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Geographical Portfolio Diversification

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Abstract

Geographical portfolio diversification is a technique that consists on diversifying a securities portfolio through different economies or regions, in order to reduce the total risk on the portfolio. Therefore, the performance of the aforementioned approach will be studied throughout this paper from different perspectives, including a risk-to-return analysis and a risk-adverse outlook. Moreover, performance measures, as the Sharpe and Treynor ratio, and the Minimum Variance Portfolio theory, will be applied. The data used so as to develop this research will be based on a twenty years period (1993-2012), including periodic monthly returns of equity and fixed income indexes. Finally, both numerical and graphical results will be presented in order to answer the research questions.

La diversificación geográfica de carteras es una técnica que consiste en diversificar carteras de activos financieros en diferentes economías o regiones geográficas con el objetivo de reducir el riesgo total de la cartera. A lo largo de este trabajo se evaluará el rendimiento de ésta técnica desde diferentes perspectivas, realizando un análisis de la relación entre el riesgo y la rentabilidad, o analizando solo el riesgo total. Para llevar a cabo esta evaluación, se utilizarán diferentes ratios, como el ratio de Sharpe y Treynor, y se aplicará la teoría de carteras de mínima varianza. Los datos usados para el desarrollo de este trabajo están basados en series históricas de 20 años (1993-2012), incluyendo rentabilidades mensuales periódicas y diferentes índices bursátiles de renta variable y renta fija. Finalmente, resultados tanto numéricos como gráficos serán presentados con el objetivo de obtener conclusiones.

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1. Introduction

This paper will introduce different methodical, theoretical and analytical aspects related with the topic of the research, that is the Geographical Portfolio Diversification.

First of all, the different approaches used for gathering data as well as which data were relevant for developing the purpose of the research will be explained. Moreover, a brief description of the theories applied and concepts used will be introduced, which will be lately explained.

Afterwards, the data collected from the different sources will be presented, followed by an exhaustive explanation of how this data were carefully selected and processed (e.g. stock indexes selected, periods of time, limitations and so on) in order to obtain quantitative and objective results.

Finally, the aforesaid results will be analysed combining the theories and concepts studied with the data obtained in order to draw conclusions on the research purpose.

1.1. Topic Selection

The topic “Geographical Portfolio Diversification” was selected among the different options provided by the Business and Economics Faculty of the University of the Balearic Islands, due to my great interest on the financial scope, especially on the financial markets. During my Bachelor’s degree on Business Administration I have tried to expand my knowledge on finance as much as possible: taking courses related to the financial markets, participating in different trading competitions of the university, and so on. Hence, this selection has allowed me to put into practice different financial approaches and theories learned during my Bachelor’s degree. Studying them further will help me to me to improve my academic knowledge in order to achieve a successful career in the financial sector.

1.2. Purpose and Research Question

Portfolio or securities diversification is a well-known technique used by the vast majority of investors and professionals of the financial sector, aiming to reduce the risk and if possible, to improve profitability. Therefore, the aim of this paper is to analyse which are the benefits and consequences of an investment portfolio diversification through different regions or economies, focusing on the total risk and return of these portfolios.

This research will pursue to answer the following **research questions**:

Q1: Which are the pros and cons of geographical portfolio diversification and which are the effects on their total risk and return?

Q2: Is it convenient to diversify in as many regions and markets as possible?

2. Methodology

The following chapter will explain the process of choosing, gathering and developing information as well as how this data has been analysed.

2.1. Research Methods

When carrying out a research, it is important to identify which research method fits best the purpose of the study. The author John D. Anderson, distinguish between two different research methods:

Quantitative Research options have been predetermined and a large number of respondents are involved. By definition, measurement must be objective, quantitative and statistically valid. [...] Qualitative Research is collecting, analysing, and interpreting data by observing what people do and say. Whereas, quantitative research refers to counts and measures of things, qualitative research refers to the meanings, concepts, characteristics, metaphors, symbols, and descriptions of things. (2006:1)

This research involved analysing objective data (e.g. stock indexes prices), through statistical ratios and measures, combined with mathematical and financial theories, to provide valid conclusions to the research question. Therefore, a quantitative research approach has been applied to this study.

2.2. Data Collection

The data collection process is a very important part when carrying out a research study. Primary and secondary data are needed in order to gather enough information for validating the results derived from the research (Fisher, 2007). Therefore, this study involved both primary and secondary data. This decision derives from the assumption that they complement each other in the sense of context understanding (Saunders et al., 2009)

As Hox & Boeije stated, there is a clear difference between primary and secondary data:

Primary data are data that are collected for the specific research problem at hand, using procedures that fit the research problem best. On every occasion that primary data are collected, new data are added to the existing store of social knowledge. Increasingly, this material created by other researchers is made available for reuse by the general research community; it is then called secondary data (2005:593)

Moreover, as the research method is based on the quantitative research, the primary and secondary data collected are mainly quantitative data, which can be defined as “Data that can be described numerically in terms of objects, variables and their values”. (Hox & Boeije, 2005:594)

In the following sub-sections, the main sources used for the research, as well as how the aforementioned data were collected, will be explained.

2.2.1 Secondary Data

Secondary data in this report mainly consists on the prices of the different financial stock indexes used to compose different portfolios thorough an established period of time. These data were mainly retrieved from the financial database *Thomson One Banker*, as well as from different financial information webpages like *Bloomberg* and *Yahoo! Finance*. Furthermore, databases as *Eurostat*, *World Bank* and *IMF* were used also as primary sources for the selection.

In order to build a strong academic /framework and provide a sufficient validity to this research, academic resources such books, reviews and articles collected from *UIB's library* and *Google Scholar* were used. The aforementioned resources provided theories and approaches in order to develop and analyse the research purpose.

The following table gives an overview of databases used for this research.

Database	Topic	URL
<i>Thomson One Banker</i>	Financial Data	http://banker.thomsonib.com
<i>Eurostat</i>	Economic Data	http://epp.eurostat.ec.europa.eu
<i>International Monetary Fund</i>	Economic Data	http://www.imf.org
<i>World Bank</i>	Economic Data	http://www.worldbank.org
<i>Google</i>	General material	http://www.google.com
<i>Google Scholar</i>	Scientific and Academic Articles	http://www.scholar.google.com

Table 1: Databases used. Source: Own elaboration

The keywords used for gathering this information were: **stock indexes, Sharpe, Treynor, Markowitz, risk-return, minimum variance portfolio, international diversification and research methods.**

2.2.2. Primary Data

Primary data for this research were obtained combining the data of the different stock indexes, and financial assets, together with the theories and formulas obtained from academic resources. These data comprised measures obtained specially for this research: monthly returns, variance, covariance, and specific ratios of selected assets in a specified period of time.

2.3. Theories Applied

The following theories, which will be further explained in the next section, were applied in order to develop and analyse the research purpose:

- **Statistical Concepts.**
Diverse statistical measures like the rate of return, variance, covariance, correlation coefficient and beta factor will be introduced.
- **Modern Portfolio Theory: Minimum Variance Portfolio.**
This part will explain how to obtain minimum variance portfolios and the meaning of this approach.
- **Performance Measures: Sharpe Ratio, Treynor Ratio and Standard Deviation.**
This part will show how assets could be evaluated in terms of risk and return using statistical measures and ratios.

3.Theoretical Framework

This section will introduce the theories and concepts that will be used to carry out the analysis of the data

3.1. Statistical Concepts

The rate of return (R_i) is commonly used to make quantifiable the profitability of an investment. This measure could be defined as the increase or decrease in your wealth associated with holding an asset for a period of time (Haugen, 2001:32). Along this research, the rate of return will be used to obtain periodic returns, which are calculated with this equation:

$$R_i = \frac{P_0 - P_i}{P_0} \times 100$$

Equation 1: Periodic rate of return

Where: P_0 is the initial price; P_i is the final price.

If this rate of return refers to a portfolio, it will be obtaining multiplying the return of each asset times their weight within the portfolio, as it is depicted in the following formula:

$$R_p = R_a \cdot X_a + R_b \cdot X_b$$

Equation 2: Portfolio rate of return

Where: X_i is the weight of the asset i in the portfolio.

The variance(σ_i^2) is an indicator of the potential deviation of the return from its expected value (Haugen, 2001:60). In order to calculate the variance of a portfolio of securities, it is necessary to know the portfolio weights for each asset and the variance-covariance matrix of them. Here there is an example of how to calculate the variance of a portfolio of two assets:

$$\sigma_p^2 = X_a^2 \cdot \sigma_a^2 + X_b^2 \cdot \sigma_b^2 + 2 \cdot X_a \cdot X_b \cdot \sigma_{ab} \quad s. t. \quad X_a + X_b = 1$$

Equation 3: Portfolio variance

Where: σ_a^2 and σ_b^2 are the variances of the assets A and B; σ_{ab} is the covariance between assets A and B

The covariance (σ_{ij}), correlation coefficient ($\rho_{i,j}$) and beta factor ($\hat{\beta}_i$) are three related concepts. The covariance shows if two variables are positively or negatively related, whereas the correlation coefficient also shows the degree of relation between two variables. The beta factor is also an indicator of relation, but it points out the degree to which an asset responds to changes in the return produced by the market (Haugen, 2001:36-45). The three concepts are presented as follows:

$$\rho_{i,j} = \frac{\sigma_{ij}}{\sigma_i \cdot \sigma_j} ; \quad \sigma_{ij} = \rho_{i,j} \cdot \sigma_i \cdot \sigma_j ; \quad \hat{\beta}_i = \frac{\sigma_{i,M}}{\sigma_M^2}$$

Equation 4: Correlation coefficient, covariance and beta factor

Where: σ_i and σ_j are the standard deviations of assets i and j ; σ_M^2 the variance of the proxy market; $\sigma_{i,M}$ the covariance of the proxy market and asset i .

3.2. Modern Portfolio Theory: Minimum Variance Portfolio

Individual securities could be combined to form portfolios, modifying their level of risk and their expected rate of return. The combination of individual stocks – or stock indexes in this research – would lead to a wide variety of portfolios, as it is possible to take short or long positions, establish different weights and so on. All those portfolios represent different investment opportunities, but there are some positions that are preferred than others. For example, given a level of expected rate of return, an investor would choose the portfolio with lower risk; or given a level of risk, the portfolio with higher expected rate of return would be selected (Haugen;2001:81). All the combinations that meet the aforementioned criterion can be plotted in a curve called minimum variance set¹, while the other combinations would be represented on the right side of this curve, as it is depicted in the Figure 1:

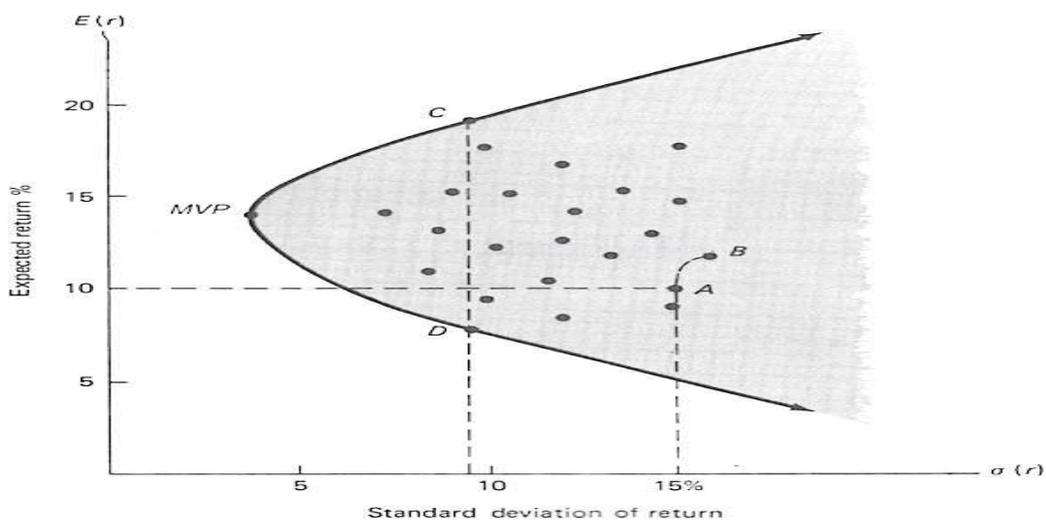


Figure 1: Minimum variance set. Source: Haugen, 2001

¹ It could be also called minimum standard deviation set, because a portfolio that minimizes variance would be identical to a portfolio that minimize standard deviation (Haugen, 2001, p.82)

At the same time, this minimum variance set can be divided into two parts. The upper part of the curve is called efficient set, and it holds the most desirable portfolios, as they have the highest attainable expected rate of return for given level of standard deviation (Haugen; 2001:82). For example, portfolios C and D (see Figure 1) have the same level of standard deviation, but only C is in the efficient set, as it has the maximum rate of return achievable for a 9% of standard deviation. In addition, these two parts are separated at the MVP point. This point represents the minimum variance portfolio, which is the one with the lowest possible level of standard deviation (Haugen; 2001:82). This portfolio is obtained by minimizing the portfolio variance or standard deviation (see Equation 3).

Finally, it is important to outline that in this research, historical rate of returns were used instead of expected rate of returns and just minimum variance portfolios were obtained. These two approaches will be further explained in the Findings section (see p.10)

3.3. Performance Measures

The standard deviation (σ_i) is a statistical measurement obtained by calculating the square root of the variance (σ_i^2). As this latter concept, the standard deviation measures the volatility of an investment based on its rates of return, meaning that high volatile assets will present a high standard deviation and vice versa. This measure is commonly used to compare the total risk of different investments, as it includes the systematic and non-systematic risk (i.e. diversifiable and non-diversifiable risk).

The Sharpe ratio (\hat{S}_p) is often referred to as an excess return to variability measure (Elton, Gruber, Brown, & Goetzmann, 2011:635). It is a performance measure based on the total risk of return (standard deviation) and it is calculated as follows:

$$\hat{S}_p = \frac{R_i - R_f}{\sigma_i}$$

Equation 5: Sharpe ratio

Where: R_i is the return of the asset i ; R_f is the return of the free-risk asset; $R_i - R_f$ is the excess return or risk premium; σ_i is the standard deviation of the asset.

The Treynor ratio (\hat{T}_p) measures the risk premium earned per unit of risk taken, when the beta factor is the risk measure (Haugen, 2001). The main difference between the Sharpe ratio and the Treynor is that the former one evaluates the total risk, while the latter is a measure based on systematic risk of return (Jobson & Korkie, 1981:890)

$$\hat{T}_p = \frac{R_i - R_f}{\beta_i}$$

Equation 6: Treynor ratio

Where: β_A is the beta factor of the asset i .

It is important to highlight that both ratios present some pitfalls in measuring performance, even though the Sharpe measure have a small number of theoretical objections (Jobson & Korkie, 1981:891). Both Sharpe and Treynor ratios, as Jobson & Korkie state, present problems when “*the market risk premium is negative and the portfolio evaluated has a larger risk, a lower mean return, and a larger performance value than the market portfolio*” (1981:891)

In addition, the Treynor ratio requires a market portfolio proxy in order to obtain the beta factor. Consequently, a measurement error in the proxy could cause decision errors using the Treynor measure (Jobson & Korkie, 1981:891).

4. Findings

This chapter will introduce the data collected from the aforementioned sources, which will be lately analysed.

4.1. Raw Data

The first step was to select assets that would represent different relevant economies all over the world, while taking into account factors such as the GDP, potential development and so on. However, there was a focus on the importance of financial markets in those relevant economies.

The following chart presents an overview of the total GDP per country in 2013 of EU's 15 top countries, Japan and USA (countries included in the G7 group):

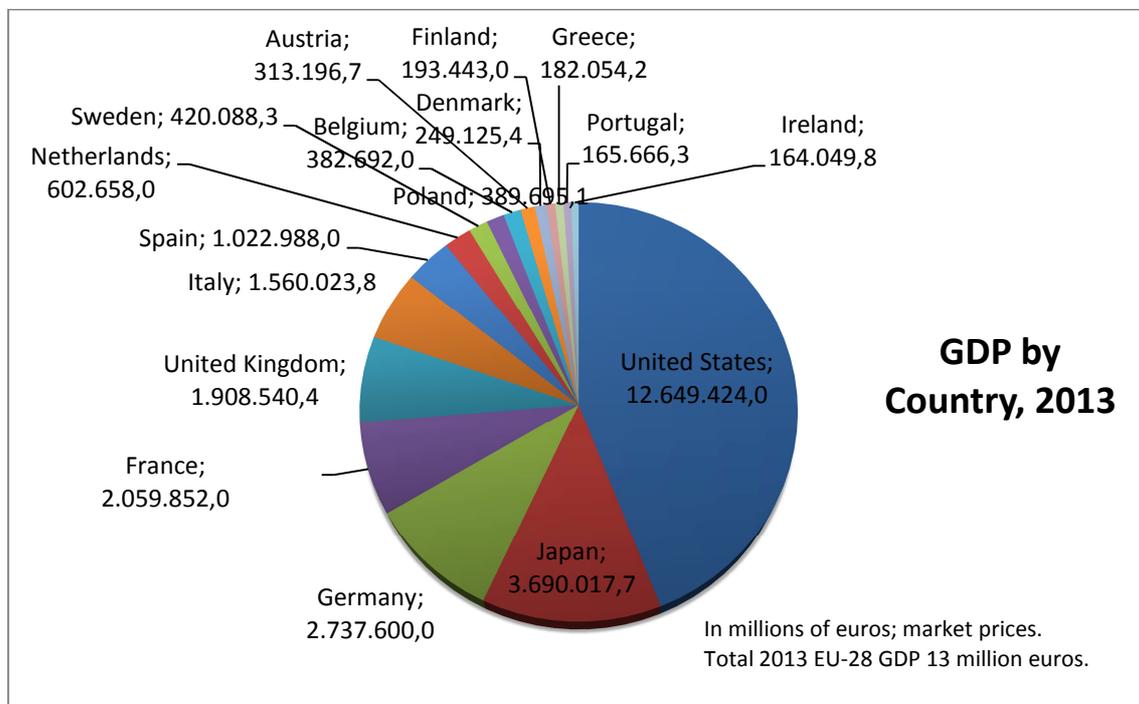


Figure 2: GDP by country 2013. Source: Eurostat

In addition, the graph below shows the top 20 countries in terms of market capitalization in 2012:

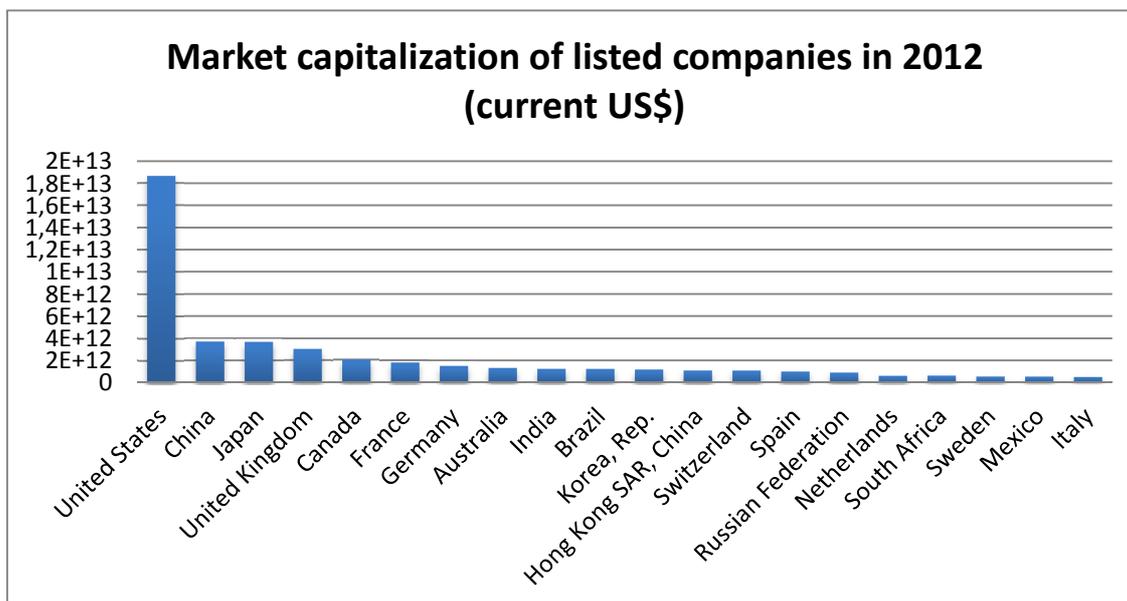


Figure 3: Market capitalization 2012. Source: World Bank

Having assessed the aforementioned factors, the following stock indexes were selected²: *IBEX 35* (Spain), *DAX 30* (Germany), *CAC 40* (France), *FTSE 100* (UK), *STOXX 600* (Europe), *S&P 500* (USA), *RUSSELL 2000* (USA; Small-Caps), *NIKKEI 225* (Japan), and *MSCI EM* (Emerging Markets all over the world). Furthermore, the *MSCI World* stock index and *EuroMTS Highest Rated Macro-Weighted Govt Bond 1-3Y* index were selected as market portfolio proxy and risk-free asset.

The following map represents different areas covered by the selected indexes:



Figure 4: Geographical distribution. Source: Own elaboration

² Even though Italy is Europe's fourth economy by means of GDP, the Italian stock index FTSE MIB was not chosen as data were only available since 1997.

Finally, in order to support the validity of this research, the collected data from the aforementioned assets comprises historical series of twenty years (1993-2012) of monthly prices, so as to obtain periodic monthly returns in both indexes and portfolios.

4.2. Asset Allocation

Using the previous selected stock indexes, it was possible to set up many different portfolios. Nevertheless, it was decided that the Spanish stock index (*IBEX 35*) would be included in all portfolios, based on the premise of a Spanish investor who would like to diversify its local investments. Consequently, the *IBEX 35* was settled as the local market portfolio.

In order to disclose relevant information and reinforce the research question, the portfolio selection was founded on the following issues:

- Is it better to diversify all over Europe or just to choose some leading European markets?
- Should an investor focus only on global leading economies?
- Should an investor take into account volatile economies, as the Emerging Markets?

Based on the aforementioned issues, the following table provides an insight of the different selected optimal portfolios:

<i>General Europe</i> (G.EUROPE)	<i>Leading Europe</i> (L.EUROPE)	<i>Global Leading Economies</i> (L.ECONOM)	<i>Global Leading Economies and Emerging Markets</i> (GLOBAL+EM)
IBEX 35 STOXX 600	IBEX 35 DAX 30 CAC 40 FTSE 100	IBEX 35 S&P 500 RUSSELL 2000 NIKKEI 225 FTSE100	IBEX 35 FTSE 100 S&P 500 NIKKEI 225 MSCI EM

Table 2: Composition of the portfolios. Source: Own elaboration

The *Global Leading Economies and Emerging Markets* portfolio is considered as the one with greater geographical diversification, followed by the *Global Leading Economies* portfolio, the *General Europe* portfolio and the *Leading Europe* portfolio. Even though the last one includes more stock indexes than the *General Europe* portfolio, this one covers more areas of Europe, making it more geographically diversified one.

It is important to highlight that other combinations were tested, but portfolios presented above were considered more suitable for this specific research. In addition, created portfolios are not nested, meaning that portfolios were not elaborated by adding or deleting stock indexes to an initial base of stock indexes (i.e. creating bigger portfolios but maintaining the same initial assets).

4.3. Ex-Ante Point of View

As it was stated in previous sections, the data collected from the different assets comprised the period between 1993 and 2012. However, portfolios were not constructed until 1998, due to the ex-ante point of view required for the Minimum Variance Portfolio theory.

According to the theoretical framework section, the MVP theory sets portfolio's variance (σ_p^2) as a mathematical combination of the variance-covariance matrix of portfolio's components and their weights within it. This variance-covariance matrix is based on historical data (i.e. historical returns) and the more data used, the more reliable statistical results obtained. Therefore, statistical measures of this research were obtained taking into account five-year periods (i.e. sixty previous monthly returns), being the main reason why optimal portfolios were not calculated until 1998.

As said before, minimum variance (MV) portfolios were created from 1998 onwards, obtaining sixteen portfolios for each portfolio class. However, every year those portfolios were rebalanced, taking into account the sixty previous monthly prices and changing optimal weights of their assets. This decision was taken in order to keep portfolios updated with the economic and financial environment, making this research more dynamic.

The following figure presents an overview of the aforesaid process:

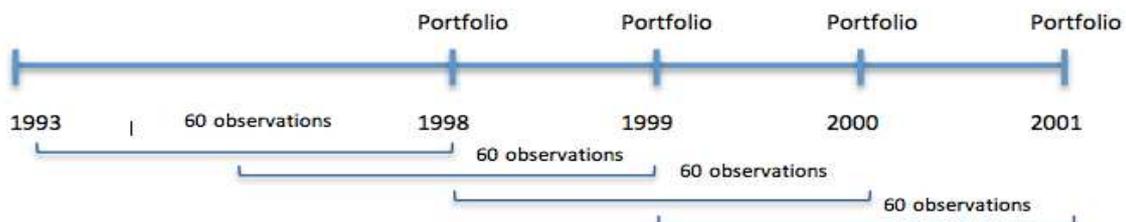


Figure 5: Ex-ante process. Source: Own elaboration

Finally, it is important to state that asset's weights within portfolios were not restricted, allowing short sales or 'bearish' positions. Some authors like Elton, Gruber, Brown, & Goetzmann (2011) believe that taking short positions will generate problems, as not all securities allow this operation. However, all the stock indexes selected are represented by Exchange Traded Funds, assets that allow short sales.

4.4. Ex-Post Point of View

In the aforementioned process, different portfolios were obtained every twelve months based on historical prices. Those portfolios reflect the optimal decision for a risk-averse investor that would like to minimize the risk of their investments through international diversification, taking into account the historical correlations between them.

Nevertheless, it is important to keep in mind that this is an approach based on estimations of historical data, and that it is not possible to make a precise prediction of neither future fluctuations of the assets, nor their future profitability. This is the reason why just minimum variance portfolios were chosen, avoiding

efficient portfolios with higher expected rate of return, as its estimation was not reliable.

For example, an investor that created a minimum variance portfolio composed by USA and European banking stocks in 2007, based on the great performance of both assets in the last ten years, did not know that in 2008 a big banking corporation as Lehman Brothers would go bankrupt and banking stocks – among others – would plunge.

According to the previous reasoning, it was decided to test the validity of the MVP approach applying an ex-post point of view, in other words, to measure posterior monthly returns of the optimal portfolios created, but taking into account annual changes in portfolio's weights (i.e. rebalancing portfolios every year).

The following section will shortly explain how these posterior monthly returns were used to obtain portfolio performance measures that will be subsequently analysed.

4.5. Portfolio Performance Measures

Given the previously explained ex-post approach, 180 observations or monthly returns were obtained for each portfolio class, starting in January 1998 until December 2012. At this point, it was possible to start composing statistical measures and ratios in order to further develop conclusions on the research purpose. Nonetheless, previously it was necessary to set two analysis parameters: firstly, which will be the frequency or period of data analysed within these 180 observations (e.g. every year, four years, and so on); secondly, which measures will be used based on different investors' perspectives.

Finally, it is also important to highlight that these performance measures were composed for both portfolios and stock indexes in order to compare results between them.

4.5.1. Data Frequency

It was decided to set two different time horizons: medium-term horizon (three years; 36 observations) and long-term horizon (fifteen years; 180 observations). Furthermore, within this long-term approach a separation between average results (i.e. average returns or standard deviation) and accumulated results (i.e. total portfolio or index return) was made.

This decision was taken in order to make this analysis statistically valid, using a reasonable number of observations and under the aforesaid premise of the more data used, the more reliable statistical results obtained. Moreover, these two time horizons were also selected to avoid results biased to market 'booms' or recession periods, giving a considerable period of time for readjust

A short-term horizon would not be totally valid for the research purpose, as results like standard deviation or returns would reflect the economic environment or financial markets situation of that specific period of time instead of the approaches used to reduce the risk. In other words, results would be more a matter of 'luck' than a matter of 'science'.

4.5.2. Performance Measures Applied

The ultimate goal of this research is to identify in which way international portfolio diversification helps to reduce risks of local investments, establishing Spain as local country. Therefore, the statistical measure of standard deviation (σ) was used to evaluate this risk-adverse perspective in the two aforesaid time horizons, showing how portfolios created could decrease risks of local investments.

At the same time, this research also aims to study how this international diversification affects to asset's profitability, either increasing it or decreasing it. Therefore, it was decided to evaluate this risk-return relation using the two ratios explained in the theoretical framework section: the Sharpe's ratio and Treynor's ratio. In both ratios, the risk-free asset was represented by the *EuroMTS Highest Rated Macro-Weighted Govt Bond 1-3Y* index, while the *MSCI World* index was used as a market portfolio proxy to obtain the betas of the different indexes and portfolios.

5. Analysis

This chapter presents an analysis that combines and discusses the findings with the theories presented in previous sections.

5.1. Risk-Adverse Analysis: Standard Deviation

The following table presents a ranking based on the standard deviation (σ) obtained of the different stock indexes studied along the research and the four optimal portfolios created. It takes into account the two aforesaid time horizons. This table gives an overview of which assets are less risky and would be more desirable for risk-averse investors. Results are presented in an ascending order, from lower to higher standard deviation.³

	98'-00'	01'-03'	04'-06'	07'-09'	10'-12'	Global
1 ^o	FTSE 100	L.EUROPE (4)	S&P 500	L.EUROPE (4)	L.ECONOM (5)	L.ECONOM (5)
2 ^o	L.ECONOM (5)	L.ECONOM (5)	MSCI WORLD	FTSE 100	STOXX 600	FTSE 100
3 ^o	MSCI WORLD	FTSE 100	FTSE 100	L.ECONOM (5)	FTSE 100	L.EUROPE (4)
4 ^o	L.EUROPE (4)	GLOBAL+ EM (5)	L.EUROPE (4)	MSCI WORLD	G.EUROPE (2)	MSCI WORLD
5 ^o	GLOBAL+ EM (5)	MSCI WORLD	G.EUROPE (2)	S&P 500	MSCI WORLD	GLOBAL+ EM (5)
6 ^o	G.EUROPE (2)	S&P 500	STOXX 600	STOXX 600	MSCI EM	S&P 500
7 ^o	STOXX 600	G.EUROPE (2)	L.ECONOM (5)	G.EUROPE (2)	GLOBAL+ EM (5)	STOXX 600
8 ^o	S&P 500	STOXX 600	GLOBAL+ EM (5)	GLOBAL+ EM (5)	S&P 500	G.EUROPE (2)
9 ^o	CAC 40	NIKKEI 225	CAC 40	CAC 40	L.EUROPE (4)	CAC 40
10 ^o	NIKKEI 225	MSCI EM	IBEX 35	IBEX 35	CAC 40	NIKKEI 225
11 ^o	DAX 30	RUSSELL 2000	DAX 30	DAX 30	NIKKEI 225	MSCI EM
12 ^o	RUSSELL 2000	IBEX 35	RUSSELL 2000	NIKKEI 225	DAX 30	RUSSELL 2000
13 ^o	MSCI EM	CAC 40	NIKKEI 225	RUSSELL 2000	RUSSELL 2000	IBEX 35
14 ^o	IBEX 35	DAX 30	MSCI EM	MSCI EM	IBEX 35	DAX30
	MAX: 7.79% MIN: 4.32%	MAX: 9.47% MIN: 4.46%	MAX: 4.14% MIN: 1.98%	MAX: 7.42% MIN: 5.10%	MAX: 7.17% MIN: 3.51%	MAX: 6.69% MIN: 4.25%

Table 3: Standard deviation ranking. Source: Own elaboration

At first sight, it can be noticed that the optimal portfolios are always above the local market portfolio (i.e. *IBEX 35*), meaning that in all medium-term horizon periods and in the long run, international diversification leads to a reduction of non-systematic risk. However, not all the minimum variance portfolios have the

³ Numerical results are presented in the *Appendix I*

same effect over the standard deviation; it is said that a greater diversification leads to a major risk reduction, but it also depends on the assets chosen.

As it was stated in the Asset Allocation sub-section (see p.), the *Global Leading Economies and Emerging Markets* portfolio is considered as the one with greater geographical diversification, followed by the *Global Leading Economies* portfolio, *General Europe* portfolio and *Leading Europe* portfolio. Nevertheless, during the five periods between 1998 and 2012, the greater diversified portfolio (*GLOBAL+EM*) is not the one who leads to a higher risk reduction.

The *Global Leading Economies* and the *Leading Europe* portfolios are the ones that are almost on the top of the ranking during the aforementioned period. In addition, both portfolios present a higher average ranking position within the medium-term horizon, as it is depicted in the following figure:



Figure 6: Standard deviation average ranking. Source: Own elaboration

Analysing these results, it seems clear that factors that affect more to portfolios performance – in terms of risk reduction – are firstly the assets that compose the portfolios, in other words, which are the characteristics those assets, and secondly, the quantity of areas or economies covered. This assumption is clearly represented in the *GLOBAL+EM* portfolio: it covers more areas and markets than the *L.ECONOM* or *L.EUROPE* portfolios, but it includes riskier and more volatile assets, as the *MSCI EM* index. The following chart provides an overview of the volatility of the optimal portfolios and local market portfolio, showing the maximum, minimum and average standard deviation of the medium-term horizon.

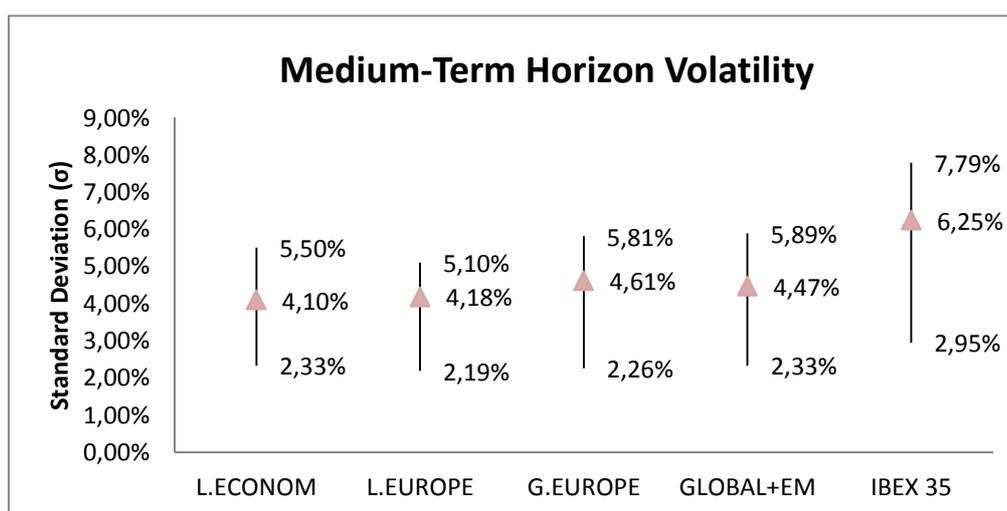


Figure 7: Medium-term horizon volatility. Source: Own elaboration

Focusing on the long-term horizon, the results obtained are very similar, with the *L.ECONOMIES* portfolio as the best portfolio in terms of risk. Besides, an improvement of the *GLOBAL+EM* portfolio is noticed. This could be because the effects of more volatile or riskier assets are reduced, as the period of time

analysed is greater. In addition, assets with a low index of volatility or risk become even more stable when the period of time is increased.

5.1. Risk-Return Analysis: Sharpe Ratio

In this case, the table presented below gives an overview of which assets have a better reward-to-variability relation, according to the Sharpe measure (\hat{S}_p). It is important to recall that this ratio measures the total risk of return (standard deviation). Results are presented in a descending order, from higher to lower Sharpe ratio⁴. In addition, the time horizons, portfolios and stock indexes presented are the same as in the Risk-Adverse Analysis (see page...).

	98'-00'	01'-03'	04'-06'	07'-09'	10'-12'	Global	Global*
1 ^o	CAC 40	MSCI EM	IBEX 35	MSCI EM	RUSSELL 2000	MSCI EM	MSCI EM
2 ^o	G.EUROPE (2)	RUSSELL 2000	STOXX 600	DAX 30	S&P 500	RUSSELL 2000	RUSSELL 2000
3 ^o	STOXX 600	IBEX 35	G.EUROPE (2)	IBEX 35	DAX 30	DAX 30	DAX 30
4 ^o	GLOBA + EM (5)	DAX 30	CAC 40	RUSSELL 2000	GLOBAL+ EM (5)	S&P 500	S&P 500
5 ^o	DAX 30	S&P 500	DAX 30	FTSE 100	L.ECONOM (5)	IBEX 35	MSCI WORLD
6 ^o	MSCI WORLD	NIKKEI 225	MSCI EM	S&P 500	MSCI WORLD	CAC 40	CAC 40
7 ^o	S&P 500	MSCI WORLD	MSCI WORLD	MSCI WORLD	STOXX 600	MSCI WORLD	STOXX 600
8 ^o	L.EUROPE (4)	CAC 40	FTSE 100	CAC 40	MSCI EM	STOXX 600	FTSE 100
9 ^o	FTSE 100	FTSE 100	GLOBAL+ EM (5)	L.ECONOM (5)	FTSE 100	G.EUROPE (2)	G.EUROPE (2)
10 ^o	IBEX 35	L.ECONOM (5)	NIKKEI 225	NIKKEI 225	G.EUROPE (2)	GLOBAL+ EM (5)	IBEX 35
11 ^o	L.ECONOM (5)	STOXX 600	L.ECONOM (5)	G.EUROPE (2)	NIKKEI 225	FTSE 100	GLOBA+ EM (5)
12 ^o	RUSSELL 2000	G.EUROPE (2)	L.EUROPE (4)	STOXX 600	L.EUROPE (4)	L.ECONOM (5)	L.ECONOM (5)
13 ^o	MSCI EM	GLOBAL + EM (5)	S&P 500	GLOBA + EM (5)	CAC 40	NIKKEI 225	NIKKEI 225
14 ^o	NIKKEI 225	L.EUROPE (4)	RUSSELL 2000	L.EUROPE (4)	IBEX 35	L.EUROPE (4)	L.EUROPE (4)
	MAX: 0.317 MIN: -0.043	MAX: 0.103 MIN: -0.314	MAX: 0.521 MIN: 0.211	MAX: 0.014 MIN: -0.247	MAX: 0.133 MIN: -0.144	MAX: 0.086 MIN: -0.082	MAX: 32.31 MIN: -6.91

Table 4: Sharpe ratio ranking. Source: Own elaboration

The results depicted in the previous table differ from the ones in the previous analysis. Portfolios that performed best (i.e. were less risky) in the risk-adverse scenario, here are the ones that present a worse risk-return relation (*L.EUROPE* and *L.ECONOMIES*) and vice versa. In addition, the local market portfolio – *IBEX 35* – seems to predominate in both time horizons, having a 6.2^o average ranking position in the medium-term horizon.

⁴ Numerical results are presented in the *Appendix II*



Figure 8: Sharpe ratio average ranking. Source: Own elaboration

There are some reasons why the portfolios obtained could not be the best option from a reward-to-variability perspective. First of all, just minimum variance portfolios were chosen, avoiding efficient portfolios of the efficient frontier with higher expected returns, as the expected returns estimation was not reliable. Secondly, some minimum variance portfolios are sacrificing profitability in a higher proportion than the reduction of risk or vice versa, leading to a lower Sharpe ratio. This proportion could be analysed by showing the relation of the standard deviation with the Sharpe ratio, as it is depicted in the following chart:

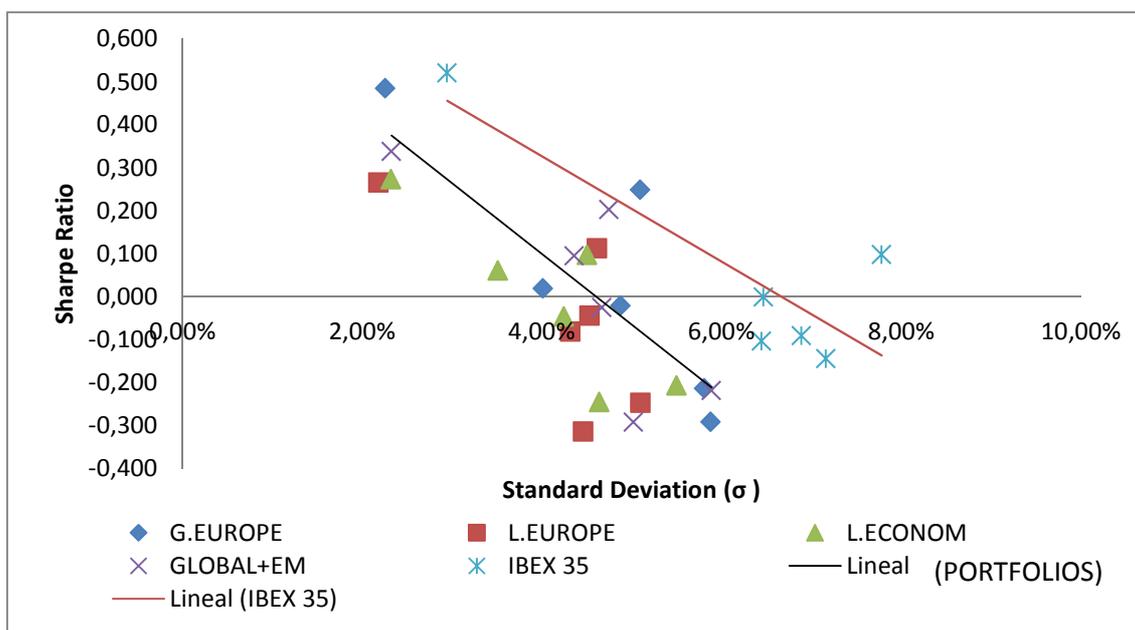


Figure 9: Sharpe ratio vs Standard deviation. Source: Own elaboration

The slopes of both MV portfolios and *IBEX 35* show how lower standard deviations should lead to higher Sharpe ratios and vice versa. However, the *IBEX 35*'s slope is flatter, meaning that a higher Sharpe ratio could be achieved with the same level of risk in comparison to the MV portfolios. Furthermore, the aforesaid proportion problem is clearly highlighted in this chart: the MV portfolios reduce the *IBEX 35*'s standard deviation from 6-7% to 4-5%, but reducing the return in a greater proportion and thus, decreasing the Sharpe ratio. Besides, this is the main reason why *L.EUROPE* and *L.ECONOM* portfolios present the worst reward-to-variability relation, while the *G.EUROPE* portfolio has the best Sharpe relation.

Finally, the long-term horizon presents very similar results to the medium-term horizon, with the exception of the *IBEX 35* in the global accumulated results. In this particular case, the so-called local market portfolio decreases five positions in comparison with the global average results. This is because the high returns obtained during the 1999-2007 period was almost faded out in the recession period of 2008-2012, leading to a lower accumulated profitability in comparison

with the average profitability and given the same variability (i.e. standard deviation).

5.1. Risk-Return Analysis: Treynor Ratio

The following analysis will be based on the Treynor ratio. It is very similar to the previous Sharpe ratio analysis, but it takes into account the systematic risk of return or non-diversifiable risk instead of the total risk. Results are presented in a descending order, from higher to lower Treynor ratio⁵.

	98'-00'	01'-03'	04'-06'	07'-09'	10'-12'	Global	Global*
1º	CAC 40	MSCI EM	IBEX 35	MSCI EM	RUSSELL 2000	MSCI EM	MSCI EM
2º	G.EUROPE (2)	RUSSELL 2000	STOXX 600	DAX 30	DAX 30	RUSSELL 2000	RUSSELL 2000
3º	STOXX 600	IBEX 35	G.EUROPE (2)	IBEX 35	S&P 500	DAX 30	DAX 30
4º	DAX 30	S&P 500	L.EUROPE (4)	RUSSELL 2000	GLOBAL+ EM (5)	S&P 500	S&P 500
5º	GLOBAL+ EM (5)	DAX 30	CAC 40	FTSE 100	L.ECONOM (5)	IBEX 35	MSCI WORLD
6º	S&P 500	MSCI WORLD	MSCI EM	S&P 500	MSCI WORLD	CAC 40	CAC 40
7º	MSCI WORLD	CAC 40	DAX 30	MSCI WORLD	STOXX 600	MSCI WORLD	STOXX 600
8º	L.EUROPE (4)	FTSE 100	FTSE 100	CAC 40	MSCI EM	STOXX 600	FTSE 100
9º	IBEX 35	STOXX 600	NIKKEI 225	L.ECONOM (5)	FTSE 100	G.EUROPE (2)	G.EUROPE (2)
10º	FTSE 100	L.ECONOM (5)	MSCI WORLD	G.EUROPE (2)	G.EUROPE (2)	GLOBAL+ EM (5)	IBEX 35
11º	L.ECONOM (5)	GLOBAL+ EM (5)	GLOBAL+ EM (5)	STOXX 600	NIKKEI 225	FTSE 100	GLOBAL+ EM (5)
12º	RUSSELL 2000	G.EUROPE (2)	L.ECONOM (5)	GLOBAL+ EM (5)	L.EUROPE (4)	L.ECONOM (5)	L.ECONOM (5)
13º	MSCI EM	L.EUROPE (4)	S&P 500	NIKKEI 225	CAC 40	NIKKEI 225	L.EUROPE (4)
14º	NIKKEI 225	NIKKEI 225	RUSSELL 2000	L.EUROPE (4)	IBEX 35	L.EUROPE (4)	NIKKEI 225
	MAX: 0.018 MIN: -0.003	MAX: 0.103 MIN: -0.16	MAX: 0.015 MIN: 0.005	MAX: 0.003 MIN: -0.012	MAX: 0.006 MIN: -0.008	MAX: 0.005 MIN: -0.004	MAX: 1.795 MIN: -0.345

Table 5: Treynor ratio ranking. Source: Own elaboration

The results presented above are almost equal to the ones presented in the Sharpe ratio analysis (see page...). However, it is possible to notice a little improvement in average ranking position of the medium-term horizon as well as in the long run, like it is shown in the following figure:



Figure 10: Treynor ratio average ranking. Source: Own elaboration

⁵ Numerical results are presented in the Appendix II

This improvement could be because minimum variance portfolios react better to systematic risk, as the non-systematic risk makes them less 'efficient' in terms of risk-to-return. In order to analyse this assumption, the next chart depicts the relation between the systematic risk and standard deviation for both portfolios and local market portfolio:

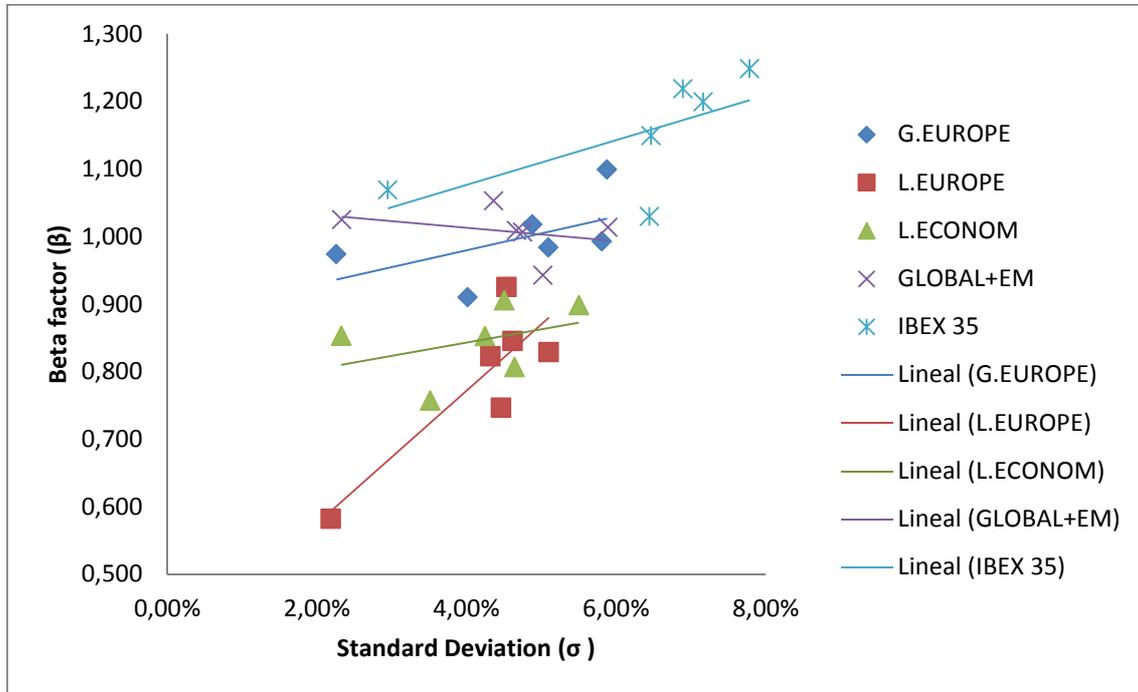


Figure 11: Beta vs Standard deviation. Source: Own elaboration

The *G.EUROPE*, *L.EUROPE*, *L.ECONOM* portfolios and the *IBEX 35* present a positive relation between the systematic risk and the standard deviation, as higher values of beta would lead to higher values of standard deviation. The *L.EUROPE* portfolio presents a greater slope, meaning that changes in the market risk or beta will affect smoothly its standard deviation. Indeed, the previous chart shows how *L.EUROPE*'s standard deviation is almost equal when the beta goes from 0.7 to 0.9. In addition, both *L.EUROPE* and *L.ECONOM* portfolios have a beta below 1 in all the periods, meaning that their returns are a bit inverse-related with the market proxy returns. This could be the reason why both portfolios are located at the bottom of the ranking

Finally, the *GLOBAL+EM* portfolio presents a negative relation between the beta and the standard deviation, meaning that lower values of market risk would increase its standard deviation. This relation could be somehow harmful for the portfolio risk, as a small decrease in its beta factor would lead to a substantial increase in *GLOBAL+EM*'s standard deviation and thus, destroying the effect of the diversification.

6. Conclusions

After an exhaustive analysis of the results obtained on the different perspectives, is it possible to draw some conclusions and answer the research questions set out at the beginning of this research.

A geographical portfolio diversification allows to a significant decrease on portfolio total risk, becoming a better option than just diversifying over one region or economy. For example, during the period of 2010 to 2012, a Spanish investor that would have chosen to invest in the *Global Leading Economies* portfolio instead of just invest in the *IBEX 35*, would have reduced its standard deviation or total investment risk from 7.17% to 3.51%. Indeed, this approach of international diversification would help to ease the negative effects of a recessionary period.

Nonetheless, the geographical portfolio diversification has some cons related with the profitability. As it was presented in the risk-return analysis, the minimum variance portfolios created underperformed according to the Sharpe and Treynor ratio. This is caused by diverse factors, such as the relation with the market proxy portfolio, the relation between the risk reduction and return, the volatility of the stock indexes used and so. Therefore, the results obtained provide enough foundation in order to make a general assumption: even portfolios geographically diversified sacrifice profitability to reduce their risk, making them not 'efficient' in terms of return.

Finally, it is important to related both risk and return with the components of each portfolio. It was posed if it is convenient to diversify in as many regions and markets as possible, and here the answer would be that it depends on the investor's aims. For example, a risk-adverse investor, that would like to reduce its risk even if it means a loss of profitability, will focus on developed and stable markets, while an investor that aims to reduce risk but keeping profitability will focus on more volatile markets. Indeed, in the previous analysis is reflected how more diversified portfolios, as the *Global Leading Economies and Emerging Markets*, present a higher risk than portfolios diversified over fewer markets, as the *Leading Europe* portfolio.

7. References

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	IBEX		STOXX600		S&P500		RUSSELL2000		FTSE100							
	RF	SD	RP	Beta	SD	RP	Beta	SD	RP	Beta						
98'-00'	0,17%	7,79%	0,93%	1,25	5,12%	1,31%	0,98	5,12%	0,99%	1,07	7,11%	0,53%	1,06	4,32%	0,63%	0,83
01'-03'	0,41%	6,89%	-0,22%	1,22	5,88%	-1,07%	1,12	5,28%	-0,34%	1,03	6,34%	0,59%	1,09	4,91%	-0,79%	0,91
04'-06'	0,20%	2,95%	1,73%	1,07	2,27%	1,33%	0,98	1,98%	0,70%	0,88	4,01%	1,05%	1,62	2,12%	0,94%	0,81
07'-09'	0,40%	6,45%	-0,26%	1,03	5,81%	-0,85%	0,98	5,75%	-0,50%	1,01	7,26%	-0,37%	1,21	5,23%	-0,25%	0,88
10'-12'	0,24%	7,17%	-0,80%	1,20	3,93%	0,35%	0,89	4,47%	0,78%	1,08	5,94%	1,02%	1,36	3,96%	0,31%	0,92
GLOBAL	0,28%	6,47%	0,28%	1,15	4,85%	0,21%	1,02	4,70%	0,33%	1,03	6,19%	0,56%	1,18	4,25%	0,17%	0,88
GLOBAL*	4,24%	6,47%	12,57%	1,15	4,85%	18,61%	1,02	4,70%	46,96%	1,03	6,19%	94,35%	1,18	4,25%	14,84%	0,88
	DAX30		CAC40		MSCI WORLD		MSCI EM		NIKKEI							
	SD	RP	Beta	SD	RP	Beta	SD	RP	Beta	SD	RP	Beta				
98'-00'	6,81%	1,40%	1,18	6,06%	2,09%	1,07	4,50%	0,92%	1,00	7,69%	0,31%	1,34	6,16%	-0,09%	0,83	
01'-03'	9,47%	-0,88%	1,76	7,09%	-1,16%	1,33	5,07%	-0,57%	1,00	6,20%	1,05%	1,02	5,96%	-0,53%	0,04	
04'-06'	3,11%	1,47%	1,35	2,58%	1,27%	1,07	2,05%	0,99%	1,00	4,14%	1,84%	1,66	4,09%	1,42%	1,44	
07'-09'	6,89%	-0,05%	1,17	6,14%	-0,76%	1,05	5,56%	-0,62%	1,00	7,42%	0,50%	1,17	7,12%	-1,09%	1,07	
10'-12'	5,60%	0,84%	1,14	5,16%	-0,09%	1,15	4,06%	0,41%	1,00	4,16%	0,33%	0,90	5,59%	0,11%	1,03	
GLOBAL	6,69%	0,56%	1,33	5,69%	0,27%	1,16	4,42%	0,23%	1,00	6,08%	0,80%	1,12	5,86%	-0,04%	0,93	
GLOBAL*	6,69%	80,20%	1,33	5,69%	21,41%	1,16	4,42%	25,89%	1,00	6,08%	200,64%	1,12	5,86%	-31,88%	0,93	
	G.EUROPE		L.EUROPE		L.ECONOM		GLOBAL+EM									
	SD	RP	Beta	SD	RP	Beta	SD	RP	Beta							
98'-00'	5,10%	1,44%	0,98	4,62%	0,69%	0,85	4,51%	0,61%	0,91	4,75%	1,13%	1,01				
01'-03'	5,88%	-1,31%	1,10	4,46%	-0,99%	0,75	4,64%	-0,73%	0,81	5,02%	-1,06%	0,94				
04'-06'	2,26%	1,29%	0,97	2,19%	0,78%	0,58	2,33%	0,83%	0,85	2,33%	0,98%	1,03				
07'-09'	5,81%	-0,83%	0,99	5,10%	-0,86%	0,83	5,50%	-0,73%	0,90	5,89%	-0,88%	1,01				
10'-12'	4,02%	0,31%	0,91	4,53%	0,03%	0,93	3,51%	0,45%	0,76	4,36%	0,65%	1,05				
GLOBAL	4,88%	0,18%	1,02	4,32%	-0,07%	0,82	4,25%	0,08%	0,85	4,67%	0,16%	1,01				
GLOBAL*	4,88%	11,18%	1,02	4,32%	-25,63%	0,82	4,25%	-1,27%	0,85	4,67%	10,16%	1,01				

Appendix I

	IBEX		STOXX600		S&P500		RUSSELL2000		FTSE100	
	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor
98'-00'	0,098	0,006	0,223	0,012	0,160	0,008	0,051	0,003	0,106	0,006
01'-03'	-0,091	-0,003	-0,252	-0,011	-0,141	-0,005	0,029	0,004	-0,244	-0,011
04'-06'	0,521	0,015	0,498	0,012	0,252	0,006	0,211	0,005	0,350	0,010
07'-09'	-0,104	-0,004	-0,215	-0,010	-0,157	-0,007	-0,107	-0,004	-0,125	-0,005
10'-12'	-0,144	-0,008	0,030	0,002	0,123	0,0057	0,133	0,0063	0,020	0,002
GLOBAL	-0,0009	-0,0001	-0,0141	-0,0007	0,0092	0,0004	0,0455	0,0024	-0,0270	-0,0013
GLOBAL*	1,2874	0,1069	2,9611	0,1805	9,0870	0,4534	14,5487	0,7996	2,4963	0,1658
	DAX30		CAC40		MSCI WORLD		MSCI EM		NIKKEI	
	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor
98'-00'	0,181	0,010	0,317	0,018	0,167	0,008	0,018	0,012	-0,043	-0,003
01'-03'	-0,136	-0,006	-0,221	-0,010	-0,192	-0,007	0,103	0,009	-0,158	-0,160
04'-06'	0,409	0,010	0,416	0,010	0,386	0,008	0,396	0,010	0,298	0,009
07'-09'	-0,066	-0,002	-0,189	-0,009	-0,184	-0,008	0,014	0,003	-0,210	-0,012
10'-12'	0,108	0,0059	-0,062	-0,002	0,044	0,002	0,022	0,002	-0,022	-0,001
GLOBAL	0,0409	0,0021	-0,0019	-0,0001	-0,0125	-0,0006	0,0858	0,0047	-0,0547	-0,0034
GLOBAL*	11,3559	0,6017	3,0164	0,1823	4,8946	0,2561	32,3106	1,7947	-6,1590	-0,3450
	G.EUROPE		L.EUROPE		L.ECONOM		GLOBAL+EM			
	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor
98'-00'	0,249	0,013	0,112	0,006	0,097	0,005	0,203	0,010		
01'-03'	-0,292	-0,013	-0,314	-0,016	-0,245	-0,011	-0,292	-0,013		
04'-06'	0,484	0,012	0,266	0,010	0,273	0,008	0,338	0,008		
07'-09'	-0,213	-0,010	-0,247	-0,012	-0,207	-0,010	-0,218	-0,010		
10'-12'	0,019	0,002	-0,044	-0,001	0,060	0,004	0,095	0,005		
GLOBAL	-0,0212	-0,0010	-0,0816	-0,0043	-0,0467	-0,0023	-0,0253	-0,0012		
GLOBAL*	1,4221	0,1070	-6,9133	-0,3150	-1,2981	-0,0182	1,2679	0,0979		

Appendix II