Transition to the Euro and Its Impact on Country Portfolio Diversification

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Abstract

We examine the impact of the introduction of the Euro on stock markets and on country diversification within the Euro-zone. We find that the abnormal return in the stock market is statistically negative under Euro currency than past European currencies for Belgium and the Netherlands stock markets while there is no impact on other major European stock markets. For minor player-countries the market reaction was concerned about the increased likelihood of some sort of financial problem after the introduction of the single currency. The evidence does not suggest a high risk to the stock market that could justify a risk premium as a result of currency union. Moreover, although Euro market integration has increased the inter-country correlations, it does not preclude the gains from international diversification which partially relies on the non-Euro countries for an optimal portfolio in a mean-variance framework.

Furthermore, since correlation stability is crucial to the size of the potential benefits from such diversification, additional insights into the inter-temporal behavior of international correlations are provided. Indeed, the evidence supports that there is a great deal of stationarity of average correlations over time between pre-Euro and post-Euro periods and it has improved since the introduction of the Euro. Also, the result shows that the Euro produced a change in volatility with a different pace within the Euro-zone vis-à-vis non-Euro countries to support a direct and opposite relationship between volatility and correlation.

Keywords: Euro; International diversification; Volatility; Serial correlation stability; European stock markets; Prospects of the Euro; Benefits of monetary union.

JEL Classification: F37, F33, G11, G15 , F21, C25.

1 Introduction

Monetary unions are groups of countries that share a currency, usually share geographical borders, but not always; and often have close trade and other financial relationships. The Euro is the largest and best-known monetary union is the "Euro-zone" utilized by 12 of the 15 countries in the European Union.[1]

[1] Also, the six Arab Gulf states plan to ask the European Central Bank for guidance on how to implement a single regional currency. The six states are Saudi Arabia, Qatar, Bahrain, Oman, Kuwait, and the United Arab Emirates. The six states aim to achieve a single currency by 2010. Southern African countries aim for monetary union by 2016. Countries within the 13-member Southern African Development Community (SADC) have decided to achieve monetary and economic union by 2016, South Africa's central bank governor Tito Mboweni said on Monday February 28, 2005. "The idea as I said is that by about 2016 there should be a SADC monetary union – by definition a SADC common currency," Mboweni told reporters in reply to a question.

"What the currency is going to be I don't know – that will be a subject of negotiation and discussion." Mboweni was speaking after a meeting of SADC central bank governors in Cape Town, which was also attended by European Central Bank President Jean-Claude Trichet.

The 12 members are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain.

Since the birth of the European currency (Euro), the European popular press has been flooded with reports about whether the Euro or the past non-euro currency is better for the European stock market. In January 1999, a group of members of the European Union (eleven states) decided to form an island of fixed exchange rates among themselves. Considering the possibility that up to ten countries that recently joined the European Union (EU) or some of them may adopt the Euro afterward, the transaction domain of the Euro may become larger than that of the U.S. dollar in the near future as the "accession countries" fulfill the monetary requirements one-by-one.[2]

Recently the Noble Price winner Mundell (2000) stated "The creation of the euro area will eventually, but inevitably, lead to competition with the dollar area, both from the standpoint of excellence in monetary policy, and in the enlistment of other currencies."

This strategy has been initiated by adopting various preliminary steps such as the integration and co-ordination of the member countries' monetary and fiscal policies, and the establishment of the European Central Bank (ECB) in Frankfurt, Germany, to regulate banks within the European borders and to issue the Euro.

The introduction of the Euro in1999 represents a momentous event in the history of world financial system that has had profound ramifications for the world economy, for various aspects of international finance, and most likely for other potential monetary unions (e.g., Gulf Arab States and Southern African Development Community (SADC) unions). Due to the strong trade relationships among European countries, the perceived benefits of the Euro are great. The creation of a single currency will improve market goods and services and capital will move easily without restrictions, to establish a more larger efficient market (e.g., Cheung and Westermann (2001); Seeder (2003); Billio and Pelizzon (2003); Hasan and Lothian (2004)). Since its

[2]The European Union (EU) is a union of twenty-five independent states based on the European Communities and founded to enhance political, economic and social co-operation. As of May 1, 2004 the members in the EU are Austria (EUR), Belgium (EUR), Denmark (DKK), Finland (EUR), France (EUR), Germany (EUR), Greece (EUR), Ireland (EUR), Italy (EUR), Luxembourg (EUR), the Netherlands (EUR), Portugal (EUR), Spain (EUR), Sweden(SEK), Switzerland (CHF, not a member of the European Union), United Kingdom of Great Britain (GBP) and Northern Ireland. Ten countries joined the EU on May 1, 2004: Cyprus (Greek part), the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. The EU may expand in the near future to include other countries such as formerly socialist countries Georgia, Ukrania, and possibly Turkey. (EUR: Euro currency).

inception in 1999, the Euro has already brought about revolutionary changes in European finance. For instance, by redenominating corporate and government bonds and stocks from twelve different currencies into the common currency, the Euro has precipitated the emergence of continent-wide capital markets in Europe that are comparable to U.S. market in its depth and liquidity.

The EU is a prime example of the establishment of the European community to foster economic integration among the countries of Western Europe. The initiation of the Euro has caused a wave by European companies to seek pan-European and global alliances. Merger and acquisition (M&A) deals in Europe totaled $1.2 trillion in 1999, exceeding the figure for U.S. deals for the first time.

European Monetary System (EMS) and Euro benefits

European Union members met at Maastricht, the Netherlands, and signed the Maastricht Treaty. According to the treaty, the EU would irrevocably fix exchange rates among the member currencies by January 1, 1999 and subsequently introduce a common European currency, replacing individual national currencies. The European Central Bank (ECB) in Frankfurt, Germany, will be solely responsible for the issuance of common currency and conducting monetary policy in the European Union. National central banks of individual countries would then function like regional member banks of the U.S. federal reserve system.

To pave the way for the European Monetary Union (EMU), the member countries of the European Union agreed to closely coordinate their fiscal, monetary and exchange rate policies and achieve a convergence of their economies (control budget deficit, control public debt, maintain price stability and prescribed exchange rate ranges).

As the Euro was introduced, each national currency of the Euro 11 countries was fixed to the Euro at a conversion rate as of January 1, 1999.[3] On January. 1, 2002 Euro notes and coins were introduced into circulation while national bills and coins were gradually withdrawn, and the changeover was completed by July 1, 2002.

Knowing that the weight of the European stock markets on the world stock portfolio was lower than 30%, companies all over the world could benefit from this development as they were able to raise capital more easily on favorable terms in Europe. In addition, the recent surge in European M&A activities, cross-border

[3] Greece joined Euro club in January 2001 when it could satisfy the convergence criterion.

alliances among financial exchanges, and the lessening dependence on the banking sectors for raising capital were all manifestations of the profound effects of the Euro.

The members of the EU believed the benefits from such a union would outweigh the associated costs in contrast to those eligible countries that chose not to adopt the new currency. Thus, it is important to understand the potential benefits and costs of monetary union.

The main benefits of adopting a common currency are a reduction of transaction costs and the elimination of exchange-rate uncertainty. These savings would accrue to practically all economic agents, benefiting individuals, companies, and governments. Although it is difficult to estimate accurately the magnitude of foreign-exchange transaction costs, a consensus estimation is around 0.4% of Europe's gross domestic product (GDP).

Economic agents should benefit from the elimination of exchange-rate uncertainty. Companies will not suffer currency loss anymore from intra-Euro-zone transactions. Companies that used to hedge exchange risk will serve hedging costs. Also, consumers can benefit from comparison shopping, as it becomes easier because of the common currency. An increased price transparency will promote Europe-wide competition, exerting a downward pressure on prices.

Reduced transactions costs together with the elimination of currency risk will have the net effect of promoting corss-border investment and trade within the Euro-zone.

By furthering the economic integration of Europe, the single currency will promote corporate restructuring through M&As, encourage optimal business location decisions, and ultimately strengthen the international competitiveness of European companies. Thus, the enhanced efficiency and competitiveness of the European economy can be regarded as the third major benefit of the monetary union.

The advent of the common currency also helps create conditions conducive to the development of continental capital markets with depth and liquidity comparable to those of the U.S. In the past, national currencies and localized legal/regulatory frameworks resulted in largely illiquid, fragmented capital markets in Europe, which prevented European companies from raising capital on competitive terms. The common currency and the integration of European financial markets pave the way for a European capital market in

which both European and non-European companies can raise money at a favorable rate.[4]

The main cost is the loss of national monetary and exchange-rate policy independence. Generally speaking, a country would be more prone to asymmetric shocks the less diversified and more trade dependent its economy is.

The Euro is as important a denomination currency as the dollar in international bond markets. Considering both the size of the Euro-zone economy and the mandate of the ECB, the Euro is likely to emerge as the second global currency in the near future, ending the dollar's sole dominance. The Japanese yen is likely to be a junior partner in the dollar-Euro condominium. However, the emergence of the Euro as another global currency may prompt Japan and other countries to explore cooperative monetary arrangement for the region.

The rest of the paper is structured as follows. Section 2 presents a short review of related studies. Section 3 outlines the suggested method, and introduces the data and the notation used in this paper. Section 4 discusses the impact of the Euro on the stock behavior and presents the initial results. Section 5 investigates whether the change of currency has influenced the benefits of the international diversification within the Euro-zone and within other non-Euro countries. In Section 6, hypotheses concerning the stationarity of inter-country correlation and volatility of returns across various Euro and non-Euro states have been tested. Finally, we conclude and present the research contribution schema in Section 7.

2 Related studies

The studies that investigated the Euro introduction are not limited. Several theoretical and empirical papers have also established a relationship between the introduction of the Euro, European economies, and financial market behavior (e.g., Buiter (1999); Danthine et al. (2000); Layard et al. (2002); Askari and Chatterjee (2005); Eiling et al. (2005)). According to a recent ECB report, the introduction of the Euro was expected to impact various of types of risks to which banks were exposed (ECB (1999)). That may include strategic, credit, market liquidity, credit institutions liquidity, settlement, operational, and legal. Each component of

[4] For a full discussion of the benefits and costs of the Euro, see Modigliani and Askari (1997)

those risks may be considered a research question by itself.

In a seminal work, Francis and Hunter (2004) examined the impact of the Euro on risk exposure of the major financial institutions. Since their study was interested in the cost of equity, they found that a statistically significant large decline in the cost of equity of the banking industries across the Euro-zone countries, non-Euro-zone European countries and three non-European countries after the introduction of the Euro.

Flavin (2004) examined the effect of the Euro on country and industry diversification. His results showed a shift in factor importance from country to industry. However, as he pointed out, the impact was present for non-European countries as well. Supported by Ammer and Mei (1996), Flavin (2004) did not focus on the economic fundamentals; in fact, he examined whether portfolio managers should emphasize geographical or industrial portfolio diversification after the introduction of the Euro.

Also, another shortcoming that could undermine the rigor of the study by Flavin (2004) is related to the sample structure. The author failed to use a sound method to distinguish the industrial sectors from geographical boundaries. The non-uniform distribution of companies across industrial sectors and across geographical boundaries in the sample could have been a source of the problem.

In fact, other studies have looked at the importance of country and industry factors in the international asset allocation. For example, using efficient tests Eiling et al. (2005) found that industry and country allocation were identical. Carrieri et al. (2004) found that increased country-level integration does not rule out industry-level segmentation. Also, they suggested that both international and industry diversifications are relevant to improve portfolio performance (e.g., Arshanapalli et al., 1997). Other factors could work in the opposite direction, for instance Goetzmann et al. (2002) found that episodes of integration were not only characterized by increased cross-country correlation but also by an expansion of the investment opportunity set.

Furthermore Flavin (2004) found that while his result was not confined to the Euro-zone, he admited that the decline in importance of country impacts may be due to factors other than the introduction of the Euro. Without investigating those factors that caused the shifts from country to industry portfolio, we deem

that the research question discussed by Flavin (2004) was not answered. For example, Campbell and Hamao (1992) showed that economic fundamentals, such as interest rates and dividend yields helped to explain U.S. and Japanese market co-movement. Flavin (2004) admited that a longer post-Euro sample would be needed to verify this. In his study, he used 48 observations (47 returns) before the Euro and 48 observations (47 returns) after the Euro for each company in his sample. Conversely, Karolyi and Stulz (1996) found little evidence that macroeconomic announcements or shocks to exchange rates or interest rates influence US and Japanese stock return correlations.

Koedijk et al. (2004) studied the impact of the introduction of the Euro on the behavior of real exchange rates. Bartram and Karolyi (2003) found that most of the impact of the introduction of the Euro came through a reduction in non-currency related risk, while De Santis et al. (2003), on the other hand, predicted that the introduction of the Euro would not have a significant effect on currency risk premium. Moreover Von Hagen et al. (1994) identified Austria, Belgium, France, Luxemburg, the Netherlands, and Germany as nations that satisfy the conditions for an optimum currency area. However, Denmark, Italy, and the United Kingdom do not satisfy those conditions. It is interesting to note that Denmark and the United Kingdom actually chose to stay out of the EMU. Von Hagen et al. (1994) suggested that Italy joined the EMU prematurely.

Recently Askari and Chatterjee (2005) looked at the benefits of the Euro, which includes lowering the cost of capital and establishing of a unified capital market. However, their study suggests that the gain is shared by the non-Euro-zone European countries. They studied the correlation between interest rates (nominal and real), and stock-market index returns (adjusted and unadjusted into common currency) before and after the Euro introduction for three different groups of countries (Euro-zone European countries, non-Euro-zone European countries, and three countries outside the European Union (i.e. Japan, the United Kingdom and Switzerland). The result is somewhat puzzling. Although the result does confirm that correlations are higher among the EU countries in general and among the Euro-zone EU countries and lower between non-European countries and European countries, it also shows that the correlation is higher between non-adopters of the Euro. That result grants support to the authors's claim that the introduction of the Euro benefited the

non-Euro-zone countries with a lower cost of capital.

Morana and Beltratti (2002) investigated the effect of the introduction of the Euro on the volatility of European stock markets. They investigated whether the Euro decreases variance of stock returns for historically unstable stock markets. They used daily data from January 1988 to May 2000 and applied the three-regime Markov Switching Model. They found that the introduction of the Euro had stabilized the Spanish and Italian stock markets. But their paper notably explored the consequences of the convergence process associated with the Euro on European stock markets and attempted to examine whether the convergence of the European economies had been associated with some form of convergence of European stock returns. Since the post-Euro sample period of the study by Morana and Beltratti (2002) is relatively short, it is not clear if their results will stand up over a longer sample period.

Contrary to the study by Morana and Beltratti (2002), which included France, Germany, Spain, Italy, the United Kingdom, and the United States, we attempt to extend the sample by using other countries in the Euro-zone (the Netherlands and Austria), other non-Euro European countries (Switzerland and Denmark). Moreover, following Ferson and Harvey (1999) we test the impact by loading on lagged variables to examine the behavior of European stock markets.

Furthermore, in contrast to the limited sample size of past studies that investigated the Euro introduction, seven years after the introduction of the Euro, we believe that our results will stand up with a longer sample period. For instance, Morana and Beltratti (2002) evaluated the changes in volatility using daily stock returns for just four Euro-zone members, namely France, Germany, Spain, and Italy over the period January 1, 1988 to May 26, 2000.

The purpose and contribution of the paper is to formally test the relation between the introduction of a monetary union (the Euro in this case) and the stock market, to examine the robustness of this relationship, investigate cross-sectional returns over three consecutive but different time periods from January 1993 to April 2006.

Building on past literature, the paper tackles the issues from the point of view of a Euro investor. Thus, the American and non-Euro indexes are converted into the Euro so that Euro returns contain gains or losses

on both the stock market and exchange rate changes. The American stocks, which represent non-European stocks, are included mainly for comparison purposes.

These related studies raise six questions that we attempt to answer empirically using a longer post-Euro sample to avoid shortcomings of past studies:

- Does the advent of the Euro positively or negatively influence the return of the stock market in the Euro-zone countries?
- Is the impact of the Euro on the stock behavior consistent for the European non-Euro countries?
- Does the monetary union, like the Euro in this case, undermine the benefit of the international diversification?
- Are returns of the European country stocks more volatile before or after the introduction of the Euro?
- How much of a difference in the inter-temporal stability of international return correlation coefficients does the investor see? Correlation stability is crucial to the size of the potential benefits from such diversification, and it is important that the correlation among key parameters may or may not be a reliable guide for future portfolio decisions.
- Has the introduction of the Euro impacted the volatility of the stock markets? Do the stationarity properties of the serial volatilities of the European stock markets vary significantly with time after the Euro?

3 Data and methodology

Description of data: We used stock returns from the major stock indexes. These include five countries in the Euro-zone (Austria, Belgium, France, Germany, and the Netherlands), three non-Euro-zone European countries (Denmark, Switzerland, the United Kingdom), and one non-European country (the United States). The data were obtained from Datastream and cover the period January 1993 to April 2006. The entire sample period for each country contains 695 observations, and all series are at weekly frequency. We analyzed the data over the three consecutive but different time periods:

Maastricht Treaty discussion period: January 1993 to December 1995; convergence period: January 1996 to December 1998; and the Euro introduction period: January 1999 to April 2006. Following Askari and Chatterjee (2005), the first and second periods were selected based on two dates. The Maastricht Treaty was signed on 7 February 1992. The begining of the period of convergence was January 1996, when the markets started to learn about the steps undertaken toward completing the convergence criteria. So, all Euro-zone members were engaged in adjusting their national economic policy during that period. In this essay, while dealing with different foreign exchanges such as the United Kingdom and others, we take a Euro perspective. In this section, we describe the variables. For the purpose of precision, the data are further classified into financial variables, and currency variables.

We analyzed the data over three consecutive but different time periods, as shown below:

Period 1: January 1993 to December 1995 - Maastricht Treaty discussions.

Period 2: January 1996 to December 1998 - Period of convergence.

Period 3: January 1999 to April 2006 - Following the launch of the Euro.

Weekly returns were computed for all country stocks, using the following equation:

$$R_{i,t} = Ln\left(\frac{I_{i,t}}{I_{i,t-1}}\right) \tag{1}$$

where $I_{i,t}$ is the value of the stock market index in country i at the end of week t.[5]

The U.S. stock index in this study is based on the S&P 500 index (labeled US_500). The other indexes represent the staple portion of the country news report, which are the best-known measures of the performance of the country stock markets.[6]

A. Financial variables

We use the log weekly returns (R_{it}) of the index of country i included in the sample.

B. Currency variable/market learning variable

We define the following dummy variables as:

[5] Foreign currency values were adjusted into European currency using weekly averages of exchange rates. Data for exchange rates were taken from the Pacific Exchange Rate Service (PERS) at UBC.

[6] It is assumed in this study that different methods in computing these indexes have no effect on the correlations. Also, we note that the replicability and investibility of these indexes can be questioned, but they still carry an important representative feature that permits the capture of any existing international opportunities.

$K_{it} = 1$ when the market i starts to learn about the steps toward the Euro, $= 0$ otherwise.

$d_{it} = 1$ if a Euro currency is adopted by country i, $= 0$ otherwise.

C. Theoretical Efforts and Equations

To measure the relation between returns and the market learning variable, we run the following regressions, using a similar approach as suggested by Schwert (1990), over the full period.

$$R_{it+1} = \delta_i + \gamma_i K_{it} + \epsilon_{t+1}. \tag{2}$$

No impact of the undertaken steps toward completion of the convergence criteria (market starts to learn about the Euro) requires γ_i to be insignificantly different from zero. R_{it+1} is the return on stock from country i at time $t + 1$, the timing of the variables supports that the market learning variable is known at the start of the return period, and K_{it} is a dummy variable equal to 1 on event week (market learning event: January 1996) $K_{it} = 1$ when the market i starts to learn about the steps toward the Euro, $= 0$ otherwise.

To measure the relation between returns and currency variable, we run the following regressions, using a similar approach as suggested by Schwert (1990), over the sample period.

$$R_{it+1} = \alpha_i + \beta_i d_{it} + \epsilon_{t+1}, \tag{3}$$

where returns are denoted by R_{it+1} and the currency variable by d_{it}. Under the null hypothesis of currency union having no impact we should see $\beta_i = 0$ in the regression result. The timing of the variables supports that the currency variable is known at the beginning of the return period.

4 The Impact of the introduction of the Euro

Nine countries over the period 1993 to 2006 were examined. All series are at a weekly frequency. The full sample period, January 1993 to April 2006, contains 695 weekly observations per country. Table 1 shows the mean rates of return and standard deviation of common stocks for selected countries over the sample period.

[TABLE 1 HERE]

Table 1 shows the annualized average weekly rate of return on common stocks for the period 1993-2006 ranged from 6.33% for the United Kingdom to 12.46% for Austria. Denmark has shown a 12.62% return, which almost equals the mean of Austria while the Austrian risk level (standard deviation) is higher than Denmark.

A number of countries have shown high standard deviations greater than 10%, such as Switzerland, Denmark, and Austria, while others, including the United States, have less than 10%. It is also noted that the mean return of the United States is less than Germany while the risk is greater in Germany. But as is suggested in the next analysis, the European investor could gain from international diversification by holding stocks from other countries, such as Austria or the United Kingdom.

[FIGURE 1 HERE]

Figure 1 depicts the relationship between the annualized mean weekly returns and their corresponding annualized standard deviation of weekly returns. It clearly shows that a number of countries have high returns (Denmark, Austria, Belgium, and Switzerland) but with high risk while other countries have shown low risk but with less return (the United Kingdom and the United States). Of course the dominance effect is visible in the case of the Netherlands and Germany, which are dominated by Austria and Switzerland. As long as the correlation coefficient between various countries stocks is less than 1.0, we suggest that the benefits of such diversification could be achieved.

Table 2 presents results of the impact of the undertaken convergence steps on the market returns of the nine countries in our sample.

[TABLE 2 HERE]

Under the null hypothesis of market learning about the Euro currency having no impact on returns, we should have $\gamma_i = 0$ for the country that adopted the Euro currency in the regression. Based on the result in Table 2 the market did not viewed or did not incorporate the information about the Euro and all the tests could not reject the null hypothesis.

To establish if there is indeed a difference between a Euro regime and a non-Euro regime, we proceeded to examine if the difference in realized returns could be explained by a difference in (ex-ante) expected returns with Equation (3) using currency variable by d_{it}. Under the null hypothesis of currency union having no impact we should see $\beta_i = 0$ in the regression result.

If $\beta_i \neq 0$ in Equation (3) that means the return contains information that can be explained by currency union being adopted.

[TABLE 3 HERE]

To investigate whether the market participants believed that the advent of the Euro held particular significance for them, we include a dummy variable that equals one if the Euro was adopted at time t, and equals zero otherwise. The null hypothesis in this case is that potential effects of the Euro on the market return is significant not only in the case of Belgium and the Netherlands, Euro-zone countries, but also Switzerland. The Durbin Watson (D.W.) statistics indicate the absence of first-order autocorrelation in the residuals. The coefficients are statistically significant for three countries and they are not significant for the others. Based on the result it is visible that the impact of the introduction of the Euro was not similar for all Euro-zone countries. We observe negative abnormal returns on selected countries such as Belgium and the Netherlands while no impact on others countries, such as Germany and France. The German, Austrian and French markets did not believe that the introduction of the Euro held any particular significance, while the markets in Belgium and the Netherlands reacted negatively. It is possible that the indicated markets were concerned about the increased likelihood of sort of financial problems after the introduction. This was not the case for Germany and France as they were the major players behind the Euro (the German economy makes up nearly a third of the 12- country Euro-zone's GDP). Also, the results show that the introduction of the Euro had a significant negative impact on the Swiss market. Like all markets, the currency market is affected by world events; key political events can have a big impact on an economy and the value of its respective currency. Also, currency traders closely follow the Swiss equity market to predict how the swiss currency (CHF) will perform against the Euro. There is a high correlation between the performance of the Swiss stock market and the CHF (against the Euro).

5 The Euro and benefits from the international diversification

5.1 The Euro and correlation structure

In this section, we perform the statistical analysis on the full period and three subsamples. The first subsample (period 1), January 1993 to December 1995, represents the Maastricht Treaty discussions period. It contains 155 observations. The second subsample (period 2), from January 1996 to December 1998, spans the convergence period, and contains 157 observations. The third subsample (period 3), from January 1999 to April 2006, includes the launch of the Euro and contains 383 observations. Past studies (Danthine et al. (2000); Flavin (2004); Francis and Hunter (2004)) that look at the diversification issue after the introduction of the Euro suffer from few shortcomings, which we attempt to preclude. For example, some studies used a small sample size, while others did not articulate the issue using various subsamples (e.g., Askari and Chatterjee (2005)) to capture the time period when the inter-country correlation coefficients were indeed increased.

In relation to our investigation, Errunza et al. (1999) examined whether trading abroad is necessary to gain from international diversification, or it is possible for domestically traded assets to mimic the behavior of global indexes. Their results showed that investors no longer need to trade abroad to obtain an internationally mean-variance efficient portfolio. Also, they pointed out that due to changes in investment barriers, including rules governing foreign portfolio investments and national events, the incremental gain from international diversification is reduced over time.

Errunza et al. (1999) stated

> The use of return correlations at the market index level to infer gains from international diversification involving foreign-traded assets as it is commonly practiced in academia and the investment industry over-states the potential benefits. The gains must be measured beyond those attainable through home-made diversification. Indeed, the need to hold assets that trade only abroad to obtain international diversification benefits is fast disappearing.

Therefore, it is often said that as capital markets around the world become more integrated over time, the gains of diversification will be reduced. This inference was achieved by comparing selected correlation coefficients between stock markets for different time periods, and the overall picture shows that correlations have increased over time. Yet, although capital-market integration has decreased some benefits of interna-

tional portfolio diversification, the correlation coefficients between markets are still far from a perfect positive correlation. Thus, there are plenty of risk-reduction opportunities for international portfolio diversification by holding international assets abroad.[7]

In addition, many empirical papers find that the benefits due to international asset diversification are still present despite increasing integration across financial markets in both stock markets (Grauer and Hakansson (1987), Santis and Gerard (1997)) and in the face of time-varying correlations (e.g., Ang and Bekaert (2002)).

[TABLE 4 HERE]

The correlation coefficients and the average pair-wise correlations per period between 1993 and 2006 are computed, following Goetzmann et al. (2002). Table 4 provides the correlations of the selected major markets in the sample during the full period and over the three subsamples.

Consistent with Adjaoute and Danthine (2004), the convergence period (period 2) was less favorable to portfolio diversification than the post-Euro period. But the causes of this circumstance are due to the beginning of the financial integration that is specified by the convergence of many economic forces and fundamental variables known to forecast the stock market as controls for business cycle fluctuations. Notably, some evidence suggests that macro-variables related to the business cycle can forecast stock-market returns (see Chen et al. (1986), Fama and French (1988), Campbell (1991); He and Ng (1994)). The use of these variables have been presented in past research by Campbell and Shiller (1988) and Fama (1991).

Initially focusing on the Euro-zone correlations, we can see that there is significant variation and rise in the correlation coefficients, as one would expect, from period 1 to period 3. We note that the rise of the correlation coefficients was achieved before the introduction of the Euro in January 1999 during the convergence period. Also, the average correlation during the Maastricht Treaty discussions period is 0.45 including non-Euro-zone countries, suggesting an important visible gain from country diversification. While during the convergence period the benefits from international diversification, especially within the Euro-zone countries have been significantly lowered but the gains are still moderate with the non-Euro countries, the

[7] Many national economies are dominated by only a few industries, and stock markets retain a distinctive national character and are only loosely linked to other markets. It is easy to find examples of national markets with firms concentrated in a few industries. Oil and construction companies dominate the economies of Saudi Arabia and its Persian Gulf neighbors. The economies of Brazil and Indonesia are similarly dependent on their natural resources. Stock markets in these countries reflect international commodity prices and hence the fortunes of the local economy.

United States, the United Kingdom, Denmark, and Switzerland.

After the official introduction of the Euro, evidence showed that correlations coefficients among some Euro zone countries have been reduced (higher diversification gains), such as Austria, whereas it shows an improvement in the other coefficients including the non-Euro-zone stocks. It is well known that the strength of the Austrian economy, which is surrounded by larger neighbors, comes from prosperous small and medium-sized firms which are often family-owned and have traditionally depended upon their banks for capital (Holzl and Reinstaller (2005)). Furthermore, over the past few years, Austria has experienced an economic policy that differs from the rest of Euro-zone countries, and the business climate has shown strength and domestic demand slowly gathered momentum during 2004. Also, the favorable position of its manufacturing sector in terms of price competitiveness along with Austria's strong ties with the more dynamic central and eastern European economies.

Thus, as one would expect to see a rise of the correlation coefficients but this result casts doubt on past studies which asserted that the introduction of the Euro had improved the correlation coefficients among the Euro-zone. If that is the case, we should see the same result for Austria but not for Denmark or the United Kingdom. Yet the possibility of a cyclical effect as suggested by Adjaoute and Danthine (2004) could provide a partial explanation since other non-Euro zone countries have experienced an improvement. Another potential explanation is that the effect of monetary union on diversification had been consumed and depleted just before the advent of the Euro and the correlation coefficients among the Euro-zone countries and non-Euro countries will return to their normal patterns and variations. The existence of a relatively moderate degree of correlation coefficients within the Euro-zone suggests that risk reduction might be achieved by diversifying equity portfolios within. Thus, the potential gain from country diversification will be further observed. Our results clearly contradict the result presented in past studies such as Flavin (2004). We note that the significance of the result presented by Flavin (2004) is questionable.

Results confirm that correlation coefficients are significantly different in the three periods, which educe a challenge on the past studies. Flavin (2004) has shown that the correlation coefficients between the Euro-zone markets are lower during post-Euro. The reasons for this contradiction are due to (1) the limitation in

the sample data of past studies, since all of them have used small post-Euro samples, whereas this study used an extended post-Euro sample; (2) ignorance of using more than two subsamples (pre- and post-Euro) to see the impact of the Euro, if any, on the correlations, this study utilizes three subsamples following Askari and Chatterjee (2005); (3) the statistical significance of the correlation coefficients was not presented; (4) and a lack of use of other non-European stocks to control and see if the rise of correlations coefficients is a global effect that has nothing to do with the Euro currency, whereas this study used U.S. stocks (S&P 500 index) to notice that.

Focusing on the non-Euro market, Table 4 reports that low correlation coefficients between the U.S. stocks, and those of Denmark and Switzerland persist during the three subsamples as well over the full sample period. Moreover, since the argument for the gain from international diversification has been based on a low correlation between returns, the result displays low correlation coefficients. The highest correlation coefficients noticed outside the Euro-zone countries is between U.S. and U.K. markets since U.S. and British equity markets have shown a strong integration and interdependence, from 0.48 in period 1 to 0.74 in period 3. Aside from confirmation of a high positive correlation between the U.K. stock return and the U.S. stock return, results show that international stock diversification is limited (correlation coefficient $\rho \approx 0.74$ for various time horizon). This result is consistent with past studies such as Goetzmann et al. (2002).

Clearly a logical practical implication supported by the sample data, the correlation among key parameters in this study may not be a reliable guide for future portfolio decisions. How much of a difference in the stability of correlation coefficients the investor sees is addressed in the next section.

Thus, we observe a necessary but not sufficient condition that a European investor gains from international diversification with non-Euro-zone countries and Austria, but it is moderately possible with Euro-zone countries; however the benefit from international diversification is very limited between Germany, France, and the Netherlands. We could conjecture that countries that are geographically close to each other will show a high correlation coefficient.[8]

[8] Note here that international diversification gains require having foreign stocks that are not part of the domestic index.

5.2 International diversification: Composition of optimal portfolios

In a mean-variance framework, the following model (4) is used to search for the optimal proportions X_i which minimizes the variance of the portfolio for given expected rates of return.

$$\begin{cases} \underset{X_j}{Min} V(X) = Var\left[\widetilde{R}_P\right] = X^{'}DX \\ \text{Subject to} \quad AX = B \\ X_j \geqslant 0, j = 1, ..., N \end{cases} \tag{4}$$

where D is the variance-covariance matrix of the rates of return on investment in country i, j $(i, j = 1, ..., N)$ and it is a symmetric positive semidefinite matrix of order $N \times N$, A is the $2 \times N$ matrix of coefficients of the linear constraints, where $\mu_p = E[\tilde{R}_p]$ is the expected portfolio return. $B = \begin{pmatrix} \mu_p \\ 1 \end{pmatrix}$ is a 2-vector of the right hand side, and X is an N-vector of the decision variables. Past studies used a similar model to get the optimal vector X_j for various rates of return, to derive the efficient frontier, that is, the locus of efficient portfolios, and to show the benefits of such international diversification. By means of quadratic programming the optimal solution is achieved for the full period and subsample periods for all countries in the sample (Panel A), for all countries without U.S. stocks (Panel B), and for all Euro-zone countries in the sample (Panel C).

[TABLE 5 HERE]

Table 5 sets out the investment proportions of optimal portfolios in each period and shows the composition of the optimal portfolios over the sample period. Nine countries have been incorporated in the study, including Euro-zone countries, and only few countries have been shown to be included in the optimal portfolios.

In Panel A, when all the countries are included during period 1, the results show that 64.19% of investment is allocated to non-Euro countries (29.11% to U.S., 15.11% to Denmark, 15.90% to Switzerland, and 4.07% to U.K.) while 35.81% is allocated to Euro-zone countries Belgium and the Netherlands. In period 2 (convergence period) the optimal solution suggests allocating more to non-Euro countries with 66.30% in

total (Switzerland was not included), whereas 33.70% to Euro-zone countries Belgium and Austria. The result in period 2 is well understood since the correlation coefficients in the previous section have shown an increase during the convergence period, thus, one expects to see a greater allocation to non-Euro countries, notably the U.S. stocks, to gain the international diversification. Subsequently in period 3, after the Euro introduction, the optimal allocation suggested allotting more to Euro countries (54.88% in total, with the majority to Austria) and less to the non-Euro countries 45.12% in total mainly to Denmark, the United Kingdom and small proportions to the United States and Switzerland. This finding was expected since the correlation after the Euro in Austria has shown a significant low correlation against other major markets in the sample and its introduction could deliver a better risk-return relationship for an international investor.

In Panel B, to avoid the influence of the U.S. stocks on the investment decision since the results could be criticized, the fact the U.S. return can greatly alter the optimal solution, and we could not accurately capture the Euro impact on international diversification. Thus, to pave the way only for the stocks in Europe, we repeat the solution of model (4) assuming that the investment can be made in all countries except with the United States. In period 1, the optimal distribution again suggests allocating more to Euro-zone countries (51.36% in total), principally Belgium and the Netherlands, and a negligible portion to Austria, while 48.64% in total is allocated to non-Euro countries (14.07% to Denmark, 12.87% to the United Kingdom, and 21.70% to Switzerland). In period 2 (convergence period), the solution proposes a lower proportion to Euro countries (38.14% in total) while 61.86% in total to non-Euro countries, mostly to Denmark with a small portion to the United Kingdom. This result is more expected and visible than the one in panel A; it clear that during the convergence period, the investment decision suggested a higher allocation to non-Euro countries contrary to the Maastricht Treaty discussion period, when the investment decision suggested allocating more to Euro countries. This result clearly advises that the convergence period, has more effect on international diversification than the previous period.

Subsequently, during period 3 the optimal portfolio consists of 54.28% in total in Euro countries - mostly in Austria - while 45.72% in total in non-Euro countries (20.17% in Denmark, 17.84% to the United Kingdom, and 7.71% to Switzerland). These findings suggest that an investor who frequently balanced her international

portfolio may have chosen to follow a pattern by decreasing investment proportion during the convergence period and revising her position after the launch of the Euro. This analysis contributes to research related to the interaction of portfolio theory and monetary union, and is also of interest to investors who select their portfolios using the Markowitz-based model.

In panel C, removing non-Euro countries from our sample allows us to see if the gains of international diversification still exist within the Euro-zone countries in our sample. Following the same analogy as in the previous panel, the results show that Belgium, the Netherlands, and Austria are included in the optimal efficient solution during period 1, by allocating 44.44%, 50.86%, and 4.70% respectively. In period 2 (convergence period) investments in Belgium, France, and Austria account for a majority but only a negligible proportion of one of the portfolios is invested in Germany – Germany has a strong correlation with France – and 3.05% is invested in the Netherlands. After the Euro introduction, the optimal portfolio consists of 14.53% invested in France, 22.11% in Belgium, and Austria accounts for the majority with 63.36% of the total investment. It is obvious that the gains from international diversification still exist.

Although Euro-zone market integration has decreased some benefits of international portfolio diversification, the correlation coefficients between markets are still far from a perfect positive correlation situation, thus, the gains from international diversification are still available in the Euro-zone and are further even more impressive when other stocks from non-Euro countries are included. This finding does not support a minimal proportion to Euro-zone countries after the advent of the Euro.

Our analysis demonstrates that in an international context the set of portfolios of risky assets that maximize expected rate of return for any standard deviation was not influenced by the introduction of the Euro, but was clearly affected earlier during the convergence period. Consistent with previous studies (Errunza (1977)), it is clearly supported that the inclusion of the non-Euro countries could deliver a better risk-return relationship.

As each national market has made the necessary economic adjustments toward completion of the convergence criteria to adopt the Euro, the expected return that maximizes a set of portfolios shifts downward, indicating that the attainable efficient frontier is dominated by the perfectly non-Euro countries frontier.

Therefore, asset portfolio managers must adjust their portfolios to reflect the pre-Euro convergence period, and must recognize that an efficient frontier during the convergence period will offer a reward-to-dispersion ratio inferior to that of a frontier after the introduction of the Euro.

6 Stationarity of inter-country correlation and volatility

6.1 Inter-temporal stability of equity market correlations

Several studies (Errunza (1977); Bertoneche (1979); Lloyd et al. (1981)) have investigated the inter-temporal pattern of correlation coefficients in international stock diversification. They find that the most important criterion for diversification feasibility is to have a correlation coefficient less than 1 between countries under investigation. However, they noticed that the correlations were generally unstable over time. Errunza's (1977) finding supported that the efficient set of an international equity portfolio is stable in different periods. Watson (1980) tested the stability of the correlations after segmenting the data into various subperiods. He found that one out of 28 correlations was unstable in a statistical sense and the results shows little detection of correlation instability over time.

Lloyd et al. (1981) study found that 32% of the pairwise correlation coefficients changed significantly. The study by Maldonado and Saunders (1981), which is the most meticulous test of international stability of inter-country correlation coefficients, was conducted by using a database of monthly returns for four stock indexes from 1957 to 1978. They contended that splitting the data of international stock indexes into two subperiods is a poor test of inter-temporal stability since only two samples of the entire population of correlation coefficients are compared. In their study, the data were separated into 22 annual subperiods in which each country's index correlation with the U.S. index was computed.

In this section, using the weekly returns time series, the annual correlation coefficients (ρ_{ijt}) between stocks returns in all the countries over the sample period for each of the 14 years from 1993 to 2006 are computed. Table (6) shows the annual correlation coefficients between national stocks along with the average pairwise correlation among the nine major markets for 1993, 1996, 1999, 2002, and 2005.[9]

[9]For space limitation the full serial inter-country correlation coefficients from 1993 to 2006 is not reported but available

[TABLE 6 HERE]

Quick observation of Table 6 suggests that the average cross-country rolling correlations for the entire set of countries in the sample differ from 1993 with a low correlation 0.38 – some correlation coefficients are not significant – to 0.48 in 1996. It is even greater than 0.60 in 1999, 2002, and 2005. For Euro countries, we observe that serial annual correlation coefficients have improved dramatically from 1993 to 2005. The increase in correlations is well maintained for the Euro countries and less maintained for non-Euro countries. A potential explanation is that the advent of the euro has improved the stability of correlation of the Euro countries. Also, we conclude that there is a visible variation in the correlation structure among all countries. Also, one point worth noting is that correlation coefficients between the Austrian market and other markets is very small, which informs the gains of international diversification are still alive.

[FIGURE 2 HERE]

Following Goetzmann et al. (2002), Figure (2) depicts the average off-diagonal cross-country rolling correlations relationship for all countries in the sample and for two subsamples: without the United States and within the Euro-zone at each period. Similar to Table 6 it shows that the correlations have changed from early 1993 to 1995 (0.40-0.60 correlations) to 1996 to 1998 (0.60-0.75) then have changed slightly after the Euro introduction, then later it swings at high value of 0.70-0.80 after 2000. It is worth mentioning that (1) the average off-diagonal is higher once non-Euro countries have been eliminated from the sample and it further increases after the introduction of the Euro, after 2000; and (2) that broadly speaking though global financial market integration, the average correlation coefficients between markets are still less than 1. The peaks in the serial correlations were observed in 2001 and 2003.

The difference in the behavior of average correlations after the introduction of the Euro consists of examining the period around that date. If there is a significant impact on the serial correlations, we would expect to see a large increase around the date the Euro was introduced into the market.

Note that if the observed difference in serial correlations is due to a difference in the currency, the change in the level of the market at the time the information is revealed should be quite large. Broadly speaking,

upon request from the author.

Figure (2) shows that serial correlations have declined right after the advent of the Euro while it was high before that date. We could contemplate that the major effect on international diversification is higher during the convergence period than after the adoption of the Euro. Then the serial correlations increase gradually afterward, and it is reasonable to potentially explain that the effect of the Euro on stock markets has been incorporated in a gradual manner or that international diversification seems to react little, if at all, to currency change. Of course we have evidence, as presented in previous sections, to suggest that the impact of the Euro on international diversification builds gradually over the course of the convergence period.

To study the effect of the Euro on the serial correlations and to test the inter-temporal stability of correlations between the selected markets in the sample over different time horizons, we proceed using the time series of the monthly average off-diagonal correlation coefficients – labeled $\overline{\rho}_t$ at month t, which are computed based on weekly returns for each of the 160 months – which are used to test whether it follows a random walk. This test is the simplest test that was used by Maldonado and Saunders (1981). If that is the case, the ex-ante planning of optimal international investments, which is a crucial prerequisite for a lucrative international future investment, may not be achievable. It is essential that the inference to be drawn is limited, although instability of correlation coefficients does not suggest that historical information on correlations is not useful in an ex-ante setting.

Table 7 presents the results of the regression Equation (5):

$$\overline{\rho}_t = \beta \overline{\rho}_{t-1} + e_t, \tag{5}$$

in the full sample and the two sub-samples. Randomness requires β to be insignificantly different from zero.

[TABLE 7 HERE]

Contrary to the Maldonado and Saunders (1981) study, which used a small sample size to test similar Equation (5), our test used a longer serial correlations, a necessary condition to Durbin-Watson (D. W.) statistics to reveal meaningful and statistically acceptable results.

Counter to past studies such as, Maldonado and Saunders (1981), the result shows that all $\beta's$ are

statistically different from zero, which rejects the randomness. Durbin-Watson (D.W.) suggests that the null hypothesis of random residuals of the regressions cannot be rejected. Thus, that the monthly average serial correlations follow a random walk is rejected. The coefficient of determination (R–square), which provides a measure of goodness fit of the estimated regression equation to the data, is between 0.50-0.80. Moreover, a quick comparative study of the result shows that there is a difference between prior Euro and post Euro periods in all samples (full sample or sample without U.S. stocks, or sample of Euro-zone countries) we observe that the coefficients are greater after the Euro period than prior. That implies that the stability of correlations has improved after the introduction of the Euro and that the probability distributions of the process are more time-invariant than before the Euro. For example, using the Euro-zone the beta coefficients have increased from 0.503 to 0.905, thus, statistical properties of average serial correlations do not change over time since the advent of the Euro. The findings in Table 7 show that international stockholders could benefit from more stable correlation coefficients after the introduction of the Euro currency.

To further validate the result and to see if the Euro has a direct impact on the stability of correlations, we propose to add a currency dummy variable in the Equation (6):

$$\overline{\rho}_t = \theta \overline{\rho}_{t-1} + \phi D_{t-1} + \varepsilon_t \tag{6}$$

Table (8) presents the results of the regression Equation using the full sample period. Randomness requires θ to be insignificantly different from zero and ϕ equals to zero implies no impact of the Euro introduction. (D_t is a dummy variable equal to 1 if the Euro currency was adopted on event month t, $= 0$ otherwise.)

[TABLE 8 HERE]

The estimated parameters and the corresponding D. W. and R-square are reported in Table 8. Again, the D.W. shows that the null hypothesis of random residuals of the regressions cannot be rejected. The relationship between average off-diagonal serial correlations is significant and it differs between the full sample (all countries) and Euro-zone countries. The second coefficient of the dummy variable shows that the impact of the Euro on the stationarity of serial correlations is greater among the Euro-zone countries

and part of the positive stability could be explained by the Euro introduction.

Pointing out to the magnitude of the parameter θ, the result shows that all $\theta's$ are statistically different from zero. The significance of the estimated θ serves as evidence that statistical properties of average serial correlations did not change over time after the advent of the Euro.

6.2 Inter-temporal stability of volatilities

Volatility is a very important measure of the risk of any portfolio and it is well documented that the volatility of asset returns is time-varying and highly persistent, thus, we want to investigate to what extent the volatility of selected markets in our sample has become more or less stable after the introduction of the Euro. Also, we want to see whether the Euro introduction has produced stability of serial volatilities of European stock markets.

The shortcomings of the study by Morana and Beltratti (2002) are (1) the use of a small size of the post-euro data, and (2) the use of daily data, which suffer from the simultaneity problem since many markets have different time periods (markets are not open at the same time) and they have different holidays. These factors could alter and pollute the estimations (e.g., Solnik and Roulet (2000)). In this study we attempt to answer volatility questions empirically using a longer post-Euro sample and weekly data that are less problematic for the estimations and to sidestep the shortcomings of past studies. Using weekly returns, we examined the changes over time.

[TABLE 9 HERE]

Based on Table 9, it appears that some countries have been in the low volatility regime before 1996 (Germany, Belgium, Netherlands, and the United States) while others have been in the high volatility regime. By comparing the result between 1995 and 1996 (period 1 and period 2 -convergence period-) we note that the volatility of some European stock markets has declined (e.g. Germany, Austria, Denmark, and France) while the volatility of others has increased (the Netherlands, Belgium, and the United Kingdom).

By comparison, between 1998 and 1999 (period 2 and period 3), we observe that after the introduction of the Euro volatility of all European stock markets declined, while the volatility of the U.S. stocks has

increased. This brisk decline can be interpreted as a reaction to the introduction of the Euro. This result is consistent with past results by Morana and Beltratti (2002) and it is consistent with results in the previous section that showed the advent of the Euro has caused a decline in returns, which is usually accompanied by a decline in the risk.

In line with Maldonado and Saunders (1981), let us assume that monthly volatility (Vol_{it}) of each country is generated by the first order process and it is autoregressive (or self-regressive) under certain assumptions. Thus, we may test for non-stationarity of the volatility process by testing for a unit root in the time series. This inference strategy has many advantages, and we show that a reliable test for a unit root in the volatility process can be conducted, and when applying this test to the volatility of each stock market, strong rejections of non-stationarity in the volatility process are obtained.

[TABLE 10 HERE]

Table (10) presents the results of the regression Equation (7) in the full sample and the two sub-periods.

$$Vol_{it} = \beta_i Vol_{it-1} + e_t \tag{7}$$

Randomness requires β_i to be insignificantly different from zero.

The results show that all β_i's are statistically different from zero, which rejects the randomness. Durbin-Watson test suggests that the null hypothesis of random residuals of the regressions cannot be rejected. Thus, the serial volatility follows a random walk is rejected, and the volatility process is stationary (all estimators are statistically significant at 1%). The coefficient of determination (R–square), which provides a measure of goodness fit of the estimated regression equation to the data, is between 0.50 and 0.90.

Furthermore, a quick comparative study of the results show that there is a difference between pre-Euro and post-Euro periods for all countries in the sample. We observe that the coefficients are lower post-Euro than pre-Euro. That implies that the stability of volatility has not improved after the introduction of the Euro and that the probability distributions of the process are less time-invariant than before the Euro. For example, non-Euro countries have shown a larger decline of the estimator than Euro countries, thus,

statistical properties of serial volatility do not change at the same structural evolution over time after the advent of the Euro in the Euro zone. This conclusion is consistent with that obtained by Adjaoute and Danthine (2004).

The findings in Table 10 show that international stockholders could have benefited from a more volatile market after the introduction of the Euro currency. Solnik and Roulet (2000), who directly contradict the Schwebach et al. (2002) contention that correlations among international security markets increase when the volatility of those market increases, found that there is a direct and opposite relationship between volatility and correlation. Higher dispersion implies lower correlation and higher diversification gains as opposed to lower dispersion and higher correlation. Consistent with Solnik and Roulet (2000) our result presented in Table 7 shows that the introduction of the Euro positively improves the stability of the average correlation among the Euro-zone countries, and in Table 10 reveals that the same event decreases the stability of the volatility among the selected stock markets in our sample.

7 Conclusion

The purpose of this study was to investigate the impact of the introduction of the Euro on European stock markets and determine how an investor could use international stocks within the Euro-zone countries as an additional investment to their national stocks to reduce the overall risk.

We have presented four major contributions in addition to those in the existing literature. First, the paper shows that under the null hypothesis of market learning about the Euro currency having no impact on returns, the evidence demonstrates that the impact of the introduction of the Euro was different for all Euro-zone countries. We observe negative abnormal returns on some countries while no impact on others (Germany and France). The German, Austrian, and French markets did not believe that the introduction of the Euro held a particular significance, while the markets in Belgium and the Netherlands reacted negatively to the introduction of the new currency.

Second, the paper examines the impact of the introduction of the Euro on the international diversification within the Euro-zone and in the non-Euro countries. The result shows that the benefit of the international

diversification still exists while the gain from such diversification was limited during the convergence period, which precedes the launch of the Euro. Evidence shows that there is a significant variation and increase in the correlation coefficients from period 1 to period 3. The rise of the correlation coefficients was achieved before the introduction of the Euro (January 1999) during the convergence period. While during the convergence period the benefits from international diversification especially within the Euro-zone countries have been significantly lowered but the gains are still moderate with the non-Euro countries (United States, United Kingdom, Denmark, and Switzerland).

Third, in a mean-variance framework, the data confirm that although Euro market integration has decreased some benefits of international portfolio diversification, the gains from international diversification are even more impressive when other stocks from non-euro countries are included. After the introduction of the Euro the findings suggest allocation of a larger proportion to Euro-zone stocks as it does not suggest reducing the proportion as was the case during the convergence period. This finding suggest that an investor who frequently balanced her international portfolio would have been better off by decreasing the investment proportion during the convergence period – a period less promising to international diversification – and revising her position after the launch of the Euro. This analysis contributes to research related to the interaction of portfolio theory and monetary union using the Markowitz-based model.

Fourth, as with past studies that have investigated the inter-temporal pattern of correlations and volatilities in international stock diversification, the results support that there is a difference between pre-Euro and post-Euro periods in all samples (full sample or sample without U.S. stocks, or Euro-zone countries); we observe that the coefficients are greater after the Euro period than before the Euro. Thus, there is a great deal of stability of average correlations over time, and it has improved after the introduction of the Euro. Furthermore, the results of the stationarity of average inter-country correlation coefficients were found to be far from a perfect positive correlation provide the essential conditions for the anticipated international diversification in ex-ante settings notably using a Markowitz model.

The changes in volatility, which may be caused by the Euro, produced less stable volatility within the Euro-zone, and that is in line with the past analysis that there is a direct and opposite relationship between

volatility and correlation. Higher dispersion implies lower correlation and higher diversification gains, with the opposite in the presence of lower dispersion and higher correlation.

The monetary union with regard to the Euro case has an additional explanatory element. That may open the gate for further empirical and theoretical studies on the issue, especially for countries that are planning to establish future regional monetary union.

The practical implications of the study are: (1) that European investors can improve their stock portfolio performance by holding Euro and non-Euro stocks. It is the stability of correlations between various markets that is a necessary prerequisite for successful ex-ante investment. It is reasonable to focus on diversification of stocks with international Euro countries, especially Austria as the empirical evidence has shown in our sample; and (2) future monetary unions, groups of countries that share geographical borders, but not always or often have close trade and other financial relationships but looking to share currency, should expect the impact of such policy as a favorable move for the international portfolio investor. Notably, a monetary union will provide them the high degree of financial integration with the outside capital markets. Currently, economic forces and demand for capital mobility have urged many nations toward full financial integration to stimulate their domestic economies and supply capital to foreign direct investment (FDI) resident in their countries, thus, their efforts toward an integration with other countries into a currency union.

The largest and best-known monetary union is the Euro-zone where the Euro is the monetary unit utilized by 12 of the 15 countries in the European Union. Global attention could now be directed to Gulf Cooperation Council (GCC) monetary union which represents the six Arab Gulf states, guided by the European Central Bank toward the implementation of a single regional currency.

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Table 1: Annualized mean weekly returns and standard deviations of the annualized returns of stocks for selected countries over the sample period (in percent)

Country	**Mean Return**	**Standard Deviation**
USA	8.30%	21.31%
Denmark	12.62%	19.91%
UK	6.33%	19.88%
Switzerland	10.99%	22.74%
Germany	9.71%	26.62%
France	7.19%	22.93%
Belgium	8.71%	19.21%
Netherlands	9.27%	23.17%
Austria	12.46%	21.54%

Table 2: The impact of the market learning about the Euro introduction on the weekly market returns of stocks for selected countries over the sample period 1993-2006

The table presents the results of the regression Equation $R_{it+1} = \delta_i + \gamma_i K_{it} + e_t$ in the full sample.No impact of the steps undertaken toward completion of the convergence criteria (market starts to learn about the Euro) requires γ_i to be insignificantly different from zero. R_{it+1} is the return on stock from country i at time $t+1$. The timing of the variables supports that the currency variable is known at the start of the return period, and K_i is a dummy variable equal to 1 on event week (market learning event: January 96) $K_{it} = 1$ when the market i starts to learn about the steps toward the Euro, $= 0$ otherwise.

	Full period ($N = 695$)			
Country i	δ_i	γ_i	D.W.	R^2
USA	0.0019 (0.0020)	−0.00046 (0.0022)	2.040	0.001
Denmark	0.0025 (0.0018)	−0.00013 (0.0021)	1.968	0.001
UK	0.0014 (0.0017)	−0.00019 (0.0020)	2.013	0.001
Switzerland	0.0042** (0.0019)	−0.0027 (0.0022)	1.984	0.0022
Germany	0.0026 (0.0024)	−0.0009 (0.0027)	1.965	0.0002
France	0.00022 (0.0022)	0.0016 (0.0025)	2.073	0.0006
Belgium	0.0021 (0.0019)	−0.00046 (0.0021)	2.014	0.0001
Netherlands	0.0034 (0.0022)	−0.0021 (0.0025)	1.963	0.001
Austria	0.0021 (0.0018)	0.000507 (0.0020)	1.818	0.0001

Note: ** denotes statistical significance at the 5 percent level. Standard errors (in parentheses) are estimated.

Table 3: The impact of the introduction of the Euro on the weekly market returns of stocks for selected countries over the sample period 1993-2006

The table presents the results of the regression Equation $R_{it+1} = \alpha_i + \beta_i d_{it} + e_t$ in the full sample.No impact of the advent of the Euro requires β_i to be insignificantly different from zero. R_{it+1} is the return on stock from country i at time $t+1$. The timing of the variables supports that the currency variable is known at the start of the return period, and $d_{it} = 1$ if the Euro currency was adopted on event week t, $= 0$ otherwise.

	Full period ($N = 695$)			
Country i	α_i	β_i	D.W.	R^2
USA	0.0035** (0.0014)	−0.0036 (0.0019)	2.0498	0.0052
Denmark	0.0034 * (0.0013))	−0.0018 (0.0017)	1.9712	0.0016
UK	0.0028** (0.0012)	−0.0027 (0.0016)	2.0196	0.0038
Switzerland	0.0044* (0.0013)	−0.0042** (0.0018)	1.9924	0.0073
Germany	0.0040** (0.0017)	−0.0036 (0.0023)	1.9699	0.0036
France	0.0026*** (0.0015)	−0.0020 (0.0021)	2.0731	0.0014
Belgium	0.0036* (0.0013)	−0.0033*** (0.0018)	2.0227	0.0049
Netherlands	0.0046* (0.0015)	−0.0050** (0.0021)	1.9758	0.0081
Austria	0.0014 (0.0012)	0.0020 (0.0017)	1.8222	0.0020

Note: * denotes statistical significance at the 1 percent level, ** denotes significance at the 5 percent level, and *** at the 10 percent level. Standard errors (in parentheses) are estimated.

Table 4: Correlation coefficients for selected countries in sub-periods

This table provides the correlation matrices of weekly equity returns of the selected countries during the three sub-periods (period 1: January 93 to December 95, period 2: January 96 to December 98, and period 3: January 99 to April 06), as well as the correlation matrices during the full sample period (January 93 to April 06). Correlation convergence versus Euro introduction periods defined by historical event.

Country	**Denmark**	**UK**	**Switzerland**	**Germany**	**France**	**Belgium**	**Netherlands**	**Austria**
Full period	*Average correlation* =**0.60**							
USA	0.47**	0.70**	0.59**	0.67**	0.67**	0.50**	0.66**	0.31**
Denmark		0.56**	0.48**	0.56**	0.52**	0.47**	0.57**	0.35**
UK			0.69**	0.72**	0.76**	0.63**	0.77**	0.41**
Switzerland				0.71**	0.70**	0.67**	0.76**	0.42**
Germany					0.82**	0.68**	0.84**	0.45**
France						0.68**	0.83**	0.40**
Belgium							0.76**	0.43**
Netherlands								0.44**
Period 1	*Average correlation* =**0.45**							
USA	0.16**	0.48**	0.39**	0.37**	0.41**	0.40**	0.48**	0.28**
Denmark		0.34**	0.28**	0.40**	0.22**	0.45**	0.38**	0.38**
UK			0.53**	0.47**	0.56**	0.43**	0.68**	0.38**
Switzerland				0.49**	0.39**	0.37**	0.55**	0.38**
Germany					0.57**	0.62**	0.66**	0.48**
France						0.51**	0.60**	0.37**
Belgium							0.64**	0.50**
Netherlands								0.49**
Period 2	*Average correlation* =**0.64**							
USA	0.51**	0.69**	0.55**	0.66**	0.63**	0.52**	0.67**	0.49**
Denmark		0.61**	0.48**	0.60**	0.52**	0.46**	0.62**	0.44**
UK			0.66**	0.74**	0.73**	0.65**	0.77**	0.55**
Switzerland				0.78**	0.74**	0.65**	0.79**	0.56**
Germany					0.80**	0.70**	0.83**	0.68**
France						0.71**	0.79**	0.60**
Belgium							0.73**	0.60**
Netherlands								0.64**
Period3	*Average correlation* =**0.61**							
USA	0.52**	0.74**	0.65**	0.71**	0.73**	0.51**	0.67**	0.25**
Denmark		0.60**	0.52**	0.58**	0.60**	0.48**	0.59**	0.31**
UK			0.73**	0.76**	0.82**	0.65**	0.79**	0.36**
Switzerland				0.73**	0.74**	0.72**	0.77**	0.35**
Germany					0.88**	0.68**	0.87**	0.37**
France						0.70**	0.89**	0.31**
Belgium							0.79**	0.36**
Netherlands								0.37**

Note: ** denotes significance at the 5 percent level.

Table 5: Composition of optimal portfolios over the sub-periods and the full period (in percent)

This table provides composition of optimal. The results are achieved based on mean-variance framework for all countries in the sample using the full period (January 93 to April 06) and the three sub-periods (Period 1: Maastricht Treaty discussions period; period 2: convergence period, and period 3: After introduction of the Euro) (Panel A), for all sample countries excluding U.S. Stocks States (Panel B), and for Euro-zone countries (Panel C).

Panel A: Optimal Composition for all countries in the sample									
Time Horizon	**USA**	**Denmark**	**UK**	**Switzerland**	**Germany**	**France**	**Belgium**	**Netherlands**	**Austria**
Period 1	29.11	15.11	4.07	15.90	- -	- -	23.38	12.43	- -
Period 2	19.39	46.90	0.01	- -	- -	- -	25.22	- -	8.48
Period 3	5.88	19.42	13.85	5.97	- -	- -	6.08	- -	48.79
Full period	13.09	25.11	12.16	2.46	- -	- -	12.61	- -	34.58
Panel B: Optimal Composition for all countries in the sample excluding U. S. Stocks									
Period 1		14.07	12.87	21.70	- -	- -	32.65	18.69	0.02
Period 2		53.34	8.52	- -	- -	- -	32.37	- -	5.77
Period 3		20.17	17.84	7.71	- -	- -	5.61	- -	48.67
Full period		26.89	19.99	5.22	- -	- -	13.06	- -	34.84
Panel C: Optimal Composition for all Euro-zone countries in the sample									
Period 1					- -	- -	44.44	50.86	4.70
Period 2					0.05	11.35	67.07	3.05	4.70
Period 3					- -	14.53	22.11	- -	63.36
Full period					- -	11.68	36.57	- -	51.75

Table 6: Serial inter-country correlation coefficients in 1993, 1996, 1999, 2002, and 2005

Country	**Denmark**	**UK**	**Switzerland**	**Germany**	**France**	**Belgium**	**Netherlands**	**Austria**
1993	*Average correlation* =**0.38**							
USA	-0.11*	0.27*	0.36**	0.28**	0.44**	0.32*	0.35**	0.23
Denmark		0.15	0.15	0.27*	-0.01	0.38**	0.27*	0.29**
UK			0.53**	0.33**	0.51**	0.33**	0.56**	0.27*
Switzerland				0.40**	0.38**	0.28**	0.51**	0.19
Germany					0.51**	0.58**	0.61**	0.55**
France						0.31**	0.51**	0.36**
Belgium							0.48**	0.43**
Netherlands								0.31**
1996	*Average correlation* =**0.48**							
USA	0.38**	0.59**	0.30**	0.50**	0.61**	0.38**	0.52**	0.41**
Denmark		0.40**	0.03	0.46**	0.49**	0.27**	0.54**	0.38**
UK			0.37**	0.59**	0.64**	0.52**	0.59**	0.45**
Switzerland				0.36**	0.37**	0.25*	0.40**	0.13
Germany					0.63**	0.50**	0.59**	0.63**
France						0.59**	0.72**	0.50**
Belgium							0.49**	0.57**
Netherlands								0.50**
1999	*Average correlation* =**0.62**							
USA	0.36**	0.72**	0.72**	0.64**	0.75**	0.54**	0.65**	0.61**
Denmark		0.36**	0.48**	0.44**	0.53**	0.43**	0.48**	0.30**
UK			0.75**	0.65**	0.72**	0.48**	0.70**	0.60**
Switzerland				0.72**	0.78**	0.66**	0.72**	0.64**
Germany					0.83**	0.67**	0.88**	0.67**
France						0.67**	0.77**	0.62**
Belgium							0.67**	0.53**
Netherlands								0.69**
2002	*Average correlation* =**0.66**							
USA	0.40**	0.81**	0.76**	0.76**	0.80**	0.65**	0.73**	0.16
Denmark		0.53**	0.43**	0.65**	0.64**	0.65**	0.68**	0.35**
UK			0.82**	0.79**	0.90**	0.81**	0.86**	0.24*
Switzerland				0.72**	0.79**	0.72**	0.77**	0.25*
Germany					0.91**	0.77**	0.87**	0.31**
France						0.83**	0.94**	0.28**
Belgium							0.85**	0.39**
Netherlands								0.33**
2005	*Average correlation* =**0.63**							
USA	0.36**	0.63**	0.49**	0.61**	0.63**	0.43**	0.63**	0.45**
Denmark		0.68**	0.50**	0.52**	0.66**	0.50**	0.62**	0.61**
UK			0.63**	0.65**	0.74**	0.68**	0.76**	0.64**
Switzerland				0.72**	0.71**	0.60**	0.69**	0.41**
Germany					0.90**	0.77**	0.85**	0.48**
France						0.78**	0.90**	0.53**
Belgium							0.78**	0.37**
Netherlands								0.60**

Note: ** denotes significance at the 5 percent level, and * at the 10 percent level.

Table 7: Random walk tests on monthly average correlations

The table presents the results of the regression Equation $\overline{\rho}_t = \beta\overline{\rho}_{t-1} + e_t$ in the full sample and the two sub-samples. Randomness requires β to be insignificantly different from zero.

	Full Sample			**Sample without U.S. Stocks**			**Euro-zone**		
Time horizon	β	D.W.	R^2	β	D.W.	R^2	β	D.W.	R^2
Full period ($N = 159$)	0.863*	2.910	0.742	0.858*	2.928	0.738	0.734*	2.589	0.534
Prior the Euro ($N = 71$)	0.754*	2.774	0.560	0.761*	2.823	0.580	0.503*	2.310	0.258
After the Euro ($N = 87$)	0.937*	2.921	0.880	0.928*	2.924	0.864	0.905*	2.812	0.822

Note: * denotes statistical significance at the 1 percent level. Regression constant suppressed to zero.

Table 8: Tests on monthly average correlations with Euro currency dummy variable

The table presents the results of the regression Equation $\overline{\rho}_t = \theta\overline{\rho}_{t-1} + \phi D_{t-1} + \varepsilon_t$ in the full sample period. Randomness requires θ to be insignificantly different from zero and ϕ equals zero implies no impact of the Euro introduction. (D is a dummy variable equals to 1 if the Euro currency was adopted on event month t, $= 0$ otherwise.

	Full Sample				**Euro-zone**			
Time horizon	θ	ϕ	D.W.	R^2	θ	ϕ	D.W.	R^2
Full period ($N = 159$)	0.697*	0.255*	2.663	0.765	0.450*	0.466*	2.268	0.615

Note: * denotes statistical significance at the 1 percent level. Regression constant suppressed to zero.

Table 9: Annual volatility of weekly returns of stocks for selected countries over the sample period 1993-2006 (in percent)

Year	**USA**	**Denmark**	**UK**	**Switzerland**	**Germany**	**France**	**Belgium**	**Netherlands**	**Austria**
1993	1.65	2.15	1.50	1.47	1.89	2.28	1.63	1.38	2.48
1994	1.66	2.21	2.11	2.09	2.34	2.36	1.43	1.69	2.02
1995	1.40	1.47	1.36	1.37	2.01	2.25	1.46	1.29	2.13
1996	2.00	1.05	1.54	1.60	1.41	1.87	1.88	1.57	1.69
1997	2.61	2.54	2.70	2.81	3.18	3.25	2.74	3.44	2.71
1998	2.91	2.58	2.86	3.87	4.00	3.45	2.77	3.74	3.29
1999	3.04	2.38	2.24	2.49	3.38	2.83	2.53	2.62	2.68
2000	3.47	2.68	2.68	1.76	3.07	3.02	2.71	2.09	2.22
2001	3.47	3.31	3.19	3.85	4.52	3.80	3.46	4.20	2.09
2002	3.31	2.89	2.59	3.28	4.38	3.84	3.24	4.29	1.82
2003	2.66	2.29	2.45	2.74	3.92	2.81	3.10	4.02	1.70
2004	1.71	1.63	1.38	1.38	1.99	1.55	1.42	1.91	1.98
2005	1.64	2.01	1.35	1.26	1.66	1.39	1.24	1.45	2.11
2006	1.00	1.73	1.22	1.00	1.96	1.74	1.64	1.74	1.91

Table 10: Random walk tests on monthly volatilities

The table presents the results of the regression Equation $Vol_{it} = \beta_i Vol_{it-1} + e_t$ in the full sample and the two sub-samples. Randomness requires β to be insignificantly different from zero.

	Full period ($N = 159$)			**Prior the Euro** ($N = 71$)			**After the Euro** ($N = 87$)		
Country i	β_i	D.W.	R^2	β_i	D.W.	R^2	β_i	D.W.	R^2
USA	0.804*	2.713	0.648	0.885*	2.581	0.775	0.763*	2.697	0.592
Denmark	0.795*	2.530	0.653	0.822*	2.459	0.736	0.781*	2.545	0.608
UK	0.807*	2.663	0.648	0.894*	2.690	0.783	0.750*	2.594	0.569
Switzerland	0.748*	2.639	0.560	0.898*	2.552	0.785	0.660*	2.548	0.451
Germany	0.836*	2.685	0.698	0.901*	2.635	0.777	0.794*	2.607	0.657
France	0.839*	2.734	0.702	0.895*	2.770	0.791	0.793*	2.571	0.653
Belgium	0.776*	2.536	0.602	0.862*	2.706	0.732	0.735*	2.471	0.547
Netherlands	0.819*	2.625	0.668	0.865*	2.369	0.737	0.793*	2.623	0.640
Austria	0.845*	2.686	0.723	0.861*	2.831	0.756	0.804*	2.371	0.707

Note: * denotes statistical significance at the 1 percent level. Regression constant suppressed to zero.

Figures

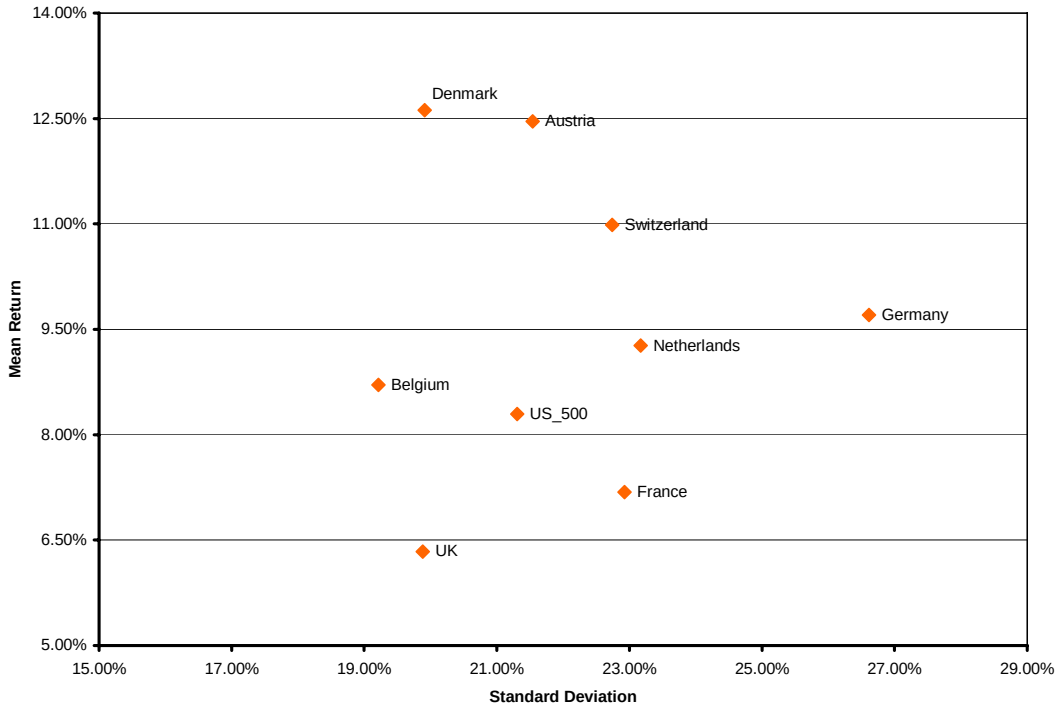

Figure 1: The relationship between annualized mean weekly returns and standard deviation

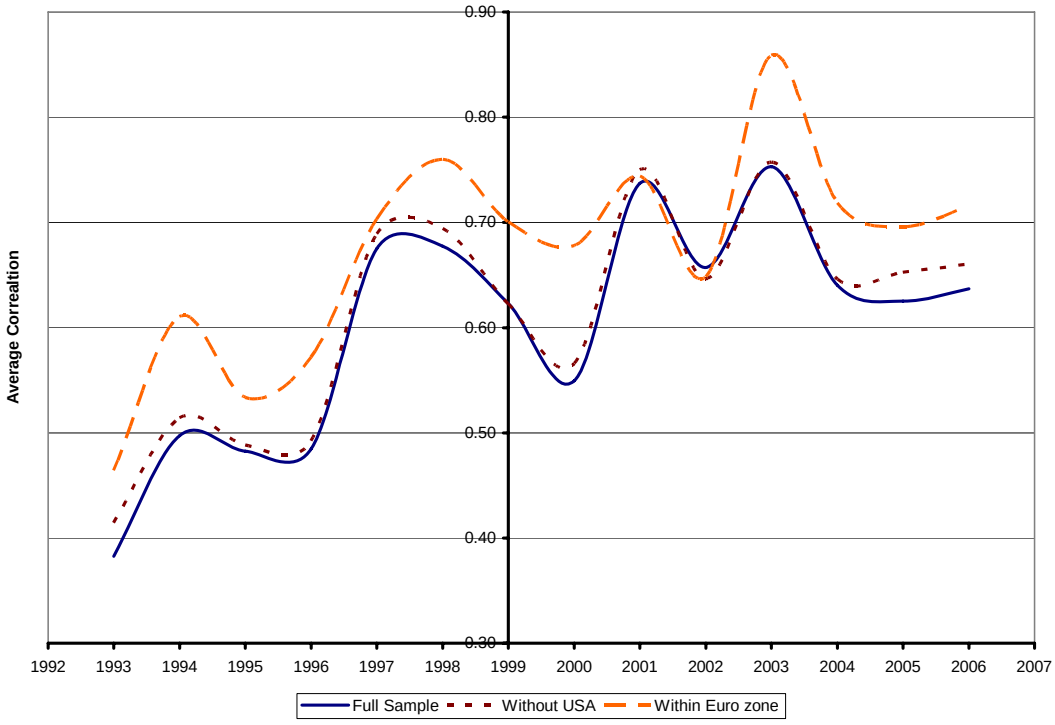

Figure 2: The times series of the average off-diagonal correlation of returns