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ABSTRACT

EMU and Portfolio Diversification Opportunities

This Paper studies the impact of EMU on portfolio diversification opportunities. We find a significant increase in the correlation between stock returns, whether they are computed on the basis of market or sector indices. This is true for two definitions of the pre-convergence and convergence periods. Diversification opportunities within the Euro-area have thus been reduced. The culprit appears to be less the disappearance of currency risk than the convergence of economic structures and/or the homogenisation of economic shocks (across the Euro-15 member states). This evolution should mark the end of pure country allocation strategies within Europe. If these are the alternatives, the increased conformity of stock returns implies that international diversification does not pay: the cost of the home bias within Euroland has been lowered (in some cases to zero). Diversification across both countries and sectors, however, remains the much superior investment strategy, and, in light of this option, the cost of the home bias continues to be significant.

JEL Classification: F30, G11 and G15
Keywords: EMU, home bias and portfolio diversification

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NON-TECHNICAL SUMMARY

This Paper studies the impact of EMU on portfolio diversification opportunities. We focus on equity markets and understand under the label 'EMU' the entire economic and monetary integration process at work in Euro-land in the 90's culminating with the advent of the Euro on January 1, 1999.

International diversification is performance improving to the extent that national stock markets of the Euro area are imperfectly correlated. The advent of the Euro has at least two possible implications in this respect. First, it corresponds mechanically to the disappearance of currency risks, and second, it is part of a broader set of structural changes likely to alter the traditional forces underlying asset returns and thus, the relevant correlation's between stock indices.

To shed light on these issues and their implications for portfolio allocation decisions, we focus on the evolving characteristics of the variance-covariance matrix of returns within Euro-land. The question we address is the following: have we observed significant changes, over the recent past, as the monetary and economic convergence process was unfolding (and with the advent of the Euro), in the characteristics of returns? And, if so, what are their implications for optimal portfolio allocations?

We find indeed that the conditions under which portfolio investors diversify across the Euro-area equity markets have changed materially in the 1990s. With an increased degree of correlation between either national stock indices, diversification opportunities have been significantly reduced. It seems difficult not to incriminate the process of economic and monetary integration process at work in Europe during this period for this result. Within this process, however, the disappearance of currency risk is decidedly less important for investors than the convergence of economic structures and/or the homogenisation of economic shocks (across the Euro-15 member states). That is, the increased stock return correlations are as manifest when we abstract from currency fluctuations than when they are computed using effective monetary returns.

As a consequence of these changes, we wonder whether the evolution of return correlations at the country level would justify abandoning the traditional country allocation model in favour of an approach based on a diversification across industrial sectors. To get an insight into this question, the time evolution of the variance-covariance matrices of sectoral returns is also studied. Two disaggregation levels are considered: at a first level, four sectors per country are considered, and at the second level, 10 sectors are taken into account.

Our finding is that indeed this evolution should mark the end of pure country allocation strategies within Europe: the increased conformity of stock returns implies that international diversification across the Euro-area on the basis of a pure country allocation model has increasingly smaller benefits.

This result has implications for the celebrated ‘home bias’, the propensity of most investors to invest disproportionately in their home market. Our results suggest that the changing economic structures within Europe and the disappearance of currency risks may have lowered the cost of the home bias within Euroland. This intuition is confirmed if the alternative to staying at home is to diversify with the use of a pure country allocation model. In some cases, the cost of the home bias thus understood has decreased to zero.

Further analysis however shows that diversification across both countries and sectors, remains the much superior investment strategy and that, in light of this option, the cost of the home bias continues to be significant in Europe.

1. Introduction

This paper studies the impact of EMU on portfolio diversification opportunities. We focus on equity markets and understand under the label 'EMU' the entire economic and monetary integration process at work in Euro-land in the 90's. In this context, international diversification is performance improving to the extent that national stock markets of the Euro area are imperfectly correlated. The advent of the Euro has at least two possible implications in this respect. First, it corresponds mechanically to the disappearance of currency risks, and second, it is part of a broader set of structural changes likely to alter the traditional forces underlying asset returns and thus, the relevant correlations between stock indices.

To shed light on these issues and their implications for portfolio allocation decisions, we start by focusing on the characteristics of the variance-covariance matrix of returns within Euro-land. The question we address is the following: have we observed significant changes, over the recent past, as the monetary and economic convergence process was unfolding (and with the advent of the Euro), in the characteristics of returns? And, if so, what are their implications for optimal portfolio allocations?

A closely related issue is whether the evolution of return correlations at the country level would justify abandoning the traditional country allocation model in favour of an approach based on a diversification across industrial sectors. To get an insight into this question, the time evolution of the variance-covariance matrices of sectoral returns is also studied. Two disaggregation levels are considered: at a first level, four sectors per country are considered, and at the second level, 10 sectors are taken into account.

Finally, given the persistence and the importance of the home bias in equity investments, the paper pursues with the following question: do the changing economic structures within Europe and the disappearance of currency risks tend to increase or decrease the cost of restricting one's investment universe to home equities?

2. The Data

For the purpose of comparison, we need pre-Euro and post-Euro periods. Given the relatively short post-Euro period, the available data constitute a severe hindrance. To bypass the difficulty, the problem is approached from two perspectives, both making the assumption that January 1st 1999 was but the final consecration of a movement of convergence started earlier. Our first, stronger, hypothesis is that the start of the convergence period may be identified with January 1995, the date of entry of the Maastricht Treaty. This enables the use the period from September 1990 to the end of 1994 as representative of the 'pre-convergence' period and to make full use of the data sample available. A more realistic hypothesis is to use the information provided by opinion polls. In fact, while one may argue that the prospects of a monetary union were surrounded with considerable uncertainty in January 1995, this uncertainty for most participating countries was resolved much ahead of the starting date of January 1999. Indeed, Table 1 indicates that for Germany, France, Netherlands, Belgium and Austria, the prospects of EMU were close to certainty as early as August 1996; by August 1997, only for Italy were there some doubts which were lifted by January 1998. The ambiguity over the exact date of the convergence period is inevitable, since it is linked with private investors' expectations about the realisation of EMU. This ambiguity justifies pursuing alternative hypotheses and exploiting data samples available to date as thoroughly as possible.

Table 1 : Expected participation in EMU 1996 - 1998

Country	Poll taken in				
	January 1996	August 1996	January 1997	August 1997	January 1998
Germany	100	100	100	100	100
France	97	100	100	100	100
Netherlands	76	100	100	100	100
Belgium	79	95	100	100	100
Austria	79	93	97	96	100
Ireland	60	82	88	96	100
Spain	7	7	31	90	100
Finland	36	48	76	91	94
Portugal	0	4	32	84	97
Italy	2	3	19	67	99
Denmark	50	42	25	16	7
Sweden	7	13	13	4	11
United Kingdom	22	8	4	1	0
Greece	0	0	0	1	0
The polls of over 200 financial and economic forecasters indicate the percentage of respondents predicting that countries will join monetary union at the outset. Respondents' assumptions regarding the likely starting date differed. Luxembourg was not included in all polls.					

Source: McCauley (1997), Consensus Economics

Weekly data on national stock market indices as well as sector indices for the Euro-land 11 countries have been collected. The indices used are the Datastream Global Equity indices. These indices are good representations of the national markets in the sense that they are broad and cover between 75% and 80% of the total capitalisation of the respective markets. Moreover, they represent valid benchmarks for comparison with other indices used in current empirical studies and have the added advantage of being available for the set of countries that are of interest to us[1]. The whole sample runs from September 10, 1990 to April 19, 1999, which yields a total of 450 weekly return observations per index[2]. The pure equity returns thus obtained are converted into local currency by adding the national currency returns for all dates prior to January 1, 1999. The spot exchange rate series are also retrieved from Datastream.

Customarily, tests of asset pricing models are conducted using monthly return observations because non-normality issues are less severe at sampling intervals greater than or equal to one month. However, if we elect to work with monthly data, the sample size becomes extremely small, particularly when it comes to comparing pre-Euro and post-Euro sub-periods. The concern with non-normality is illustrated in Table 2 which contains summary statistics on national index returns for the pre-1999 portion of our

[1] We used the FT Actuaries indices for *eight countries* and obtained outputs qualitatively similar to those reported here. We therefore decide to work with Datastream Global Equity indices which are available for *all the Euro-land countries*, in contrast to FT Actuaries.

[2] The total return observations is 380 for Luxembourg rather than 450.

sample. As will be done systematically, we illustrate our arguments by taking the viewpoints of the German and French investors. Based on the Jarque-Bera statistic (which is a chi square with two degrees of freedom), the normality assumption is rejected for all 11 countries and both types of investors. The normality is rejected both because of fat tails and asymmetry as indicated by the kurtosis and skewness coefficients. In fact, given that the kurtosis coefficient $k \rightarrow N\left(3,\ \frac{24}{T}\right)$ and the skewness $s \rightarrow N\left(0,\ \frac{6}{T}\right)$, and that the Jarque-Bera is a combination of the latter two statistics, it is easy to see that asymmetry is present in all but three stock returns (Austria, Finland and Italy) when we focus on returns expressed in DMK. With no exception, index returns are characterised by fat tails. Belgium, Finland and Italy exhibit asymmetry when returns are expressed in FRF and fait tails are present for all countries.

The main question here is to figure out the likely consequences of this non-normality on the battery of tests that are going to be undertaken in this study. Given the evidence of fat tails, the primary message is that sample second moments are unreliable estimates of the true population moments, which might not even exist[3]. The very simple and conservative assumption that is maintained here is that the general form of the underlying return distribution (whatever it is) does not change significantly over the time period of our study, so that correlation and covariance matrices computed over two consecutive sub-periods can be viewed as coming from the same distribution.

Table 3 reports the unconditional correlations obtained for the pre-1999 part of our sample.

[3] Fat tails suggest that returns can be modelled by stable paretian distributions which can have infinite second moments.

Table 2: Euro-land Country Index Returns: Pre 99 Summary Statistics

PANEL A: Returns in DMK

	Aust	Belg	Germ	Spai	Finl	Fran	Irel	Ital	Luxe	Neth	Port
Mean	0.006683	0.152334	0.119917	0.14267	0.227939	0.13043	0.18674	0.09262	0.12745	0.17795	0.12409
Median	0.039258	0.164229	0.162868	0.24149	0.194118	0.20265	0.163	0.17367	0.15412	0.20724	0.06831
Maximum	5.45129	3.822995	4.917269	6.11959	8.027822	4.09096	4.63247	7.64595	2.78089	3.81916	5.1023
Minimum	-4.10076	-5.60237	-6.50709	-5.85532	-8.22668	-5.61873	-6.1001	-7.45092	-5.18211	-7.198	-6.3702
Std. Dev.	1.154506	1.043792	1.171001	1.61138	2.019024	1.34975	1.35494	2.03477	0.89676	1.21888	1.25712
Skewness	0.093372	-0.34847	-0.70753	-0.42946	-0.18779	-0.45904	-0.3415	-0.1542	-0.79187	-0.8438	-0.299
Kurtosis	4.87744	5.455887	6.64091	4.71451	4.795005	4.6387	5.58872	3.79131	7.44067	8.77074	6.41768
J.-Bera	61.9973	113.5064	265.7541	64.0461	58.57412	61.4499	124.842	12.5624	240.801	629.604	209.664
Probability	0	0	0	0	0	0	0	0.00187	0	0	0
Observ.	418	418	418	418	418	418	418	418	260	418	418

PANEL B: Returns in FRF

Mean	0.002797	0.148449	0.116032	0.13879	0.224054	0.12654	0.18286	0.088735	0.12418	0.17407	0.12021
Median	-0.001154	0.14253	0.130832	0.197105	0.151529	0.18546	0.17483	0.152552	0.1707	0.15952	0.0943
Maximum	5.81735	3.963525	5.283329	6.393852	7.785446	4.45702	4.873	6.71786	2.79443	3.59612	5.37656
Minimum	-4.52516	-5.578945	-6.48366	-5.66917	-8.25724	-5.53013	-5.9949	-7.31701	-5.1588	-7.1746	-6.3468
Std. Dev.	1.161068	1.070855	1.206177	1.576226	1.997849	1.27124	1.31963	2.019268	0.88358	1.18859	1.27752
Skewness	0.265701	-0.222488	-0.61948	-0.29749	-0.20292	-0.40396	-0.2617	-0.10622	-0.9155	-0.7891	-0.2169
Kurtosis	5.229234	5.300714	6.480786	4.616246	4.860617	4.69561	5.64081	3.561202	7.82736	9.41663	6.09074
Jarque-Ber	91.47014	95.63994	237.7532	51.66226	63.1648	61.4425	126.232	6.271359	288.793	760.48	169.654
Probability	0	0	0	0	0	0	0	0.04347	0	0	0
Observ.	418	418	418	418	418	418	418	418	260	418	418

This table gives the unconditional whole sample moments of the Euro-land index returns. The sample used runs from December 31, 1990 to December 28, 1998 and observations are sampled weekly. Returns are continuously compounded and annualised. The Jarque-Bera is a chi square with two degrees of freedom and tests for both asymmetry and fat tails in the series.

Table 3: Unconditional Whole Sample Correlations:

PANEL A: Returns in DMK

Aust	1.000									
Belg	0.503	1.000								
Germ	0.608	0.641	1.000							
Spai	0.474	0.559	0.658	1.000						
Finl	0.425	0.473	0.525	0.487	1.000					
Fran	0.539	0.599	0.715	0.669	0.507	1.000				
Irel	0.501	0.504	0.527	0.498	0.495	0.547	1.000			
Ital	0.333	0.451	0.532	0.593	0.432	0.550	0.398	1.000		
Neth	0.597	0.684	0.744	0.657	0.581	0.721	0.640	0.499	1.000	
Port	0.383	0.512	0.556	0.524	0.413	0.534	0.439	0.428	0.551	1.000

PANEL B: Returns in FRF

Aust	1.000									
Belg	0.516	1.000								
Germ	0.622	0.661	1.000							
Spai	0.456	0.541	0.645	1.000						
Finl	0.412	0.460	0.514	0.472	1.000					
Fran	0.504	0.566	0.697	0.646	0.487	1.000				
Irel	0.485	0.491	0.522	0.473	0.480	0.506	1.000			
Ital	0.324	0.442	0.525	0.583	0.422	0.537	0.382	1.000		
Neth	0.588	0.678	0.745	0.640	0.568	0.693	0.621	0.488	1.000	
Port	0.397	0.531	0.575	0.512	0.404	0.511	0.431	0.422	0.549	1.000

The sample used runs from December 31, 1990, to December 28, 1998. The table gives the unconditional whole sample correlations of the Euro-land index returns. Returns are continuously compounded and annualised.

3. Statistical Analysis of Correlation and Variance-Covariance Matrices of Returns Based on Country Indices

To assess the extent to which the adoption of a common policy in the convergence phase has led to a significant modification of the investment opportunities within Euro-land, the whole sample is partitioned into two sub-samples of equal size. In a first approach, the first sub-sample runs from December 31, 1990 to December 26, 1994 and corresponds to the four years preceding the starting date of the Maastricht Treaty. The second sub-sample runs from January 2, 1995 to December 28, 1998 and corresponds to the first definition of the convergence period. Section 4 presents the corresponding results for a more restricted definition of the convergence period.

The modification of the investment opportunity set, if any, must manifest itself in the changing structure of the variance-covariance matrices of the pre convergence and convergence periods. In principle, a test of the stability of the covariance matrices can suffice. But given that correlation matrices are more appropriate to judge on the significance of international diversification benefits, we will consider tests of stability of both correlation and covariance matrices. The tests that are used are the Jenrich [1970] and Box [1949] c^2 statistics which have been used in a number of empirical studies (Longin and Solnik [1995], Kaplanis [1985, 1988] to cite a few).

Operationally, denote by m_{1v} and m_{2v} the variance-covariance matrices of the first sub-sample (pre-convergence) and second sub-sample (convergence), respectively. The corresponding correlation matrices are denoted by m_{1c} and m_{2c} respectively. For a test based on covariance matrices, the Box test is based on a ratio of determinants: $\left|m_{1v}+m_{2v}\right|/\left|m_{1v}\right|+\left|m_{2v}\right|$, while the Jenrich uses as its principal input the quantity $trace\ (m_{1v}-m_{2v})/(m_{1v}+m_{2v})$. The null hypothesis to be tested through the Jenrich statistic when covariance matrices are involved is $m_{1v}=m_{2v}=m_v$. When correlation matrices are considered instead, the null hypothesis evaluated is $m_{1c}=m_{2c}=m_c$. To focus on tests of equality of correlation matrices first, we define:

$\overline{m_c}=(T_1 m_{1c}+T_2 m_{2c})/(T_1+T_2)=(\bar{r}_{ij})$ = "average" correlation matrix , where T_1 and T_2 represent the relevant sample sizes.

d_{ij} = Kronecker delta = identity matrix of the same dimension as $\overline{m_c}$.

$$S=\left(d_{ij}+\bar{r}_{ij}\bar{r}^{ij}\right)$$

$$Z=\left[\frac{T_1T_2}{T_1+T_2}\right]^{1/2}\overline{m_c}^{-1}(m_{1c}-m_{2c})$$

The Jenrich test statistic can then finally be computed as:

$$c^2=\frac{1}{2}tr\left(Z^2\right)-dg'(Z)S^{-1}dg(Z)$$

This test statistic is a chi square with degrees of freedom equal to $\frac{n(n-1)}{2}$ where *n* is the number of assets (or countries).

For a test of stability of covariance matrices, the test statistic is computed in exactly the same way as the test for stability of correlation matrices, after making appropriate substitutions (replacing correlation matrices by covariance matrices) and adjusting for the number of degrees of freedom. When we replace the correlation matrices with the corresponding covariance matrices, the appropriate test statistic then becomes:

$$c^2 = \frac{1}{2} tr\left(Z^2\right)$$

The number of degrees of freedom in that case is $\frac{n(n+1)}{2}$. It thus appears that the number of degrees of freedom is lower in the correlation case, because the diagonal elements of the correlation matrices are not an object of test. Hence, the second term in the statistic for testing the equality of correlation matrices can be viewed as a correction term, since the comparison of correlation matrices involves a lower degree of freedom ($\frac{n(n-1)}{2}$). To summarise, in the context of the present study involving 11 countries, the Box and Jenrich statistics based on covariance matrices have 66 degrees of freedom whereas the Jenrich statistic using correlation matrices has 55 degrees of freedom. For practical reasons, Luxembourg is excluded from our sample and we adjust the degrees of freedoms accordingly.

The small sample properties of both tests have been investigated by Kaplanis [1985]. It turns out that if the sample size is too small, the two tests can give conflicting conclusions. Hence, the use of both tests here can give guidance on possible sample issues. The output of the calculations is reported in Table 4 below.

Table 4 : Test of Stability of Covariance and Correlation Matrices When Returns Are Expressed in DMK and in FRF

	Test of Corr. Matrices Jenrich	**Test of Cov. Matrices Jenrich**
Returns in DMK	171.752 *(0.0000)*	231.681 *(0.0000)*
Returns in FRF	172.259 *(0.0000)*	230.489 *(0.0000)*

When we focus on pre convergence vs. convergence periods, the first sub-sample runs from December 31, 1990 to December 26, 1994 while the second sub-sample runs from January 2, 1995 to December 28, 1998. The p-values are given in parentheses below each statistic.

Clearly, there is a strong evidence that both the correlation and variance-covariance matrices are unstable over time. The extremely low p-values given in parentheses reject the null hypothesis of equality of the two matrices, implying that the diversification benefits during the convergence period are different from those prevailing in the period before convergence. Additional information is presented in Figures 1 and 2 where we display the pre-convergence and convergence period country pair correlations. (The corresponding numerical figures are reported in Tables D and E in the Appendix) The pre-convergence correlations are sorted in ascending order, and plotted along with the unsorted corresponding convergence period correlations. It is striking that every convergence period correlation is higher (with 3 or 4 exceptions when returns are expressed in DMK or FRF respectively) than its pre-convergence period counterpart. The formal Jenrich tests confirm that these differences are statistically significant.

Of course, it is a relevant question to inquire whether this pattern of increasing return correlations is specific to Euro-land countries and thus, presumably, associated with the process of economic and monetary unification, or whether it is merely a reflection of a broader world wide trend, possibly as a consequence of increasingly mobile international capital flows. Evidence on this question is provided in Figure 3 where we display the evolution of the return correlations between stock indices representing the major regions of the world. The regions that are considered here are: Americas (AM), Far East (FE), Pacific-Basin (PB), Australasia (AU), Non-European Union (NE), European Union (EE) and Asia (AS). While there is some increase in the level of correlations as the data in the Appendix (Table C) suggest, the changes in correlations are significantly more pronounced in the case of Euro-land countries (the average of region pair correlations was 0.454 during the pre convergence period, and it moved to only 0.585 during the convergence period)[4]. In addition, with the exception of the correlations involving the Far East and Pacific Basin regions, the level of correlations tend to be lower than those observed within Euro-land.

Table 5 indicates that these changes in correlations were accompanied by an increase in the standard deviations of returns across Europe, with Italy being the sole exception and the Netherlands the extreme illustration. While it is easy to find some rationale for the increase in correlations (see section 8), it is not clear that the increase in the risk level has any causal relationship with EMU or the process of European economic integration, and it is difficult to decide whether this increase in standard deviations is likely to be permanent or not. It is interesting to notice however, that there is some presumption that return correlations increase during periods of high volatility (e.g., see the contagion literature). The increase in the standard deviations in returns may in this sense explain part of the common increase in correlations both in Euro-land and elsewhere in the developed world.

The intermediate conclusion to draw from the analysis of this section is that *the process of economic and monetary integration in place in Europe seems to be accompanied with an increase in the correlation of national stock indices indicating that the benefits of international diversification using country allocation models within Euro-land have diminished*. A similar but less pronounced process of increasing correlations among country or regional indices is manifest elsewhere in the world, suggesting that EMU factors are not the only ones at work. It remains true that diversification opportunities on a purely geographical basis are better if extended outside the European region.

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4 Contrast this with an average pre convergence correlation of 0.333 and a convergence period average correlation of 0.585 for Euro-land countries.

Table 5: Return Volatilities in Euro-land

Country	Pre-Conv.	Converg.
Neth.	0.7306081	1.39186
Belg.	0.7774509	1.114882
Germ.	0.9380667	1.286281
Port.	0.9956962	1.376585
Aust.	1.0016007	1.027208
Irel.	1.1253629	1.268636
Fran.	1.1486571	1.355324
Spai.	1.3931264	1.565336
Finl.	1.7876227	1.972845
Ital.	1.815288	1.796955

Figure 1

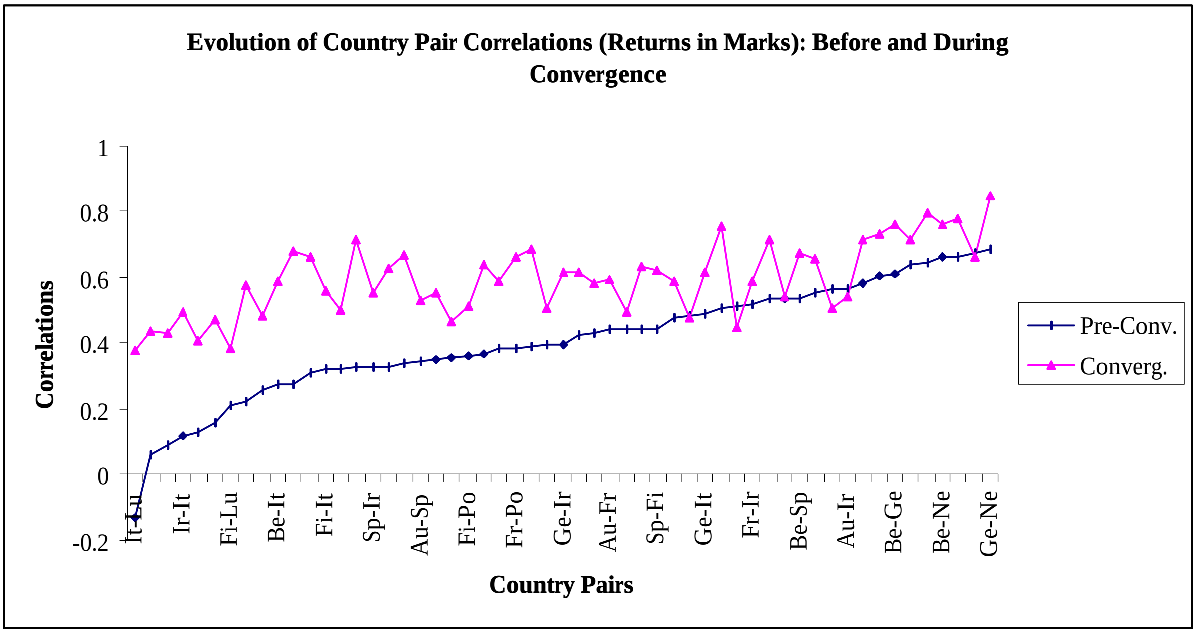


Figure 2

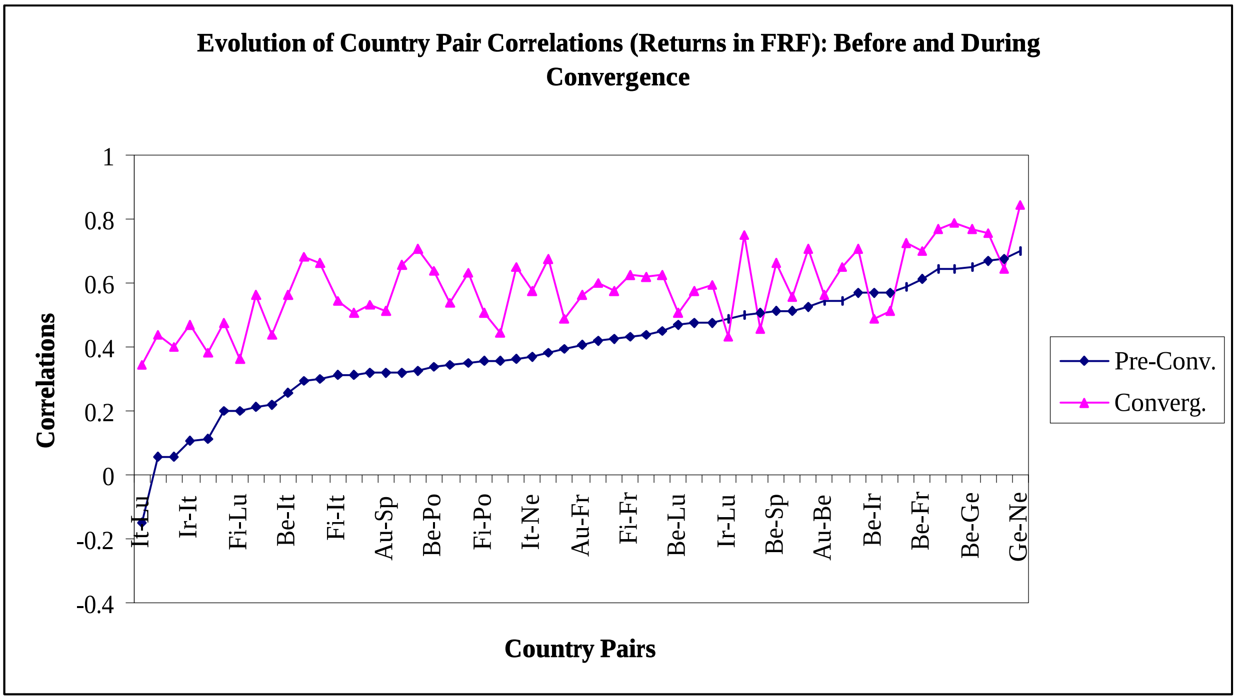
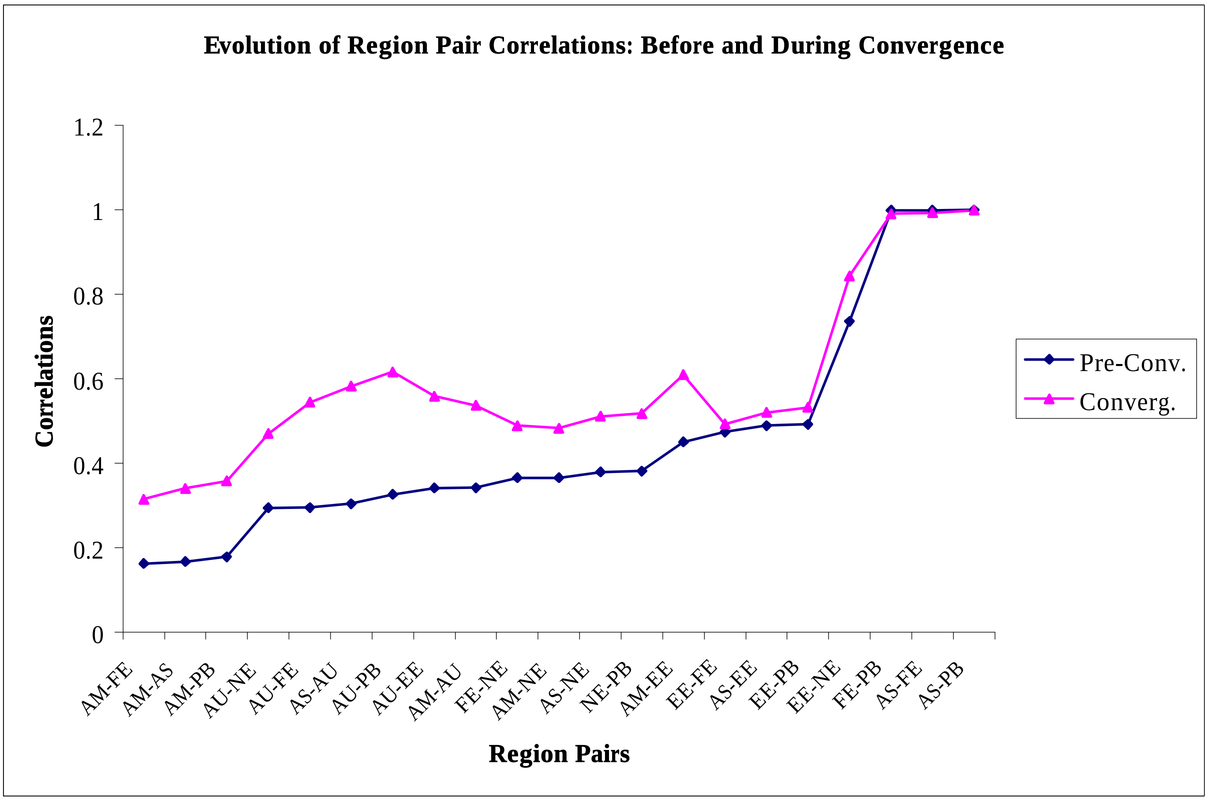


Figure 3



4. A More Cautious Definition of the Convergence Period.

In this section, the analysis above is revisited using the ‘Consensus Economics’ definition of the convergence period. On the basis of the information provided in Table 1, we date the start of the convergence period at August 1997 (extending until the end of our data sample, i.e. April 19, 1999) and accordingly, define a pre-convergence period of same length, i.e. starting on November 13, 1995.

Table 6 reports the return correlations obtained for the pre-convergence and convergence periods for both types of investors. The results strikingly confirm what was obtained with the first sample decomposition. Whether returns are computed in DMK or FRF, only two of the 45 correlations are lower in the convergence period than in the pre-convergence one! Not surprisingly, Table 7 confirms that the pre-convergence and convergence covariance and correlation matrices differ significantly.

Thus, even with a narrower definition of the convergence period, the data send the same message. The recent years, associated with increasing economic integration in Europe culminating with EMU, have seen an increase in the equity return correlations confronting European investors with reduced diversification opportunities. An important question is whether these changes are an (almost) mechanical consequence of decreasing currency risk (which altogether disappeared in the latter part of our sample) or whether they rather reflect underlying changes in the ‘real’ structures of economies engaged in a process of monetary and economic integration. Some insight into this question is provided by repeating the previous exercise in a context where currency fluctuations prior to January 1, 1999 have been neutralised.

Table 6: Correlations Based on Consensus Economics Periods
PANEL A: Pre Convergence, Returns in DMK

Aust	1									
Belg	0.63	1								
Germ	0.58	0.575								
Spai	0.39	0.478	0.51	1						
Finl	0.4	0.376	0.489	0.37	1					
Fran	0.38	0.549	0.61	0.43	0.3451	1				
Irel	0.46	0.521	0.528	0.38	0.3219	0.541	1			
Ital	0.33	0.512	0.326	0.37	0.3905	0.479	0.3799			
Neth	0.56	0.663	0.778	0.58	0.4533	0.586	0.6041	0.3788	1	
Port	0.27	0.426	0.471	0.41	0.3729	0.393	0.3225	0.3457	0.4435	1

PANEL B: Convergence Period, Returns in DMK

Aust	1									
Belg	0.55	1								
Germ	0.66	0.822	1							
Spai	0.62	0.745	0.834	1						
Finl	0.68	0.665	0.815	0.73	1					
Fran	0.73	0.801	0.907	0.83	0.7992	1				
Irel	0.59	0.501	0.639	0.56	0.6688	0.596	1			
Ital	0.53	0.692	0.76	0.85	0.6894	0.813	0.5075	1		
Neth	0.7	0.809	0.902	0.82	0.8281	0.911	0.6661	0.7671	1	
Port	0.59	0.694	0.753	0.75	0.6053	0.779	0.5013	0.7298	0.745	1

PANEL C: Pre Convergence, Returns in FRF

Aust	1									
Belg	0.63	1								
Germ	0.61	0.586	1							
Spai	0.38	0.464	0.501	1						
Finl	0.44	0.405	0.518	0.38	1					
Fran	0.35	0.518	0.586	0.4	0.3532	1				
Irel	0.46	0.511	0.53	0.36	0.3463	0.506	1			
Ital	0.3	0.485	0.3	0.35	0.3888	0.452	0.3486	1		
Neth	0.56	0.658	0.775	0.57	0.4726	0.564	0.5946	0.3538	1	
Port	0.3	0.441	0.495	0.4	0.401	0.376	0.3282	0.3268	0.4493	1

PANEL D: Convergence, Returns in FRF

Aust	1									
Belg	0.57	1								
Germ	0.67	0.825	1							
Spai	0.62	0.746	0.834	1						
Finl	0.66	0.658	0.81	0.72	1					
Fran	0.73	0.803	0.907	0.83	0.7947	1				
Irel	0.58	0.497	0.633	0.56	0.663	0.586	1			
Ital	0.55	0.699	0.765	0.85	0.6882	0.818	0.5084	1		
Neth	0.69	0.806	0.901	0.82	0.8253	0.91	0.6588	0.77	1	
Port	0.6	0.699	0.755	0.75	0.6011	0.781	0.4952	0.7344	0.7443	1

The Pre Convergence period based on Consensus Economics runs from November 13, 1995 to July 28, 1997 whereas the Convergence Period runs from August 4, 1997 to April 19, 1999.

Table 7 : Test of Stability of Covariance and Correlation Matrices When Returns Are Expressed in DMK and in FRF (Consensus Economics)

	Test of Corr. Matrices Jenrich	Test of Cov. Matrices Jenrich
Returns in DMK	92.971 *(0.00003)*	198.125 *(0.00000)*
Returns in FRF	92.476 *(0.00004)*	197.148 *(0.0000)*

The Pre Convergence period based on Consensus Economics runs from November 13, 1995 to July 28, 1997 whereas the Convergence Period runs from August 4, 1997 to April 19, 1999.

5. Taking the Viewpoint of the Euro- Investor

Given the evidence reported in the previous sections, the rest of the analysis will abstract from currency risk and concentrate on the implications for diversification benefits of the changes in economic structures associated with EMU. While the argument can be made that currency fluctuations within the Euro area have been significant in the years before full convergence, the impact of these fluctuations do not seem to be visible in a portfolio diversification context (offsetting effects). Hence, the single viewpoint of the European investor is adopted; this is appropriate post January 1, 1999 and return data are expressed in Euro at single conversion rates: the official, permanent conversion rates of December 31st 1998. That is, we convert all national and sector indices in Euro at the December 31st 1998 conversion rates, also for index values preceding the formal advent of EMU and compute our returns on that basis. The implicit underlying hypothesis is that the currency exchange rate movements since 1990 have been mostly neutral to stock returns and that the main measurable effect of the advent of the Euro is not so much the result of the disappearance of currency risks but rather follows the changes in economic structure that the process of economic and monetary unification has provoked. The justification for this choice can be debated in relation to currency variations shown in the Appendix (Table F). We will indeed show that, as far as our analysis is concerned, currency fluctuations have played a minor role in the 1990's (in Europe). That is, the result of the two preceding sections will be fully confirmed in the hypothetical context of this section, suggesting that the increase in return correlations measured in the preceding subsections may be due, to a greater extent, to the evolving economic structure rather than to the simple elimination of currency risk. If this is so, one may conjecture that the described evolution may not have terminated its course with the arrival of the single currency.

Turning to the full sample and using the broader definition of convergence period mentioned in section 2, Figure 4 corresponds to Figures 1 and 2 for the return data 'purged' from currency fluctuations (where consequently, the single viewpoint of the Euro-investor is relevant). The upward shift in the correlation matrix is clearly visible, confirming the decrease in international diversification benefits. If the convergence period is further decomposed in two sub-periods, it is also found that the correlations of the second period of convergence are much higher than those of the first phase (results not reported here). Thus, not only have correlations increased between pre convergence and post convergence, but they also continue to do so during the post convergence period!

Figure 4

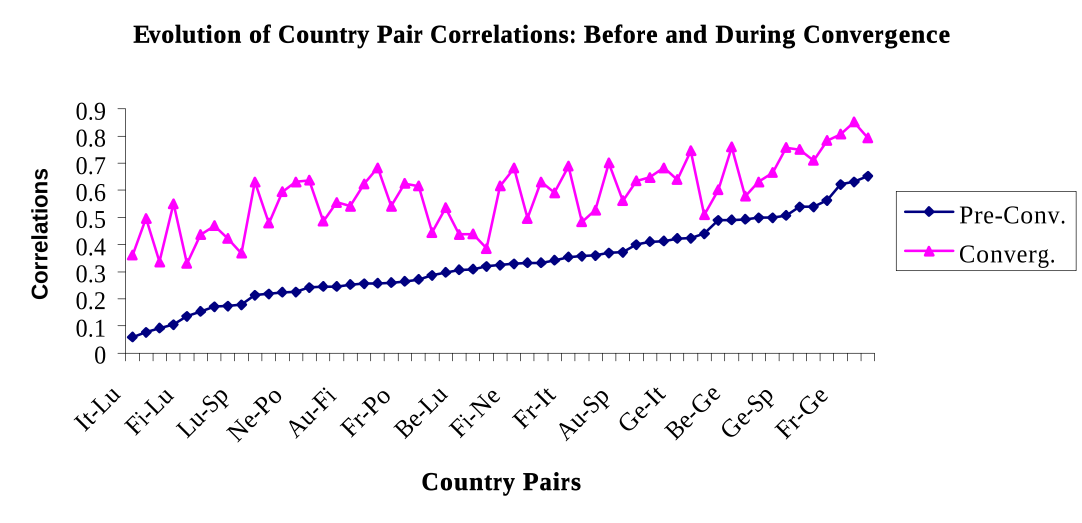


Table 8 below confirms, not surprisingly, that for these return data as well the covariance and correlation matrices are significantly different in the pre and post convergence sub-periods.

Table 8: Test of Stability of Covariance and Correlation Matrices

	Test of Corr. Matrices	**Test of Cov. Matrices**	
	Jenrich	**Jenrich**	**Box**
Pre Convergence vs Convergence	124.507	201.437	161.568
	(0.0000)	*(0.0000)*	*(0.0000)*

The pre- convergence period runs from September 10, 1990 to December 26, 1994 while the convergence sub-sample runs from January 2, 1995 to April 19, 1999. The p-values are given in parentheses below each statistic.

6. Countries or Sectors?

In order to gain further insights on the process at work, the analysis above is repeated mutatis mutandis, using sector indices available for the Euro-land economies. The results obtained in the previous section suggest that one may use the single Euro-investor viewpoint since it applies equally to investors of all EMU member countries and leads to a much clearer picture. Unless otherwise noted, the broader definition of the convergence period is retained and this enables the use of the full data sample.

First, consider a broad decomposition into four sectors per country distinguishing the 'Resources', 'Financials', 'Non-financials', and 'Non-financials excluding resources' (partially overlapping) sectors. Figures 5.A to 5.D report the results when country/sector returns are paired, i.e., we look at the country to country correlations among 'Financials' returns, then 'Non-financials', etc. Although somewhat less so for the 'Resources' sector, the same pattern of increasing correlations over the period under review is observed. Note as well that the sector by sector return correlations tend to be lower than the corresponding correlations using aggregate country indices.

These results are confirmed at a finer level of disaggregation as indicated in Table 9 where a ten-sector decomposition is used. The average (across countries) pair-wise correlations increases in nine sectors out of ten, the UTILS sector being the single exception. The correlation increases range from 4.15 percentage points (from 0.2944 to 0.3359 for the CYSER sector) to 19 points ((from 0.20875 to 0.39883 for the NYCSR sector). Quite understandably, correlation levels are rather lower at this higher level of disaggregation.

Figure 5.A

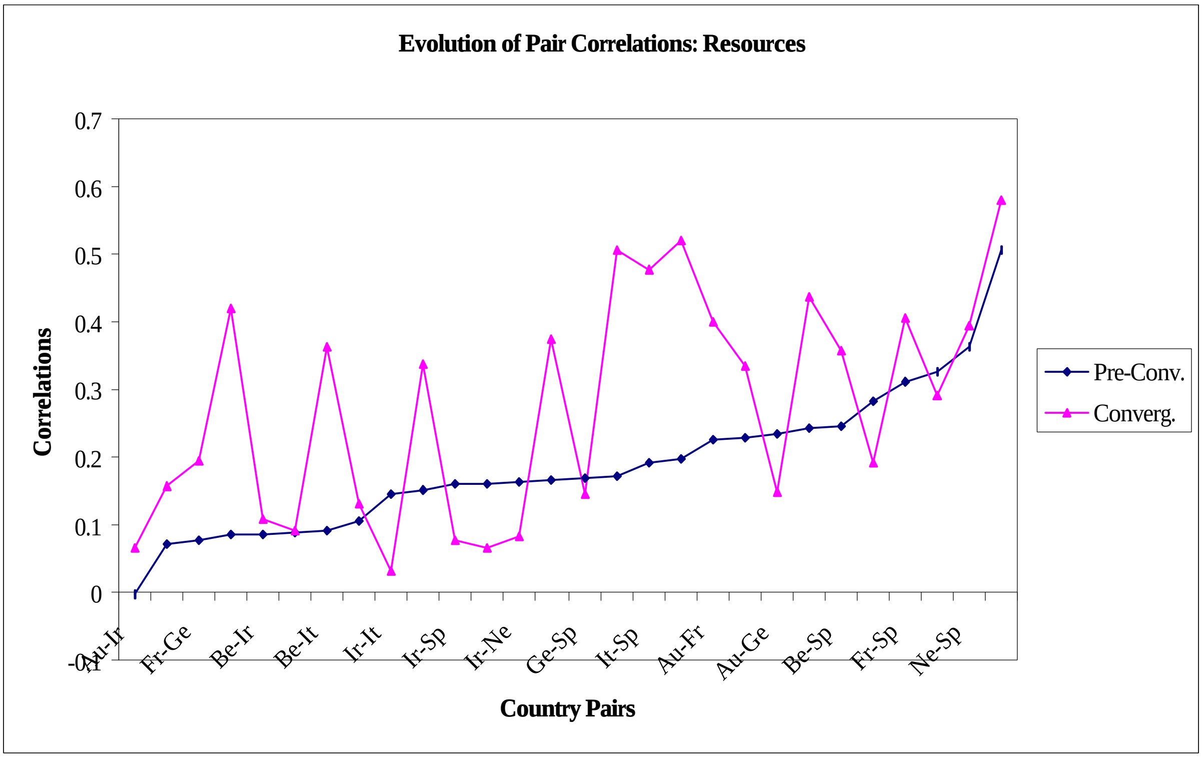


Figure 5.B

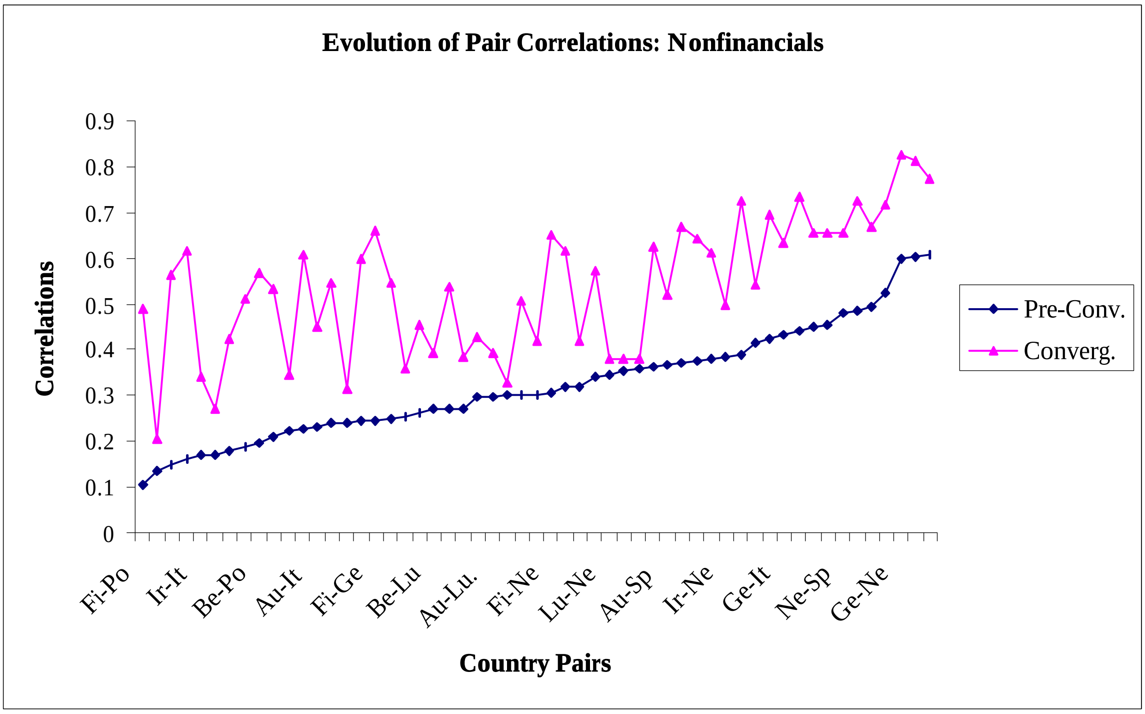


Figure 5.C

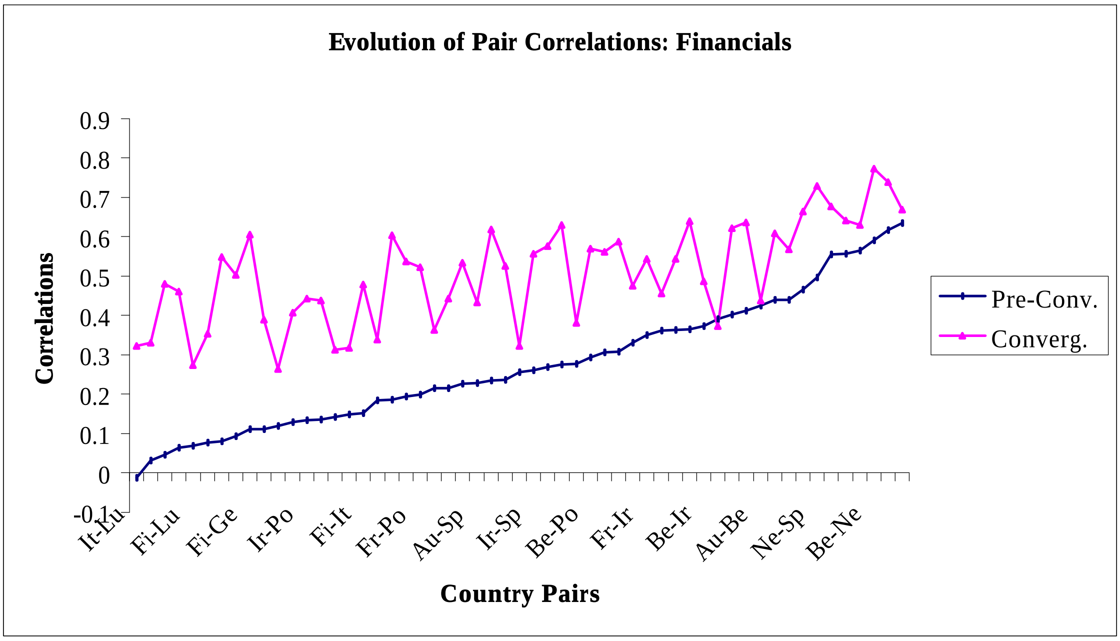


Figure 5.D

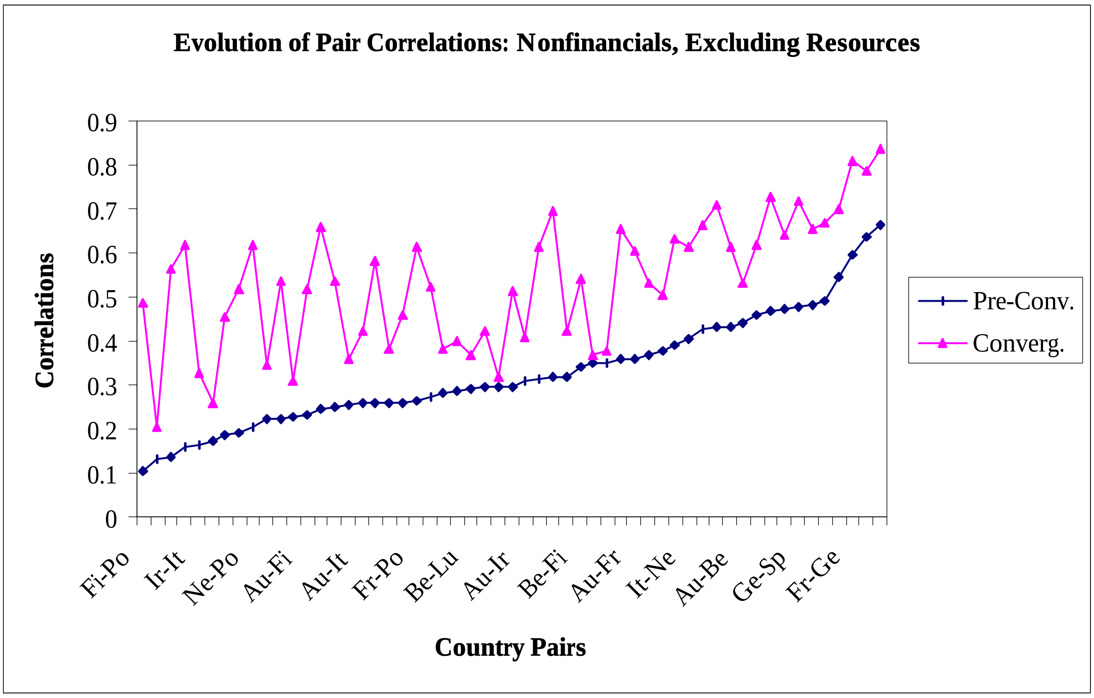


Table 9: Average Correlations of Ten Industry Groups Within Euro-land

	BASIC	CYSER	CYCGD	GENIN	ITECH	NYCG	NYCSR	RESOR	TOTLF	UTILS
Pre Convergence Period										
Mean	0.197	0.2944	0.2046	0.2703	0.122	0.27	0.20875	0.1872	0.3707	0.2403
Median	0.159	0.2797	0.1687	0.2453	0.1449	0.2581	0.21266	0.1662	0.37901	0.2631
Maximum	0.536	0.5814	0.5783	0.5987	0.2213	0.5263	0.36925	0.5063	0.62549	0.4256
Minimum	-0.048	0.0763	0.0027	0.0352	-0.0479	0.081	-0.003	-0.002	0.06102	0.0388
Std. Dev.	0.157	0.1245	0.1486	0.121	0.0808	0.1079	0.11328	0.1057	0.15929	0.1093
Skewness	0.633	0.4142	0.973	0.4627	-1.0455	0.4416	-0.3622	0.9523	-0.0224	0.0453
Kurtosis	2.501	2.2264	3.2397	2.7709	3.1004	2.7591	1.933	4.3306	1.96855	2.4956
Convergence Period										
Mean	0.285	0.3359	0.297	0.4035	0.2908	0.3339	0.39883	0.2747	0.5457	0.1889
Median	0.184	0.3079	0.2645	0.4023	0.2446	0.3258	0.4123	0.3117	0.54873	0.161
Maximum	0.689	0.6244	0.6624	0.6726	0.4708	0.6403	0.57649	0.5797	0.77234	0.5034
Minimum	-0.06	0.1152	0.0689	0.1857	0.1275	0.0708	0.2467	0.0317	0.31699	0.0393
Std. Dev.	0.222	0.1395	0.1562	0.1256	0.1291	0.1374	0.09471	0.1655	0.10549	0.1284
Skewness	0.078	0.347	0.8001	0.0884	0.5009	0.2541	-0.0358	0.1048	-0.0953	1.162
Kurtosis	1.483	2.0187	2.9309	2.0654	1.7085	2.2009	1.91191	1.657	2.54756	3.5651

The industry groups considered are: RESOR = resources, BASIC= basic industries, GENIN = general industrials, CYCGD = cyclical consumer goods, NCYCG = non-cyclical consumer goods, CYSER = cyclical services, NCYSR = non-cyclical services, UTILS = utilities, ITECH = information technology, TOTLF = financials. For each industry group, we compute the cross country correlation matrix of the returns and report the relevant statistics.

It follows from the above results that diversification opportunities are much better at the sector level than at the country level despite the fact that the European unification process appears manifest here as well in the form of an increase in the correlation among sector index returns. The suggested implication seems to be that allocating simultaneously across sectors and countries is a superior investment option. This assertion is next investigated by addressing the question of whether the gains from diversification require investing internationally or whether they can be reaped by limiting one's portfolio allocation to national equities.

7. The Cost of the Home Bias

The focus here is placed on the characteristics of the optimal portfolios of national investors constrained to investing in home equities and those of optimally diversified portfolios across Euro-land. The diversification in Euro-land can be achieved along two distinct lines: either across countries or across countries *and* sectors. We use the 10 sector disaggregation of Table 9. Tables 10.A to 10.D report the characteristics of the Minimum Variance Portfolio (MVP) and the Tangent Portfolio (TP) of a European investor selecting freely (without short-selling constraints) among the 10 sector indices either in his home country (French and German perspectives) or in 10 Euro-land countries. Here, we consider the pre-convergence and convergence periods as well.

To provide relevant outputs, let $m_{s,T}$ denote the vector of expected returns for a chosen investment opportunity set "s" over a sample period T. "s" refers to country indices when one diversifies by country, to sector indices in the case of an asset allocation by sectors within a given country, or to sector indices when we consider diversification by country and by sector in Euro-land. $\Omega_{s,T}$ is the variance-covariance matrix associated with the expected returns of the selected investment opportunity set. If $W_{s,T}^{MVP}$ and $W_{s,T}^{TP}$ are the vector of weights of the Minimum Variance Portfolio (MVP) and the Tangent Portfolio (TP) respectively, then:

$$W_{s,T}^{MVP} = \frac{\Omega_{s,T}^{-1}\underline{1}}{\underline{1}'\Omega_{s,T}^{-1}\underline{1}}$$

$$W_{s,T}^{TP} = \frac{\Omega_{s,T}^{-1}m_{s,T}}{\underline{1}'\Omega_{s,T}^{-1}m_{s,T}}$$

Here, $\underline{1}$ is a column vector of ones with the appropriate dimension. Given the portfolio weights $W_{s,T}$, one can then easily compute the expected return, $E(R_p)$, and variance, $V(R_p)$, as well as the Sharpe ratio of the MVP or TP:

$$E(R_p) = W_{s,T}^{'}m_{s,T}$$

$$V(R_p) = W_{s,T}^{'}\Omega_{s,T}W_{s,T}$$

$$Sharpe = \frac{E(R_p)}{\sqrt{V(R_p)}}$$

As is explicit from the computation of the optimal weights of the minimum variance and the tangent portfolios, we abstract from the existence of a riskless asset in our allocation problem. Also, short sales are permitted and the only constraint that we impose is that the portfolio be fully invested (sum of the weights equal to one: $\underline{1}'\, W_{s,T} - 1 = 0$).

As mentioned above, we provide portfolio characteristics by considering three leading diversification alternatives: 1) diversification by country within Euro-land, 2) diversification by sectors within a given country (France and Germany) and 3) diversification by sectors across Euro-land (focus on countries and sectors simultaneously). For each of these strategies, we provide output for both the pre-convergence and convergence periods.

While our results have to be taken with a grain of salt because no short selling restriction is imposed (with the result that in some instances, the considered portfolios would have included unusually large short positions) [5], the results of the strategy consisting of diversifying by sectors across all of Euro-land are impressively superior (both in terms of the Sharpe ratios and risk of the MVP). Such a strategy would also have permitted a minimal loss of performance between the pre-convergence and the convergence periods despite the increase in correlation of returns noted above.

The home bias – leading to a strategy of diversifying 'at home' across industry would have been very costly in terms of both measures of performance, but so is the pure country allocation strategy across Euro-land. On the other hand, limiting one's investment horizon to the home country would have entailed a minimal loss of performance for either the French or the German investors (the two types of investors considered) if the alternative is a pure country allocation strategy. To put it differently, if the international investment alternative is based on a pure country allocation, the 'home bias' is not very costly in terms of performance (Sharpe ratio) or in terms of risk (for the investor interested in the minimum variance portfolio). In fact, for the French investor, a 'home biased' portfolio would have outperformed the international 'country allocation' strategy during the 'pre-convergence' period.

These results underline the sub-optimality of the traditional two-step allocation procedures consisting in first allocating to countries, and then, operating a 'value oriented' stock selection within each country. They also suggest that this frequent practice of the investment advisory industry may have a causal relationship with the home bias.

The arguments made above on the cost of the home bias and its implication for optimal portfolio allocation are further reinforced by restricting the analysis to the Consensus Economics sub-periods and using the DMK and FRF as numeraire currencies. As the results in Table 10.E indicate, the convergence period performance ratios are lower, irrespective of the type of portfolio and the currency of reference. Again, the valid alternative portfolio allocation strategy in the post-convergence era seems to be the one focusing on sectors and countries simultaneously.

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[5] Imposing short selling constraints would amount to using a restricted set of country or sector portfolios. Given the nature of our exercise (which is not meant to identify realistic portfolios), we think it is more informative to preserve the full breadth of our sample of stock returns.

Table 10.A: International Diversification by Country

	MVP1	MVP2	TP1	TP2
Austria	-0.06933255	0.570661882	-0.62271807	-1.16619701
Belgium	0.308530748	0.470652149	-0.12049101	1.236503643
Finland	-0.00208894	-0.11074957	0.192321883	0.318590949
France	-0.08367694	-0.03404844	-0.11085488	0.154834482
Germa.	0.068656228	0.083483691	0.143535964	-0.92480574
Ireland	-0.0321054	0.256168385	0.281323804	0.939672073
Italy	-0.01034946	-0.01726868	-0.2063736	-0.25492938
Netherl.	0.65309373	-0.27128428	1.463967615	0.327838054
Portugal	0.260021694	0.119516657	-0.00957495	-0.01655405
Spain	-0.09274911	-0.06713179	-0.01113675	0.385046983
$E(R_p)$	0.0663	0.10435	0.20462	0.545432
$V(R_p)$	0.408247	0.738017	1.259972	3.857566
Sharpe	0.103765272	0.12146727	0.18229201	0.277705148

This table gives the weights of country indices in the Minimum Variance Portfolio (MVP) and the Tangent Portfolio (TP). MVP1 and MVP2 stand for pre convergence and convergence Minimum Variance Portfolios respectively, while TP1 and TP2 are the corresponding Tangent Portfolios.

Table 10.B: Diversification by Industry: German Case

	MVP1	MVP2	TP1	TP2
Basic	0.037579682	0.062220805	0.528788734	0.045000088
Cyclical CG	-0.03401575	-0.0075316	-0.72729458	0.120363192
Cyclical Serv.	0.028285357	0.024787093	-0.12361212	0.095861844
General Ind.	-0.00740825	-0.08798103	-0.18703055	-0.29005986
Inform. Tech	-0.00647038	-0.0289989	0.371687999	0.071076729
Non-cyclical CG	-0.06471365	0.01297134	0.168466113	0.189494875
Non-cyclical serv.	0.21049095	0.255489085	0.396243799	0.177823157
Resources	0.097105103	0.070845689	-0.36753543	-0.27940601
Financials	-0.01234226	-0.05028437	-0.1778627	-0.042295
Utilities	0.751489187	0.748481884	1.11814874	0.912140978
$E(R_p)$	0.054796823	0.099563835	0.233041347	0.244106326
$V(R_p)$	0.370899277	0.394250433	1.577370059	0.966606252
Sharpe	0.089976146	0.158567992	0.185552233	0.248287145

This table gives the weights of German sector indices in the Minimum Variance Portfolio (MVP) and the Tangent Portfolio (TP) in an allocation by sector within Germany. MVP1 and MVP2 stand for pre convergence and convergence Minimum Variance Portfolios respectively, while TP1 and TP2 are the corresponding Tangent Portfolios.

Table 10.C: Diversification by Industry: the French Case

	MVP1	MVP2	TP1	TP2
Basic	0.36208588	0.332294768	0.259203949	0.183930167
Cyclical CG	0.0543102	-0.22635855	0.710216008	-0.44067269
Cyclical Serv.	0.112585812	0.605366994	-1.08417612	0.700872994
General Ind.	-0.08256922	-0.16604577	-0.38574462	-0.11781442
Non-cyclic. CG	0.170272377	0.114348042	1.006522077	0.475409974
Non-cycli. Serv.	0.202783421	0.078369438	0.48664666	0.011633146
Resources	0.118992511	0.12393848	-0.03512431	0.176207984
Financials	-0.0368079	0.01797704	-0.53585876	-0.02223691
Utilities	0.098346925	0.120109556	0.578315111	0.032669748
$E(R_p)$	0.108841419	0.189244698	0.434585734	0.286764745
$V(R_p)$	0.744838624	0.711841471	2.974017101	1.07866186
Sharpe	0.126113942	0.224301448	0.252001853	0.276110611

This table gives the weights of French sector indices in the Minimum Variance Portfolio (MVP) and the Tangent Portfolio (TP) in an allocation by sector within France. MVP1 and MVP2 stand for pre convergence and convergence Minimum Variance Portfolios respectively, while TP1 and TP2 are the corresponding Tangent Portfolios.

Table 10.D: Euro-land Wide Diversification by Sectors

	MVP1	MVP2	TP1	TP2
$E(R_p)$	0.072706294	0.070393514	0.892045234	0.967017345
$V(R_p)$	0.104725897	0.115190696	1.284898912	1.58241002
Sharpe	0.224669937	0.207407255	0.786959526	0.768731632

This table gives the weights of sector indices in the Minimum Variance Portfolio (MVP) and the Tangent Portfolio (TP) in an allocation by country and sector. MVP1 and MVP2 stand for pre convergence and convergence Minimum Variance Portfolios respectively, while TP1 and TP2 are the corresponding Tangent Portfolios. The industry groups considered in each Euro-land country are : RESOR = resources (8 indices), BASIC= basic industries(10 indices), GENIN = general industrials(10 indices), CYCGD = cyclical consumer goods(7 indices), NCYCG = non-cyclical consumer goods(10 indices), CYSER = cyclical services(10 indices), NCYSR = non-cyclical services(8 indices), UTILS = utilities(6 indices), ITECH = information technology(5 indices), TOTLF = financials(10 indices). In principle, if each industry group is available in each of the participating countries, then we should have a total of 11 x 10 = 110 investable indices. However, some sectors are not available in some countries so that the number of investable indices is reduced to 84.

Table 10.E: Consensus Economics Optimal Portfolio Weights

PANEL A: Returns in DMK

	MVP1	MVP2	TP1	TP2
Aust	0.3717	NA	-0.124	NA
Belg	0.1764	0.66452	0.1876	2.15722217
Germ	0.31076	0.01197	0.1594	-1.947099
Spai	0.03135	-0.0725	0.0873	0.42383197
Finl	-0.03522	-0.215	-0.0309	1.03349291
Fran	0.00514	0.65668	-0.1584	1.11786848
Irel	0.2526	0.43514	0.5102	0.45547633
Ital	-0.04078	-0.073	-0.0466	0.23830925
Neth	-0.27758	-0.4987	0.1122	-2.6569123
Port	0.20563	0.09096	0.3032	0.17781023
E(Rp)	0.28975	0.2343	0.436	1.0926901
V(Rp)	0.34502	1.89031	0.5192	8.81558653
Sharpe	0.4933	0.17042	0.6051	0.36801998

PANEL B: Returns in FRF

	MVP1	MVP2	TP1	TP2
Aust	0.35174	NA	-0.1892	NA
Belg	0.1632	0.60309	0.1754	2.01706698
Germ	0.22646	-0.0321	0.0613	-2.7362388
Spai	0.0526	-0.0433	0.1137	0.52227575
Finl	-0.06069	-0.2099	-0.056	1.17994922
Fran	0.07425	0.70293	-0.1042	1.87293984
Irel	0.27259	0.4618	0.5537	0.49829915
Ital	-0.02441	-0.1154	-0.0308	0.02642717
Neth	-0.23966	-0.4583	0.1857	-2.5982244
Port	0.18391	0.09117	0.2904	0.2175051
E(Rp)	0.28088	0.23245	0.4405	1.2162967
V(Rp)	0.36496	1.93997	0.5724	10.1510126
Sharpe	0.46494	0.16689	0.5823	0.3817551

8. What Do Our Results Suggest as to the Impact of EMU on the Underlying Economic Structures?

It is helpful at this stage to conceptualise the environment in which the individual investor operates. Variations in firm profitability as reflected in country-wide stock indices result from the interaction of shocks affecting economies, economic structures themselves and their evolution through time, and macro-economic policies. To see this interaction, one may start by inquiring whether the nature of shocks affecting economic agents is impacted by the economic integration process. Let us think of supply shocks first. It is unlikely that the process of economic and monetary integration would result in an increase in the commonness of supply shocks. It may however affect the structure of national economies in a way that technology disturbances will increasingly show up at the country level. This is the case if economic integration increases the degree of specialisation of national economies. At the limit in a one-sector economy, sectoral shock and economy-wide shocks fully coincide. If, however, EMU is accompanied with a higher degree of diversification in national economic structures, supply shocks become less important at the macroeconomic level in the sense that either they wash out (if the number of sectors is large enough and under the plausible assumption that sectoral shocks are little correlated) or they show up as EU-wide risk factor if all the national EMU economies represent the same portfolio of economic sectors.

Thinking of demand shocks now, it is clear that policy shocks within EMU – be they associated with monetary policy (interest rate shocks, foreign exchange shocks) or fiscal policy - are fully or increasingly common in nature. If one believes in the importance of animal spirits, it can similarly be argued that the impact of EMU, if any, must be to make European consumers and investors more alike and subject to the same sort of psychological factors. Finally, demand shocks associated with foreign demand are bound to get more similar under a common currency, besides being influenced by the same structural factors as those discussed above (more common if economies are getting to be more diversified and thus more alike, less so if specialisation is increasing).

In a sense, the above discussion illustrating the interactions between shocks, policies and structures suggests the possibility of two polar outcomes from the process of economic and monetary integration. In the unfavourable case, European economies are getting more specialised, foreign demand shocks translate more and more into differential country shocks calling for differentiated stabilisation policies (at variance with the constraints of a monetary union). The other polar case is one where economic structures become more diversified, countries represent better diversified and also more homogenous portfolios of sectors and common macroeconomic policies are increasingly appropriate.

Our results seem to clearly support the latter interpretation of what has been and is currently happening within Euro-land. They appear to accord with a large portion of the recent macro literature. Fatas (1997), among others, looks at the correlation between employment growth rates and finds that European countries represent increasingly better diversified portfolios of regions. Imbs (1999) also finds that developed, increasingly service related economies are getting more and more alike.

9. Conclusions

The conditions under which portfolio investors diversify across the Euro-area equity markets have changed materially in the 1990s. With an increased degree of correlation between either market or sectoral stock indices, diversification opportunities have been significantly reduced. It seems difficult not to incriminate the process of economic and monetary integration process at work in Europe during this period for this result. Within this process, the disappearance of currency risk is decidedly less important for investors than the convergence of economic structures and/or the homogenisation of economic shocks (across the Euro-15 member states). That is, the increased stock return correlations are as manifest when we abstract from currency fluctuations than when they are computed using effective monetary returns. This evolution should mark the end of pure country allocation strategies within Europe. Indeed, if these are the alternatives, the increased conformity of stock returns implies that the cost of the home bias within Euroland has been lowered (in some cases to zero). Diversification across both countries and sectors, however, remains the much superior investment strategy. In light of this option, the cost of the home bias continues to be significant.

APPENDIX

Table A: Unconditional Pre and Convergence Periods Summary Statistics

PANEL A: Pre Convergence Summary Statistics

	AUSTR	BELG.	FINL	FRAN.	GERM	IRELA	ITALY	LUXEM	NETHE	PORTU	SPAIN
Mean	-0.0401	0.0319	0.1191	0.0557	0.0301	0.10346	0.006	0.2121	0.0924	0.0161	0.05
Median	-0.0705	0.0724	-0.008	0.1291	0.0554	-0.0749	-0.104	0.1084	0.0991	0	-0.0175
Maximum	5.5086	2.5657	6.7605	4.457	4.9172	5.39144	5.084	3.3797	2.3794	2.8432	4.7624
Minimum	-7.2925	-3.4116	-6.46	-4.177	-4.5389	-4.4701	-4.879	-1.957	-2.039	-5.291	-4.5158
Std. Dev.	1.3618	0.8583	1.8083	1.19	1.0778	1.30524	1.734	0.8985	0.7593	1.0455	1.4388
Skewness	-0.2504	-0.1002	0.4039	0.0657	-0.1896	0.55686	0.149	0.7486	0.067	-0.431	-0.0371
Kurtosis	7.648	4.0832	4.1495	3.864	6.1948	4.93809	3.1	4.1553	2.9708	5.8544	4.0929
Jarque-Bera	204.89	11.377	18.506	7.1605	97.038	46.8431	0.926	23.097	0.1763	83.352	11.248
Probability	0	0.0034	1E-04	0.0279	0	0	0.629	1E-05	0.9156	0	0.0036
Observation	225	225	225	225	225	225	225	155	225	225	225

PANEL B: Convergence Period Summary Statistics

Mean	0.0448	0.2183	0.3246	0.192	0.1766	0.25467	0.203	0.1783	0.2323	0.1842	0.2523
Median	0.1237	0.3023	0.3181	0.2492	0.2368	0.26826	0.145	0.2323	0.2456	0.1149	0.3044
Maximum	3.4464	3.8328	5.8755	3.9867	2.7848	3.93614	5.169	6.3828	3.656	5.0664	6.3164
Minimum	-3.6196	-5.6564	-8.184	-5.53	-6.5061	-5.9338	-7.438	-5.244	-7.109	-6.502	-5.6296
Std. Dev.	1.0295	1.1174	1.9772	1.3583	1.2891	1.27147	1.801	0.9551	1.395	1.3797	1.5688
Skewness	-0.3505	-0.657	-0.994	-0.696	-1.0512	-0.9153	-0.426	0.2961	-1.007	-0.312	-0.3442
Kurtosis	4.3426	6.7352	6.4728	4.9877	6.4779	8.06502	4.802	14.553	8.0789	6.762	5.2008
Jarque-Bera	21.505	146.98	150.15	55.225	154.83	271.93	37.23	1254.5	279.89	136.33	49.852
Probability	2E-05	0	0	0	0	0	0	0	0	0	0
Observation	225	225	225	225	225	225	225	225	225	225	225

This table gives the unconditional summary statistics of the first sub-sample (pre convergence period) of the Euro-land index returns (in Euro). The sub-sample runs from September 10, 1990 to December 26, 1994 and observations are sampled weekly. Returns are continuously compounded and annualized.

Table B: Pre and Convergence Period Correlation Matrices

PANEL A: Pre Convergence Correlation Matrix

Austria	1										
Belgium	0.493	1									
Finland	0.252	0.342	1								
France	0.400	0.424	0.3323	1							
Germany	0.499	0.491	0.2569	0.6219	1						
Ireland	0.357	0.44	0.2601	0.3603	0.324	1					
Italy	0.218	0.213	0.2456	0.3543	0.4228	0.1539	1				
Luxemb.	0.287	0.307	0.1361	0.1731	0.3087	0.3196	0.0593	1			
Netherl.	0.499	0.562	0.3291	0.6522	0.6305	0.4895	0.4102	0.332	1		
Portugal	0.171	0.257	0.0763	0.2643	0.2414	0.2451	0.1052	0.091	0.2254	1	
Spain	0.371	0.413	0.2237	0.5388	0.5076	0.2975	0.3692	0.178	0.5388	0.271	1

PANEL B: Convergence Period Correlation Matrix

Austria	1										
Belgium	0.577	1									
Finland	0.542	0.591	1								
France	0.635	0.745	0.6308	1							
Germany	0.632	0.759	0.6835	0.8069	1						
Ireland	0.483	0.509	0.5417	0.5271	0.6162	1					
Italy	0.479	0.631	0.5551	0.6886	0.6397	0.437	1				
Luxemb.	0.445	0.438	0.3303	0.4218	0.4388	0.3863	0.3604	1			
Netherl.	0.666	0.784	0.6819	0.7931	0.8512	0.602	0.6481	0.497	1		
Portugal	0.47	0.624	0.4961	0.6249	0.6375	0.4864	0.5504	0.337	0.6316	1	
Spain	0.561	0.683	0.5946	0.7097	0.7569	0.5356	0.7006	0.368	0.75	0.616	1

This table gives the unconditional correlations of the pre and convergence periods of the Euro-land index returns (in Euro).

Table C : Unconditional Correlations of Other Regions of the World

PANEL A: Pre Convergence Correlations

AMERICAS	1						
ASIA	0.1676907	1					
AUSTRALASIA	0.3420364	0.304517	1				
EEC	0.4502127	0.489253	0.3411	1			
FAR_EAST01	0.1626266	0.9985	0.295	0.47406	1		
NON_EEC01	0.3653845	0.378988	0.2942	0.73584	0.36538	1	
PACIFIC_BASIN01	0.1784735	0.999236	0.3265	0.49204	0.99842	0.38137	1

PANEL B: Convergence Period Correlations

AMERICAS	1						
ASIA	0.340735	1					
AUSTRALASIA	0.53693	0.581872	1				
EEC	0.609744	0.520372	0.5587	1			
FAR_EAST01	0.314605	0.992436	0.5446	0.49291	1		
NON_EEC01	0.48334	0.510832	0.4704	0.84359	0.48922	1	
PACIFIC_BASIN01	0.358277	0.998625	0.6164	0.53208	0.99059	0.51753	1

Table D: Unconditional Correlations (Returns in DMK)

PANEL A: Pre Convergence Period

Aust	1										
Belg	0.53660	1									
Germ	0.42548	0.61400	1								
Spai	0.34662	0.53700	0.51013	1							
Finl	0.22558	0.43324	0.32515	0.44608	1						
Fran	0.44165	0.64169	0.64824	0.58506	0.44458	1					
Irel	0.56784	0.56479	0.39787	0.32783	0.47566	0.5190	1				
Ital	0.13218	0.27485	0.48755	0.39328	0.32058	0.3401	0.1178	1			
Luxe	0.51173	0.44318	0.15807	0.08708	0.21185	0.2583	0.4833	-0.131	1		
Neth	0.55339	0.66233	0.68473	0.60430	0.53363	0.6626	0.6735	0.38571	0.3956	1	
Port	0.32355	0.32783	0.27588	0.36832	0.36315	0.3865	0.3571	0.35229	0.0611	0.3088	1

PANEL B: Convergence Period

Aust	1										
Belg	0.54415	1									
Germ	0.61771	0.76077	1								
Spai	0.53261	0.67593	0.75791	1							
Finl	0.57565	0.58523	0.71716	0.62506	1						
Fran	0.59345	0.71413	0.79854	0.71750	0.63393	1					
Irel	0.54165	0.50692	0.61905	0.55238	0.58875	0.5897	1				
Ital	0.40944	0.58876	0.61559	0.68786	0.55865	0.6715	0.4939	1			
Luxe	0.45167	0.49397	0.47167	0.42956	0.38286	0.4831	0.4794	0.38157	1		
Neth	0.65913	0.76101	0.84972	0.73301	0.71369	0.7806	0.664	0.59127	0.5045	1	
Port	0.50001	0.63002	0.68002	0.64024	0.51435	0.6612	0.4643	0.55410	0.4351	0.6640	1

Table E: Unconditional Correlations (Returns in FRF)

PANEL A: Pre Convergence Period

Aust	1										
Belg	0.544759	1									
Germ	0.447629	0.6481	1								
Spai	0.320727	0.50972	0.49896	1							
Finl	0.212673	0.42360	0.32802	0.43437	1						
Fran	0.407621	0.61340	0.64224	0.56586	0.43029	1					
Irel	0.571723	0.57090	0.41642	0.31698	0.47287	0.5115	1				
Ital	0.111494	0.25914	0.47427	0.37989	0.31048	0.3208	0.1090	1			
Luxe	0.505567	0.46604	0.19873	0.05718	0.20135	0.2179	0.4893	-0.1525	1		
Neth	0.545713	0.66567	0.69838	0.58657	0.52613	0.6417	0.6774	0.37051	0.3907	1	
Port	0.315576	0.33706	0.29318	0.35213	0.35614	0.3651	0.3590	0.34090	0.0560	0.3023	1

PANEL B: Convergence Period

Aust	1										
Belg	0.560095	1									
Germ	0.624814	0.76615	1								
Spai	0.515230	0.66354	0.74898	1							
Finl	0.562725	0.57482	0.70905	0.61659	1						
Fran	0.565067	0.69744	0.78857	0.70390	0.62503	1					
Irel	0.511510	0.48560	0.60279	0.52877	0.57751	0.5547	1				
Ital	0.379878	0.56544	0.59664	0.67469	0.54617	0.6549	0.4662	1			
Luxe	0.453979	0.50558	0.47534	0.40233	0.36547	0.4356	0.4314	0.34241	1		
Neth	0.649089	0.75488	0.84613	0.72360	0.70777	0.7693	0.6459	0.57307	0.4860	1	
Port	0.507949	0.63725	0.68413	0.63195	0.50716	0.6499	0.4457	0.53693	0.4382	0.6603	1

Table F: Currency Returns

PANEL A: DMK Returns Against Other Euro-land Currencies

	ATS	BEF	ESP	FMK	FRF	IRP	ITL	LUF	NLG	PSC
Mean	0.002639	0.0008	-0.03305	-0.02625	0.003885	-0.007	-0.0339	0.00262	0.00303	-0.0169
Median	0.005454	0.003028	-0.00514	-0.00397	0.016873	0.02536	-0.0074	0.00457	0.00464	-0.0017
Maximum	1.887337	1.962902	1.64792	2.13159	1.391829	1.84225	2.6263	0.89609	1.74339	1.5577
Minimum	-1.79991	-1.65267	-4.13025	-5.91884	-1.44092	-4.9629	-5.07	-0.84166	-1.5620	-2.644
Std. Dev.	0.365714	0.345744	0.49111	0.64257	0.349599	0.57194	0.5989	0.21593	0.39249	0.3575
Skewness	-0.11509	0.369364	-1.72232	-2.85751	-0.24802	-1.7080	-1.9056	-0.03205	0.00547	-1.8214
Kurtosis	7.240137	11.99241	15.6363	26.8432	5.326523	16.5303	18.905	5.36255	6.57419	16.069
J-Bera	314.0529	1417.876	2987.71	10470.2	98.55711	3391.69	4659.0	60.5124	222.497	3206.0
Probability	0	0	0	0	0	0	0	0	0	0
Observ.	418	418	418	418	418	418	418	260	418	418

PANEL B: FRF Returns Against Other Euro-land Currencies

Mean	-0.001247	-0.00308	-0.00389	-0.03694	-0.03013	-0.0108	-0.0378	-0.00065	-0.0008	-0.0208
Median	-0.012703	-0.01966	-0.01687	-0.03089	-0.00504	-0.0012	-0.0209	-0.00804	-0.0112	-0.0114
Maximum	2.146706	1.661731	1.44092	1.41996	1.581367	1.65214	2.0754	1.22244	2.00276	1.7372
Minimum	-1.497532	-1.60836	-1.39183	-4.39867	-5.70711	-4.5014	-3.6291	-1.13835	-1.5483	-2.4522
Std. Dev.	0.353941	0.400917	0.34959	0.41529	0.577941	0.49808	0.5685	0.24317	0.34025	0.4203
Skewness	0.472881	0.270928	0.24802	-3.05414	-3.31913	-1.7410	-0.991	0.1087	0.62903	-0.7327
Kurtosis	9.207642	6.207924	5.32652	34.0739	33.20284	19.1469	9.7371	8.80195	9.61644	7.5216
J-Bera	686.7267	184.3447	98.55711	17467.18	16655.18	4752.06	858.944	365.1914	790.02	393.487
Probability	0	0	0	0	0	0	0	0	0	0
Observ	418	418	418	418	418	418	418	260	418	418

Table G: Optimal Portfolio Characteristics: Returns in DMK

	MVP1	MVP2	TP1	TP2
Aust	-0.0584431	0.60325417	-0.8616618	-1.6385557
Belg	0.35738194	0.44686837	0.16754626	1.73530373
Germ	0.22755863	0.19483068	0.59428564	-0.9214717
Spai	-0.0673971	-0.0657429	-0.3193248	0.46474210
Finl	-0.0049129	-0.1361071	0.17908531	0.33532885
Fran	-0.0679396	-0.0141340	-0.078210	-0.1561431
Irel	-0.0664060	0.19495807	0.12538742	1.06092540
Ital	-0.0077568	-0.0287811	-0.2268347	-0.3998143
Neth	0.41922977	-0.3195902	1.45244209	0.05966042
Port	0.26868537	0.12444432	-0.0327146	0.46002446
E(Rp)	0.08325919	0.09223738	0.26998220	0.71701031
V(Rp)	0.50956860	0.75236939	1.65236348	5.84856791
Sharpe	0.11663553	0.10633871	0.21003048	0.29648357

Table H: Optimal Portfolio Characteristics: Returns in FRF

	MVP1	MVP2	TP1	TP2
Aust	-0.0363346	0.56595838	-0.8263275	-1.7340071
Belg	0.30999706	0.37715379	0.12328722	1.69901289
Germ	0.04836573	0.08039663	0.40905420	-1.0648642
Spai	-0.0490738	-0.0408689	-0.2968532	0.503377
Finl	0.00105510	-0.1376628	0.182023682	0.34600287
Fran	0.09422818	0.10784828	0.08412622	-0.0378447
Irel	-0.0834778	0.25357643	0.10515755	1.14200811
Ital	-0.0200508	-0.0216542	-0.2355214	-0.4023124
Neth	0.49427053	-0.2841058	1.51046993	0.10498313
Port	0.24102058	0.09935833	-0.0554165	0.44364387
E(Rp)	0.08942705	0.09472654	0.27307546	0.73570692
V(Rp)	0.53830537	0.79271737	1.64377547	6.15674983
Sharpe	0.12188620	0.10639287	0.21299109	0.29650299

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