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"Stock Markets' Integration Analysis"

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Abstract

Globalization brought increased attention to stock markets throughout the world. As a straightforward consequence of the economic integration between the European country members, the stock markets of these countries are expected to follow a path of steadily increasing integration due to the gradual intensification of the economic and monetary integration. However the establishment of EMU and the introduction of the common currency do not have the same effect on the European stock markets. The members of EMU were at different point of readiness when the final decision had been taken since many countries in EU were already taking part in other kind of integration initiatives. The main aim of this study is to analyze daily data of selected European stock markets in an attempt to point out significant changes in the degree of market integration among different stock markets using different econometric techniques.

Keywords: Market Integration, Stock Markets, Stock Return Correlations, Co-Integration and Related Tests.

JEL Classification: G14, G15, C01

1. Introduction

The foundation and the establishment of EMU in 1999 commence an era where both monetary and fiscal policies in the euro zone became more coordinated. Stock market prices represent the economic conditions in each country and thus stock markets in EMU should be more integrated as a result of more similar conditions across the countries (Ripley, 1973). Additionally, during recent years there has been a positive progress towards financial integration in the EU with the implementation of single market legislation.

The EU's stock markets are still governed by different legal systems and other major obstacles such as legal, regulatory, tax or technical obstacles to cross border activity within the EU result in some degree of segmentation.

To date, several methods have been developed in dealing with this challenge. The fields of international macroeconomics and international finance have developed different but related methodologies to test for financial integration, ranging from simple empirical methodology tests to more complex models such as time series models, asset pricing models and others.

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2. The Objective of this Study

The main objective of this empirical study is to verify whether the establishment of EMU affects the integration of the European stock markets and to investigate whether the integration of the European stock markets has increased after the EMU.

The theory of efficient markets suggests that if there are not imperfections, a stock market index reflects all available information, including any other kind of information contained in other stock exchanges indices. If national stock markets were integrated, the lags of the price adjustments in these stock markets would be reduced (Koch and Koch, 1991).

From a theoretical or an empirical point of view, many studies analyze the linkages among national stock market indices. The empirical results usually testify to significant correlation between markets located in near geographic areas. This is frequently attributed, among others, to a number of different factors such as the relaxation of controls on capital movements and foreign exchange transactions, improvements in computer and communication technology that have lowered the cost of cross border information flows and financial transactions and expansion in the multinational operations of major corporations. This globalization of financial transaction has meant that stock markets are becoming more synchronized and the adjustment delays in international prices are increasingly shorter.

3. Literature Review

In recent years, there has been an extensive scientific interest and research on testing and measuring interdependence of stock markets (Corhay et al., 1993, and Koch and Koch, 1993). Other studies on stock markets in EU have found much evidence for high degree of integration among major European stock markets in the late ‘70s and ‘80s (Taylor and Tonks 1989, Dickinson, 2000). Little evidence for low degree of integration among several European stock markets has been found as well (Chan, et al., 1997). The relationship among major European stock markets had weakened during the period 1990-1994 (Gerrits and Yuce, 1999). Additionally, previous work has shown the lack of interdependence across national markets, supporting the benefits of international diversification (Grubel, 1968, Solnik, 1995).

Correlation between stock market returns provides an alternative to complex modeling methodology, such as time-series models, asset pricing models etc., for checking evidence of integration, mainly due to its simplicity.

Several authors have investigated the link between business cycle synchronization, country return correlations and financial integration. Erb, Harvey, and Viskanta, (1994) have found some evidence that cross-equity correlations in the G-7 countries are affected by the business cycle. The same relationship has been noticed by Ragunathan, Faff and Brooks (1999), in the specific case between U.S.A. and Australian markets. Bracker, Docking, and Koch (1999) have found a statistically significant relationship between bilateral import dependence and the degree of stock market integration.

Dumas, Harvey, and Ruiz (2000) have taken the opposite view and have calculated the theoretical degree of return correlations both under integration and segmentation, after controlling for the degree of commonality of country outputs. They have found that the assumption of market integration leads to a better

explanation of the level of observed correlations than the assumption of market segmentation.

King and Whadhawani (1990), King, Sentana and Whadhawani (1994), Karolyi and Stulz (1996), and Bekaert and Harvey (2000) investigate time-varying linkages between international stock markets and find that correlations have increased when global factors dominate domestic ones. In addition, several authors have documented that correlations are much higher when markets go simultaneously down, further reducing the insurance effect from international diversification as in Longin and Solnik (2001).

4. Available Data and Methodology

The available data used in this study consists of the daily stock index closing prices of 11 of EMU countries[1] namely, Belgium (BEL 20), Germany (DAX 30), Greece (ASE 20), Spain (IBEX 35), France (CAC 40), Ireland (ISEQ), Italy (MIB 30), the Netherlands (AEX), Austria (ATX), Portugal (PSI 20) and Finland (FOX), the three members of the EU that refused to join EMU namely, Denmark (KFX), Sweden (OMX) and the UK (FTSE 100). The inclusion of Denmark, Sweden and the UK was necessary because these countries have strong linkages with EMU member states.

The sample period starts from January 1, 1995 when the last contemporary stock index was introduced in Italy and extends up to July 27, 2004 totaling 2497 observations for each series. All data was provided by the Bank of England.

Before proceeding, it is of interest to examine the hypothesis of a stationary series for the 14 EU's available stock market indexes. In this way, the weak-form efficient market hypothesis for each of the 14 stock markets is examined. As already noticed, various tests are nowadays being applied in order to test the latter hypothesis, with most widely utilized among them the unit root tests. Specifically, the unit root test of Dickey-Fuller (*Dickey and Fuller, 1979, 1981)* is the most widely used unit root test.

Let us consider the following AR (1) process:

$$y_t = \mu + \rho y_{t-1} + \varepsilon_t$$

Where μ (constant) and ρ are parameters and variable ε_t is assumed to be white noise. Series y_t is a stationary time series if $-1<\rho<1$. If $\rho=1$, the series are non-stationary. The Dickey-Fuller (DF) Unit Root Test, tests then the null hypothesis:

$$H_0 : \rho = 1$$

vs

$$H_1 : \rho < 1$$

However, the above-described simple DF test is valid only if the series are an AR (1) process. If the series are correlated at higher order lags the assumption of white noise is violated. In order to correct this restriction, the augmented Dickey-Fuller (ADF) test makes a parametric correction for higher order correlation by assuming that the series follows an AR (ρ) process, adjusting accordingly the test methodology. The Eviews econometric software package performs the widely used test, the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) test.

[1] Luxembourg was excluded due to the lack of stock index price data. However that effect is not so big since it is the smallest stock market and is closely related to the German.

In this analysis, the ADF Unit Root Test is used in order to check the stationarity (essentially the non-stationarity) of the stock indexes for the 14 European countries. Since the series of stock indexes contain a trend it is decided to include both a constant and a trend in the regression line described above, in order to perform the unit root tests. The results from the 14 ADF Unit Root Tests are summarized in Table 4.1.

***Table 4.1*: ADF Unit Root Test Results on Stock Indexes for Each Stock Market**

Country	ADF Test Statistic	1% critical value	5% critical value	10% critical value
UK	-1.566197	-3.9672	-3.4142	-3.1289
Germany	-1.191458	-3.9672	-3.4142	-3.1289
France	-1.021715	-3.9672	-3.4142	-3.1289
Spain	-1.390643	-3.9672	-3.4142	-3.1289
Italy	-1.095407	-3.9672	-3.4142	-3.1289
Portugal	-1.087684	-3.9672	-3.4142	-3.1289
Ireland	-1.508940	-3.9672	-3.4142	-3.1289
Netherlands	-1.025832	-3.9672	-3.4142	-3.1289
Belgium	-1.471366	-3.9672	-3.4142	-3.1289
Denmark	-1.383805	-3.9672	-3.4142	-3.1289
Finland	-1.337519	-3.9672	-3.4142	-3.1289
Austria	-0.195072	-3.9672	-3.4142	-3.1289
Sweden	-1.234804	-3.9672	-3.4142	-3.1289
Greece	-1.037013	-3.9672	-3.4142	-3.1289

The null hypothesis of a unit root (i.e. non-stationarity of the series) is rejected against the one-sided alternative if the t-statistic (ADF test statistic) shown in column 2 is less than (lies to the left of) the critical values (in Table 4.1 critical values for 1%, 5% and 10% significance level are also shown). As we observe, all ADF statistics are greater than the 1%, 5% and 10% critical values, indicating that we have no reason to reject the null hypothesis of the test.

Having concluded that the daily stock indexes are not stationary series for each country, and in order to investigate the degree of integration of the European stock markets after EMU, a new series of first differences of stock indexes for each country for the purpose of this research it is used, defined as:

$$\mathrm{Re}\,turn_t = 100 * \left[\ln(Index_t) - \ln(Index_{t-1})\right]$$

Hence, the returns series are formed taking first differences of the logarithm of series indexes, multiplied by 100. Summary statistics are presented for the returns series for the 14 European countries in Table 4.2.

Columns 2-5 of Table 4.2 present the average daily return for each country, the standard deviation, skewness and kurtosis. A first look at the returns characteristics reveals that the distribution of the returns is almost symmetric, with skewness around zero, with a negative sign for almost all returns (except Belgium and Sweden). The large positive kurtosis (especially for Portugal, Belgium, Finland and Austria) indicates that the observations cluster more and have longer tails than those in the normal distribution. In order to verify the deviation from normality indicated from the Kurtosis statistics, columns 6-7 present the Jarque-Bera test statistic for normality in stock returns and the associated p-value of the test. Additionally, the last

two columns show the results of another normality test, namely the Kolmogorov-Smirnov test statistic and the associated p-value. As it is observed, both tests reject the null hypothesis of the normality distribution for the returns for all countries at a 1% significance level (p-value<0.01).

Now, once again ADF Unit Root Test is utilized in order to verify that the transformed time series (stock returns) are stationary series. Since the series of returns fluctuate around zero, and do not exhibit any obvious trend, only a constant term in the regression line is included.

Table 4.2: Summary Statistics of Stock Returns: Daily Data 2/1/1995-26/7/2004

Countries	Average return	Std. Dev.	Kurtosis	Skewness	Jarque-Bera	p-value	Kolmogorov-Smirnov	p-value
UK	0,0138	1,1377	2,6910	-0,1669	760,36	0,00	2,90	0,00
Germany	0,0243	1,6097	2,7773	-0,2273	819,06	0,00	3,42	0,00
France	0,0256	1,4544	2,3806	-0,0814	588,62	0,00	2,52	0,00
Spain	0,0373	1,4185	2,4706	-0,1858	645,39	0,00	2,67	0,00
Italy	0,0248	1,4739	2,3188	-0,0736	588,03	0,00	2,39	0,00
Portugal	0,0331	0,9699	7,2617	-0,5656	5.591,6	0,00	4,59	0,00
Ireland	0,0419	1,0264	4,6553	-0,4962	2.344,9	0,00	3,74	0,00
Netherlands	0,0216	1,5107	3,7458	-0,0984	1.455,5	0,00	3,40	0,00
Belgium	0,0226	1,1553	5,1203	0,2528	2.739,7	0,00	3,90	0,00
Denmark	0,0404	1,1161	2,3545	-0,2780	605,17	0,00	3,18	0,00
Finland	0,0419	2,1714	5,8720	-0,4431	3.650,2	0,00	3,61	0,00
Austria	0,0259	1,0041	5,3185	-0,6942	3.127,6	0,00	3,19	0,00
Sweden	0,0341	1,5767	2,9592	0,1105	910,66	0,00	2,36	0,00
Greece	0,0397	1,6634	3,8996	-0,0478	1.574,2	0,00	4,07	0,00

The Augmented Dickey-Fuller (ADF) unit root test for the new series of first differences of the stock indexes performed by the E-views package are presented in Table 4.3.

Table 4.3: ***ADF Unit Root Test Results on Stock Returns for Each Stock Market***

Country	ADF Test Statistic	1% critical Value	5% critical value	10% critical value
UK	-49.73786	-2.5666	-1.9395	-1.6157
Germany	-50.96147	-2.5666	-1.9395	-1.6157
France	-49.43468	-2.5666	-1.9395	-1.6157
Spain	-48.37762	-2.5666	-1.9395	-1.6157
Italy	-50.33695	-2.5666	-1.9395	-1.6157
Portugal	-43.52468	-2.5666	-1.9395	-1.6157
Ireland	-45.53540	-2.5666	-1.9395	-1.6157
Netherlands	-49.35989	-2.5666	-1.9395	-1.6157
Belgium	-43.33697	-2.5666	-1.9395	-1.6157
Denmark	-47.56042	-2.5666	-1.9395	-1.6157

Finland	-49.42846	-2.5666	-1.9395	-1.6157
Austria	-47.96936	-2.5666	-1.9395	-1.6157
Sweden	-49.28503	-2.5666	-1.9395	-1.6157
Greece	-42.62519	-2.5666	-1.9395	-1.6157

The results of the ADF test statistic values are all less than the corresponding critical values, indicating that the null hypotheses of unit roots in the first differences of the stock prices (i.e. stock returns) are rejected at a 1% significance level, suggesting that the stock returns are stationary.

5. Stock Market Returns Correlations

As already noted, the establishment of EMU and the introduction of the euro directly removed a number of existing barriers between the European countries joining the EMU, and therefore, it is likely for one to expect that co-integration between the European countries from the specific time period and on is quite possible to increase. Examining the correlations between stock market returns provides an alternative to complex modeling methodology for checking evidence of integration, mainly due to its simplicity.

Table 5.4 presents simple Pearson's correlations for the period between 02/01/1995 and 26/07/2004 that is the correlations covering the sample period. The last two rows of Table 5.4 present average stock return correlations and the associated standard deviations. Accordingly, Tables 5.5 and 5.6 display Pearson's correlation coefficients for the two sub-periods that is the period before EMU (sample period 02/01/1995 - 31/12/1998) and the period after EMU (sample period 02/01/1999 - 26/07/2004), respectively. For the case of Greece the first period is 02/01/1995 – 31/12/2000 and the second 02/01/2001 – 26/07/2004.

A significant increase in the correlation coefficients of a country's stock returns between period 1 (before EMU) and period 2 (after EMU) would imply that the specific stock market has become more integrated contemporaneously in the second period. In Table 5.7 the comparisons of the average correlations of the two sub-periods are shown. Differences of the average correlations show that average correlations of returns have been increased in the period after the establishment of EMU in seven cases and have been decreased in seven. This is not a clear indication of a change in the degree of integration in the stock markets under consideration. Furthermore in order to verify if the average stock returns correlations differ statistically significantly between the two sub-periods (before and after EMU) the t-test for equality of means is utilized. The results of the 14 in total t-tests are reported in Table 5.8. The null hypothesis $H_0 : av1 - av2 = 0$ is tested against the alternative $H_0 : av1 - av2 \neq 0$. P-values of the tests indicate that differences in the average correlations between the two sub-periods are statistically significant, at a 5% significance level in six cases (p-value<0.05).

Based on this statistical result the conclusion is that three of the stock markets, France, Spain and Italy became more integrated in period 2 and three markets, Ireland, Denmark and Austria, became less integrated in the same period. For the remaining stock markets there is not clear indication of any change since the paired sample t-test has failed to support any change in the degree of integration.

Table 5.4: Correlations for the EU Member States (Returns, sample period 02/01/1995 - 26/07/2004)

	UK	*Germany*	*France*	*Spain*	*Italy*	*Portugal*	*Ireland*	*Netherlands*	*Belgium*	*Denmark*	*Finland*	*Austria*	*Sweden*	*Greece*
UK	1													
Germany	0,712	1												
France	0,795	0,787	1											
Spain	0,704	0,712	0,794	1										
Italy	0,688	0,688	0,770	0,743	1									
Portugal	0,503	0,536	0,568	0,606	0,526	1								
Ireland	0,572	0,514	0,533	0,481	0,473	0,419	1							
Netherlands	0,792	0,793	0,841	0,757	0,718	0,553	0,566	1						
Belgium	0,663	0,664	0,707	0,625	0,596	0,452	0,502	0,771	1					
Denmark	0,548	0,556	0,575	0,554	0,514	0,467	0,482	0,603	0,512	1				
Finland	0,582	0,585	0,627	0,580	0,536	0,493	0,461	0,627	0,450	0,506	1			
Austria	0,417	0,473	0,437	0,447	0,407	0,405	0,416	0,453	0,427	0,403	0,355	1		
Sweden	0,694	0,683	0,741	0,678	0,649	0,527	0,499	0,717	0,567	0,573	0,711	0,405	1	
Greece	0,253	0,261	0,256	0,269	0,234	0,267	0,266	0,290	0,258	0,261	0,258	0,206	0,254	1
Average	0,610	0,613	0,649	0,612	0,580	0,486	0,476	0,652	0,554	0,504	0,521	0,404	0,592	0,256
StDeviation	0,011	0,016	0,015	0,014	0,015	0,010	0,010	0,015	0,012	0,011	0,022	0,010	0,016	0,017

Table 5.5: Correlations for the EU Member States (Returns, sample period 02/01/1995 - 31/12/1998)

	UK	*Germany*	*France*	*Spain*	*Italy*	*Portugal*	*Ireland*	*Netherlands*	*Belgium*	*Denmark*	*Finland*	*Austria*	*Sweden*	*Greece**
UK	1													
Germany	0,647	1												
France	0,715	0,661	1											
Spain	0,642	0,633	0,703	1										
Italy	0,607	0,545	0,663	0,649	1									
Portugal	0,503	0,567	0,547	0,587	0,505	1								
Ireland	0,594	0,606	0,526	0,485	0,477	0,480	1							
Netherlands	0,732	0,743	0,712	0,677	0,609	0,589	0,585	1						
Belgium	0,659	0,684	0,663	0,616	0,568	0,547	0,546	0,742	1					
Denmark	0,581	0,646	0,540	0,567	0,529	0,515	0,531	0,632	0,558	1				
Finland	0,606	0,664	0,586	0,547	0,525	0,499	0,580	0,661	0,610	0,597	1			
Austria	0,529	0,677	0,536	0,536	0,477	0,516	0,559	0,588	0,562	0,521	0,549	1		
Sweden	0,685	0,642	0,686	0,627	0,585	0,513	0,535	0,698	0,625	0,560	0,711	0,505	1	
Greece	0,239	0,253	0,226	0,264	0,206	0,300	0,288	0,278	0,273	0,250	0,264	0,233	0,242	1
Average 1	0,595	0,613	0,597	0,579	0,534	0,513	0,522	0,634	0,589	0,541	0,569	0,522	0,614	0,255
StDeviation	0,009	0,013	0,012	0,013	0,015	0,010	0,009	0,012	0,009	0,010	0,015	0,011	0,013	0,016

*Period 02/01/1995-31/12/2000

Table 5.6: Correlations for the EU Member States (Returns, sample period 02/01/1999 – 26/07/2004)

	UK	*Germany*	*France*	*Spain*	*Italy*	*Portugal*	*Ireland*	*Netherlands*	*Belgium*	*Denmark*	*Finland*	*Austria*	*Sweden*	*Greece**
UK	1													
Germany	0,735	1												
France	0,828	0,839	1											
Spain	0,736	0,752	0,841	1										
Italy	0,751	0,785	0,848	0,811	1									
Portugal	0,515	0,530	0,588	0,620	0,541	1								
Ireland	0,564	0,475	0,535	0,477	0,475	0,384	1							
Netherlands	0,815	0,812	0,895	0,797	0,797	0,543	0,557	1						
Belgium	0,664	0,657	0,726	0,633	0,629	0,412	0,484	0,781	1					
Denmark	0,535	0,518	0,590	0,547	0,513	0,443	0,458	0,591	0,494	1				
Finland	0,577	0,562	0,647	0,604	0,570	0,513	0,425	0,619	0,402	0,480	1			
Austria	0,373	0,369	0,388	0,393	0,343	0,309	0,326	0,391	0,372	0,337	0,287	1		
Sweden	0,698	0,700	0,765	0,703	0,699	0,542	0,482	0,725	0,544	0,578	0,716	0,357	1	
Greece	0,263	0,268	0,274	0,271	0,253	0,240	0,253	0,299	0,253	0,267	0,263	0,187	0,263	1
Average 2	0,619	0,616	0,674	0,630	0,617	0,475	0,454	0,663	0,542	0,489	0,513	0,341	0,598	0,258
StDeviation	0,013	0,018	0,016	0,015	0,014	0,010	0,011	0,017	0,013	0,012	0,025	0,009	0,017	0,017

*Period 02/01/2001-26/07/2004

Table 5.7: Correlations Comparisons in the two Sub-Samples

Average 1	0,595	0,613	0,597	0,579	0,534	0,513	0,522	0,634	0,589	0,541	0,569	0,522	0,614	0,255
StDeviation	0,009	0,013	0,012	0,013	0,015	0,010	0,009	0,012	0,009	0,010	0,015	0,011	0,013	0,016
Variance	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Average 2	0,619	0,616	0,674	0,630	0,617	0,475	0,454	0,663	0,542	0,489	0,513	0,341	0,598	0,258
StDeviation	0,013	0,018	0,016	0,015	0,014	0,010	0,011	0,017	0,013	0,012	0,025	0,009	0,017	0,017
Variance	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000
Dif. Av2-Av1	0,024	0,003	0,077	0,050	0,082	-0,038	-0,069	0,029	-0,046	-0,052	-0,056	-0,181	-0,016	0,003

paired sample t-test

Table 5.8: Hypothesis Testing about the Difference in the two Averages (Av1-Av2)

Av1-Av2	-0,024	-0,003	-0,077	-0,050	-0,082	0,038	0,069	-0,029	0,046	0,052	0,056	0,181	0,016	-0,003
StD Av1-Av2	0,081	0,147	0,090	0,082	0,103	0,076	0,069	0,105	0,089	0,065	0,104	0,065	0,071	0,034
t-test	-1,078	-0,062	-3,098	-2,198	-2,888	1,778	3,579	-0,993	1,878	2,881	1,950	10,016	-0,623	-0,315
p-value	0,302	0,952	0,009	0,048	0,014	0,101	0,004	0,341	0,085	0,014	0,075	0,000	0,545	0,759

(*) Av1-Av2 is statistically significant different from zero at a 5% significance level since p-value < 0.05

6. Conclusions

Apparently the establishment of the EMU and the introduction of the common currency do not have the same effects on the European stock markets. In three cases the stock market return correlations have increased and in other three have decreased. These results can be attributed to the EMU at least partially. The establishment of EMU was not the only reason for a change in the degree of integration in the European stock markets. The members of the EMU were at different points of readiness when the final decision had been taken. Before the EMU many countries in the EU were already taking part in other kind of integration initiatives (Taylor and Tonks, 1989). The German and the Austrian markets started an integration process through the DM before the euro while the Italian market, with a great weight of listed foreign companies, was already internationalized. All these unique characteristics of the stock markets make it impossible to clarify the effect of the EMU to all European stock markets (Yang, et al., 2003, Noia, 2001).

Other factors that have influenced the stock market return correlations during the recent years are the relaxation of controls on capital movements and foreign exchange transactions and generally the deregulation and market liberalization, major improvements in computer and communication technology that have lowered the cost of cross border information flows and financial transactions and the expansion in the multinational operations of major corporations (Bracker, et al., 1999, Chan,et al., 1997). These developments are clearly part of the globalization of the financial transactions and the higher synchronization of the stock markets while they are not clearly identified in an empirical study of this type.

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