Risk management in internationally diversified portfolio’s.

Masterproef voorgedragen tot het bekomen van de graad van
Master in de Toegepaste Economische Wetenschappen

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Abstract.

We simulated a portfolio, which is diversified over two advanced markets and two emerging markets. This portfolio is equally weighted over the four countries, namely USA, UK, Mexico and South-Africa. The aim of the simulation is to look at the effect of using yearly rolled over forward contracts to hedge the investor’s foreign currency exposure. This simulation is done from the perspective of a eurozone investor. We spread the sample over a period of ten years: from 1999, the introduction of the euro into the financial markets, to the end of 2008. We also measured the ex post regret, which is one of the main determinants in the choice of a hedge ratio’s level, that the investor would have encountered during this holding period.
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1) Introduction

An international investor is exposed to different risks. He/she is exposed to: country based risk, industrial/sector based risk, world based risk and currency based risk. All these risks have an influence on the performance of a security, the one more than the other. Before elaborating on these topics, we will first explain the reasons for international diversification from the perspective of risk management.

A. Why diversify a wealth over several countries?

From the Capital Asset Pricing Model (CAPM) one can justify a diversification of an investment over different assets only if these assets are not positively correlated. By diversifying over non-positively correlated assets, one can eliminate the non-systematic risk. The residual risk, i.e. the systematic risk, will be remunerated by the market, under the form of premium.

The same philosophy mentioned in the previous paragraph is applied to the global investments. In this context the authors speak of an International Capital Asset Pricing Model (ICAPM) instead of CAPM. The major difference between these two models is the involvement of currency risk. By diversifying a portfolio over different non-correlated markets (countries) one will reduce significantly the volatility of his/her portfolio and realise a superior return compared to domestic wealth allocation only. One can argue that an investor can reduce risk too by allocating a part of his/her wealth into risk free assets, but by doing so one will at the same time reduce the expected return of his/her portfolio as well. We know from CAPM that the return of a well diversified portfolio is equal to the risk free return plus a risk premium. So by adding foreign non-correlated assets in the portfolio one can reduce the volatility and increase the expected return.

B. How low are world markets correlated these days?

Bruno Solnik and François Longin (1995) studied the market evolution of seven major countries between 1960 and 1990 and they found that the correlations between these markets were unstable. They also found that there is a high correlation between markets during high market volatility. Goetzman et al (2004) did the same research over a period of 150 years and they concluded that roughly half the benefits of diversification available to the international investor are due to the increase in number of world markets, which are available to the investor too. The other half is due to lower average correlation among the available world markets. The instability of the correlation among world markets is a source of criticism for many authors about the added value of
international diversification based on country risks. These authors suggest, instead of international diversification, i.e. choosing the country where to allocate the wealth first and afterwards choosing securities within that country, investors should adopt global industry diversification. Like it is stated in the book of Bruno Solnik and Dennis McLeavey, *Global Investments*, the arguments used against international diversification are: “that many capital markets are being deregulated and open to foreign investors, markets that used to be segmented are moving toward global integration, increase in capital mobility, more members to the World Trade Organisation, the expansion of organisations like the European Union.” This newly created economical environment makes companies become increasingly global oriented in their operations.

This new phenomenon of companies being globally oriented makes the legal nationality of a company less important. As a firm competes globally and derives a significant part of its cash flow from abroad, its value is affected by global factors, not primarily by the location of its headquarter. This phenomenon makes country factors less important in the allocation of wealth.

**C. Country risk**

The facts described above make the legal nationality of securities, traded in the different stock exchanges, not completely obsolete. Securities are still vulnerable to country related risks. Gunter Duffey et al. (2001) argued that one can categorize country based risks in three levels: operational level (constraints on management and corporate activity), transfer level (restriction on capital flow) and ownership-control level (government policies with regard to ownership/managerial control). In recent history we have witnessed the strong existence of these risks by the action taken by the Russian government to close the Russian stock exchange market during trading days, with as result security holders being deprived of their rights to sell or buy securities. This clearly demonstrated the existence of these risks.

The political risk includes local government policies that lower the actual (after tax) return on the foreign investment or make the repatriation of dividend, interest and principal more difficult. Country based risk also includes default risk due to government actions and the general uncertainty regarding political and economic developments in the foreign country. In this context we can again use Russia as an example. In the second half of the nineties the Russian government defaulted on their bonds with as a consequence that the US-government which was obliged to bail-out the hedge fund giant Long Term Capital Management (LTCM), which was run by Myron Scholes and Robert Merton, the founders of the modern option pricing model, known as “*Black and Scholes*”.
Today, country risk is in the spotlight more than ever. The financial crisis we are going through at this moment is showing us were the country based risks are located in the developed countries. We are seeing the ratings of countries like Ireland, Greece, East-European countries and so on being downgraded, with as an immediate effect the increase of the spread in their loans.

D. World based risks

The integration of the different world markets, *globalized world markets*, has a double effect on the international portfolio investment. The first effect is the creation of diversification opportunities around the world. The rise of countries like China, India, Brazil South-Africa and many others, offers a new geographical investment opportunity. As I mentioned before, for an investor it is very important to diversify his/her investment. In a non-globalized world the investors diversification opportunities are limited to domestic assets. The absence of international investment possibilities will lead to 100% exposure to country risk, which is not the case in a globalized world, because then he/she can diversify that risk. But in order to be able to minimize this risk the different world markets should not be correlated.

The non-correlation of the world markets is *condicio sine qua non* in order to realize this risk minimalization. This condition brings us to the second effect of the globalization of the world markets. Like I mentioned before, there is statistical evidence that shows a strong increase of world markets correlation. Many studies have been conducted up to this present day, all have the same conclusion, namely that the long-term global market correlation structure between various periods in world economics history is not constant: times of high volatility go together with high world market interdependency. The period that we are going through at this moment is a perfect illustration of this increased world market correlation. In the nineties we experienced the South-East Asian crisis that contaminated the Latin-American market, which caused the default of Argentina. Today, in 2009, we are experiencing the amplification of this world market interdependency. In the summer of 2007 a subprime crisis started in the United States of America, and today we are in the first quarter of 2009 and almost the entire world is in recession. In the management paradigm they call this phenomenon the “*butterfly effect*”, the butterfly opens his wings on the other side of the world and causes a storm here. Being aware of the existence of this market interdependency, some investors are shifting from country based wealth allocation focus to sector/industrial based wealth allocation focus.
**E. Industrial/sector based risk**

An investor who chooses to allocate his/her wealth in one or a few sectors, will be most of the time exposed to high volatilities. People who had only invested in the financial sector would have encountered a volatility in their returns today that mankind has never seen before. In the automobile sector we are noticing a significant volatility too. These volatilities indicate that an investor can hold a portfolio of non-correlated industries, but still encounter difficulties in both industries at the same time. Even though there is a kind of interdependence between the two sectors that I gave here as an example, we are still noticing significant volatility in other sectors, like in the commodities.

**F. Currency risk**

The volatility of a foreign currency plays a major role in the return of an internationally diversified portfolio, therefore a portfolio manager should pay close attention to the currency movement of the globally allocated wealth. This topic is the main focus of this paper, namely the impact of the foreign currency on an internationally diversified portfolio.

Bruno Solnik and Sébastien Michenaud argued in their paper “Applying regret theory to investment choices: currency hedging decision” that after an investor has chosen the geographical allocation of his/her wealth then the choice whether or not to hedge the currency exposure will be partly determined by regret. If one fully hedges his/her foreign currency exposure and the foreign currency appreciates against the domestic currency then one will lose the positive differences, on the other hand if one decide to be fully exposed and the foreign currency depreciates against the domestic currency, one will encounter a huge loss on his/her investment.

Empirical studies have shown that an American investor who had invested in the eurozone from late 1998 to late 2000 and had decided not to hedge his/her exposure would have incurred a currency loss of 40%. Conversely, a fully hedged investor would have missed the 50% appreciation of the euro from late 2001 to late 2004. These empirical findings give an approximation of the extent of the regret that can be incurred in choosing an internationally diversified portfolio’s currency policy. Before continuing further we will first explain what one should understand under “regret”.

Bruno Solnik (2008) gave the following definition of regret: “Regret is a cognitively mediated emotion of pain and anger when agents observe that they took a bad decision in the past and could

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have taken one with better outcome. In financial markets, agents will experience regret when their investment yields, ex post, a lower performance than an obvious alternative investment they could have chosen. Contrary to disappointment, which is experienced when a negative outcome happens relative to prior expectations, regret is strongly associated with a feeling of responsibility for the choice that has been made.” From this definition one can derive its importance in making the decision whether or not to hedge a currency exposure. Solnik and Michenaud have tried to explain the choice of the level of the hedge ratio \((h^*)\) through this theory, with \(h^* \in [0,1]\).

If the hedge ratio is equal to nil then the internationally allocated wealth is completely exposed to the foreign currency volatility, on the other hand a hedge ratio equal to one means that the internationally allocated wealth is completely covered against foreign currency fluctuation.

### G. The hedge ratio explained

The objective of any rational investor is to minimize the impact of the foreign currency’s volatility on his/her internationally diversified portfolio as much as possible. In order to achieve that goal the investor should choose the right hedging ratio. There are two main factors that influence the level of the hedge ratio: the risk aversion of the investor and his regret aversion. (see Michenaud and Solnik 2008). A global survey of institutional investors, conducted by Mellon/Russel in 2004, brought to light that on worldwide average 39% of the investors were adopting the no-hedging policy, 34% of the investors were adopting the 50% naive hedging policy and only 14% of the investors were adopting a 100% hedging policy and the other 13% were adopting other hedging policies. The countries which were in favour of the 50% hedge ratio are the non-European advanced markets, like US and Japan. According to Solnik and Michenaud (2008), this phenomenon of adopting a 50% hedging policy can be regarded as an investor with a large regret aversion.

If the return of the internationally diversified portfolio is not correlated with the return of the foreign currency, both measured in the domestic currency of the investor, then the exposure on the foreign currency should be fully hedged. In this situation the appointment of a currency overlay manager is appropriate, this is an expert in foreign exchange markets. Conversely, when there is a significant correlation between the return of the asset and the foreign currency movement then the separate optimization of the portfolio and the foreign currency exposure can lead to suboptimal results, Jorion (1994). In his mean-variance analysis of currency overlay, he found that the choice of a currency overlay manager is a suboptimal one. Therefore the investor should look for a mean-variance hedge ratio.
2) Portfolio construction methodology

The portfolio of which we are measuring its ex post performance is constructed from the perspective of an investor from the eurozone. This means that the euro is his/her numeraire currency. Using Larsen and Resnick (2000) portfolio building approach, then the euro rate of return will be, $R_{i€, t+1}$. For investing in the $i^{th}$ foreign stock market over the holding period from time $t$ to $t+1$, $R_{i€, t+1}$ is given by:

$$R_{i€, t+1} = R_{i,t+1} \ell_{i,t+1} + R_{i,t} \ell_{i,t+1}$$  \hspace{1cm} (1)

Where $R_{i,t+1}$ is the local currency rate of return on the $i^{th}$ stock market, $\ell_{i,t+1} = (S_{i,t+1} - S_{i,t})/S_{i,t}$ is the rate of appreciation of the local currency against the euro, and $S_{i}$ is the spot exchange rate expressed in euro terms for the currency that is associated with the $i^{th}$ national stock market index fund investment.

Further currency exposure that an investors from the eurozone faces, can be hedged by a position in forward foreign exchange contracts.

$$f_{i,t+1} = (S_{i,t+1} - F_{i,t})/S_{i,t}$$  \hspace{1cm} (2)

is the normalized return on a long position in a forward contract written on currency $i$ with price $F_{i,t}$ (in euro term) at time $t$ that spans the holding period from $t$ to $t+1$.

Glen and Jorion (1997) developed the following formula for the return of a portfolio hedged against currency exposure:

$$R_{i€, t+1} = R_{i€, t+1} - h f_{i,t+1}$$  \hspace{1cm} (3)
Where \( h_i \) is the hedge ratio on the \( i^{th} \) currency.

The minimum hedge ratio can be calculated in two different ways, depending on the underlying assets. In this case, the underlying assets are the foreign currencies. If the forward currency used to hedge the currency volatility of an asset has the same denominator as the currency that is being hedged, then the hedge ratio will be calculated just by regressing the return of the assets against the return of the currency, using Ordinary Least Squares (OLS). Conversely, when the used currency forward does not have the same denominator as the currency that is being hedged, then the minimum-variance hedge ratio can be found by regressing the return of the asset, denominated in the liquid currency, against the return of the currency forwards denominated in the local currency of the asset that is being hedged. Putting this in a formula it becomes:

\[
X = \alpha + \beta Y + \epsilon
\]  

(4)

With \( X \) the asset that is being hedged, \( \alpha \) the intercept, \( \beta \) the regression coefficient, \( Y \) the currency/forwards and \( \epsilon \) a noisy term.

In the first case \( h^* = \beta \), in the second case \( h^* = (\sigma_X/\sigma_f) \rho_{XF} \) with \( \sigma_X \) the volatility of the lognormal asset return \( X \), \( \sigma_f \) the volatility of the lognormal forward returns and \( \rho_{XF} \) the correlation coefficient between the lognormal returns of the foreign asset and the forward contracts.

Finally the forward exchange premium is calculated as follows:

\[
f_{i,t+1}^2 = (F_{i,t} - S_{i,t})/S_{i,t}
\]  

(5)

Having used these formulas to calculate the ex post return of the simulated portfolio, we will next discuss the empirical findings.

3) Empirical findings

Like we stated before in this paper, we studied the ex post effect of an investment policy from the perspective of an investor from the eurozone. The question here is: what would the effect be, end 2008, if an investor from the eurozone would have decided to diversify his/her investment, by allocating it over advanced markets and emerging markets, namely the United-State of America (US),
the United-Kingdom (UK), South-Africa (SA) and Mexico (MX), in the beginning of 1999, the year of the introduction of the euro in the financial market. The assumption we make here is that the investor chose a 12-month buy-and-hold investment horizon period and he used 12-month forward contracts to hedge the currency exposure. In other words, the investor made a yearly forwards-roll over.

**A. Data**

We constituted the portfolio based on the monthly return of indices of four countries: the United-States of America, the United-Kingdom, South-Africa and Mexico. For the US we used, the S&P 500, for the UK, the FTSE 100, for South-Africa, the FTSE/JSE and for Mexico, the Mexico IPC. All the data are generated from “Datastream International”. In what follows we will discuss the different outputs of the correlation measurements.

Table 1 provides summary statistics of the monthly stock market returns over the entire 120 month sample period. The sample shows the pairwise correlation coefficients between stock market pairs, the mean return and the standard deviation of national stock markets. The same statistics are also presented for the FTSE Euro top 100 and the World Indices are in euro terms; their pairwise(paired?)correlation is 0.92

The table clearly shows that all the markets are correlated. There is not a market pair of which the correlation is not above 0.50. Like I mentioned before, the Capital Asset Pricing Model
shows that low pairwise correlations are the source of gain from international portfolio diversification. Hence, looking at this table’s output, one can strongly question the benefits of international diversification.

A closer look at Table 1 shows that the standard deviation of returns are larger in euro terms than it is in local currency for each stock market. This indicates that the investor from the Eurozone faces a greater total risk than the local currency investor. This is due to currency volatility from investing in all foreign stock markets in the sample. This exposure to local currency fluctuation can be reduced, or even eliminated, through effective hedging. This will be handled in detail in the next paragraph. Table 1 also shows the pairwise correlations between the FTSE Euro top 100 Index, the national stock markets, the FTSE World top 100 Index and the national indices.

Table 1 also shows the pairwise correlations between the FTSE Euro top 100 Index, the national stock markets, the FTSE World top 100 Index and the national indices.

Table 2

<table>
<thead>
<tr>
<th>Currency</th>
<th>USD</th>
<th>GBP</th>
<th>ZAR</th>
<th>MP</th>
<th>MN (%)</th>
<th>SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>1</td>
<td>0.45</td>
<td>0.20</td>
<td>0.71</td>
<td>-0.06</td>
<td>2.79</td>
</tr>
<tr>
<td>GBP</td>
<td></td>
<td>1</td>
<td>0.26</td>
<td>0.49</td>
<td>-0.16</td>
<td>1.89</td>
</tr>
<tr>
<td>ZAR</td>
<td></td>
<td></td>
<td>1</td>
<td>0.30</td>
<td>-0.53</td>
<td>4.55</td>
</tr>
<tr>
<td>MP</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>-0.33</td>
<td>3.54</td>
</tr>
</tbody>
</table>

The triangle provides the correlation matrix of exchange rate changes in euro terms. MN and SD, respectively, denote the mean exchange rate change and standard deviation of exchange rate changes.

Table 2 presents summary statistics of the monthly exchange rate changes versus the Euro for each of the 4 currencies over the 120-month sample period. Examination of the mean exchange rate changes shows that the values are negative for all countries, indicating that the Euro depreciated against all these currencies.

Additionally, we notice that the mean currency returns and the standard deviations of the exchange rate changes are small in comparison to the stock market mean and standard deviations presented in the previous table. The correlations are very small too, compared to the correlations of the stock exchanges. However, the correlation between the US-dollar return and Mexican Peso return is very high. Given the fact that US-dollars are much more liquid than Mexican Pesos, an investor can use US-dollars to hedge his/her currency exposure in the Mexican market. This hedging strategy is called “cross hedging”.
Table 3

Pariwise correlations between stock markets and currency exchange changes.

<table>
<thead>
<tr>
<th>currency/market</th>
<th>USD</th>
<th>GBP</th>
<th>ZAR</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>0.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MX</td>
<td></td>
<td></td>
<td>0.63</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 measures the pairwise correlations between the foreign exchange returns and the return of the indices. In this table we see that the interdependence between the indices and the foreign exchange returns are very low in the advanced market, namely under 0.50, but significant at a 5% significance level. Meanwhile, in the emerging markets we notice a very high correlation between the return of the indices and the return of the foreign exchanges. Thus the hedge ratio needed to cover the currency volatility in the advanced markets is very low. Conversely, in the emerging markets, the currency volatility mitigating hedge ratio is very high.

B. Monthly behaviour of the different indices from 1999.01 to 2008.12

After having measured the correlation of the different indices and concluded that there is a very strong interdependence between advanced markets and emerging markets and advanced and emerging markets in relation to each other. We also concluded that there is a significant influence of the different currencies on the performance of the indices, in the emerging markets even more than in the advanced ones. We will now further discuss the ex post performance of a portfolio that was diversified in these different markets.

The ex ante decision whether or not to invest in these markets was based on data that was generated before the introduction of the Euro. The adoption of the euro went together with the expansion of the world geographical market correlation. Markets are more than ever integrated. Let me first start with the random walk theory developed by Eun and Resnick (1997). According to this theory, investors will hedge their foreign currency exposure only if the forward premium is positive.

A positive forward premium means that the market expects the domestic currency to appreciate. On the other hand if the forward premium is negative, this indicates that the market expects the foreign currency to appreciate against the domestic currency of the investor. Thus they concluded hedging is appropriate only if the forward premium is positive, because in this case the
market thinks that there is a high probability that the domestic currency of the investor will appreciate against the foreign currency. By hedging, the foreign exchange volatility he/she will lock in a future positive return on his/her currency exposure.

Table 4


<table>
<thead>
<tr>
<th>period</th>
<th>FW premium ZAR</th>
<th>FW premium MP</th>
<th>FW premium GBP</th>
<th>FW premium US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/12/1999</td>
<td>-12.31%</td>
<td>-23.96%</td>
<td>-2.22%</td>
<td>-1.83%</td>
</tr>
<tr>
<td>1/12/2000</td>
<td>-7.15%</td>
<td>-15.10%</td>
<td>-2.67%</td>
<td>-2.56%</td>
</tr>
<tr>
<td>1/12/2001</td>
<td>-5.45%</td>
<td>-11.59%</td>
<td>-0.95%</td>
<td>-1.22%</td>
</tr>
<tr>
<td>1/12/2002</td>
<td>-6.37%</td>
<td>-6.73%</td>
<td>-1.04%</td>
<td>0.90%</td>
</tr>
<tr>
<td>1/12/2003</td>
<td>-6.06%</td>
<td>-6.48%</td>
<td>-1.17%</td>
<td>1.27%</td>
</tr>
<tr>
<td>1/12/2004</td>
<td>-5.91%</td>
<td>-4.51%</td>
<td>-2.02%</td>
<td>0.83%</td>
</tr>
<tr>
<td>1/12/2005</td>
<td>-4.85%</td>
<td>-6.53%</td>
<td>-2.40%</td>
<td>-0.74%</td>
</tr>
<tr>
<td>1/12/2006</td>
<td>-4.35%</td>
<td>-5.52%</td>
<td>-1.62%</td>
<td>-1.95%</td>
</tr>
<tr>
<td>1/12/2007</td>
<td>-5.31%</td>
<td>-3.19%</td>
<td>-1.40%</td>
<td>-1.26%</td>
</tr>
<tr>
<td>1/12/2008</td>
<td>-7.02%</td>
<td>-3.27%</td>
<td>-0.98%</td>
<td>0.31%</td>
</tr>
</tbody>
</table>

Table 4 presents the yearly forward premia, calculated according to formula (5): forward price at intercept day minus the spot exchange rate at intercept day divided by the same spot at intercept day. Looking at these forward premia one can see, according to the random walk theory, that the investor would have covered him/her self only against one currency, the US-dollar, and this only for the periods 2002, 2003, 2004, and 2008, because in these periods the market expected the euro to appreciate against the US-dollar. In all other cases, again according to the random walk approach, if the investor had covered him/her-self against his/her currency exposure, it would have been a suboptimal decision.

In what follows we will examine the behaviour of the different indices individually and afterwards look at the ex post performance of the equally weighted portfolio. The different cases discussed are: if one had chosen to not diversify in foreign markets, to diversify but not to hedge against currency exposure, to diversify and use the 50% naïve hedge ratio and finally to diversify and hedge fully the currency exposure. We will also take a closer look at the ex post trade-off between realised return and reduced volatility.
Graph 1 shows the behaviour of the monthly lognormal return of the different indices, during the periods 1999 until the end of 2008. As one can see these returns are marked by three periods: first the South-American market distress at the end of the nineties, that can partly explain the high volatility around the second half of 1999, second is the explosion of the dotcom bubble in 2001, which caused a stronger market volatility than in 1999, and finally the financial crises that we are going trough at this moment, which began as subprime crisis and ended causing a world recession. The volatility that has been noticed during this financial tsunami is unique in its kind.

This graph gives us two very important parts of information: the first is that during high market volatility the emerging markets exhibit a much higher volatility than the advanced markets, second, and the most important one, is that during market distress all the world markets are strongly correlated, which makes one wonder where diversification opportunity is, when you need it the most.
Graph 2


Graph 2 shows the lognormal return of the different foreign currencies, in euro term, during the sample period. The two emerging market currencies, the Mexican Peso and the South-African Rand, exhibit a very strong fluctuation over the entire sample period, meaning the exposure in these currencies needs to be hedged. The only question that the investor needs to ask here is: should I be fully covered or partially covered? The answer to this question, lies in the dependency upon the correlation between the stock exchange return and the currency exchange return. Looking at Table 3, we concluded that one should be fully covered against currency fluctuation in the emerging markets and partially covered in the advanced markets.

**C. Average performance results**

Table 6 presents the average performance results during the holding period, from the introduction period of the euro into the financial markets in 1999, until the end of 2008. The results presented in the table show the average portfolio mean return, the standard deviation stated in percent per year and the average Sharpe (SHP) measure of portfolio performance.
Examination of Table 6 indicates that, if one had diversified over the two advanced markets, United State of America and United-Kingdom, and the two emerging markets, Mexico and South-Africa, and did not hedge his/her currency exposure, the portfolio would have performed much better than all other strategies. The internationally diversified and not hedged portfolio has a Sharp ratio of 2.13%, which is much higher than solely investing in the eurozone, SHP of -20.09%, or an internationally diversified portfolio, hedged against currency volatility for 50% or 100%, SHP of -3.86% and -10.72%.

An investor from the eurozone is much better off diversifying his/her wealth internationally than solely investing in the eurozone market. An other finding from Table 6 is that the higher the hedge ratio is, the higher the negative performance of the portfolio will be.

Table 5

<table>
<thead>
<tr>
<th></th>
<th>not diversified</th>
<th>diversified and not hedge</th>
<th>diversified and 50% hedged</th>
<th>diversified and 100% hedged</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN (%)</td>
<td>-5.08%</td>
<td>0.55%</td>
<td>-0.92%</td>
<td>-2.40%</td>
</tr>
<tr>
<td>SD (%)</td>
<td>25.31%</td>
<td>25.99%</td>
<td>23.88%</td>
<td>22.36%</td>
</tr>
<tr>
<td>SHP</td>
<td>-20.09%</td>
<td>2.13%</td>
<td>-3.86%</td>
<td>-10.72%</td>
</tr>
</tbody>
</table>

In each cell the MN, SD and SHP, respectively denote the mean portfolio return, portfolio standard deviation, and Sharp reward-to-variability ratio.

Graph 3 shows the trade-off between volatility and return for an investor from the eurozone who had a 12-month buy- and- hold investment period. Looking at Graph 3 one can notice that the four investment policies led to four different outcomes.

The policy not to diversify and solely invest in the eurozone has as outcome the coordinate (-5.08%,25.31%) This means that the eurozone Index volatility over the investment period was 25.31% on a yearly basis and the average return was -5.08% on yearly basis too.

On the other hand if one had adopted the investment policy of internationally diversifying and not hedging against foreign currency exposure, one would have known a volatility on his/her portfolio of 25.99% and would have realised a positive return of 0.55%, which is, compared to the investment policy of “domestic only”, a significantly better policy.

An investor with an average risk and regret aversion, hedge ratio equal to 50%, would have reduced the volatility on his/her internationally diversified portfolio with 2.11% ( from 25.99% to 23.88%), which is statistically not significant on the 5% significance level. This volatility reduction would have led to an average loss of approximately 0.92%. As far as the absolute risk and regret aversion investor is concerned, the outcome would have been worst. For a small volatility reduction of 2.63% one would have encountered an average loss of 2.40%.
D. Regret over the holding period

According to Michenaud and Solnik (2008) the optimal hedge ratio is always between 50% and 100%, because risk aversion and regret aversion, the two components of a hedge ratio, are positive. When an investor hedges fully his/her foreign currency exposure, then he/she maximizes the regret associated with a strong appreciation of the foreign currency. On the other hand, if he/she chooses to be fully exposed to the foreign currency fluctuation, then again he/she maximizes the regret associated with the depreciation of the foreign currency. In this paper we have tried to measure the extent of regret for a non-regret-avers investor, a medium regret-avers investor and a fully regret-avers investor. Table 6 presents the results.

Table 6 presents the number of times that an investor who had hedged his/her foreign currency exposure, would have encountered regret, according to the definition given above. Here 1 means by hedging the investor would have realised a higher return and 0 means the other way round, being covered against the currency volatility was a suboptimal choice.
Examination of Table 6 shows us that the regret of not being hedged is the lowest in the Mexican Peso and highest in the British Pound. Namely 6 out of the 10 times, hedging the Mexican currency exposure was the right choice, meanwhile in the British Pound exposure, it was the opposite. As far as the US-dollar and the South-African Rand is concerned, the regret is balanced, fifty-fifty in both cases.

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</table>

| Total      | 5               | 4               | 6                   | 5                |

*a 1 means that hedging was the right choice and 0 means hedging was a wrong choice.*

4) Summary and conclusion

The aim of any rational investor is to avoid risk as much as possible while realising a superior return on his/her investment. Looking for investment opportunities in the foreign markets can help achieve that goal. The international portfolio diversification possibility has never known a growth rate like we are experiencing it today. The rise of countries like Brazil, China, India, South-Africa and many more, brought new wealth diversification possibilities with them.

These new opportunities have created portfolio diversification possibilities, but they also increased the interdependence between the different world markets. We know from the Capital Asset Pricing Model that the absence of world markets correlation is the source of superior portfolio performance. Therefore one can question the positive impact of international portfolio diversification based on country specific risk and justify the growing interest in industry/sector based wealth allocation.

The wall street journal of Monday, May 11, 2009 had the following title on the front page: “Taste for risk is emerging, as is worry. Investors are aggressively piling back into markets shunned as risky weeks ago–driving up stocks in the developing world and causing alarm among some central bankers.” This phenomenon indicates that even though there is an increase in markets correlation – especially during high markets volatility, like the period we are going through at this moment – that
new emerging markets apparently still offer investment possibilities. This finding shows that country based elements still play a very important role in the ex ante investment choice.

The ex post portfolio that I have simulated clearly shows that an investor is better off with international diversification than solely domestic diversification. It also demonstrates that the level of the hedge ratio depends on the risk and regret avers of the investor. For a non-risk and non-regret avers investor, the average realised return would have been positive, 0.55% return against 25.99% of volatility. On the other hand for a medium risk and regret avers investor, the average realised return would have been negative, -0.92% against a 2.11% reduction of volatility. Finally, for the fully risk and regret avers investor the loss would have been bigger than the medium one. He would have encountered an average loss of 2.40% against a small reduction of volatility of 2.63%.

5) Acknowledgements

My first great thanks goes to my parents and two brothers who were my supporters since my first day at the Ghent University. My next special thanks goes to my friends the twin brothers Kristof Buyse and Pieter Buyse, I am very grateful to their contribution on this thesis. I would also like to thank my thesis promotor professor Michael Frommèl for his very useful input. I am very thankful too, to Brahim Al Farisi, Alexandre Pylyser and Michiel Hermans for reading the paper and given their opinion. Another special thanks goes to professor André Farber from Solvay Business School and his assistant Benoit Dewael for their critical remarks.

6) Bibliography


Appendix 1

Ex ante monthly returns of the different countries included in the portfolio².

² http://solvay.ulb.ac.be/cours/pirotte/INGESTintfin/index.html
United Kingdom

United States
Appendix 2

World industrial risk measured, in the Banking sector and in the Business and Public Services sector\(^3\).

\(^3\) http://solvay.ulb.ac.be/cours/pirotte/INGESTintfin/index.html