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Portfolio diversification benefits within Europe: Implications for a US investor

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Abstract

This paper investigates the possibility of cointegration between the United States and 11 European equity markets before and after the convergence period of 1995. The results indicate that during the pre-convergence and post-convergence periods, some country groups, with and without the US equity market, exhibited cointegration while others did not. For the European Union markets, however, at least one cointegrating vector emerged in either period, but no cointegration among them surfaced during the Euro introduction period of 1999. These results suggest that a US investor can still benefit from country diversification within the European Union markets.

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1. Introduction

Economists have shown that an investor can benefit from diversification when (s)he holds a portfolio of domestic and foreign assets. International portfolio diversification produces economic gains because returns on domestic securities do not correlate perfectly with returns from foreign securities. Several studies have demonstrated the

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international diversification advantages stemming from low correlations, the most recent of which are those by Meric and Meric (1989), Divecha, Drach, and Stefek (1992), Michaud, Bergstrom, Frashure, and Wolahan (1996), DeFusco, Geppert, and Tsetsekos (1996), and Kempa and Nelles (2001). The reasons for such low international correlations, according to those authors, are barriers to international trade and investment, lack of free trade, inadequate information on foreign securities, or simply home investor bias. By contrast, another strand of the literature, including Lau and McNish (1993), Rahman and Yung (1994), Koutmos and Booth (1995), Meric and Meric (1997), and Adjaoute and Danthine (2001a), documents a significant increase in correlations and volatility transmission between equity markets during and after the international stock market crash of 1987. In general, in recent years, the liberalization and deregulation efforts by many countries enhanced the financial integration among the global capital markets. Consequently, analysts have claimed that global market integration has diminished the benefits of international diversification since the correlation between equity markets has increased.

A common element of the above studies was that correlations among equity markets were estimated using relatively short-term horizons such as weekly, monthly, or quarterly. Kasa (1992) points out that the benefits from international diversification, as indicated by low correlations, may be overstated for investors with long-range investment horizons if a common trend among equity markets is present. As a result, a number of studies have employed cointegration techniques to examine whether linkages and long-term comovements among developed and emerging equity markets existed. However, these studies have produced a mix of results and conclusions as to the potential gains from diversification. For instance, although Kasa (1992) and Arshanapalli and Doukas (1993) have found evidence of (a bivariate) cointegration between the United States and several European equity markets, Byers and Peel (1993) and Kanas (1998, 1999) have found exactly the opposite. Perhaps differences in the sample periods and different methodologies have been responsible for such divergence of results.

An interesting question arises as to whether a foreign investor, such as a US investor, is expected to benefit from investing in the European equity markets in light of the presence of the European Monetary Union (EMU). The EMU represents the final stage of a complete economic and monetary union among the countries participating in the European Union [namely Austria, Belgium, Denmark, Finland (recently joined), France, Germany, Greece (recently joined), Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and UK]. These countries entered the Maastricht Treaty, in January 1995, which provides the nominal convergence criteria and the end of the fixing of the conversion rates.¹ It is assumed that a minimum and necessary requirement for the formation of a successful EMU over time is the existence of stable long-run relationships that tie together the variables in each criterion; otherwise, the chances for long-run success of an EMU

¹ The nominal convergence criteria for any country to qualify for participation in the EMU are: (a) no devaluation of a currency in the 2 years preceding the entrance into the union; (b) inflation rate no higher than 1.5% above the average of the three countries with the lowest inflation rates; (c) long-term interest rate not in excess of 2% above the average of the three countries with the lowest inflation rates; and (d) government deficits and debts not exceeding 3% and 60% of the GDP, respectively.

would be bleak. Economic convergence between these countries would imply a comovement of their outputs, earnings, and, consequently, equity markets (as it has been found in past studies; i.e., Cheung & Ng, 1998; Canova & DeNicole, 1995). If that is indeed the case, then classical portfolio theory would predict that increased dependence between countries participating in the EMU should reduce the attractiveness of portfolio holdings in these countries (relative to such holdings in other countries) due to increases in market correlations (e.g., Adjaoute & Danthine, 2001b, 2003).

Moreover, the introduction of the Euro, the European common currency, in January 1999 could be interpreted as the final integrative force of the fundamentals among the European equity markets (e.g., Morana & Beltratti, 2002), which would either further diminish any diversification benefits (e.g., Kool, 2000; Schroeder, 2002) or increase such benefits, due to higher liquidity and lower transaction costs associated with the Euro (e.g., Masson & Turtleboom, 1997; Portes & Rey, 1998). The mixed evidence on diversification benefits implies varying degrees of integration among these equity markets, and makes a forceful case for the existence of the ‘home bias’ phenomenon.

Therefore, in view of the above arguments, the purpose of this paper is to explore further the issue of possible diversification benefits, from the perspective of a US investor, in the unified European market. Although simple correlation tests may indicate benefits for investors with short-term horizons, bivariate and multivariate cointegration tests will reveal whether long-term common stochastic trends exist between the United States and the 11 European equity markets. Evidence of such long-run comovement would suggest greatly overstated benefits for US investors with longer-range investment horizons who seek diversification in these markets. The empirical analysis in this paper will consist of cointegration and Granger causality analyses for the 1987–2002 period.

The rest of the paper is organized as follows. Section 2 presents a brief description of the data, some summary statistics, and the methodological design of the study. Section 3 contains the results from the preliminary statistical investigation regarding correlations and unit root tests, and the main empirical findings from cointegration and Granger causality analyses. This section also contains a discussion of the empirical findings. Finally, Section 4 summarizes the study and concludes with some general observations.

2. Methodology, data, and descriptive statistics

The plan for the subsequent empirical investigation will be as follows. We will begin with the data description and construction; continue with a preliminary statistical analysis, which includes some descriptives and unit root tests; and conclude with the outline of the main methodological design of the study, which entails cointegration and Granger causality analyses.

2.1. Data description and sampling

The data are comprised of daily price index levels published by DataStream International for 11 European equity markets (Belgium, Finland, France, Germany,

Greece, Ireland, Italy, The Netherlands, Portugal, Spain, and UK) and the US market as represented by the S&P500.² These market indices are comprehensive, are similarly constructed by Datastream International, and are used in this study so as to achieve comparability among them. The time period is from January 1987 to December 2002. Our study is the first one, to our knowledge, which utilizes a wider data period, all 10 EMU equity markets including the UK and the US markets along with country clusters, and a more comprehensive methodology. For instance, past studies either used shorter sample periods (e.g., [Adjaoute & Danthine, 2001a, 2001b](#)) or simple correlation analyses (e.g., [Beckers, 1999](#)) or cointegration and/or Granger causality analyses (e.g., [Ahlgren & Antell, 2002](#); [Nystedt, 2000](#)).

The starting date for our analysis was chosen on the fact that consistent data were recorded since 1987 for all equity markets. However, our starting point coincides with the year in which major equity markets crashed (in October) and that may impact upon our empirical (i.e., cointegration and causality) results. For that reason, the analyses below will be conducted with and without this influential year. The October 1987 market crash has revealed that national equity markets did not operate autonomously, as previously thought, and that kindled the interest of researchers to further examine this issue and its implications. Regarding the European markets, for instance, some of studies (e.g., [Arshanapalli & Doukas, 1993](#); [Dickinson, 2000](#)) found stronger linkages (and cointegration) following the crash, while others (e.g., [Chan, Gup, & Pan, 1997](#); [Gerrits & Yuce, 1999](#)) reported exactly the opposite. Additionally, [Nystedt \(2000\)](#) and [Ahlgren and Antell \(2002\)](#) found evidence of tighter linkages (i.e., causality) between the European Union equity markets. This paper sheds more light to the mixed extant empirical literature by presenting multivariate cointegration and Granger causality findings in greater detail.

Finally, it would be instructive to split the sample period into three subperiods, from January 1987 to December 1995 (the ‘preconvergence’ period), from January 1996 to December 2002 (the ‘postconvergence’ period), and from January 1999 to December 2002 (the ‘Euro introduction’ period). The rationale for the first two subperiods is the fact that in 1995, all EMS member countries were supposed to adhere to the Maastricht Treaty criteria for economic convergence in preparation for the upcoming Monetary Union. During the preconvergence period, a number of events affected most of the European equity markets including speculative raids to some currencies, serious efforts by governments to liberalize the financial markets, and a cloud of uncertainty surrounding the prospects of monetary union by several European countries. The postconvergence period was characterized by increasing economic integration in Europe among more European economies and, of course, the adoption of the new Euro currency. In fact, this last development provided the reason for the third subperiod during which the Euro replaced the national currencies of the EMU members, implying a common monetary policy for all EMU members henceforth and a closer coordination of fiscal and other economic policies of member countries. The advent of the Euro was considered as strengthening the argument of

² No consistent data were found for Austria, Denmark, Luxembourg, and Sweden since 1987, and thus these markets were omitted from this analysis.

increased equity market linkages within the EMU, suggesting diminished diversification benefits.

2.2. Descriptive statistics

Table 1 presents summary statistics for the 11 European and the US equity market returns (computed by taking the first log difference of each series) for the entire period and the first two subperiods. Investors will be interested in the mean and standard deviation of these returns, as indicators of the expected level and the volatility of their investment portfolios. Secondly, they may also want to know if the risk/return tradeoff was more or less favorable in one market than in another. In that case, an increase in the average return per unit of risk (ARUR) would signal whether one market has been worthwhile compared to another. Looking at the preconvergence subperiod, we observe that only the UK, Greece, and Ireland had returns around or over 20%, whereas Italy experienced a mild negative return growth. Also, the standard deviations are relatively low except for that of Italy, which was the highest in the group. Asymmetric behavior in the returns is also evident, as seen by the skewness coefficients, which are mostly negative and significant, and the kurtosis coefficients, which also are pronounced and statistically significant. For instance, for returns with negative skewness, we can say that they are characterized by more likely extreme bad surprises (or risk), which may not be preferable to a highly risk-averse investor. With respect to the risk–return tradeoff, as seen by their ARURs, most markets had less risk per unit of return compared to Germany, Italy, and Spain, which offered the smallest mean return.³

In contrast, the convergence period exhibits for almost all countries returns in quite high double digits. Even more strikingly, perhaps, is the significant increase in their standard deviations. The skewness coefficients are again all negative and significant, indicating less likely but small losses and more likely but extreme gains. With the exception of Germany, Greece, Portugal, Finland, and UK, the rest of the markets offered an attractive risk–return tradeoff (as evidenced by their low ARURs).

Finally, in both subperiods, while most return series exhibit linear time dependencies, as seen by the LB(.) values for the returns, all of them display pronounced nonlinear dependencies, based on the significance of the LB²(.) of the squared returns. Moreover, all return series exhibit serious departures from the normal distribution, as evidenced by the significant Jarque–Bera (J–B) statistics, suggesting the presence of leptokurtosis in the return series.

2.3. Unit roots, cointegration, and Granger causality

In order to test for cointegration, the first step is to check if each series is integrated of the same order. Four null hypotheses are formulated below to test for the presence of a unit root. Next to each hypothesis, the corresponding regression models are reported as well.

³ The preconvergence period analysis was conducted with and without the 1987 year, but the results were essentially (i.e., qualitatively) the same and thus the entire period results are displayed in the table.

Table 1
Descriptive statistics

	Mean	S.D.	Skewness	Kurtosis	ARUR	LB (10)	LB ² (10)	J–B
<i>Entire period: 1987–2002</i>								
Belgium	0.0859	5.3989	−0.1844*	8.3591*	1.591	63.743**	117.817**	24.543**
France	0.0687	5.4906	−0.3354*	6.4760*	1.251	76.223**	116.817**	23.332**
Germany	0.0598	7.9393	−0.2561*	5.8334*	0.754	42.362**	120.991**	25.432**
Greece	0.1973	5.4552	0.4453*	9.4531*	0.276	66.859**	84.743**	26.543**
Italy	0.1766	22.624	−0.3556*	6.1949*	0.780	54.082**	139.881**	24.441**
The Netherlands	0.1406	9.4360	−0.5347*	7.8001*	1.491	64.112**	120.551**	25.423**
Spain	0.0409	3.0468	−0.4107*	7.6634*	1.343	65.712**	136.826**	27.434**
Portugal	0.0049	1.5540	−0.6724*	13.717*	0.315	67.443**	146.342**	22.554**
Ireland	0.3758	18.134	−0.7580*	10.836*	2.072	53.216**	147.463**	22.667**
Finland	0.0955	13.743	−1.3064*	38.674*	0.695	69.433**	126.342**	25.554**
UK	0.2700	19.910	−0.3341*	6.7884*	1.356	79.226**	136.352**	27.543**
US	0.1520	9.4779	−0.1451*	9.1540*	1.603	66.543**	152.553**	29.083**
<i>Preconvergence period: 1987–1995</i>								
Belgium	0.0459	2.4779	−0.4454*	7.7591*	0.539	32.732**	57.881**	11.321**
France	0.0527	1.4876	−0.2554*	2.4760*	0.282	14.233	58.081**	13.332**
Germany	0.0318	3.4193	−0.8761*	11.253*	1.075	16.333	71.449**	14.441**
Greece	0.1973	6.4212	0.1363	10.453*	0.325	54.121**	77.084**	13.875**
Italy	−0.0019	11.824	−0.3532*	3.6749*	–	55.072**	65.438**	12.331**
The Netherlands	0.0996	2.4060	−0.5187*	5.0321*	0.241	15.332	76.765**	14.782**
Spain	0.0096	1.0968	−0.6167*	6.9034*	1.142	34.430**	66.322**	14.990**
Portugal	0.0349	1.2140	−0.3324*	7.3717*	0.347	56.655**	89.063**	16.643**
Ireland	0.1978	6.4134	−0.2370*	9.9036*	0.324	77.454**	86.443**	14.998**
Finland	0.0306	1.0743	0.0834	3.1674*	0.351	45.544**	55.454**	16.751**
UK	0.3390	9.7590	−0.0511*	3.5784*	0.286	16.655	76.545**	17.221**
US	0.1349	2.8979	−0.5731*	4.8670*	0.214	15.776	89.756**	20.661**
<i>Postconvergence period: 1996–2002</i>								
Belgium	0.1296	7.2379	−0.1511	3.8711*	0.558	55.745**	78.381**	16.875**
France	0.0861	7.4916	−0.2604*	2.2260*	0.870	43.223	66.432**	15.552**
Germany	0.0913	10.770	−0.1877*	2.1574*	1.179	43.223	58.432**	14.442**
Greece	0.2793	32.614	0.0148	7.6443*	1.167	54.322**	83.322**	16.975**
Italy	0.3709	29.936	−0.3082*	2.9429*	0.809	14.112	33.451**	14.332**
The Netherlands	0.1856	13.226	−0.4057*	2.6921*	0.712	11.133	43.251**	15.332**
Spain	0.0735	4.1978	−0.3297*	2.9224*	0.571	15.212	33.526**	14.752**
Portugal	0.0229	5.2140	−0.3344*	3.3323*	2.276	17.411	46.433**	13.778**
Ireland	0.5635	25.008	−0.6042*	4.7696*	0.443	13.116	47.433**	15.977**
Finland	0.1606	19.574	−0.9174	17.177*	1.218	12.432	33.322**	16.553**
UK	0.2008	26.592	−0.3291*	1.8564*	1.324	44.323**	55.322**	15.645**
US	0.1698	13.127	−0.1071*	3.5790*	0.773	16.511	44.543**	18.991**

ARUR=average return per unit of risk; LB=Ljung–Box portmanteau test statistics for linear [LB(.)] and nonlinear [LB²(.)] dependencies; J–B=Jarque–Bera statistic for normality.

* Denotes statistical significance at the 5% level.

** Denotes statistical significance at the 1% level.

Hypothesis 1.

$$H_0 : \rho = 0 \quad \text{Regression model : } \Delta y_t = \alpha_0 + \rho y_{t-1} + u_t \tag{1}$$

Hypothesis 2.

$$H_0 : \rho = 1 \quad \text{Regression model : } y_t = \alpha_0 + \rho y_{t-1} + u_t \tag{2}$$

Hypothesis 3.

$$H_0 : \rho = 0 \quad \text{Regression model : } \Delta y_t = \alpha_0 + \alpha_1 t + \rho y_{t-1} + u_t \tag{3}$$

Hypothesis 4.

$$H_0 : \rho = 1 \quad \text{Regression model : } y_t = \alpha_0 + \alpha_1(t - T/2) + \rho y_{t-1} + u_t. \tag{4}$$

In models 1 and 3, the error (disturbance) terms, u_t , are assumed to be serially uncorrelated, whereas models 2 and 4 allow for serial correlation in the disturbance term. [Dickey and Fuller \(1979\)](#) show that the common test statistic, the conventional ‘ t ratio,’ for the null hypothesis of $\rho=0$ does not have a t distribution even as the sample size becomes infinite.⁴ Models 2 and 4 represent the [Phillips and Perron \(1988\)](#) test statistics denoted as $Z(t_{\alpha}^*)$ and $Z(t_{\alpha}^{\Delta})$, respectively.⁵ Once the series is found to be integrated of the same order, cointegration tests can be applied.

Although several tests of cointegration have been developed, the approach used in this paper is based on the [Johansen \(1988\)](#) and [Johansen and Juselius \(1990\)](#), or JJ henceforth. To illustrate these approaches briefly, consider a VAR of order p :

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + Bx_t + \varepsilon_t \tag{5}$$

where y_t is a k vector of nonstationary $I(1)$ variables, x_t is a d vector of deterministic variables, and ε_t is a vector of innovations. This VAR can be rewritten as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \tag{6}$$

where

$$\Pi = \sum_{i=1}^p A_i - I \quad \text{and} \quad \Gamma_i = - \sum_{j=i+1}^p A_j. \tag{7}$$

Granger’s representation theorem asserts that if the coefficient matrix Π , which is called the long-run impact matrix, has reduced rank $r < k$, then there exist $k \times r$ matrices α

⁴ The distribution of the t ratio, or the t_{μ} for model 1 or t_{τ} for model 3, to differentiate it from the conventional t statistic has specific percentiles.

⁵ In the Phillips–Perron models, the null hypothesis is $\rho=1$, with the stationary alternative of $\rho < 1$.

and β , each with rank r such that that $\Pi = \alpha\beta'$ and $\beta'y_t$ is stationary [or $I(0)$]. The cointegrating rank is r and each column of β is the cointegrating vector. The α coefficients can be interpreted as measuring the average speed of adjustment toward the cointegrating relationships in the vector error correction model.

JJ have suggested the examination of the rank of Π , which is equal to the number of nonzero eigenvalues, as the manner in which to test for the number of cointegrating relations. In this respect, there are two tests of whether the eigenvalues of the estimated Π matrix are significantly different from zero: the trace test and the maximum eigenvalue test. The trace test and the maximum eigenvalue test are expressed as follows:

$$\lambda_{\text{trace}}(\mathbf{r}) = -T\Sigma \ln(1 - \lambda_i) \quad (8)$$

$$\lambda_{\text{max}}(\mathbf{r}, \mathbf{r} + 1) = -T \ln(1 - \lambda_{r+1}) \quad (9)$$

where λ_i equals the estimated values of the characteristic roots (eigenvalues) obtained from the estimated Π matrix, \mathbf{r} is the numbers of cointegrating vectors, and T equals the number of usable observations. The trace test evaluates the null hypothesis that the number of distinct cointegrating vectors is less than or equal to r against a general alternative. The maximum eigenvalue test examines the number of cointegrating vectors versus that number plus one. If the variables in X_t are not cointegrated, the rank of Π is zero and all characteristic roots are zero. Since $\ln(1) = 0$, each of the expressions in $\ln(1 - \lambda_i)$ will equal zero in that case. Finally, the maximum likelihood tests of JJ ensure that coefficient estimates are symmetrically distributed and asymptotically efficient using standard χ^2 tests. The critical values for these tests, for up to six variables, are given by JJ and by [Osterwald-Lenum \(1992\)](#) for, at most, 11 variables (for a multivariate cointegration tests).

Because each series may have nonzero means, deterministic trends, and/or stochastic trends, the cointegrating equations may have intercepts and deterministic trends. As a consequence, the asymptotic distribution of the likelihood ratio test statistic for cointegration does not have the usual χ^2 distribution and may depend on the assumptions made with respect to deterministic trends. Therefore, we need to make several assumptions regarding the trends underlying the series. We will consider the following five deterministic trend assumptions, namely, $H_2(\mathbf{r})$, $H_1^*(\mathbf{r})$, $H_1(\mathbf{r})$, $H^*(\mathbf{r})$, and $H(\mathbf{r})$. These hypotheses are summarized below:

1. The level data y_t have no deterministic trends and the cointegrating equations do not have intercepts:

$$H_2(\mathbf{r}) : \Pi y_{t-1} + Bx_t = \alpha\beta' y_{t-1} \quad (10)$$

2. The level data y_t have no deterministic trends and the cointegrating equations have intercepts:

$$H_1^*(\mathbf{r}) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) \quad (11)$$

3. The level data y_t have linear trends and the cointegrating equations have only intercepts:

$$H_1(\mathbf{r}) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha \perp \gamma_0 \quad (12)$$

4. The level data y_t and the cointegrating equations have linear trends:

$$H^*(r) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha \perp \gamma_0 \tag{13}$$

5. The level data y_t have quadratic trends and the cointegrating equations have linear trends:

$$H(r) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha \perp (\gamma_0 + \gamma_1 t) \tag{14}$$

where the terms associated with $\alpha \perp$ are the deterministic trends ‘outside’ the cointegrating relations. When a deterministic trend appears both inside and outside the cointegrating relationship and the decomposition is not uniquely identified, Johansen identifies the part that belongs inside the error correction term by orthogonally projecting the exogenous terms onto the α space so that $\alpha \perp$ is the null space of α such that $\alpha' \alpha \perp = 0$.

Although, for the purposes of exposition of a comprehensive multivariate cointegration test, we included all possible assumptions, we will make the case for selecting assumption 2 as the most plausible one for the ensuing analysis. Under this case, no trend is assumed in either the cointegrating equation or the VAR because the equity index values are expressed in natural logarithms. As a result, when the first difference in each index is taken, the result is a return series. However, an intercept term is assumed in view of the impositions of any restrictions on the series and the absence of any dummy variables (for capturing seasonality or other events).

In case of the presence or absence of a long-run relationship, the possibility of a short-run relationship between/among the equity markets may still exist. We can use the Granger causality test with an error correction term (if cointegration exists) or without an error correction term (if cointegration does not exist) to investigate this issue. The Granger (1969) method seeks to determine how much of a current variable, y , can be explained by past values of y and whether adding lagged values of another variable, x , can improve the explanation. The Granger causality test is used to test for presence of short-term causal relationships between two equity markets. The Granger test takes the following form:

$$y_t = \alpha_0 + \sum \alpha_i y_{t-i} + \sum \beta_j x_{t-j} + \varepsilon_t \text{ and} \tag{15a}$$

$$x_t = \alpha_0 + \sum \alpha_i x_{t-i} + \sum \beta_j y_{t-j} + \mu_t \tag{15b}$$

In this case, y is said to be “Granger-caused” by x if x helps to predict y . In other words, one looks at the coefficients on the lagged x values to see if they are statistically significant (based on an F test).

3. Empirical findings and discussion

This section contains the results from the correlations, unit root tests, cointegration, and Granger causality analyses. Along with the presentation of the main empirical results, a discussion regarding their implications is included.

3.1. Correlations

Table 2 presents the correlation coefficients of the daily returns for all equity markets for the three subperiods (1987–1995, 1996–2002, and 1999–2002). From the pre-convergence period results, we observe some high positive correlations among the European (marked in boldface numbers) market returns, and between the United States and each European market return. The postconvergence period exhibits much higher correlations

Table 2
Correlation matrix, 1987–2002

	BEL	FIN	FRA	GER	GRE	IRE	ITA	NET	POR	SPA	UK	US
<i>Preconvergence period: 1987–1995</i>												
BEL	1.00	0.299	0.753	0.814	0.302	0.868	0.757	0.732	0.051	0.816	0.601	0.497
FIN		1.000	0.027	0.049	−0.330	0.390	0.396	0.296	0.345	0.508	0.228	0.121
FRA			1.000	0.885	0.684	0.810	0.304	0.895	0.301	0.538	0.883	0.783
GER				1.000	0.728	0.876	0.555	0.853	0.241	0.637	0.799	0.751
GRE					1.000	0.493	0.072	0.622	0.213	0.124	0.685	0.761
IRE						1.000	0.622	0.611	0.398	0.623	0.820	0.719
ITA							1.000	0.371	−0.129	0.753	0.225	0.719
NET								1.000	0.553	0.684	0.761	0.700
POR									1.000	0.240	0.564	0.570
SPA										1.000	0.578	0.378
UK											1.000	0.957
<i>Postconvergence period: 1996–2002</i>												
BEL	1.00	0.757	0.796	0.854	0.726	0.773	0.817	0.832	−0.253	0.864	0.844	0.843
FIN		1.000	0.659	0.523	0.750	0.777	0.818	0.817	−0.561	0.808	0.723	0.856
FRA			1.000	0.900	0.742	0.727	0.872	0.865	−0.544	0.851	0.860	0.873
GER				1.000	0.732	0.753	0.875	0.880	−0.459	0.874	0.872	0.878
GRE					1.000	0.732	0.838	0.824	−0.495	0.842	0.852	0.861
IRE						1.000	0.752	0.871	−0.292	0.883	0.880	0.879
ITA							1.000	0.841	−0.484	0.863	0.865	0.868
NET								1.000	−0.376	0.884	0.881	0.880
POR									1.000	−0.364	−0.395	−0.436
SPA										1.000	0.988	0.880
UK											1.000	0.991
<i>Euro introduction period: 1999–2002</i>												
BEL	1.00	−0.549	−0.786	−0.812	0.106	0.243	−0.720	−0.762	0.563	−0.654	−0.244	−0.573
FIN		1.000	0.479	0.423	0.500	−0.553	0.160	0.487	−0.301	0.258	0.243	0.436
FRA			1.000	0.954	−0.382	−0.107	0.912	0.975	−0.724	0.854	0.510	0.843
GER				1.000	−0.342	−0.043	0.925	0.940	−0.609	0.914	0.522	0.818
GRE					1.000	−0.372	−0.588	−0.324	0.325	−0.342	0.022	−0.211
IRE						1.000	0.122	−0.081	0.152	0.163	0.050	0.049
ITA							1.000	0.891	−0.634	0.883	0.465	0.748
NET								1.000	−0.759	0.834	0.601	0.890
POR									1.000	−0.424	−0.396	−0.699
SPA										1.000	0.593	0.759
UK											1.000	0.749

Greece joined the Euro zone in 2001; Finland in 1995.

not only among the European markets but also with the US markets. Finally, the Euro introduction period reveals several negative relationships among the European markets and weak correlations of the British and the US equity markets with the European markets.

These results present indeed a mixed and a puzzling picture. We saw that the rise in the correlations of these markets in the second subperiod was accompanied by increases in the standard deviations of returns. It is not clear, however, whether this increase in the level of risk has any causal relationships with EMU, or it is simply a reflection of a wider worldwide trend of greater global financial integration. Hence, the simple conclusion from the above is that the process of economic and monetary integration within Europe appears, at first glance, to be associated with an increase in the correlation of national equity markets, which imply that the benefits of international diversification using country allocation models within the EMU land have diminished. A similar process of increasing correlations among the European and the US market is evident in the portconvergence subperiod, suggesting that EMU factors may not be the only ones at play. However, during the last few years when the EMU was mostly in effect, some equity markets showed signs of weak linkages among themselves, implying that some short-run gains from diversifying among some European equity markets still existed. Nonetheless, these findings are univariate (and static) in nature and do not tell the entire picture (i.e., they do not reflect the dynamic relationships among markets) and so the cointegration results below will determine whether these short-term correlations are also appropriate indicators of diversification benefits for long-term US investors.

3.2. Unit root results

Table 3 presents the results of the four unit root tests for the first two subperiods (1987–1995 and 1996–2002) only. The third subperiod, 1999–2002, produced similar results as the second subperiod and, as such, they are omitted from the table. Appropriate lag lengths were selected according to the Akaike Information Criterion. Moreover, F tests and t tests were conducted to determine lag lengths and produced very similar results. The unit root tests were corrected for (possible) serial correlation and autoregressive heteroscedasticity. Finally, the Ljung–Box, [LB(.)], tests on residuals showed lack of serial correlation in each case.

The boldface numbers below each country row refer to the second subperiod. Based on the results, for all equity markets, the null hypothesis of the presence of a unit root cannot be rejected. Further testing on the first differences of each stock price index series does not indicate the presence of a second unit root, which implies that they are stationary. Therefore, for those countries, individual equity markets appear to be $I(1)$. Because all country stock index levels are $I(1)$, all are likely candidates for cointegrating markets, to which we turn next.

3.3. Cointegration results

The Johansen and Juselius (or JJ) cointegration test is applied to several cases or country groups, as follows. First, cointegration is checked pairwise between each country

Table 3
Unit root tests on European and US stock markets, 1987–2002

Country	t_{μ}	$Z(t_{\alpha}^*)$	t_{τ}	$Z(t_{\hat{\alpha}})$
Belgium	-1.0403	-0.0123	-0.8361	-1.5321
	-1.0343	-0.0111	-0.8222	-1.4443
Finland	-1.1904	-1.3234	-0.7533	-1.2212
	-1.1884	-1.3234	-0.7544	-1.2222
France	-1.1405	-1.2232	-0.8767	-1.6367
	-1.1545	-1.2443	-0.8443	-1.6332
Germany	-1.2305	-0.3627	-0.9901	-1.2211
	-1.2225	-0.3337	-0.9554	-1.2012
Greece	-1.1106	-1.3321	-0.9971	-1.9855
	-1.1046	-1.3443	-0.9665	-1.8897
Ireland	-0.8303	-0.9435	-1.3569	-1.6378
	-0.8443	-0.9443	-1.3776	-1.6443
Italy	-1.0004	-0.6738	-1.3409	-1.7768
	-1.0444	-0.6443	-1.3776	-1.7443
The Netherlands	-1.0583	-1.3425	-0.4663	-1.6272
	-1.0554	-1.3556	-0.4776	-1.6443
Portugal	-0.9645	-1.2231	-0.6453	-1.7890
	-0.9776	-1.2665	-0.6777	-1.8009
Spain	-1.2763	-0.9867	-1.1713	-1.6345
	-1.2223	-0.9665	-1.1554	-1.6112
UK	-1.2925	-0.8875	-0.5922	-2.0987
	-1.2654	-0.8655	-0.5554	-2.1018
US	-1.1014	-1.2218	-0.6998	-2.1127
	-1.0718	-1.2099	-0.7028	-2.0918

Statistic	Model	Null hypothesis	Critical values		
			1%	5%	10%
t_{μ}	$\Delta y_t = \alpha_0 + \rho y_{t-1} + u_t$	$H_0: \rho = 0$	-3.461	-2.886	-2.571
$Z(t_{\alpha}^*)$	$y_t = \alpha_0 + \rho y_{t-1} + u_t$	$H_0: \rho = 1$	-3.431	-2.862	-2.570
t_{τ}	$\Delta y_t = \alpha_0 + \alpha_1 t + \rho y_{t-1} + u_t$	$H_0: \rho = 0$	-3.991	-3.433	-3.133
$Z(t_{\hat{\alpha}})$	$y_t = \alpha_0 + \alpha_1(t - T/2) + \rho y_{t-1} + u_t$	$H_0: \rho = 1$	-3.960	-3.412	-3.121

None of the above statistics is significant at conventional levels; numbers in boldface refer to the second subperiod (1996–2002); Adjusted Dickey–Fuller: t_{μ} , no trend; t_{τ} , with trend.

Phillips–Perron: $Z(t_{\alpha}^*)$, no trend; $Z(t_{\hat{\alpha}})$, with trend.

and Germany, excluding the United States. Second, cointegration tests are conducted in a similar fashion between each European country and the United States, including Germany. Third, all European countries were tested for multivariate cointegration for the entire sample period. Finally, cointegration is tested for four country groups with Germany first and the United States next. These country groups are:

- Country Group 1: Belgium, Finland, France, Italy, The Netherlands, UK, Germany
- Country Group 2: Greece, Ireland, Portugal, Spain, Germany
- Country Group 3: Belgium, Finland, France, Italy, The Netherlands, UK, United States
- Country Group 4: Greece, Ireland, Portugal, Spain, United States.

The rationale for the above four country groups follows. Groups 1 and 3 were created on the fact that these countries represent the largest and the most developed ones within the European community in which Germany was the prevalent country, whereas groups 2 and 3 (excluding Germany and the United States) were made on the recognition that these countries represent the weaker economies most of which were under consideration for inclusion in the European Union. Furthermore, these weaker countries (with the exception of Ireland) began launching market liberalization measures in the early 1990s, compared to their advanced counterparts, which had already liberalized their markets, and had not achieved fully open financial markets until the late 1990s. Overall, these country clusters can provide information on whether the larger or the smaller equity markets have achieved tighter linkages among themselves and whether the smaller markets have become more or less integrated with the larger ones over time (i.e., in the postconvergence period and subperiod).

Finally, the inclusion of the UK and the US equity markets in two country groups is based on two reasons: first, for the purpose of investigating the nature of market integration between EMU and some outside markets especially when these have very strong linkages with the European Union (i.e., the UK primarily) or are international leaders (i.e., the United States); second, to examine the impact of the EMU, within and across markets, among strong and ‘weak’ economies alike, after it has been established and in operation, from the perspective of a US investor.

Concentrating now on cointegration analysis, and before discussing the results, we must report that the five assumptions from these tests included a lag interval (in first differences) from one to four. The first step in the JJ cointegration test is to determine the lag length for the vector autoregression (VAR). q log-likelihood statistic compares the adequacy of m versus $m+1$ lags. Results of this test indicate that the null hypothesis of more than one lag in the VAR cannot be rejected. Intuitively, one can interpret the cointegration results as follows. If there exist two or more shared common stochastic trends in a given pair or group of countries, respectively, then it must be the case that some countries’ equity markets behave independently of the others in the long run. By contrast, if we find only one shared common stochastic trend in a given group or pair, then it would mean that these equity markets have a single common long-run path and any one equity market may be representative of the behavior of the group. Therefore, an investor should only invest in one of these markets and not in all of them.

The results from the JJ cointegration tests are displayed in [Tables 4 and 5](#). [Table 4](#) contains the results from the bivariate cointegration tests (i.e., those for each country with Germany and the United States, respectively), whereas [Table 5](#) contains the multivariate cointegration results (i.e., those among the four groups of countries identified above).⁶ From the findings in [Table 4](#), under the five cointegration assumptions outlined earlier, we can see that there are mixed results, as far as the first subperiod is concerned.

⁶ As before, for the first subperiod the analysis was done without the 1987 year, but the results did not show any significant differences from those which included that year, and thus the results presented in the tables refer to the entire subperiod.

Table 4
Bivariate cointegration test results

Each country with Germany (US)					
Data trend	None	None	Linear	Linear	Quadratic
Rank of CE(s)	No intercept	Intercept	Intercept	Intercept	Intercept
Number of CE(s)	No trend	No trend	No trend	Trend	Trend
Selected (5% level) number of cointegrating equations by model (columns)					
<i>First subperiod: 1987–1995^a</i>					
Belgium					
Trace	0(0)	1(0)	2(0)	1(0)	2(0)
Max eigen	1(0)	0(0)	2(0)	1(0)	2(0)
Finland					
Trace	0(0)	0(0)	0(0)	0(0)	0(0)
Max eigen	0(0)	0(0)	0(0)	1(0)	0(0)
France					
Trace	0(2)	0(0)	2(0)	0(0)	2(2)
Max eigen	0(0)	0(0)	0(0)	0(0)	0(0)
Ireland					
Trace	1(0)	0(0)	1(0)	0(0)	2(0)
Max eigen	1(0)	0(0)	1(0)	0(0)	0(0)
Portugal					
Trace	0(0)	0(1)	0(0)	0(1)	0(0)
Max eigen	0(0)	0(0)	0(1)	0(0)	0(0)
Spain					
Trace	0(0)	0(0)	2(0)	0(0)	2(0)
Max eigen	0(0)	0(0)	0(0)	0(0)	0(0)
UK					
Trace	0(0)	0(0)	0(0)	0(0)	0(2)
Max eigen	0(0)	0(0)	0(0)	0(0)	0(0)
<i>Second subperiod: 1996–2002^b</i>					
UK					
Trace	0(0)	0(0)	0(1)	0(1)	0(1)
Max eigen	0(0)	0(0)	0(1)	0(1)	0(1)

^a Pairs of Greece, Italy, and The Netherlands with Germany and the US show no cointegration (and thus omitted).

^b Pairs of Belgium, Finland, France, Germany, Greece, Ireland, Italy, The Netherlands, Portugal, and Spain, with Germany and the US show no cointegration (and thus omitted); these values were estimated under the five assumptions of cointegration; lags interval (in first differences): 1–4.

Specifically, there seems to exist different cointegrating relationships between each country (i.e., Belgium, Finland, France, Ireland, Portugal, Spain, and UK) with Germany, under different assumptions, and different cointegrating relationships between each

Notes to Table 5:

Country group 1: Belgium, Finland, France, Germany, Italy, The Netherlands, UK; country group 2: Greece, Germany, Ireland, Portugal, Spain; country group 3: Belgium, Finland, France, Italy, The Netherlands, UK, US; country group 4: Greece, Ireland, Portugal, Spain, and US.

^a Refers to the first subperiod, since in the second subperiod, there is no cointegration for these groups.

^b The first (second) set of numbers refers to the first (second) subperiod; probability values in parentheses; lags interval (in first differences): 1–4.

Table 5
Multivariate cointegration test results

Panel A: country groups							
Data trend	None	None	Linear	Linear	Quadratic		
Rank of CE(s)	No intercept	Intercept	Intercept	Intercept	Intercept		
Number of CE(s)	No trend	No trend	No trend	Trend	Trend		
Selected (5% level) number of cointegrating equations by model (columns)							
<i>First subperiod: 1987–1995</i>							
Group 1							
Trace	2	2	2	2	2		
Max eigen	2	2	2	2	2		
Group 2							
Trace	1	1	2	1	1		
Max eigen	1	1	2	1	2		
Group 3							
Trace	2	2	2	2	2		
Max eigen	2	2	2	2	2		
Group 4							
Trace	0	0	0	0	0		
Max eigen	0	1	1	1	0		
<i>Second subperiod: 1996–2002</i>							
Group 1							
Trace	0	0	0	0	0		
Max eigen	0	0	0	0	0		
Group 2							
Trace	0	1	1	0	1		
Max eigen	0	1	0	1	1		
Group 3							
Trace	1	1	2	1	1		
Max eigen	1	1	0	0	0		
Group 4							
Trace	0	0	0	0	0		
Max eigen	0	0	0	0	0		
Panel B: country groups: exclusion tests [$\chi^2(2)$]							
1 ^a	Belgium	Finland	France	Germany	Italy	The Netherlands	UK
	19.8612***	1.0526	20.4321***	6.1756	18.7182***	1.1432	2.5432
	(0.0000)	(0.3040)	(0.0000)	(0.0129)	(0.0000)	(0.2863)	(0.1113)
2 ^a	Greece	Germany	Ireland	Portugal	Spain		
	14.6032***	5.0645	3.5432	1.3728	15.6689***		
	(0.0000)	(0.0560)	(0.0667)	(0.2234)	(0.0000)		
3 ^b	Belgium	Finland	France	Italy	The Netherlands	UK	US
	10.7189***	3.8917	12.0216***	6.4372	0.0690	0.6112	4.4543
	(0.0000)	(0.0421)	(0.0000)	(0.0109)	(0.8016)	(0.4321)	(0.0231)
	3.7189	1.3327	1.3321	6.7652**	0.6543	5.3322**	0.3343
	(0.0489)	(0.2221)	(0.3320)	(0.0009)	(0.0106)	(0.0021)	(0.5411)

country and the United States. A clear indication of no cointegration is found (but not reported) in the cases of the pairs between Greece, Italy, and The Netherlands with Germany and the United States. The second subperiod results, however, surprisingly suggest no cointegration between all market pairs and Germany and the United States (although the UK–US pair shows some cointegration, which is reported).

Although there is no evidence of cointegration on a bilateral basis between the European equity markets and Germany, and between the European markets and the US market individually, it could still be possible that these markets, as a group, may be cointegrated. Therefore, a multilateral JJ test was applied to the four country groups identified above. The optimal lag length was two and was chosen by applying the Akaike Information Criterion and the Schwarz Information Criterion on the undifferenced VAR models. The results from these tests are exhibited in panel A of [Table 5](#) for the four country groups. Again, as in the case of the bivariate results, the evidence is mixed. For the first subperiod, all groups show mixed cointegration results (in terms of presence of no, one, or more cointegrating vectors). From the second subperiod results, unambiguous evidence of no cointegration is seen in groups 1 and 4, but mixed in the other two groups (in terms of the presence of one or two cointegrating vectors).

To further shed light on the above results, we performed some exclusion tests (on the coefficients of the cointegrating vectors related to each variable) in order to determine if each equity market is indeed participating to the cointegrating space. The rejection of the null hypothesis of exclusion of a variable from the cointegrating space confirms the presence of close links among the variables in the system. In the event of accepting the null hypothesis, the conclusion would be absence of cointegration among all equity markets or simply absence of close linkages among them. The results from these tests, based on the test statistic distributed as a χ^2 with r degrees of freedom, are reported in panel B of [Table 5](#) and are applied to the results from the second assumption of an intercept but no trend in the series. The exclusion tests for group 1 (in the first subperiod) indicate that Finland, Germany, The Netherlands, and UK can be excluded from that group (system) since they do not participate in the cointegrating space. For group 2 (in the first subperiod again), Germany, Ireland, and Portugal can be excluded from the system. Finally, for group 3 for each subperiod (the first/second row of numbers refers to the first/second subperiod), the interpretation is analogous. For example, Finland, Italy, The Netherlands, UK, and the United States can be excluded from that group; but in the second subperiod, Belgium, Finland, France, The Netherlands, and the United States can be excluded from the group. Taken overall, for the second subperiod, these results indicate lack of linkages among these European equity markets and the United States, a finding that is consistent with the previous table's findings.

Panel A of [Table 6](#) displays the cointegration results for all the European Union equity markets (excluding the UK and the United States) for both subperiods. The results indicate one cointegrating relationship (in the second subperiod) or more cointegrating relationships (in the first subperiod) among the markets. The exclusion tests (based on the second assumption again) indicate that Belgium, Finland, Germany, Greece, Ireland, The Netherlands, and Spain can be excluded from the entire group in the first subperiod; and Belgium, Finland, Greece, Ireland, and Italy from the same group in the second subperiod.

Table 6
Multivariate cointegration tests, European Union equity markets

Panel A: all European Union markets, first subperiod ^a					
Data trend	None	None	Linear	Linear	Quadratic
Rank of CE(s)	No intercept	Intercept	Intercept	Intercept	Intercept
Number of CE(s)	No trend	No trend	No trend	Trend	Trend
<i>Selected (5% level) number of cointegrating equations by model (columns)</i>					
Trace	2	1	2	2	2
Max eigen	2	1	1	1	1

Exclusion tests [$\chi^2(2)$]

Belgium: 6.3325 (0.0124); Germany: 3.1255 (0.0635); Italy: 10.6554**** (0.0000); Spain: 2.4431 (0.1247); Portugal: 8.9885*** (0.0021); The Netherlands: 3.5667 (0.0601)

Second subperiod

Trace	1	1	1	1	1
Max eigen	1	1	1	1	1

Exclusion tests [$\chi^2(1)$]

Belgium: 2.6655 (0.0874); Germany: 23.1231** (0.0000); Italy: 2.6651 (0.1340); Finland: 3.1231 (0.0755); Greece: 2.1244 (0.1406); Ireland: 5.5443 (0.0185); France: 7.7764* (0.0060); Spain: 11.4321** (0.0008); Portugal: 21.4345** (0.0000); The Netherlands: 12.1267** (0.0007)

Panel B: Euro introduction period: all European Union markets^b

Trace	0	0	0	0	0
Max eigen	0	0	0	0	0

Probability values in parentheses.

^a Either subperiod does not include the UK or the US.

^b This subperiod does not include the UK.

* Refers to significance at the 5% level.

** Refers to significance at the 1% level.

*** Refers to significance at the 10% level.

Finally, panel B of Table 6 exhibits the European Union countries that adopted the Euro in January 1, 1999. The results from the multivariate cointegration tests do not show any evidence of cointegration among these equity markets in the post-Euro period. This is a surprising result given the great strides these countries have made during the last 5 years to converge among themselves, fiscally and monetarily, within the context of a single currency. Of course, that date does not really correspond to the actual use of the Euro by citizens in these countries, rather the date for the subsequent official use of the currency, in January 2001. These results also have implications for the so-called ‘home bias’ phenomenon, or the propensity of investors to favor their home market. In other words, these findings suggest that the changing economic structures within Europe and the elimination of currency risk may have actually lowered the cost of the ‘home bias’ within the Eurozone. Overall then, our result suggests that country differences have not yet disappeared within the European Union equity markets and thus it may be premature to say that country diversification within the EU does not pay off any more (in favor of, say, sector diversification).

3.4. Granger causality results

Although the results of the cointegrating tests indicate that there is no consistent evidence of a long-run relationship between the United States and the European equity markets, in each subperiod, as shown in [Tables 4 and 5](#), it is still possible that short-run relationships may still exist. Given that the return series are not cointegrated, we can employ the Granger causality test without error correction terms to investigate the above possibility. Consequently, the Granger test was applied to the first differences of each equity market with Germany (in panel A) and then to each European market with the US market (in panel B) for the preconvergence and the postconvergence periods. The results are shown in [Table 7](#). Since this test is highly sensitive to the lag orders of the right-hand side variables, the Akaike and the Schwarz Information Criteria were again applied to determine the optimal lag length, which was in all cases two. We also performed the Granger causality test with all countries in the sample, but these results were omitted from the table (but are available upon request). The results exhibited in panel A suggest unilateral Granger causality running from France, Ireland, Italy, The Netherlands, Spain, and the UK to Germany with a feedback from the latter to the UK only in the first subperiod. In the second subperiod, bilateral causality is seen between Germany and France, and Italy and the UK. From panel B, it is very clear that the US equity market affects all (but Finland's and Portugal's) markets without any evidence of feedbacks in any subperiod (although France seems to Granger-cause the US market in the second subperiod).

What can one conclude then, overall, from the above cointegration and Granger causality results regarding the diversification benefits for a US investor wishing to invest in the European Union's equity markets? First and foremost, the issue of cointegration continues to be a debated one as some authors suggest that absence of cointegration may be due to either structural breaks in the series or to invalid restrictions on the cointegrating relationship. Moreover, other authors claim that the use of more/less aggregated data (e.g., daily, weekly, or monthly) reveals different conclusions on cointegration since jumps and other extreme fluctuations present in daily or weekly data tend to be smoothed out in monthly (or quarterly) data. Nonetheless, in this paper's case, the cointegrability property of these returns has decreased in the European Monetary System, perhaps due to changes within the exchange rate mechanism (like the widening of the fluctuation bands from $\pm 2.25\%$ in the 1980s to $\pm 15\%$ in the early 1990s), or to the gradual process of convergence of the interest rates of individual EMS countries (with that of Germany's), a process that makes the cointegrating relationship variant over time (see [Caporale & Pittis, 1993](#); [Hassapis, Pittis, & Prodromides, 1999](#)). Finally, other authors ([Bajo-Rubio, Sosvilla-Rivero, & Fernandez-Rodriguez, 2001](#)) found some evidence of cointegration among some EMS members but not with others.

Second, there could be other factors at work that may explain our results. For instance, the economically 'weaker' European countries such as Greece, Portugal, and Spain have gone through various and different periods of market liberalizations compared to their more advanced partners or the United States. Each European country has sought, in varying degrees, to free up restrictions to international capital flows to attract global investors, but these countries are not yet fully integrated into the world economy. A case in point is the recent inclusion of Greece's equity market into the group of advanced equity markets now

Table 7

Granger causality tests of the relationships between US, UK, and European Union equity markets

Null hypothesis	First subperiod		Second subperiod	
	F statistic	Probability	F statistic	Probability
<i>Panel A: European markets with Germany, each subperiod</i>				
Germany does not Granger-cause Belgium	0.30763	0.90859	0.78986	0.46915
Belgium does not Granger-cause Germany	2.51491	0.02767	2.00857	0.09078
Germany does not Granger-cause Finland	0.92860	0.46111	1.28139	0.27564
Finland does not Granger-cause Germany	0.86471	0.01170	1.73425	0.13213
Germany does not Granger-cause France	1.31321	0.21065	207.536**	0.00000
France does not Granger-cause Germany	1260.70**	0.00000	845.467**	0.00000
Germany does not Granger-cause Greece	0.35034	0.88239	0.70562	0.58162
Greece does not Granger-cause Germany	0.63456	0.66221	4.36435*	0.00162
Germany does not Granger-cause Ireland	2.18671	0.05235	1.22345	0.29617
Ireland does not Granger-cause Germany	247.782**	0.00000	197.321**	0.00000
Germany does not Granger-cause Italy	0.53213	0.52301	4.42361*	0.00133
Italy does not Granger-cause Germany	687.356**	0.00000	450.453**	0.00000
Germany does not Granger-cause Nether.	1.17592	0.97562	0.44526	0.77534
Nether. does not Granger-cause Germany	318.945**	0.00000	843.771**	0.00000
Germany does not Granger-cause Portugal	2.45362	0.03216	2.44632	0.03524
Portugal does not Granger-cause Germany	1.11261	0.34526	0.42617	0.79536
Germany does not Granger-cause Spain	1.67721	0.16375	2.24536	0.06425
Spain does not Granger-cause Germany	794.445**	0.00000	521.667**	0.00000
Germany does not Granger-cause UK	3.63425*	0.00134	88.8178**	0.00000
UK does not Granger-cause Germany	689.709**	0.00000	550.331**	0.00000
<i>Panel B: European markets with US</i>				
US does not Granger-cause Belgium	172.188**	0.00000	140.345**	0.00000
Belgium does not Granger-cause US	2.04710	0.06908	1.53621	0.38627
US does not Granger-cause Finland	2.49625	0.03326	2.30728	0.02156
Finland does not Granger-cause US	2.51106	0.02810	1.74234	0.13812
US does not Granger-cause France	1.21014	0.30441	3.52413*	0.00221
France does not Granger-cause US	190.442**	0.00000	133.526**	0.00000
US does not Granger-cause Germany	313.805**	0.00000	221.425**	0.00000
Germany does not Granger-cause US	3.94482**	0.00061	0.52134	0.71732
US does not Granger-cause Greece	1.89443	0.09123	4.55991*	0.00115
Greece does not Granger-cause US	4.84132**	0.00020	0.54231	0.70320
US does not Granger-cause Ireland	165.628**	0.00000	122.514**	0.00000
Ireland does not Granger-cause US	3.04352*	0.00917	1.87435	0.11132
US does not Granger-cause Italy	47.0972**	0.00000	35.5227**	0.00000
Italy does not Granger-cause US	2.52288	0.02817	1.66435	0.15324
US does not Granger-cause Netherlands	138.297**	0.00000	91.2871**	0.00000
Netherlands does not Granger-cause US	8.25345**	0.00161	0.64265	0.62715
US does not Granger-cause Portugal	2.72543	0.01767	2.97951	0.01831
Portugal does not Granger-cause US	1.72367	0.12645	0.82415	0.51324
US does not Granger-cause Spain	57.6009**	0.00000	38.5211**	0.00000
Spain does not Granger-cause US	1.79796	0.10954	1.95322	0.09627
US does not Granger-cause UK	109.220**	0.00000	78.6722**	0.00000
UK does not Granger-cause US	1.33718	0.10520	2.06271	0.08532

Sample periods, 1987–1995 and 1996–2002 (3914 observations total for sample).

* Denotes statistical significance at 5% levels.

** Denotes statistical significance at 1% level.

routinely reported by several international organizations. Therefore, the relaxation of restrictions on foreign exchange and capital flows may not be sufficient to attract the attention of foreign investors and further strengthen international market linkages. Perhaps other factors are at play as well, including information dissemination differences, accounting standards, and other types of investment risks (including ‘home bias’), which may influence an investor’s decision for further portfolio diversification. As a result, it is not surprising that the European equity markets, as a group, would not provide strong evidence of long-term comovements with the US market or among themselves, thereby suggesting that potential diversification benefits within Europe still exist for a US investor.

A word of caution is warranted at this point, however. It has been shown that the correlations among these markets keep increasing in light of the pace of globalization and convergence within the European Union. Greater financial integration, in turn, will certainly increase the degree of comovement among these equity markets (and economies as a whole) and may become a factor in asset allocation decisions, which suggests that the changing nature of global diversification benefits will need to be accounted for over time.

4. Summary and conclusions

In this paper, we presented an analysis of cointegration among all European Union equity markets and between them and the UK and the US equity markets since 1987. The empirical analysis was conducted on several country groups and utilized cointegration and Granger causality methodologies, among other tests. The empirical results indicate that beginning in 1996, when the European equity markets embarked in the process of financial and economic convergence in preparation of the EMU and a single currency, there was mixed evidence of cointegration among them. Such evidence remained mixed even when the US equity market was included in that country group. Similarly, the European Union countries did not exhibit any strong cointegration ties in the preconvergence and postconvergence periods and, perhaps most importantly, these markets did not show any cointegration even during the Euro introduction period (of January 1, 1999). Taken overall, these findings make a strong case for the existence of a significant ‘home bias’ within the Euroland. Finally, bivariate Granger causality tests, with and without the US equity market, did not indicate any significant feedbacks of any European equity market with Germany, in either subperiod. However, the results revealed significant causality with the United States running from the United States to the European markets especially in the postconvergence period.

Therefore, we have seen and concluded that monetary integration within EMU has been distinguished by alternating advances and retreats. For some country groups, the long-term stability of economic fundamentals and the introduction of the Euro have generated limited changes to their macroeconomic environment, while for other country groups, the transition to the use of a common currency entailed a significant economic shift. Regardless, it is apparent that the economic effects of monetary integration are often inconsistent within and across countries (or equity markets, here) since it is quite sensible that economic integration strengthens the financial linkages within economic regions but fails to enhance global financial integration.

These results have important implications for long-run diversification benefits for a US investor. First, since these European markets do not share a common stochastic trend with the US equity market, the simple correlations of returns between these markets are not dependent on the investment horizon but do indicate diversification benefits for both short-term—albeit to a lesser extent—and longer-term investors. Second, since these European markets were not found to be cointegrated since the mid 1990s, it is best not to view them as one asset class within a well-diversified global portfolio but rather than as separate asset classes. Finally, as it will be a typical characteristic within the ever-increasing pace of global financial integration, return correlations will keep increasing over time and that would suggest that they be considered as an important factor in asset allocation decisions in the future.

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