Sectoral Equity Returns in the Euro Region: Is There any Room for Reducing the Portfolio Risk?

Balli, Faruk and Ozer-Balli, Hatice

Massey University Department of Economics and Finance, Massey University Department of Economics and Finance

2009

Sectoral Equity Returns in the Euro Region: Is There any Room for Reducing the Portfolio Risk?

Faruk Balli
Massey University

Hatice Ozer-Balli
Massey University

April 9, 2009

Abstract

The economic integration among Euro members has important consequences for the factors driving asset pricing and asset trading within the financial markets. In particular, since the start of the Euro, cross-country equity index correlations in the region have showed upward trends and domestic investors have allocated their portfolios mostly inside of the region. This paper studies the impact of these recent structural changes on the Euro-wide sectoral equity indices. We modeled the return and volatility of the Euro sector equity indices between years 1992 and 2007. We documented that aggregate world equity or global sector equity indices have not been affecting the sector equity indices since the beginning of the Euro. Aggregate Euro stock index, however, still has been affecting most of the sector equity indices, even though its effect has been declining remarkably for some sectors. In particular, we found that financial sector indices (financial services, insurance, and banking) are being affected increasingly by the aggregate Euro equity index fluctuations after the start of the Euro. However, some "basic industry sector" indices, including basic resources, food and beverage, health-care, retail services, and oil & gas had become less dependent to the aggregate Euro index within the same period, suggesting that diversification across these sectors within the region would be much more effective tool for reducing portfolio risk.

JEL classification: G12; G15
Keywords: Stock Market Correlation, Sector Equity Indices, Euro Portfolio Bias, Euro, GARCH.

1 Introduction

Since late 1990s, equity markets in many developed countries had become increasingly integrated in terms of asset pricing and asset trading. Among those markets, Euro area equity markets is an interesting subject of study due to the rapid changes caused by the unification process and the introduction of the common currency. A large number of studies have interpreted the European equity market integration after the start of the monetary union in terms of the asset pricing. Some studies analyze the effect of global risk factors on the asset prices across the region (Bekaert and Harvey (1997), Hardouvelis, Malliaropulos, and Priestley (2000), and Stulz and Karolyi (2001), Christiansen (2007)). Other researches focused on the cross-correlations in the equity markets in the region. For example, Adjaout and Danthine (2003) compared correlations among country index returns within two subperiods. They found that cross-country return correlations are significantly higher after the start of the Euro compared to the period before. More recently, Baele et al. (2004) and Bekaert and Ng (2005) also found that the Euro equity markets have become more integrated and that cross-country equity return correlations in this region have showed upward trends.

The other part of the literature gives evidence of European equity market integration via the volume of asset trading. Adam et al. (2002) interpreted the recent decrease in equity and bond home bias as an evidence of further integration in the Euro area. Their study have noted that the share of foreign equity holdings among domestic investors was relatively steady prior to the start of the Euro, and it has increased considerably since then. Similarly, Adjaout et al. (2002) and Baele et al. (2004) found higher economic integration in Euro area which leads higher volume of international asset trading across the borders. Some studies also pointed out that the decrease in home bias among the region is accompanied with the tendency in holding foreign portfolio within the region (Euro equity bias). Figure 1 illustrates the Euro share of EMU members' foreign portfolio holdings. It is observed that most of the Euro members are holding more than 50 % of their foreign portfolio within the region.

Overall, both increasing cross-country correlations of equity market returns and increasing tendency in allocating portfolio inside the euro region suggest that diversifying the portfolio across the region has a clear limitation in reducing the portfolio risk. In this paper, we consider the issue for the Euro area stock markets in a different perspective. Instead of examining the national equity indices, we focus on the Euro-wide sectoral equity indices.

There are many studies on sectoral diversification in the equity markets, however they don't have a consensus on the "true effect" of industrial structure of the domestic economy on equity markets. For example, Heston and Rouwenhorst (1994) documents that the industrial structure explains little of the cross sectional difference in country return volatility and low correlation between the countries exists because of the country specific variations. According to Adjaout and Danthine (2001a, 2001b) and Carrieri et al. (2004), the dominance of country effects has diminished, but industry factors are still less important than country factors.

On the other hand, Roll (1992) indicates that industrial structure of the domestic economy is essential in explaining the correlations among the country sector indexes. Cavaglia et al. (2000) and Isakov and Sonney (2002) also show that industry factors (almost) match the country factors and expect that industry factors will become even more important in the future. Therefore, there is still strong incentive to see if sectoral diversification matters in Euro region. In this paper we contribute to the literature in twofolds. First, we modeled return and volatility of the Euro-wide sector equity indices by disregarding the national borders in the Euro region and taking into account of effects of aggregate Euro index (regional shocks), aggregate world index and global sector index (global shocks). Second, we use longer data series to observe the sector equity indices fluctuations detached from the effect of technology bubbles on Euro stock markets which took place in the late 1990s.[1]

We used $GARCH$ $(1,1)$ process to model the return and volatility of the sector equity indices and measured the magnitudes of spillovers of aggregate Euro equity index, global sector equity index and aggregate world equity index on the volatility of the Euro sector equity indices. Then, we formed the volatility spillovers following Bekaert and Harvey (1997), Ng (2000), Bekaert et al. (2005). We found that spillovers of aggregate world index and global sector equity index have diminished sharply after the start of the Euro. This finding supports Hardouvelis et al. (2000) who claimed the European stock market returns are driven by the Europe-wide risk factors instead of the global factors. We also found that aggregate Euro index has different levels of impact on the sectoral equity indices after the start of the

[1] Brooks and Negro (2004) showed that potential benefits of sectoral diversification within Euro region is mostly driven by the technology bubbles in the early years of Euro.

Euro. Euro aggregate index is increasingly effective in explaining the volatility of the financial sector indices (banking, financial services and insurance), whereas for the volatility of some "basic industry sector" equity indices (basic resource, food and beverage, health-care, retail services, oil and gas), the effect of aggregate Euro index has diminished considerably in the same period. In fact, previous literature on this issue have different results merely depending on the time interval of the dataset. In the very first years of the Euro, the potential gains of sectoral diversification is measured relatively higher (see Baca et al. (2000), Cavaglia et al. (2000), Kraus (2001), and Moerman (2004)). Our results suggest that potentials of the sectoral diversification within the region is not zero or one game, but the clusters of the sector indices, i.e., financial sectors, TMT, and basic industry sectors have been reacting differently to the aggregate Euro index fluctuations. Among some sectors, to some extent, there is still good potential to diversify the portfolio risk.[2]

The remainder of this paper is organized as follows. Next section discusses the data for Euro sector equity indices along with aggregate euro and world indices and offers some preliminary analysis of the data. The econometric models of volatility spillovers are set forth in detail in Section 3 and the empirical results are presented in Section 4. Section 5 concludes the paper.

2 Data and Descriptive Statistics

We use weekly Euro area equity sector indices taken from the Dow Jones STOXX database. Dow Jones Euro STOXX size indices are derived from Dow Jones STOXX size indices and designed to provide a broad yet liquid representation of large, mid and small capitalization companies in the Euro region. The Euro STOXX indices cover countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. In the data set, we employed weekly prices of 18 leading sector indices including 300 equities issued among Euro members [3]. Indices returns are collected in years between 1992 and 2007 to capture the effect of the Euro in a broad sense and minimize the effect of technology

[2]TMT stands for Technology, Media and Telecom. Basic industry sectors include automobile and parts, basic resources, chemistry, construction materials, food and beverage, health-care, industrial goods, oil and gas, non-cycled goods, retail services, travel and leisure, and utility sectors.

[3]The name of the sectors are listed in Table 1. The name of the equities listed in the Euro sector equity indices can be obtained from the web-page: *http://www.stoxx.com/*

bubbles on the equity markets which is in its peak level in late 1990s. Global sector equity indices are derived from the Dow Jones STOXX Global 1800 index, a large investable index that comprises the 600 largest stocks by market capitalization from each of three regions: Europe, Americas and Asia/Pacific.[4] [5]

Aggregate Euro equity index, is derived from the Dow Jones STOXX 600 index and it is also designed to provide a liquid representation of large, mid and small capitalization companies of 12 Euro-zone countries. Similarly, the world equity index (Index universe) is a combination of all developed market stocks in the Dow Jones World Index. World, namely a broad market benchmark, covers 47 countries and represents 95% of the market capitalization of emerging markets , 95% of the market capitalization of Europe and 95% of the market capitalization of all other developed markets on a country-by-country basis.

Table 2 contains summary statistics for the returns of the sector equity indices, for the aggregate world equity indices, and for the aggregate Euro equity indices. The average weekly returns of Euro area sector indices are in the range from 0.05% (Basic Resources) to 0.2% (such as Telecom, Technology). The variability of the returns is much more dispersed across the indices; the standard deviation of the weekly returns is between 1.0% (Construction materials and Utility) and 2.1% (Technology). Generally, the return of the sector equity indices tends to be more variable as its average return gets higher. The return distributions are skewed to the left (except Health-care services, Oil& gas, and Telecom), and all the distributions show excess kurtosis. Accordingly, the Jarque and Bera (1980) test rejects normality for all the series. The last two column of the tables present the Ljung-Box (1978) portmanteau test statistics Q and Q^2 (for the squared data) to test for first and second-moment dependencies in the distribution of the sector equity indices. For most of the sector equity indices, The Q statistic is significant, suggesting that sector equity indices are serially correlated. The Q^2 statistic is significant for all sectors, providing evidence of strong second-moment dependencies (conditional heteroskedasticity) in the distribution of the sector equity indices. [6]

[4]We employed the same sector indices for the global sector indices as well. The list of the equities in global sector indices can be downloaded from the web-page: *http : //www.stoxx.com/*

[5]Developed markets include for Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, for the Americas: Canada and the United States, and for Asia/Pacific: Australia, Hong Kong, Japan, New Zealand and Singapore.

[6]Ljung and Box (1978) tests if any of a group of autocorrelations of a time series are different from zero. The

3 The GARCH Model

The conditional return on the Euro sector equity index (s), aggregate Euro equity index (eu), global sector equity index (ws), and aggregate world equity index (w) are modeled with AR (1) process;

$$R_{\mathrm{s},t} = a_{\mathrm{s}} + b_{\mathrm{s}} R_{\mathrm{s},t-1} + \varepsilon_{\mathrm{s},t} \;, \tag{1}$$

$$R_{\mathrm{eu},t} = a_{\mathrm{eu}} + b_{\mathrm{eu}} R_{\mathrm{eu},t-1} + \varepsilon_{\mathrm{eu},t} \;, \tag{2}$$

$$R_{\mathrm{w},t} = a_{\mathrm{w}} + b_{\mathrm{w}} R_{\mathrm{w},t-1} + \varepsilon_{\mathrm{w},t} \;, \tag{3}$$

$$R_{\mathrm{ws},t} = a_{\mathrm{ws}} + b_{\mathrm{ws}} R_{\mathrm{ws},t-1} + \varepsilon_{\mathrm{ws},t} \;. \tag{4}$$

The conditional mean of each sector index return is assumed to be dependent on its own lag, the aggregate Euro equity index lag, aggregate world equity index lag, and global sector equity index lag.

$$R_{\mathrm{s},t} = a_{\mathrm{s}} + b_{\mathrm{s}} R_{\mathrm{s},t-1} + \eta_{\mathrm{eu},t-1} R_{\mathrm{eu},t-1} + \eta_{\mathrm{w},t-1} R_{\mathrm{w},t-1} + \eta_{\mathrm{ws},t-1} R_{\mathrm{ws},t-1} + \epsilon_{\mathrm{s},t} \tag{5}$$

The mean spillover effects of aggregate Euro, aggregate world, and global sector equity indices returns on each euro sector equity indices are measured with $\eta_{\mathrm{eu},t-1}$, $\eta_{\mathrm{w},t-1}$, $\eta_{\mathrm{ws},t-1}$, respectively.

The disturbances in each model (1)–(4) is assumed to be normally distributed with a zero mean and the conditional variance following a GARCH (1,1). The volatility of sector equity indices is defined as;

$$\sigma^2_{\mathrm{s},t} = \omega_{\mathrm{s}} + \alpha_{\mathrm{s}} \varepsilon^2_{\mathrm{s},t-1} + \beta_{\mathrm{s}} \sigma^2_{\mathrm{s},t-1} \;, \tag{6}$$

where ω_{s}, α_{s}, and β_{s} are supposed to be greater than zero and $\alpha_{\mathrm{s}}+\beta_{\mathrm{s}}$ is less than or equal to 1. The idiosyncratic shocks in equations (1)–(4) are assumed to be independent. However this

Ljung-Box test is based on the autocorrelation plot. However, instead of testing randomness at each distinct lag, it tests the "overall" randomness based on a number of lags. The null hypothesis is there is no serial correlation among the series.

is not applicable for unexpected returns of sector equity indices ($\epsilon_{\mathrm{s},t}$), where;

$$\epsilon_{\mathrm{s},t} = \varepsilon_{\mathrm{s},t} + \phi_{\mathrm{eu},t-1}\varepsilon_{\mathrm{eu},t} + \phi_{\mathrm{w},t-1}\varepsilon_{\mathrm{w},t} + \phi_{\mathrm{ws},t-1}\varepsilon_{\mathrm{ws},t}. \tag{7}$$

The equation above lets us observe the conditional variance of the unexpected return of sector indices.[7] The conditional variance of each sector equity index based on the information lagged (I_{t-1}) is formulated as;

$$h_{\mathrm{s},t} = E(\epsilon^2_{\mathrm{s},t}|I_{t-1}) = \sigma^2_{\mathrm{s},t} + \phi^2_{\mathrm{eu},t-1}\sigma^2_{\mathrm{eu},t} + \phi^2_{\mathrm{w},t-1}\sigma^2_{\mathrm{w},t} + \phi^2_{\mathrm{ws},t-1}\sigma^2_{\mathrm{ws},t}\,. \tag{8}$$

Verbally, conditional variance of each sector equity index (s) depends on the variance of contemporary aggregate Euro equity index, aggregate world equity index, and global sector equity index. The coefficient ϕ_i, corresponds the volatility spillovers of each market i on sector equity indices. Say, if $\phi_{\mathrm{w},t-1}$ is positive and significant, then the volatility of unexpected returns for sector (s) tends to be higher. Accordingly, the sign and significance of the parameters, $\phi_{\mathrm{eu},t-1}$, $\phi_{\mathrm{w},t-1}$, $\phi_{\mathrm{ws},t-1}$ determine whether volatility-spillover effects from aggregate Euro index, aggregate world index, and global sector equity index respectively, are powerful on explaining the conditional variance of sector equity indices. The conditional variance of the aggregate Euro and aggregate world equity indices' unexpected returns depend only their own idiosyncratic volatility and the conditional variance of global sector index's unexpected return depends only on the aggregate world index and its own idiosyncratic volatility.[8]

The specification of the functions for the spillover parameters; η_{eu}, η_{w}, η_{ws}, ϕ_{eu}, ϕ_{w}, and ϕ_{ws} have different representations with various volatility-spillover models. In some models, the spillover parameters are time-varying and those parameters are explained with other exogenous factors. In other models, spillover parameters are assumed to be constant throughout the entire sample period. It is called constant spillover model. We applied the latter methodology where; $X_{a,t} = X_a$ for t=1,2, ...,n, and for any spillover parameters X.

[7] In this paper, we only consider about the spillover effects of the aggregate Euro, aggregate world and global sector indices on the return of the sector indices in Euro region. We also assume that the unexpected returns of aggregate Euro, aggregate world are just equal to their own idiosyncratic shocks whereas the unexpected returns of global sector indices depends on the aggregate world index and its own idiosyncratic shocks. In other words, $\epsilon_{\mathrm{eu},t} = \varepsilon_{\mathrm{eu},t}$, $\epsilon_{\mathrm{w},t} = \varepsilon_{\mathrm{w},t}$, and $\epsilon_{\mathrm{ws},t} = \varepsilon_{\mathrm{ws},t} + \phi_{\mathrm{w},t-1}\varepsilon_{\mathrm{w},t}$.

[8] Equations are not provided.

3.1 Variance ratio

To measure the magnitude of the global and regional shocks on the unexpected return of each sector equity index, we employed the variance ratios;[9]

$$VR_{\mathrm{s},t}^{\mathrm{w,ws}} = \frac{\phi_{\mathrm{w},t-1}^2 \varepsilon_{\mathrm{w},t}^2 + \phi_{\mathrm{ws},t-1}^2 \varepsilon_{\mathrm{ws},t}^2}{h_{\mathrm{s},t}} \tag{9}$$

$$VR_{\mathrm{s},t}^{\mathrm{eu}} = \frac{\phi_{\mathrm{eu},t-1}^2 \varepsilon_{\mathrm{eu},t}^2}{h_{\mathrm{s},t}} \tag{10}$$

The variance ratio is helpful to explain how powerful is the spillovers on the unexpected return of each sector equity indices. From the variance ratios we obtain a measure of the impact of global shocks (through aggregate world and global sector indices) and regional shocks (through aggregate Euro index) before and after the start of the Euro. By comparing the simple averages of the variance ratios, we will evaluate the magnitude of the regional and global shocks on the volatility of the sector equity indices.

4 Empirical Analysis

4.1 Constant Spillover Model

We estimate the spillover model in three steps using the Quasi Maximum Likelihood (QML) method with (univariate) Gaussian likelihood functions. The estimation is conducted using the Berndt, Hall, Hall, and Hausman (1974) (hereafter BHHH) numerical optimization algorithm. The theoretical framework of GARCH model in this paper is based up on the maximization procedure of BHHH (1974) with Quasi Maximum likelihood methods. The parameters are estimated by maximizing a univariate log likelihood function. Table 3 and 4 report the results from estimating the constant spillover model, for years 1992–1998 and 1999–2007, respectively. AR(1) parameter of each sector equity indices is small, positive, and significant, which implies a weak first-order autocorrelation, mostly consistent with the summary statistics reported in

[9] For the sake of simplicity, we classified the variance ratios as regional shocks from aggregate Euro index and global shocks from aggregate world and global sector equity indices. We did not further decompose the variance ratios of global shocks.

the Table 2. For the period 1992–1998, sector equity indices returns depend strongly on its own lagged values and lag of aggregate Euro index returns, i.e, $R_S(-1)$ and $R_{\text{eu}}(-1)$, whereas lags of aggregate world index, and global sector equity indices have mostly statistically insignificant effects on the returns of sector equity indices except Media, Travel and leisure, technology and telecom sectors. After the start of the Euro, for most of the sector equity indices, similarly, own lag and lag of aggregate Euro index returns explain the sector equity index returns, but the mean effects of the global factors, i.e, lags of aggregate world index return, and global sector equity indices return, do not have significant effect on explaining the sector equity returns. In both tables, the sum of the α_s and β_s is more than 0.9 but less than 1, which states that the volatility process is highly persistent and stationary. Regarding volatility spillovers effects, for each sector equity index, volatility spillover coefficient of aggregate Euro index, ϕ_{eu}, is positive and significant in both periods, before and after the start of Euro. This result supports the view that sector equity indices are being affected by the aggregate Euro index at all the times. Volatility spillover coefficients of the aggregate world and global sector equity indices, i,e, ϕ_{w} and ϕ_{ws}, are statistically significant and bigger in magnitude in the period of 1992–1998. Nevertheless, those global factors became statistically insignificant and smaller in magnitude in the period 1999–2007. Overall, all these findings support the view that Euro sector equity indices are mostly driven by European-wide factors rather than global factors after the start of the Euro.

Table 5 and 6 provide the robust Wald tests for four different joint hypotheses regarding spillover effects of both regional and global factors. First columns of both tables show the results for testing if there exists mean spillover effects of both global and regional factors on the sector equity indices ($H_o : \eta_{\text{eu}} = \eta_{\text{w}} = \eta_{\text{ws}} = 0$). In both tables, before and after the start of the Euro, for most of the sector equity indices, the mean spillover effects are not statistically significant. The second columns of both tables show the Wald test results for testing if there exists volatility spillover effects ($H_o : \phi_{\text{eu}} = \phi_{\text{w}} = \phi_{\text{ws}} = 0$). There is enough evidence to support that volatility spillover effects are not equal to zero as for all sector equity indices $Wald_2$ statistic is significant at 0.01 level. This is also another way of supporting our previous findings that there exists strong volatility spillover effects on sector equity indices. In the third and fourth columns, we decompose the spillover effects to determine if the shocks are regional (through aggregate Euro index) or global (through aggregate world index and global sector equity indices). As we expected, in both tables 5 and 6, aggregate Euro index spillovers are very powerful in explaining the fluctuations in Euro equity sector indices returns for both periods; before and after the start of the Euro as for all sector equity indices we strongly reject the null hypothesis of no euro spillover effects. In the last columns we report the $Wald_4$ statistics for testing if the spillover effects of global factors is significant ($H_o : \eta_{\text{w}} = \eta_{\text{ws}} = \phi_{\text{w}} = \phi_{\text{ws}} = 0$). We observed that before the start of the Euro, for all sector equity indices, global factors are affective and statistically significant, however after the start of the Euro, for almost all sector equity indices (except for technology, telecom, and travel and leisure sector indices) the global factors spillover effects are no longer significant. This finding supports the view that Euro sector equity indices are not driven by global factors after the start of the Euro.

Till now, we have only discussed the sign and significance of the spillover parameters. In fact, the magnitude of the parameters are not particularly relevant to evaluate the quantitative influence of the regional and global factors on sector equity indices. To access the importance of the aggregate Euro index and aggregate world and global sector equity indices, on the volatility of the sector equity indices, the time series of the variance ratios $VR^{\text{eu}}_{s,t}$, $VR^{\text{w,ws}}_{s,t}$, are employed. Table 7 reports the mean and standard deviations of the variance ratios of global factor effects(both aggregate world and global sector equity indices) on sector equity indices for two samples, before and after the start of the Euro. Table 7 supports our previous findings that the global factors have lost their power on explaining both return and volatility of the sector equity indices. There is a substantial decline in the variance ratios of the sector equity indices. In particular, for some sectors including, insurance, media, industrial goods, retail services, non-cycled goods, the decline is extremely remarkable. One can comment on that the influence of the global factors on the volatility of the all sector equity indices have diminished since the start of the Euro.

Table 8 reports the mean and standard deviations of the variance ratios of aggregate Euro index on the volatility of the sector equity indices. In the first glance, it seems that the aggregate Euro index is still affecting the volatility of the sector indices returns significantly. In particular, for the financial sector indices(banking insurance and financial service sectors), the variance ratios of aggregate Euro index have increased remarkably after the start of the Euro, and again compared to other sector equity indices, the level of variance ratio of aggregate Euro index on the volatility of the financial sector equity indices is much higher.[10] At the same time, for some basic industry sectors, including, basic resources, food and beverage, health-care, oil-gas, retail services and utility the variance ratio of euro aggregate index has decreased remarkably in the same period, even for some sectors, mean of the variance ratio of aggregate Euro index is statistically insignificant. These findings argue that the effect of the aggregate Euro index on basic industry sector indices has been diminishing lately, which may be considered as the initial appearances of "independent" sector equity indices inside of the Euro region.[11]

4.2 Correlation Changes

Table 9 reports the change in cross-correlations between sector equity indices before and after the start of the Euro. It is apparent that the change in cross correlations are negative and statistically significant, stating that the cross-correlations between sector equity indices has diminished after the start of the Euro.[12][13] Interestingly, we also observed that the decrease in cross correlations between sector equity indices are relatively bigger if one of the pairs in the correlation set is a "basic industry sector equity indices." In other words, "basic industry sector equity indices " have become much less correlated with other sector equity indices after the start of the Euro. This may also be considered as an evidence of the independency of the 'basic industry" sector equity indices. The table also provides additional information about the cross-relations between the sector equity indices. For instance, the cross correlations between technology, media and telecom sector equity indices and other indices have changed

[10] For financial sectors, the average level of variance ratio of aggregate Euro index after the start of the Euro is around 38%, whereas for the rest of the sectors it is around 22%.

[11] Harmonization of fiscal and monetary policies within the European Monetary Union has influenced financial sectors more, and they become increasingly integrated with the regional movements. However,-to some extent-"basic industry sectors" become relatively less dependent to the aggregate Euro index which may be an important evidence to get the connection between the specialization in output across Euro region and sector equity index movements.

[12] We exploit from Fisher Z-transformation to test the difference between correlation coefficients. The application of the test has been discussed further in the Appendix.

[13] In the table, for the sake of brevity, we did not report the significance level of the change in cross-correlations, most of the negative coefficients are statistically significant for 1% level though.

extraordinarily after the start of the Euro. In particular, the change in cross correlations between Technology and Basic Resource equity indices is 1.02, stating that not only the correlations between those sector equity indices decreases but also makes a sign change. Positive correlation between these sector indices before the start of the Euro becomes negative after then. These results, partially confirm the findings of Krause (2000) who stated that sector equity indices in the Euro region are observed to have clusters and become super sectors such as TMT,(Technology media and Telecom), Financial services and Basic Industries, and they have been moving independently from each other. Indeed, clustered TMT sector has been moving more "differently" from other sectors. Brooks and Negro (2004) provided an explanation why TMT sectors are not correlated with other sectors is that those sectors have been identified in financial circles as being central to the stock market bubble took place in the Euro region, and the stock market bubble did not affect other sector equity indices in the same level.

4.3 Robustness Checks

In order to make our results stronger, we further compare our results by employing same dataset with the previous literature who claimed that there is greater potential for sectoral diversification in the Euro region. Empirically, we limit our dataset to year 2002 to compare our results with the previous literature. We re-performed the GARCH(1,1) model with spillover extensions and reported the variance ratios of the aggregate Euro index on the volatility of sector equity indices in table10. It is obviously seen that excluding financial sector indices and TMT, the variance ratios of aggregate Euro index on the sector equity indices are remarkably lower in magnitude and most of them statistically insignificant in the early years of the Euro, compared to the variance ratios in the second column of table 8. to make a rough comparison, the average variance of aggregate Euro index on the volatility of sector equity indices(excluding financial sectors and TMT, is around 15%, between years 1999 and 2002. The same ratio is around is around 31% between years 1992 and 1998.

In addition, we reconstruct the change in correlation matrix in table 11 for the given period. It is clearly observed that differences of the change in the correlations of the sector equity returns, is highly negative and significant.[14] We also observed negative sign in the change

[14]We did no point the significance levels of the changes in correlations in the table. However, for almost all

in correlations of the sector equity indices returns for periods 1992-1998, and 1999-2007, but neither signs nor magnitudes are as sharp as our findings in table 11.

Overall, both the results in table 10 and 11 supports the view of Krause (2000) and Moerman (2004) that there are greater potentials in sectoral diversification across the Euro region in the early years of Euro. However, our findings with longer dataset, reveals that it seems sectoral diversification (excluding some basic industry sectors) is not providing same potentials for reducing the portfolio risk.

5 Concluding Remarks

In this paper, we provided important results for the portfolio holders that have Euro equity bias. First, we documented that Euro area sector indices are not driven by the global factors, after the start of the Euro. Aggregate Euro index is still strong and significant in explaining most of the sector equity returns. We observed that financial sector indices(banking, financial services and insurance) are even being affected more by the aggregate Euro index after the start of the Euro. Some basic industry sectors, i.e., basic resources, food and beverage, healthcare, utility, retail services, oil-gas had become less dependent to the aggregate Euro index at the same period. Our results are different from the existing literature which revealed greater potentials of sectoral diversification within the Euro region in the early years of Euro. Mainly, we found that diversification within some basic industry sectors might be much effective to decrease the portfolio risk. We limited our dataset same as to the previous studies' ones and showed that our methodology gave similar results with the previous studies, which makes our results more robust.

6 Appendix

6.1 Testing $Ho : \rho_1 = \rho_2$

We exploit from Fisher's Z-transformation to test the difference between correlation coefficients. To test the hypothesis, $H_o : \rho_1 = \rho_2$, the z-test is employed:

changes in correlations of sector pairs, it is high significant and negative.

$$z = \frac{Z_1 - Z_2}{\sigma_{Z_1 - Z_2}} \tag{11}$$

where Fisher's Z-transformation and the standard error of the difference between Fisher Z's are:

$$\begin{aligned} Z &= 0.5 * Ln(\frac{1 + |r_i|}{1 - |r_i|}) \\ \sigma_{Z_1 - Z_2} &= \sqrt{\sigma^2_{Z_1} + \sigma^2_{Z_2}} = \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}} \end{aligned}$$

where r_i is the sample correlation coefficient referring to the sector indices before and after the money union and n is the sample size of each set of indices. The observed z-ratio is compared with the critical values in standard Z-Table.

References

Adjaout,K. and J.P. Danthine, (2001a). EMU and portfolio diversification opportunities, Discussion paper series No. 2962, Centre for Economic Policy Research

Adjaout,K. and J.P. Danthine, (2001b). Portfolio diversification: alive and well in Euroland!, Discussion paper series No. 3086, Centre for Economic Policy Research

Adam, Klaus; Tullio Jappelli, Annamaria Menichini, Mario Padula, and Marco Pagano(2002). Analyse, compare, and apply alternative indicators and monitoring methodologies to measure the Evolution of capital market integration in the European Union, Report to the European Commission.

Adjaout, K.; and J.-P Danthine (2003). European Financial Integration and Equity Returns: A Theory-Based Assessment, in Gaspar, V. *et al*, The transformation of the European financial system, ECB, Frankfurt.

Adjaout, K.; and Laura Botazzi,J.Danthine,Andreas Fischer, Rony Hamaui,Richard Portes,(2002). EMU and Portfolio Adjustment ,CEPR Policy Paper No:5.

Baca, S. P., B. Garbe, and R. A. Weiss (2000). The rise of sector effects in major equity markets, Financial Analysts Journal, September-October, pp. 35–40.

Baele, Lieven; Annalisa Ferrando, Peter Hördahl, Elizaveta Krylova, and Cyril Monnet,(2004). Measuring financial integration in the Euro area, European Central Bank, Occasional Paper No. 14.

Bekaert, G. and Harvey, C. R. (1997). Emerging equity market volatility Journal of Financial Economics 43, 29-77.

Bekaert, G., Harvey C. R. and Ng A. (2005). Market integration and contagion, Journal of Business, 78, 39–69.

Berndt, E. R.; B. H. Hall, R. E. Hall, and J. A. Hausman. (1974). Estimation and Inference in Nonlinear Structural Models, Annals of Economics and Social Measurement, 3, 653-66.

Brooks, R., and M. D. Negro (2004). The rise in co-movement across national stock markets: Market integration or IT Bubble?, Journal of Empirical Finance, 11, p 659–680.

Carrieri, F., V. Errunza and S. Sarkissian, (2004). Industry Risk and Market Integration, Management Science, 50, pp.207–221.

Cavaglia, S., C. Brightman and M. Aked, (2000). The increasing importance of industry factors, Financial Analyst Journal, September/October 2000, pp. 41–54

Christiansen, C. (2007). Volatility-Spillover effects in European bond markets, European Financial Management, 13, pp.9230–948.

Doyle, B.; and J. Faust,(2002). Breaks in the variability and co-movement of G-7 Economic Growth, Board of Governors of the Federal Reserve Working paper.

Griffin, J.M. and G.A. Karolyi, (1998). Another look at the role of the industrial structure of markets for international diversification strategies, Journal of Financial Economics, Vol. 50, pp.351–373

Glass, Gene V. and Kenneth D. Hopkins (1996). Statistical Methods in education and Psychology, copyright by Allyn and Bacon.

Hardouvelis, G., D. Malliaropulos, and R. Priestley (2000). , EMU and European Stock Market Integration, CEPR Discussion Paper No. 2124.

Heston, S.L. and K.G. Rouwenhorst, (1994). Does industrial structure explain the benefits of international diversification?, Journal of Financial Economics, Vol. 36, pp. 3–27

Isakov, D. and F. Sonney, (2002.) Are practitioners right? On the relative importance of industrial factors in international stock returns. Swiss Journal of Economics and Statistics, 140, pp.355-379.

Jarque, C. M. and Bera, A. K. (1980). Efficient Tests for Normality, Economics Letters 6, pp. 255-259

Kraus, T. (2001). The impact of EMU on the structure of European equity returns: An empirical Analysis for the fist 21 months. IMF Working Paper 01/84.

Lewis, Karen (1999). Trying to Explain Home Bias in Equities and Consumption, Journal of Economic Literature 37, 571-608.

Ljung, G. M. and Box, G. E. P. (1978). On a Measure of Lack of Fit in Time-Series Models, Biometrika, 65, pp. 297-3003

Moerman, Gerard A. (2004). Diversification in Euro Area Stock Markets: Country versus Industry, ECB Working Paper, No:327.

Ng, Angela (2000). Volatility spillover effects from Japan and the US to the Pacific-Basin, Journal of International Money and Finance 19, 207-233.

Roll, R., (1992). Industrial structure and the comparative behavior of international stock market indices, The Journal of Finance, Vol 47, pp. 3–41

Rouwenhorst, K.G., (1999). European equity markets and the EMU, Financial Analyst Journal, Vol 55 (3), pp. 57–64

Stulz, R. M. and G. A. Karolyi (2001). Are financial assets priced locally or globally? in G.M. Constantinides, M. Harris, R. M. Stulz (ed.) Handbook of the Economics of Finance, 16, pp. 975–1020.

Table 1: **List of Sector Indices**

Auto and Parts (AUT)
Banking (BNK)
Basic Resources (BSRS)
Chemistry (CHM)
Construction and Materials (CNS)
Financial Services (FNSR)
Food and Beverages (FOOD)
Health Care (HTH)
Industrial Goods (IDS)
Insurance (INSR)
Media (MED)
Oil and Gas (OIL)
Non-Cycled Goods (PRHGD)
Retail Services (RTL)
Technology (TECH)
Telecom (TEL)
Travel and Leisure (TRV)
Utilities (UTI)

Table 2: **Descriptive Statistics**

	Mean	STD	Skew	Kurt	Q(1)	Q(4)	$Q^2(1)$	$Q^2(4)$
AUT	0.1	1.7	–0.50	7.64	0.05***	0.05***	0.20***	0.20**
BNK	0.1	1.4	–0.44	6.98	0.07***	0.03***	0.21***	0.27***
BSRS	0.05	1.2	–0.59	7.12	0.10***	0.01***	0.12***	0.15***
CHM	0.1	1.4	–0.24	4.74	0.04***	−0.02	0.16***	0.23***
CNS	0.1	1.0	–0.57	5.74	0.05***	0.01***	0.16***	0.23***
FNSR	0.2	1.2	–0.48	6.58	0.08*	0.03**	0.21***	0.23***
FOOD	0.1	1.3	–0.45	6.11	0.01*	0.01	0.16***	0.17**
HTH	0.1	1.2	0.004	6.01	−0.03	−0.01	0.24***	0.16***
IDS	0.1	1.3	–0.44	5.53	0.07**	0.03***	0.11***	0.11***
INSR	0.1	1.4	–0.27	5.35	0.07**	0.03***	0.21***	0.25***
MED	0.2	1.5	–0.52	10.22	0.11***	−0.01	0.27***	0.17***
OIL	0.1	1.5	0.25	3.94	0.01*	0.01	0.25***	0.17***
PRHGD	0.1	1.5	–0.29	5.35	0.01	−0.02	0.20***	0.14***
RTL	0.2	1.2	–0.16	5.33	0.04**	0.01***	0.16***	0.11***
TECH	0.2	2.1	–0.88	9.27	0.06***	0.04*	0.13***	0.15*
TEL	0.2	1.8	0.03	5.56	0.07***	0.02***	0.17***	0.19***
TRV	0.1	1.4	–0.21	5.29	0.10***	0.02*	0.25***	0.14***
UTI	0.08	1.0	–0.08	4.26	0.01	0.01	0.23***	0.17***
EURO	0.1	1.0	–0.11	4.21	0.03***	0.03***	0.17***	0.19***
WORLD	0.05	0.07	–0.17	3.65	0.05**	0.01***	0.21***	0.20***

Notes: The table reports the summary statistics for the weekly returns (in %) of Euro sector equity indices. The following statistics are reported: Mean, standard deviation (STD), skewness (Skew), kurtosis (Kurt), autocorrelation of order 1 and 4 (Q(1)-Q(4)), and autocorrelation of the squared time series of order 1 and 4 ($Q^2(1)$-$Q^2(4)$). *, **, and *** indicate that the Ljung and Box (1978) test statistic is significant at 10%, 5%, and 1% levels respectively.

Table 3: **GARCH Estimates for the Sector Indices in Euro Region for the Period 1992–1998.**

	$R_S(-1)$	$R_{\text{eu}}(-1)$	$R_{\text{w}}(-1)$	$R_{\text{ws}}(-1)$	ϕ_{eu}	ϕ_{w}	ϕ_{ws}	α_s	β_s
AUT	0.08***	−0.08***	0.02*	0.02	0.79***	0.08***	0.10***	0.07***	0.90***
BNK	0.03***	−0.03*	0.02	0.02	0.35***	0.03**	0.04***	0.07**	0.89***
BSRS	0.04**	−0.06**	0.01*	0.01	0.71***	0.05***	0.13***	0.05***	0.90***
CHM	0.04**	−0.06**	0.01*	0.01	0.71***	0.05***	0.13***	0.05***	0.90***
CNS	−0.01	0.02**	−0.01	−0.07**	0.45***	0.11***	0.18***	0.08***	0.91***
FNSR	−0.01	0.02	−0.01	0.05***	0.44***	0.10***	0.11***	0.08**	0.87***
FOOD	−0.11***	0.02	−0.01	0.01	0.51***	0.05**	0.18***	0.07***	0.87***
HTH	−0.05	0.01	0.02	0.01	0.43***	−0.02	0.23***	0.09***	0.77***
IDS	−0.07**	−0.08***	−0.01	0.08***	0.51***	0.09**	0.18***	0.05***	0.92***
INSR	0.06**	−0.08**	0.04**	0.01	0.60***	0.08***	0.20***	0.07***	0.87***
MED	−0.13***	0.02	−0.04**	0.03**	0.46***	0.04***	0.20***	0.07***	0.85***
OIL	0.07**	−0.10***	0.02	0.01	0.61***	0.02*	0.03*	0.07***	0.82***
PRHGD	0.08***	−0.07**	0.002	0.001	0.75***	0.01*	0.14***	0.02*	0.87***
RTL	0.13***	−0.09***	0.001	0.001	0.55***	0.02	0.18***	0.10**	0.68***
TECH	0.07***	0.01	0.06**	−0.03**	0.70***	0.001	0.10***	0.04*	0.93***
TEL	0.17***	−0.07***	0.08**	−0.01**	0.75***	−0.02	0.08***	0.07**	0.91***
TRV	0.12***	0.01	0.18***	−0.01	0.55***	0.09*	0.18***	0.06**	0.91***
UTI	−0.14***	0.08***	−0.01	0.05**	0.37***	−0.04*	0.22***	0.06**	0.84***

Notes: The GARCH model for sector equity indices is defined as follows;

$R_{\text{s},t} = a_{\text{s}} + b_{\text{s}} R_{\text{s},t-1} + \eta_{\text{eu},t-1} R_{\text{eu},t-1} + \eta_{\text{w},t-1} R_{\text{w},t-1} + \eta_{\text{ws},t-1} R_{\text{ws},t-1} + \epsilon_{\text{s},t}$ where $\epsilon_{\text{s},t} = \varepsilon_{\text{s},t} + \phi_{\text{eu},t-1}\varepsilon_{\text{eu},t} + \phi_{\text{w},t-1}\varepsilon_{\text{w},t} + \phi_{\text{ws},t-1}\varepsilon_{\text{ws},t}$.

$R_{\text{s},t}$ is the weekly return of each sector equity indices in Euro area. $R_{\text{eu}}(-1)$, $R_{\text{w}}(-1)$, and $R_{\text{ws}}(-1)$ are the mean spillover effects of the returns of aggregate Euro index, aggregate world index and global sector index, respectively. ϕ_{eu}, ϕ_{ws}, and ϕ_{w} are the volatility spillover effects of the returns of aggregate Euro index, aggregate world index and global sector index, respectively. $\varepsilon_{\text{s},t}$ has mean of 0 and conditional variance of $\sigma^2_{\text{s},t} = \omega_{\text{s}} + \alpha_{\text{s}}\varepsilon^2_{\text{s},t-1} + \beta_{\text{s}}\sigma^2_{\text{s},t-1}$.

Constants of each variance equation and mean equation are not reported for the sake of brevity. *, **, and *** indicate that the relevant coefficient is significant at 10%, 5%, and 1% levels, respectively.

Table 4: **GARCH Estimates for the Sector Indices in Euro Region for the Period 1999–2007.**

	$R_S(-1)$	$R_{\text{eu}}(-1)$	$R_{\text{w}}(-1)$	$R_{\text{ws}}(-1)$	ϕ_{eu}	ϕ_{w}	ϕ_{ws}	α_s	β_s
AUT	0.07***	−0.05	−0.001	0.004	0.75***	0.01	0.001	0.07***	0.90***
BNK	0.05***	−0.03*	0.01	0.001	0.75***	0.001	0.001	0.07**	0.90***
BSRS	0.04**	−0.06**	0.01*	0.01	0.71***	0.05***	0.13***	0.05***	0.90***
CHM	0.04**	−0.02	0.01	−0.01	0.45**	0.001	0.003	0.02*	0.97***
CNS	0.01	0.03**	−0.001	−0.001	0.43***	0.02	0.01	0.08***	0.88***
FNSR	0.02	0.05***	0.02	−0.01	0.63	0.001	0.001	0.07	0.91***
FOOD	0.02*	−0.03***	−0.002	0.001	0.38***	−0.001	−0.001	0.04*	0.91***
HTH	−0.001	−0.03*	0.004	0.007	0.40***	0.02	−0.01	0.03*	0.86***
IDS	−0.02	0.05***	−0.02*	0.01	0.66***	0.01	0.02	0.06**	0.86***
INSR	0.02	0.06***	−0.06*	0.01	0.56***	0.001***	0.02*	0.06***	0.92***
MED	0.06***	0.01	0.02	0.02	0.48***	−0.04	0.001	0.07***	0.82***
OIL	0.11**	0.08*	0.001	0.001	0.46***	0.001	0.001	0.06**	0.93***
PRHGD	0.06***	−0.04**	0.001	0.001	0.58***	−0.002	0.02*	0.04**	0.94***
RTL	0.07**	−0.05***	0.03	0.001	0.48***	−0.001	0.03	0.04*	0.85***
TECH	0.10***	−0.08***	−0.01	−0.02	0.67***	0.06	−0.01	0.05*	0.94***
TEL	0.1*	−0.12**	−0.02	−0.02	0.48***	0.07*	−0.01	0.05**	0.94***
TRV	0.05***	0.03*	0.04*	0.01	0.46***	0.004	0.003	0.07**	0.90***
UTI	0.05**	0.03**	−0.001	0.001	0.66***	0.004	0.003	0.07**	0.91***

Notes: The GARCH model for sector equity indices is defined as follows;

$R_{\text{s},t} = a_{\text{s}} + b_{\text{s}} R_{\text{s},t-1} + \eta_{\text{eu},t-1} R_{\text{eu},t-1} + \eta_{\text{w},t-1} R_{\text{w},t-1} + \eta_{\text{ws},t-1} R_{\text{ws},t-1} + \epsilon_{\text{s},t}$ where $\epsilon_{\text{s},t} = \varepsilon_{\text{s},t} + \phi_{\text{eu},t-1}\varepsilon_{\text{eu},t} + \phi_{\text{w},t-1}\varepsilon_{\text{w},t} + \phi_{\text{ws},t-1}\varepsilon_{\text{ws},t}$.

$R_{\text{s},t}$ is the weekly return of each sector equity indices in Euro area. $R_{\text{eu}}(-1)$, $R_{\text{w}}(-1)$, and $R_{\text{ws}}(-1)$ are the mean spillover effects of the returns of aggregate Euro index, aggregate world index and global sector index, respectively. ϕ_{eu}, ϕ_{ws}, and ϕ_{w} are the volatility spillover effects of the returns of aggregate Euro index, aggregate world index and global sector index, respectively. $\varepsilon_{\text{s},t}$ has mean of 0 and conditional variance of $\sigma^2_{\text{s},t} = \omega_{\text{s}} + \alpha_{\text{s}}\varepsilon^2_{\text{s},t-1} + \beta_{\text{s}}\sigma^2_{\text{s},t-1}$.

Constants of each variance equation and mean equation are not reported for the sake of brevity. *, **, and *** indicate that the relevant coefficient is significant at 10%, 5%, and 1% levels, respectively.

Table 5: **Tests for Spillover Effects for Years 1992–1998**

	$Wald_1$	$Wald_2$	$Wald_3$	$Wald_4$
AUT	3.35	837.22***	840.42***	118.11***
BNK	18***	469.33***	400.32***	33.25***
BSRS	8.15***	277.39***	240.84***	44.80***
CHM	4.76	287.26***	259.05***	41.51***
CNS	0.32	461.39***	361.15***	118.18***
FNSR	2.25	349.33***	224.28***	169.14***
FOOD	5.86*	392.11***	259.11***	174.01***
HTH	1.01	142.32***	97.43***	38.11***
IDS	8.14**	531.11***	518.55***	14.11***
INSR	2.80	486.66***	399.71***	90.31***
MED	2.85	406.11***	242.22***	93.05***
OIL	13.33***	312.11***	143.21***	163.22***
PRHGD	8.14**	374.12***	301.14***	57.33***
RTL	2.12	312.11***	271.32***	31.45***
TECH	7.14*	313.44***	185.21***	125.31***
TEL	1.52	150.31***	116.32***	39.21***
TRV	0.32	178.32***	107.43***	35.21***
UTI	0.33	177.32***	165.32***	35.21***

Notes: The table reports the joint robust Wald test statistics for the following null hypotheses regarding the spillover effects in the constant spillover model:

$Wald_1 : H_o : \eta_{\mathrm{eu}} = \eta_{\mathrm{w}} = \eta_{\mathrm{ws}} = 0$ (No mean spillover effects)
$Wald_2 : H_o : \phi_{\mathrm{eu}} = \phi_{\mathrm{w}} = \phi_{\mathrm{ws}} = 0$ (No volatility spillover effects)
$Wald_3 : H_o : \eta_{\mathrm{eu}} = \phi_{\mathrm{eu}} = 0$ (No Euro spillover effects)
$Wald_4 : H_o : \eta_{\mathrm{w}} = \eta_{\mathrm{ws}} = \phi_{\mathrm{w}} = \phi_{\mathrm{ws}} = 0$ (No global factor spillover effects)

*, **, and *** indicate that the relevant coefficient is significant at 10%, 5%, and 1% levels, respectively.

Table 6: **Tests for Spillover Effects for Years 1999–2007**

	$Wald_1$	$Wald_2$	$Wald_3$	$Wald_4$
AUT	4.08	517.13***	524.21***	4.67
BNK	3.61	1340.32***	1301.65***	3.76
BSRS	8.73**	238.44***	241.33***	1.13
CHM	6.75*	813.23***	800.21***	1.17
CNS	0.80	654.12***	660.85***	2.69
FNSR	0.25	634.81***	630.11***	4.67
FOOD	3.39	201.19***	188.21***	3.27
HTH	4.00	174.12***	176.87***	2.12
IDS	5.15	188.65***	169.01***	3.11
INSR	1.40	603.15***	594.33***	4.76
MED	0.87	257.65***	236.82***	2.93
OIL	2.36	247.21***	242.73***	1.26
PRHGD	1.58	778.51***	776.37***	2.87
RTL	3.32	570.64***	541.92***	3.48
TECH	6.20∗	529.68***	510.21**	3.61***
TEL	5.91*	320.14***	328.67***	3.92***
TRV	10.8**	364.83***	332.48***	9.19*
UTI	7.49*	541.54***	551.22***	0.41

Notes: The table reports the joint robust Wald test statistics for the following null hypotheses regarding the spillover effects in the constant spillover model:

$Wald_1 : H_o : \eta_{\text{eu}} = \eta_{\text{w}} = \eta_{\text{ws}} = 0$ (No mean spillover effects)
$Wald_2 : H_o : \phi_{\text{eu}} = \phi_{\text{w}} = \phi_{\text{ws}} = 0$ (No volatility spillover effects)
$Wald_3 : H_o : \eta_{\text{eu}} = \phi_{\text{eu}} = 0$ (No Euro spillover effects)
$Wald_4 : H_o : \eta_{\text{w}} = \eta_{\text{ws}} = \phi_{\text{w}} = \phi_{\text{ws}} = 0$ (No global factor spillover effects)

*, **, and *** indicate that the relevant coefficient is significant at 10%, 5%, and 1% levels, respectively.

Table 7: **Variance Ratio: World Aggregate Index and Global Sector Index**

	1992-1998		1999-2007	
	Mean	STD	Mean	STD
AUT	0.02	0.01	0.001	0.03
BNK	0.01	0.01	0.002	0.02
BSRS	0.21	0.03	0.005	0.01
CHM	0.08	0.05	0.01	0.01
CNS	0.17	0.11	0.01	0.01
FNSR	0.09	0.01	0.001	0.005
FOOD	0.06	0.08	0.001	0.04
HTH	0.18	0.08	0.001	0.001
IDS	0.21	0.11	0.0001	0.0001
INSR	0.34	0.11	0.08	0.01
MED	0.21	0.13	0.01	0.03
OIL	0.18	0.04	0.04	0.04
PRHGD	0.38	0.05	0.01	0.04
RTL	0.30	0.05	0.06	0.11
TECH	0.04	0.07	0.01	0.11
TEL	0.03	0.05	0.001	0.03
TRV	0.14	0.05	0.01	0.001
UTI	0.01	0.01	0.001	0.02

Notes: The table reports the mean and standard deviation of the sector indices' variance ratios for the constant spillover model within different sub-samples. The variance ratio for both the aggregate world index and global sector equity indices' spillover effect on the volatility of the sector equity index return is formulated as;

$VR_{\mathrm{s},t}^{\mathrm{w,ws}} = \frac{\phi_{\mathrm{w},t-1}^2 \varepsilon_{\mathrm{w},t}^2 + \phi_{\mathrm{ws},t-1}^2 \varepsilon_{\mathrm{ws},t}^2}{h_{\mathrm{s},t}}$ where $h_{\mathrm{s},t} = \sigma_{\mathrm{s},t}^2 + \phi_{\mathrm{eu},t-1}^2 \sigma_{\mathrm{eu},t}^2 + \phi_{\mathrm{w},t-1}^2 \sigma_{\mathrm{w},t}^2 + \phi_{\mathrm{ws},t-1}^2 \sigma_{\mathrm{ws},t}^2$.

Table 8: **Variance Ratio: Euro Aggregate Index**

	1992-1998		1999-2007	
	Mean	STD	Mean	STD
AUT	0.29	0.06	0.26	0.06
BNK	0.31	0.11	0.40	0.09
BSRS	0.28	0.04	0.18	0.10
CHM	0.28	0.07	0.28	0.16
CNS	0.32	0.14	0.30	0.15
FNSR	0.27	0.04	0.34	0.05
FOOD	0.32	0.08	0.16	0.11
HTH	0.28	0.04	0.15	0.10
IDS	0.33	0.10	0.36	0.11
INSR	0.27	0.06	0.38	0.06
MED	0.28	0.14	0.26	0.08
OIL	0.26	0.11	0.15	0.04
PRHGD	0.43	0.11	0.29	0.06
RTL	0.32	0.05	0.18	0.12
TECH	0.23	0.04	0.30	0.10
TEL	0.22	0.03	0.27	0.03
TRV	0.25	0.05	0.17	0.10
UTI	0.33	0.10	0.22	0.10

Notes: The table reports the mean and standard deviation of the sector indices' variance ratios for the constant spillover model within different sub-samples. The variance ratio for both the aggregate world index and global sector equity indices' spillover effect on the volatility of the sector equity index return is formulated as;

$VR^{\mathrm{eu}}_{\mathrm{s},t} = \frac{\phi^2_{\mathrm{eu}}\varepsilon^2_{\mathrm{eu},t}}{h_{\mathrm{s},t}}$ where $h_{\mathrm{s},t} = \sigma^2_{\mathrm{s},t} + \phi^2_{\mathrm{eu},t-1}\sigma^2_{\mathrm{eu},t} + \phi^2_{\mathrm{w},t-1}\sigma^2_{\mathrm{w},t} + \phi^2_{\mathrm{ws},t-1}\sigma^2_{\mathrm{ws},t}$.

Table 9: **Changes in Correlations (1992–1998, 1999-2007)**

	AUT	BNK	BSRS	CHM	CNS	FNSR	FOOD	HTH	IDS	INSR	MED	OIL	PRHGD	RTL	TECH	TEL	TRV
BNK	–0.09																
BSRS	–0.02	0.07															
CHM	–0.02	0.03	0.03														
CNS	–0.09	0.01	0.06	0.06													
FNSR	–0.10	0.00	0.03	0.00	0.00												
FOOD	–0.07	–0.12	–0.25	–0.11	–0.12	–0.23											
HTH	–0.25	–0.29	–0.23	–0.19	–0.15	–0.22	–0.18										
IDS	–0.17	–0.12	–0.12	–0.12	–0.18	–0.15	–0.19	–0.16									
INSR	–0.46	–0.53	–0.58	–0.50	–0.69	–0.53	–0.58	–0.24	–0.30								
MED	–0.80	–0.79	–0.97	–0.93	–0.97	–0.85	–0.97	–0.64	–0.40	–0.14							
OIL	–0.11	–0.32	–0.33	–0.24	0.04	–0.21	–0.32	–0.15	–0.15	–0.57	–0.93						
PRHGD	–0.16	–0.09	–0.19	–0.17	–0.18	–0.14	–0.17	–0.15	0.00	–0.21	–0.44	–0.19					
RTL	–0.54	–0.69	–0.78	–0.78	–0.83	–0.73	–0.85	–0.70	–0.50	–0.07	–0.24	–0.89	–0.48				
TECH	–0.89	–0.92	–1.02	–0.95	–1.09	–0.96	–1.01	–0.65	–0.47	–0.20	0.03	–0.98	–0.45	–0.20			
TEL	–0.80	–0.83	–0.93	–0.92	–0.98	–0.89	–1.01	–0.79	–0.45	–0.30	–0.05	–0.95	–0.49	–0.22	–0.05		
TRV	–0.06	–0.05	–0.04	–0.01	–0.11	–0.04	–0.27	–0.08	–0.08	–0.29	–0.59	–0.07	–0.03	–0.43	–0.71	–0.67	
UTI	–0.01	0.01	0.09	0.02	0.04	–0.01	–0.24	–0.21	–0.14	–0.55	–0.88	–0.02	–0.14	–0.72	–0.91	–0.85	–0.04

Note: The table reports the changes in correlations for the weekly returns (in %) of the sector equity indices between two periods:1992-1998 and 1999-2007.

Table 10: **Variance Ratio: Euro Aggregate Index**

	1999-2002	
	Mean	STD
AUT	0.20	0.14
BNK	0.40	0.10
BSRS	0.16	0.15
CHM	0.18	0.11
CNS	0.20	0.14
FNSR	0.40	0.11
FOOD	0.09	0.11
HTH	0.13	0.12
IDS	0.33	0.11
INSR	0.31	0.12
MED	0.27	0.15
OIL	0.12	0.12
PRHGD	0.20	0.19
RTL	0.18	0.12
TECH	0.37	0.13
TEL	0.38	0.07
TRV	0.16	0.11
UTI	0.20	0.11

Notes: The table reports the mean and standard deviation of the sector indices' variance ratios for the constant spillover model within different sub-samples. The variance ratio for both the aggregate world index and global sector equity indices' spillover effect on the volatility of the sector equity index return is formulated as;

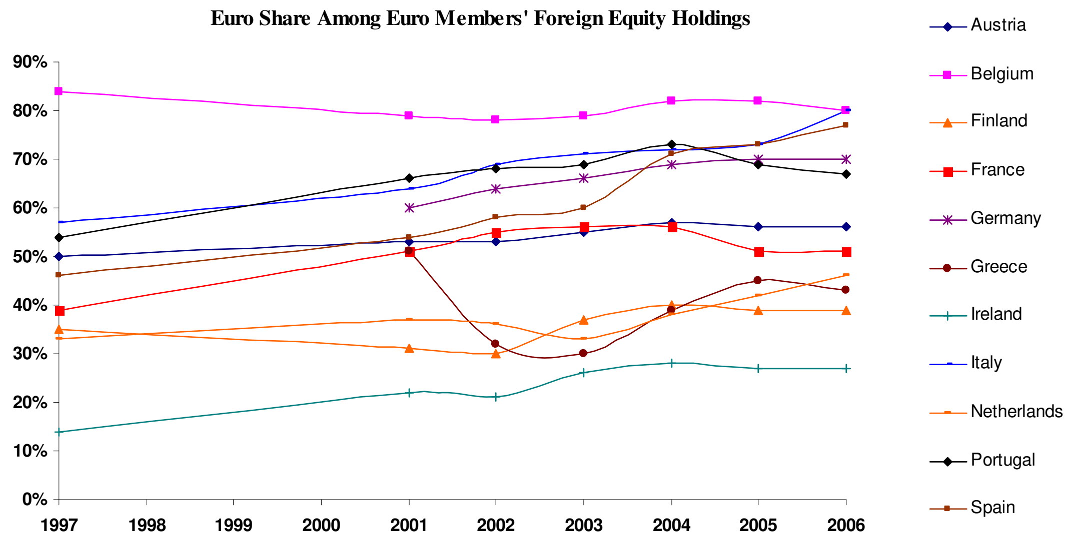
$VR^{\mathrm{eu}}_{\mathrm{s},t} = \frac{\phi^2_{\mathrm{eu}}\varepsilon^2_{\mathrm{eu},t}}{h_{\mathrm{s},t}}$ where $h_{\mathrm{s},t} = \sigma^2_{\mathrm{s},t} + \phi^2_{\mathrm{eu},t-1}\sigma^2_{\mathrm{eu},t} + \phi^2_{\mathrm{w},t-1}\sigma^2_{\mathrm{w},t} + \phi^2_{\mathrm{ws},t-1}\sigma^2_{\mathrm{ws},t}$.

Table 11: **Changes in Correlations (1992–1998, 1999-2002)**

	AUT	BNK	BSRS	CHM	CNS	FNSR	FOOD	HTH	IDS	INSR	MED	OIL	PRHGD	RTL	TECH	TEL	TRV
BNK	–0.35																
BSRS	–0.73	–0.59															
CHM	–0.52	–0.17	–0.31														
CNS	–0.49	–0.21	–0.13	–0.01													
FNSR	–0.43	–0.04	–0.70	–0.17	–0.26												
FOOD	–0.81	–0.42	–0.32	–0.12	–0.19	–0.38											
HTH	–0.68	–0.17	–0.52	–0.16	–0.13	–0.10	–0.18										
IDS	–0.66	–0.13	–0.68	–0.43	–0.37	–0.23	–0.60	–0.37									
INSR	–0.30	–0.06	–0.73	–0.27	–0.34	–0.03	–0.57	–0.20	–0.20								
MED	–0.58	–0.16	–0.86	–0.66	–0.48	–0.28	–0.85	–0.54	–0.03	–0.16							
OIL	–0.68	–0.19	–0.39	–0.14	–0.08	–0.22	–0.12	–0.16	–0.32	–0.33	–0.55						
PRHGD	–0.58	–0.04	–0.67	–0.37	–0.27	–0.14	–0.47	–0.31	–0.03	–0.12	–0.13	–0.26					
RTL	–0.26	–0.34	–1.05	–0.88	–0.71	–0.43	–1.23	–0.90	–0.48	–0.21	–0.35	–0.91	–0.52				
TECH	–0.64	–0.19	–0.87	–0.59	–0.54	–0.27	–0.79	–0.46	–0.03	–0.19	0.03	–0.47	–0.05	–0.30			
TEL	–0.63	–0.37	–1.03	–0.93	–0.77	–0.52	–1.17	–0.84	–0.18	–0.34	–0.05	–0.82	–0.29	–0.24	–0.06		
TRV	–0.22	–0.03	–0.60	–0.18	–0.24	–0.06	–0.46	–0.22	–0.23	–0.05	–0.25	–0.26	–0.14	–0.29	–0.29	–0.44	
UTI	–0.33	–0.13	–0.79	–0.53	–0.39	–0.19	–0.75	–0.40	–0.19	–0.06	–0.14	–0.50	–0.21	–0.26	–0.15	–0.24	–0.15

Note: The table reports the changes in correlations for the weekly returns (in %) of the sector equity indices between two periods:1992-1998 and 1999-2002.

Figure 1



Data Source: IMF's Coordinated Portfolio Integrated Survey(CPIS) database for years 1997, 2001-2006.
The graph illustrates the euro share in each euro member's foreign equity holdings.