather beneficial for the oversea investor in terms of risk and especially of return. This is rather a global benefit because we took the same results for the American the European and the Japanese investor. This has to do not only the interest rates differential but also with the exchange rate differences and the benefit of diversification.

We mentioned that diversification provides a very good risk reduction. With the optimal portfolio we proved that implementing only diversification is not enough. The foreign exchange risk is great enough to indicate the necessity of hedging. So to proceed in a currency hedging policy is rather obligatory. With currency hedging one can succeed in obtaining a very good risk reduction in combing with optimization can attain much higher return investing in an international bond portfolio rather than investing in a domestic bond index.

We saw that as in the equally weighted portfolio as in the optimal portfolio the preferable hedge ratio was not 0.33 –0.77 that Fisher Black indicates. In all three cases of both portfolios the hedge ratio ranges between 0.9 and 1. This can be explained as an effort for global movement of capital from every country of the world to participate to this effort. As a result

we have a universal hedge ratio, which ranges to specific values according to the examination period.

The certain are that the optimal hedge ratio is less than one. The explanation might sustain at Siegel's Paradox, which is responsible for taking profits of carrying currency risk. Another explanation was given by Solnik (1993) who claims that a global hedge ratio less than one is explained by the dual role played by national bills as a risk-free asset and a foreign currency hedging device (short position) for all other investors. So the hedge ratio is on the average less than one to compensate the demand for risk free assets.

Except of the existence of a universal hedge ratio we found that hedging is "free lunch" for all cases we faced with the exception of Japanese case in the equally weighted portfolio. With the term "free lunch" we mean that we obtain more return investing in an international portfolio with contemporaneous risk reduction.

Addressing the question whether currency management is necessary the answer of the empirical work is positive. We saw the existence of covariances between securities and currencies and between securities themselves. As we explained before we conclude that the forward rate is not a good predictor of the expected future spot exchange rate. This makes us to believe that the best hedging policy is the active currency management, which permits the investor to avail itself of this inability of prediction.

Another argument that is supportive to the necessity of active currency management is the following. In chapter 3 we observed that the difference between currency hedged and unhedged return for a particular bond index is rather small. This might be explained by the fact that exchange rates revert to fundamental in the long run (mean reversion). So active currency management for a long run in combining with portfolio's optimization can get the excess return from the international investment. So we are coming to agree with Perrold and Schulman that currency hedging is a better decision for long run investment period, because in long term perspective investors should think of currency hedging as having a zero-expected return.

Furthermore we found the existence of correlations between securities themselves and between securities and currencies. The lower the intermarket correlations the greater the potential risk and reward improvement from intermarket diversification. In addition in table 5 is obvious the low correlation between bonds and currencies. These low intermarkets correlations (tables 6,7,8) and low correlations between securities and currencies (table 5) can give the excess return implementing the proper active currency management and the equity optimization.

Finally we mention that every investor should choose what hedging decision wants to follow according to its risk tolerance. But as can be seen from the two portfolios if he chose the **unhedged** case he will take more risk than the correspondence reward.

Appendix

$(1+e)$: foreign market return in local currency
$(1+x)$: the change in the exchange rate (expressed in local currency)
$(1+f)$: the forward rate measured by the interest rate parity
$(1+\sigma_{es})$: the covariance between the securities return and exchange rate returns.

(μ_m): the average across countries of the expected returns on the world market portfolio
(σ_m): the average across countries of the volatility of the world market portfolio
(σ_e): the average across all pairs of countries of exchange rate volatility

$(1-\lambda)$: fraction of exchange rate hedged
σ_i^2: variance of excess return on lending currency j for investor (i)
w_{im} : fraction of investor (i)'s wealth in the market
σ_{im}^2: variance of excess return on the market for investor (i)
w_{ij} : short position by investor (i) in currency j as a fraction of gross short position in all currencies.
σ_{ijm}: covariance between excess returns on lending currency j and on the market for investor (i)
w_{ij} : short position by investor (i) in currency j as a fraction of wealth
σ_{ijk}: covariance between excess returns on lending currency j and k for investor (i)
λ: hedge ratio

j: investor
W: wealth
λ_j: risk tolerance for country j
M_i: stock market capitalization for country (i)
x_i: weight of stock in a log portfolio
λ : the average risk tolerance of all investors
y_i: weight of currency (i) bill in the log portfolio
h_i: hedge ratio
μ (S): the expected percentage movement in the exchange rate
σ^2 (S): variance of the expected percentage movement

f: % filter rule
MA_L: moving average long period
MA_S: moving average short period
P: position value
N_L: number of technical trading rules which gives buy signals
N_S number of technical trading rules which gives shell signals
$P_{T,I}$: number of futures for hedging
R_T: the tactically hedged portfolio
R_u : the return on unhedged bonds
R_H: the return on currency-hedged bonds
R_{CO}: the return on currency overlay strategy
R_A: the return on active composite trading rule

μ_p :portfolio mean
σ_p^2 : portfolio variance
p :the total portfolio

x:the underlying assets (stocks or bonds)
f: the currency forward contracts

w_x: the asset weights

R_{EW}= the return of the equally weighted portfolio

R_{OP}= the return of the optimal portfolio

w_i = the markowitz weights for the bonds of the six foreign countries with i=1-6

R_i= the return of the i foreign bond

h= the hedge ratio

$e_{h,i}$= the hedged exchange rate return of the i foreign currency

e_i= the exchange rate return of the i foreign currency

w_{LB} = the markowitz weight for the local bond

R_{LB}= the return of the local bond

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