Is there a euro area identity within international stock market volatilities?

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Abstract: Previous studies have investigated the comovements of international equity returns by using mean correlations, cointegration, common factor analysis, and other approaches. This paper investigates the evolution of the affinity among major euro and non-euro area stock markets in the period 1966-2006 by using distance-based methods for clustering analysis of time series. A periodogram-based metric for mean and squared returns is used to compute distances between the series. This method solves the shortcoming of unequal sample sizes found for different countries. Then, by using dendrogram and multimidensional scaling techniques based on the computed distances, we display clusters for the series of returns and volatilities. The data were divided into two sample periods: previous and subsequent to the introduction of the euro as an electronic currency. For market returns, euro-area countries do not seem to come closer after the introduction of the euro. There is some identity that is maintained after 1998. For squared returns, we found a clear change with the introduction of the euro. Up to 1998, there is a weak linkage among euro area countries. After 1998, the euro area stock markets volatilities have become considerably more homogeneous. For reference, we explored also the correlations among the series. We found that some stock markets within the European Monetary Union are strongly correlated in returns and in squared returns, and that some euro and non-euro area markets are not correlated in returns, but are weakly correlated in squared returns.

Keywords: Cluster analysis; Euro area; International stock markets; Returns and squared returns; Periodogram; Volatility.

1. Introduction

The volatility pattern often seen in financial time series has increased the interest of researchers in identifying dependences in stock-market indices and returns. Cross-countries stock returns correlation has been extensively studied in the economic and financial literature for portfolio diversification and risk management purposes (see Agmon, 1972, Lin, Engle and Ito, 1994, Longin and Solnik, 1995, Karolyi and Stulz, 1996, Mei and Ammer, 1996, Ramchmand and Susmel, 1998, Ball and Torous, 2000, Yang, Tapon and Sun, 2006, and Morana and Beltratti, 2006). Many studies have found small international stock-markets correlations in periods of low volatility (small absolute returns), and much higher correlations in periods of high volatility (large absolute returns). In contrast, other studies such as Longin and Solnik (2001) suggested that high correlations between international stock markets may be not related to high volatilities but to the market trend.

International equity markets comovements and euro area market integration have been also widely studied using vector error correction and cointegration approaches (see Arshanapalli and Doukas, 1993, Bessler and Yang, 2003, Syriopoulos, 2004, Tahai, Rutledge and Karim, 2004, Voronkova, 2004 and Rita and Costantini, 2006), factor model approaches (see Engle and Susmel, 1993, and Hui, 2005). For a review of measures of equity market integration in the euro area, see the survey by Baele, Ferrando, Hördahl, Krylova and Monnet (2004). However, the identification of similarities or dissimilarities in international stock returns seems not to be enough explored in the empirical financial literature using cluster analysis. The general problem in clustering of financial time series is concerned with the separation of a set of asset return series into groups, or clusters, with the property that series in the same group have similar stochastic dependence structure and series in other groups are quite distinct.

In this paper, we examine the degree of similarity in the major euro and non-euro area stock markets using clustering techniques for financial time series. The clusters of countries are formed by looking to the dendrogram and the principal coordinates associated with the log normalized periodogram ordinates for the returns and squared returns. Our purpose is to investigate whether the structure of stock markets comovements change over time from before to after the introduction of the euro. In addressing this issue we attempt to analyze some important questions: 1) Is there a financial integration in the euro area markets?; 2) Which stock markets and countries have become more integrated?; 3) What is the degree of affinity among euro and non-euro area financial markets?; 4) Is the cross-country homogeneity similar for returns and squared returns?

The remainder of the paper is organized as follows. Section 2 presents the nonparametric distance-based methods for time series classification. Section 3 describes the data set used in this paper. Section 4 presents the cluster analysis evidence for the empirical results. Section 5 explores correlations for returns and squared returns. Conclusions are summarized in the final section.

2. Diatance measures for financial time series

To perform cluster analysis of time series, we have to define a relevant measure of distance between the time series in a data set. If we are interested in grouping stock returns with similar second-order moments, a natural extension of previous distance methods would be the use of the information about the squared returns. The idea behind the analysis of squared returns is the same as the analysis of the return volatilities.

The following nonparametric approach is based on the autocorrelations of the squared returns. Let $R = (r_{t,1}, \ldots, r_{t,k})'$, $t = 1, 2, ..., n$ be a vector of k return series, where $r_t = \log P_t - \log\, P_{t-1}$ is the difference of log prices, and let $\widehat{\rho}_i^{(SR)} = (\widehat{\rho}_{i,1}^{(SR)}, \ldots, \widehat{\rho}_{i,m}^{(SR)})$ be the sample autocorrelations of the squared return series i for some m such that $\widehat{\rho}_{i,m}^{(SR)} \cong 0$ for $m < n$. A distance between two return series $r_{t,x}$ and $r_{t,y}$ can be defined as the Euclidean distance between the autocorrelation functions (Galeano and Peña, 2000) of the squared returns (ACFSR metric),

$$d_{ACFSR}(x, y) = \sqrt{\sum_{j=1}^{m} \left(\widehat{\rho}_{x,j}^{(SR)} - \widehat{\rho}_{y,j}^{(SR)} \right)^2}. \tag{1}$$

Alternatively, we may use a distance measure with some weights decaying with the autocorrelation lag, as suggested by Caiado, Crato and Peña (2006). Another useful method is based on the Euclidean distance between the log normalized periodogram ordinates (Caiado, Crato and Peña, 2006) of the squared returns (LNPSR metric),

$$d_{LNPSR}(x, y) = \sqrt{\sum_{j=1}^{[n/2]} \left[\log NP_x^{(SR)}(\omega_j) - \log NP_y^{(SR)}(\omega_j) \right]^2}, \tag{2}$$

where $NP_x^{(SR)}(\omega_j) = P_x^{(SR)}(\omega_j)/\widehat{\gamma}_0$ is the normalized periodogram of return series $r_{t,x}$, $P_x^{(SR)}(\omega_j) = n^{-1}|\sum_{t=1}^{n} r_{t,x} e^{-it\omega_j}|^2$ is the periodogram at frequencies $\omega_j = 2\pi j/n$, $j = 1, ..., [n/2]$ (with $[n/2]$ the largest integer less or equal to $n/2$) in the range 0 to π, and $\widehat{\gamma}_0$ is the sample variance. Similar expression is defined for $NP_y^{(SR)}(\omega_j)$. The periodogram is a useful tool to describe the cyclical behavior of an observed time series. It is common practice to scale the periodogram, dividing by the sample variance so that it captures only the autocorrelation structure. The advantages of above measures over other distance-based methods are that they convey all the stochastic structure of the processes and they are easy to implement and computational fast.

For two return series $\{x_t, t = 1, ..., n_x\}$ and $\{y_t, t = 1, ..., n_y\}$ with unequal sizes $n_x \neq n_y$, we can use the periodogram interpolation method proposed by Caiado, Crato and Peña (2007). This method consist of a linear interpolation of the individual periodogram ordinates at Fourier frequencies so that we estimate the periodogram ordinates of the squared return series with longer (shorter) length from the squared return series with the shorter (longer) length. Let $r = [p\frac{m_x}{m_y}]$ be the largest integer less or equal to $p\frac{m_x}{m_y}$ for $p = 1, ..., m_y$, and $m_y < m_x$. The interpolated periodogram ordinates of x_t are given by the expression

$$P_x'^{(SR)}(\omega_p) = P_x^{(SR)}(\omega_r) + \left(P_x^{(SR)}(\omega_{r+1}) - P_x^{(SR)}(\omega_r) \right) \times \frac{\omega_{p,y} - \omega_{r,x}}{\omega_{r+1,x} - \omega_{r,x}}. \tag{3}$$

We then use the following the distance measure between the log normalized periodogram ordinates of the two series (ILNPSR metric),

$$d_{ILNPSR}(x, y) = \sqrt{\sum_{p=1}^{m_y} \left[\log NP_x'^{(SR)}(\omega_p) - \log NP_y^{(SR)}(\omega_p) \right]^2}, \tag{4}$$

where $NP_x'^{(SR)}(\omega_p)$ is the interpolated normalized periodogram of the series with longer length and $NP_y^{(SR)}(\omega_p)$ is the normalized periodogram of the series with shorter length. This approach could be quite useful since the usual metrics based on the Euclidean distances and pairwise correlations cannot be used for comparison of financial time series with unequal length.

3. Data description

We consider data of daily index returns for 27 international stock markets: Brazil, Argentina, and Mexico (Middle and South America), United States and Canada (North America); India, Hong-Kong, Indonesia, Malaysia, Korea, Japan, Singapore, Taiwan, and Australia (Asia and Pacific); Netherlands, Austria, Belgium, France, Germany, United Kingdom, Spain, Italy, Sweden, Norway, and Switzerland (Europe); and Egypt and Israel (Middle East). These data, reported in Table 1, were obtained from Yahoo Finance (http://finance.yahoo.com) and correspond to close prices adjusted for dividends and splits.

Table 2 reports summary statistics (mean, standard deviations, skewness, and kurtosis coefficients, and Ljung-Box test for the k-th autocorrelations) of the indices returns for the whole sample periods. We found negative skewness coefficients for all markets except Netherlands, Belgium, Argentina, United States, and Taiwan, which show small positive skewness coefficients. The return series for all the markets are highly leptokurtic except Brazil, Japan, and Taiwan, which have moderate (less than 5) excess of kurtosis. There are significant autocorrelations up to order 20 in the returns for all markets but Norway, Israel, and Taiwan, which do not reject the null hypothesis of no autocorrelation at the 5% significance level.

4. Clusters analysis

To investigate the affinity among stock markets, we perform a cluster analysis of the time series of daily stock-market indices using all available data in the sample periods 1966-1998 (for all countries except Canada, Italy, Sweden, Norway, Egypt and Israel) and 1999-2006 with the introduction of the euro (for all countries).

For each data set, we compute a distance matrix with $k(k-1)/2$ different pairs (where k is the number of countries) using the interpolated-periodogram based method for returns and squared returns. We group the time series using the hierarchical clustering tree (or dendrogram) by complete linkage method (see for instance, Johnson and Wichern, 1992) which minimizes the maximum distance between time series features in the same group in such a way that series in the same group are similar to one another and series in different groups are as distinct as possible. We consider also the useful technique of multidimensional scaling, or principal coordinates analysis, which creates a configuration of k points in a map of p dimensions (in this case, two dimensions) with the Euclidean distances among stock markets using the information about the time series features.

Table 1
Daily indices of international stock markets

Stock market	Country	Code	Period	Sample size
Americas				
New York Stock Exchange	United States	US	31:12:65 - 04:10:06	10259
TXS Venture Exchange	Canada	CAN	03:01:00 - 04:10:06	1716
Sao Paolo Stock Exchange	Brazil	BRA	27:04:93 - 04:10:06	3329
Buenos Aires Stock Exchange	Argentina	ARG	08:10:96 - 04:10:06	2473
Mexico Stock Exchange	Mexico	MEX	08:11:91 - 04:10:06	3721
Asia/Pacific				
Bombay Stock Exchange	India	IND	01:07:97 - 04:10:06	2293
Hong Kong Stock Exchange	Hong-Kong	HK	31:12:87 - 04:10:06	4890
Jakarta Stock Exchange	Indonesia	INDO	01:07:97 - 04:10:06	2233
Kuala Lumpur Stock Exchange	Malaysia	MAL	03:12:93 - 04:10:06	3165
Korea Stock Exchange	Korea	KOR	01:07:97 - 04:10:06	2277
Japan Stock Exchange	Japan	JAP	04:01:84 - 04:10:06	5602
Singapore Stock Exchange	Singapore	SING	28:12:87 - 04:10:06	4692
Taiwan Stock Exchange	Taiwan	TAI	02:07:97 - 04:10:06	2277
Australian Stock Exchange	Australia	AUST	03:08:84 - 04:10:06	5607
Europe				
Amsterdam Stock Exchange	Netherlands	NET	12:10:92 - 04:10:06	3557
Vienna Stock Exchange	Austria	AUS	11:11:92 - 04:10:06	3437
Brussels Stock Exchange	Belgium	BEL	09:04:91 - 04:10:06	3899
Paris Stock Exchange	France	FRA	01:03:90 - 04:10:06	4185
Xetra Stock Exchange	Germany	GER	26:11:90 - 04:10:06	4000
London Stock Exchange	United Kingdom	UK	02:04:84 - 04:10:06	5687
Madrid Stock Exchange	Spain	SPA	05:07:93 - 04:10:06	3321
Milan Stock Exchange	Italy	ITA	03:01:00 - 04:10:06	1752
Stockholm Stock Exchange	Sweden	SWE	08:01:01 - 04:10:06	1452
Oslo Stock Exchange	Norway	NOR	07:02:01 - 04:10:06	1429
Swiss Stock Exchange	Switzerland	SWI	09:11:90 - 04:10:06	4001
Middle East				
Egypt Stock Exchange	Egypt	EGY	02:07:97 - 04:10:06	1815
Tel Aviv Stock Exchange	Israel	ISR	01:07:97 - 04:10:06	1853

Table 2
Summary statistics for international stock-market returns

Market	Mean×100	Std.dev.×100	Skewness	Kurtosis	$Q(20)$	Size
Americas						
United States	0.006	0.43	0.04	5.54	170.9*	10258
Canada	0.007	0.38	-0.60	7.35	31.8**	1715
Brazil	0.028	0.78	-0.19	3.83	142.7*	3328
Argentina	0.043	1.02	0.19	7.43	39.1*	2472
Mexico	0.037	0.53	-0.12	5.53	81.6*	3721
Asia/Pacific						
India	0.033	0.62	-0.69	8.75	70.4*	2292
Hong-Kong	0.005	0.51	-0.30	6.76	90.3*	4889
Indonesia	0.039	0.58	-0.67	8.15	109.2*	2232
Malaysia	0.009	0.35	-0.62	10.96	76.5*	3164
Korea	0.028	0.72	-0.46	6.66	49.2*	2276
Japan	0.002	0.62	-0.06	4.40	41.1*	5601
Singapore	0.009	0.45	-0.37	7.47	109.8*	4691
Taiwan	0.011	0.64	0.01	4.72	28.5	2276
Australia	0.014	0.29	-0.59	6.98	185.9*	5606
Europe						
Netherlands	-0.006	0.69	0.03	7.14	88.2*	3556
Austria	0.038	0.42	-0.83	8.50	67.0*	3436
Belgium	0.010	0.52	0.27	9.26	135.8*	3898
France	-0.001	0.63	-0.04	6.40	46.5*	4184
Germany	-0.000	0.72	-0.03	5.65	45.6*	3999
United Kingdom	-0.000	0.50	-0.15	6.54	69.6*	5686
Spain	0.008	0.57	-0.01	5.32	50.5*	3320
Italy	-0.000	0.53	-0.24	8.06	40.3*	1751
Sweden	0.005	0.59	-0.09	6.45	39.7*	1451
Norway	0.023	0.52	-0.48	6.66	19.0	1428
Switzerland	0.002	0.54	-0.01	7.27	59.7*	4000
Middle East						
Egypt	0.047	0.45	-0.19	13.80	134.9*	1814
Israel	0.024	0.62	-0.23	5.69	30.5	1852

* (**) Significant at the 1% (5%) level; $Q(20)$ is the Ljung-Box statistic with 20 lags.

4.1. Sample period 1966-1998

Figure 1 shows the maps of distances across stock markets using the interpolated periodogram method. For returns, we appear to have all the markets nearly at the same first coordinate except Mexico. Looking at the second coordinate, we found that the major euro area and non-euro area European markets are close together, and Asian/Pacific markets are at the same location with exception of Singapore. For squared returns, the cross-country groups seem not to be homogenuos with respect to the economic zone.

Figure 2 represents the dendrograms for the stock markets by complete linkage algorithm from which the clusters of markets can be identified. The interpolated periodogram method for returns can split the indices returns into two very reasonably clusters: Cluster 1 = (IND, HK, BRA, KOR, TAI, AUST, GER, MAL), Cluster 2 = (NET, BEL, AUS, SPA, FRA, SWI, US, JAP, ARG, INDO), and separate from the others and from each other MEX and SING. Cluster 1 includes two of the major European markets (Germany and United Kingdom), most of Asian/Pacific countries (India, Hong-Kong, Korea, Taiwan, Australia and Malaysia) and Brazil. Cluster 2 includes five euro area markets (Netherlands, Belgium, Austria, Spain and France), United States, Argentina, Japan and Indonesia. Mexico and Singapore were not grouped.

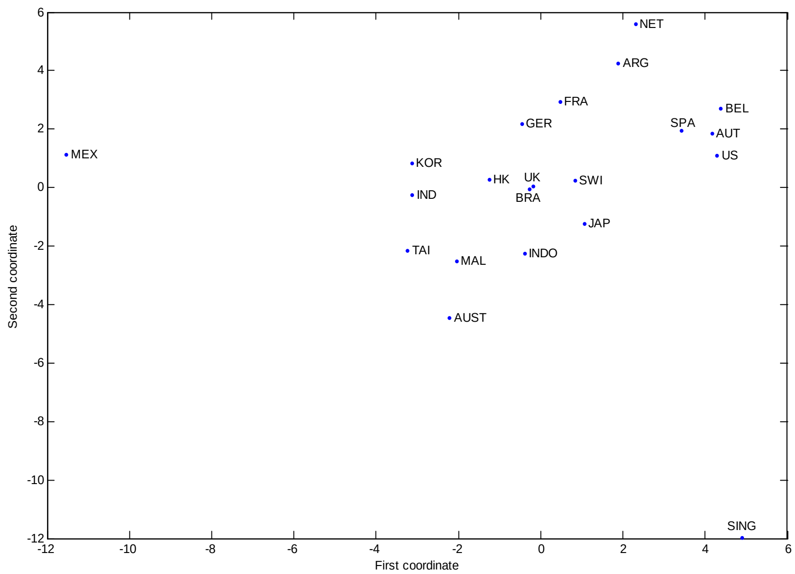
The clustering tree for squared returns yields three clusters: Cluster 1 includes the European countries Netherlands, Germany and Switzerland, the Asian/Pacific countries Australia, Hong-Kong and Korea, United States and Brazil. Cluster 2 includes the European countries Belgium, France and United Kingdom, the Asian/Pacific countries Taiwan, Japan and Indonesia, and Mexico. Cluster 3 includes the European countries Austria and Spain, the Asian/Pacific countries Malaysia and Singapore, and Argentina.

4.2. Sample period 1999-2006

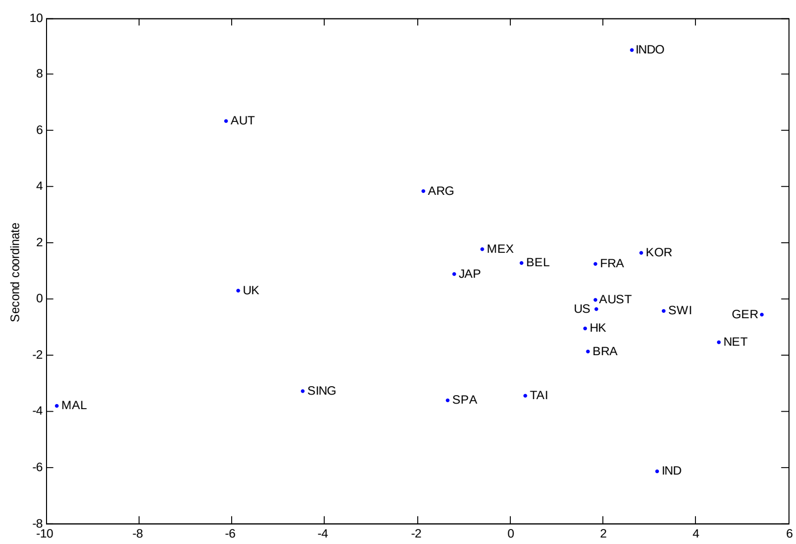
Figure 3 focus on the principal coordinates approach associated with the log normalized periodogram ordinates in the period from 1999 to 2006. For the mean return series, we found that the euro area countries France, Netherlands, Belgium and Germany and the non-euro markets Switzerland, United Kingdom and U.S. are very close together in the same homogeneous cluster. The South/Middle American, the Asian/Pacific and the Middle East markets tend to cluster together. Norway market is a clear outlier. The second map suggests that the euro area countries become more homogenous in squared returns since the beginning of third stage of the European Monetary Union (EMU). We appear to have all the euro area stock markets (except Italy and Austria), Sweden, Switzerland, United Kingdom and U.S. at the same location, and most Asian/Pacific markets in the same distinct cluster. Norway and Italy form separate clusters. Similar patterns are found in the dendrograms presented in Figure 4.

5. Mean and squared correlation analysis

For reference, the problem of identification of similarities among stock markets is also analyzed by mean and squared correlation approach. The data set used in the empirical study cover the sample period 2001-2006 for a total of 293 weekly return observations for euro area markets Netherlands, Austria, Belgium, France, Germany, Spain, and Italy, and non-euro area markets United Kingdom, Sweden, Norway, Switzerland, United States, Canada, Australia and Japan.

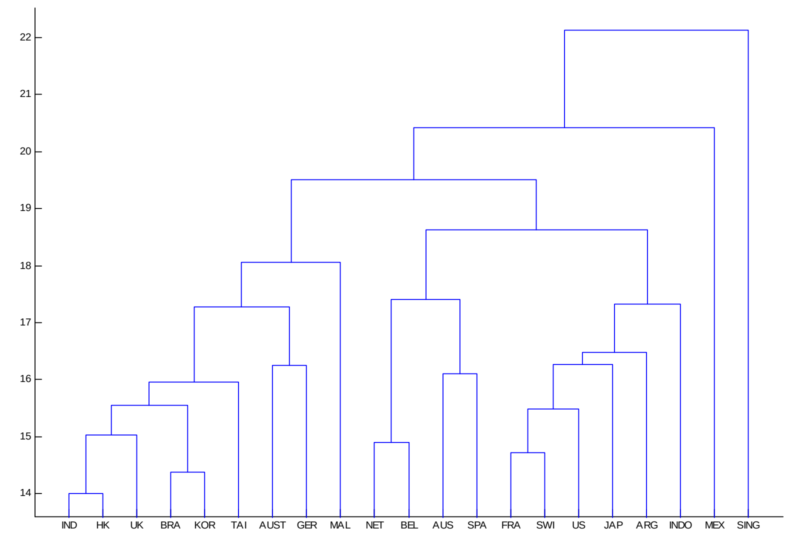


(a) Returns

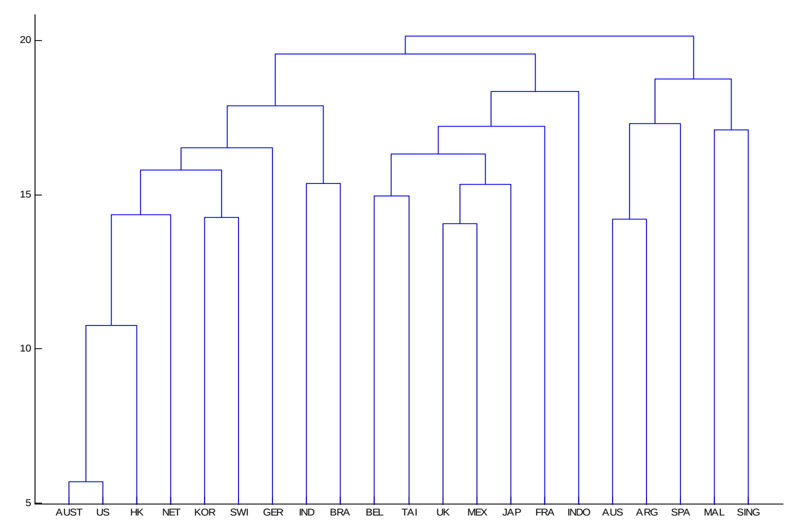


(b) Squared returns

Figure 1. Maps of international stock markets in the sample period 1966-1998

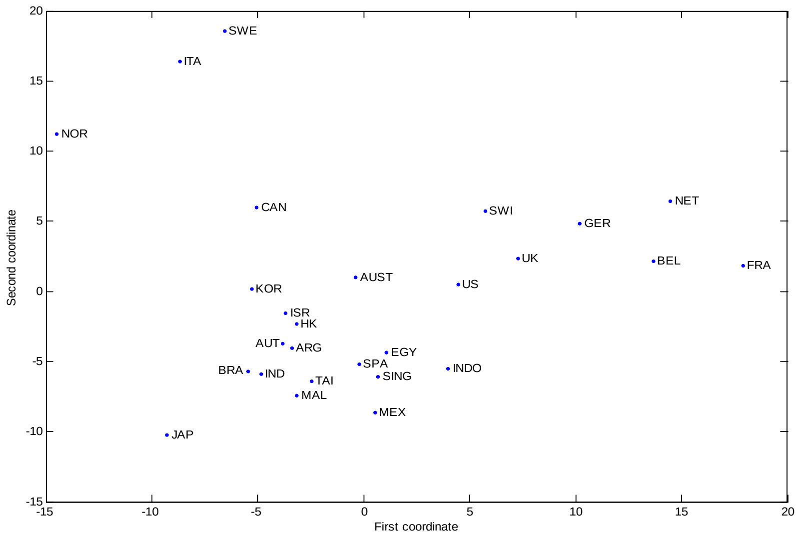


(a) Returns

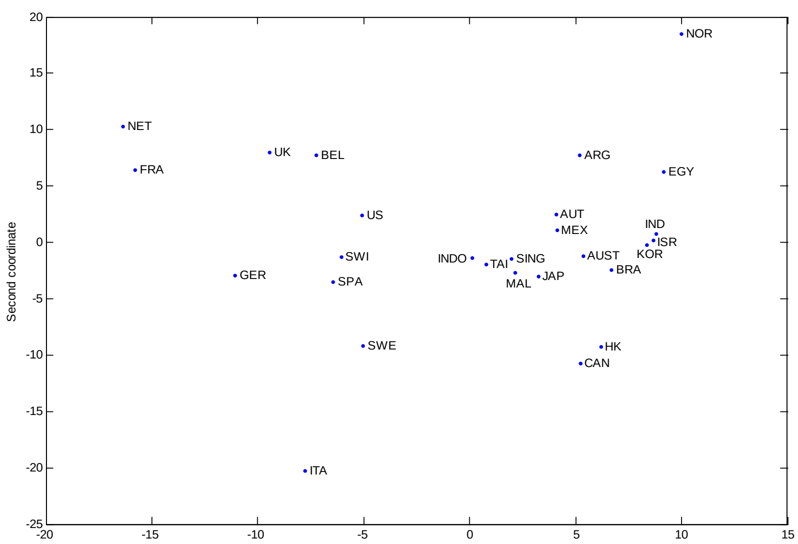


(b) Squared returns

Figure 2. Dendrograms of international stock markets in the sample period 1966-1998

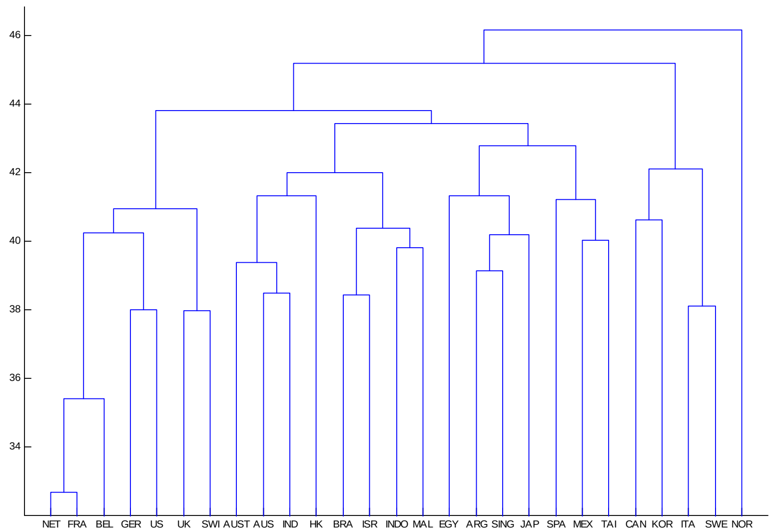


(a) Returns

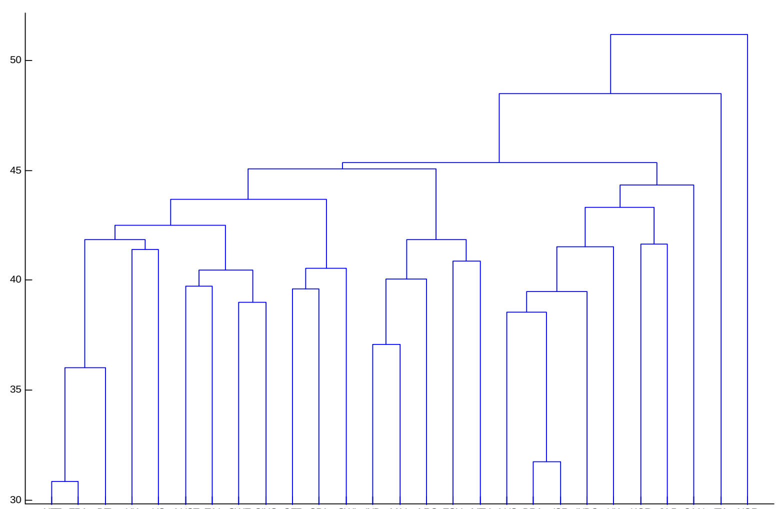


(b) Squared returns

Figure 3. Maps of international stock markets in the sample period 1999-2006



(a) Returns



(b) Squared returns

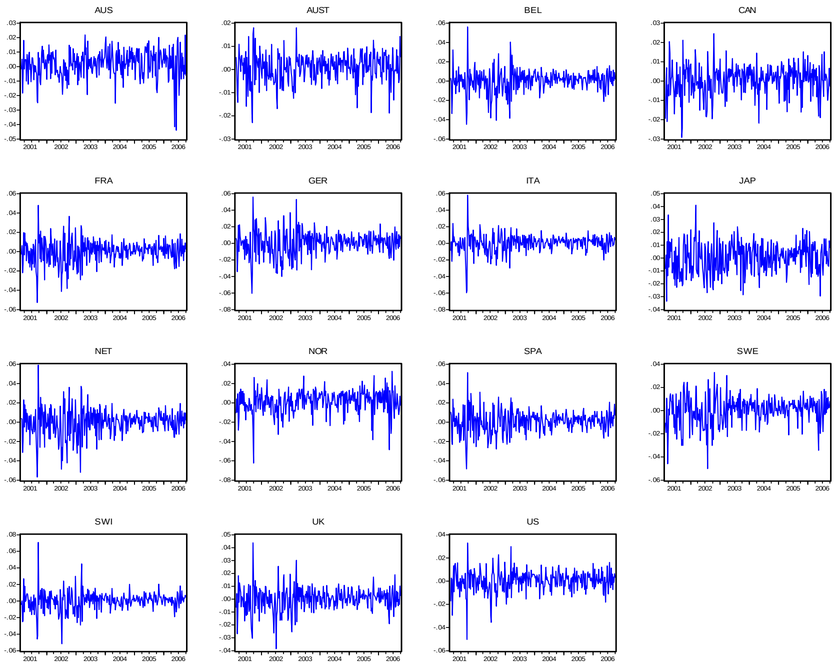
Figure 4. Dendrograms of international stock markets in the sample period 1999-2006

Table 3
Correlation matrices for the weekly returns

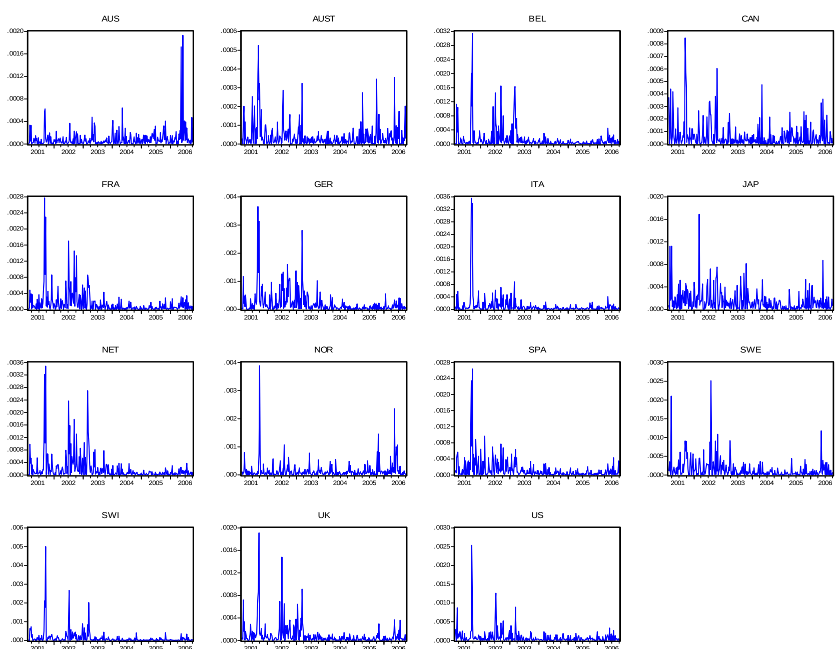
	AUS	BEL	FRA	GER	ITA	NET	SPA	AUST	CAN	JAP	NOR	SWE	SWI	UK	US
Euro															
AUS	1.00														
BEL	0.43	1.00													
FRA	0.40	0.84	1.00												
GER	0.41	0.79	0.91	1.00											
ITA	0.43	0.78	0.89	0.86	1.00										
NET	0.40	0.87	0.94	0.89	0.85	1.00									
SPA	0.42	0.75	0.85	0.83	0.83	0.82	1.00								
Non-euro															
AUST	0.47	0.54	0.58	0.56	0.62	0.57	0.58	1.00							
CAN	0.32	0.06	0.10	0.15	0.19	0.09	0.14	0.23	1.00						
JAP	0.31	0.10	0.19	0.25	0.19	0.21	0.20	0.25	0.26	1.00					
NOR	0.35	0.15	0.17	0.15	0.14	0.15	0.16	0.13	0.27	0.24	1.00				
SWE	0.22	0.00	0.04	0.04	0.04	0.01	0.05	0.06	0.22	0.28	0.66	1.00			
SWI	0.39	0.78	0.85	0.82	0.81	0.84	0.80	0.54	0.13	0.20	0.16	0.03	1.00		
UK	0.43	0.80	0.89	0.84	0.85	0.86	0.79	0.59	0.11	0.19	0.10	-0.04	0.83	1.00	
US	0.41	0.62	0.72	0.72	0.73	0.68	0.68	0.58	0.27	0.22	0.14	0.06	0.72	0.73	1.00

Figure 5 plots the return and squared return series. The beginning of this period was characterized by a climate of economic and political instability in Europe and United States due to the high and low values of the dollar against the euro, the Israel-Palestine conflict, the terrorist attack on September 11, and the subsequent climate of uncertainty, with strong impacts on international stock markets.

Tables 3 and 4 show the correlation matrices for the weekly returns and squared returns. It can be seen that correlations among euro area market returns and squared returns are high (i.e., more than 0.7) except Austria, which shows moderate mean correlations and low squared correlations. There are very high correlations between neighboring countries Netherlands, France, Germany and Belgium. We found that the mean correlations between the non-euro area countries Australia, Switzerland, United Kingdom and U.S., and the euro area countries are slightly higher than squared correlations. Moreover, there are eight mean correlations and one squared correlation higher than 0.8 among Switzerland, United Kingdom, France, Germany, Italy and Netherlands, and 20 mean correlations and 15 squared correlations higher than 0.6 among Switzerland, United Kingdom, U.S., and the euro area countries (with the exception of Austria). In contrast, Sweden shows mean correlations lower than 0.05 with the euro area countries (except Austria and Spain), whereas the squared correlations among these countries are higher than 0.25. The mean correlations between non-euro area countries Switzerland and Sweden, United Kingdom and Sweden, and U.S. and Sweden are 0.03, -0.04 and 0.06, whereas the squared correlations among these countries are 0.24, 0.34 and 0.23.



(a) Weekly returns



(b) Weekly squared returns

Figure 5. Plots for major international stock markets in the period 2001-2006

Table 4
Correlation matrices for the weekly squared returns

	AUS	BEL	FRA	GER	ITA	NET	SPA	AUST	CAN	JAP	NOR	SWE	SWI	UK	US
Euro															
AUS	1.00														
BEL	0.19	1.00													
FRA	0.19	0.84	1.00												
GER	0.18	0.71	0.86	1.00											
ITA	0.24	0.74	0.81	0.75	1.00										
NET	0.14	0.88	0.91	0.81	0.75	1.00									
SPA	0.16	0.74	0.83	0.80	0.82	0.76	1.00								
Non-euro															
AUST	0.38	0.36	0.41	0.46	0.55	0.38	0.42	1.00							
CAN	0.24	0.29	0.23	0.23	0.39	0.22	0.25	0.35	1.00						
JAP	0.20	0.13	0.14	0.17	0.11	0.16	0.15	0.21	0.14	1.00					
NOR	0.35	0.10	0.07	0.07	0.12	0.04	0.09	0.28	0.33	0.09	1.00				
SWE	0.26	0.29	0.27	0.26	0.29	0.26	0.23	0.25	0.28	0.16	0.46	1.00			
SWI	0.13	0.76	0.74	0.76	0.78	0.73	0.76	0.45	0.38	0.11	0.09	0.24	1.00		
UK	0.17	0.79	0.80	0.77	0.74	0.80	0.72	0.43	0.31	0.16	0.13	0.34	0.81	1.00	
US	0.22	0.50	0.53	0.54	0.64	0.48	0.48	0.53	0.53	0.04	0.04	0.23	0.68	0.64	1.00

6. Conclusions

In this paper, we investigated the evolution of similarities among major euro and non-euro area stock markets in the period 1966-2006. We performed a cluster analysis using a interpolated-periodogram based method for daily stock indices returns and squared returns. This approach provides useful information about the time series behavior in terms of the stochastic dependence and volatility effects, and solves the shortcoming of unequal sample sizes found for different countries.

The data were divided into two sample periods: previous and subsequent to the introduction of the euro as an electronic currency. For market returns, euro area countries do not seem to come closer after the introduction of the euro. There is some identity formed by the euro area countries Netherlands, Belgium, France and Germany and by the non-euro area countries Switzerland and U.S that is maintained after 1998. For squared returns, we found a clear change with the introduction of the euro. Up to 1998, there is a weak linkage among euro area countries. After 1998, the euro area stock markets volatilities have become considerably more homogeneous. Moreover, we appear to have Netherlands, France, Belgium, Germany, Spain close together and close to the non-euro area countries Switzerland, Sweden, United Kingdom, U.S., Australia, Singapore and Taiwan. Norway and Italy seem to be two clear outliers.

We explored also the correlations among weekly returns and squared returns in the sample period 2001-2006. We found that euro area neighboring countries France, Belgium, Netherlands and Germany are strongly correlated in returns and in squared returns. Canada, Japan and Norway show low mean and squared correlations with the euro area stock markets. France, Belgium, Netherlands, Germany, Italy, Netherlands, Spain, Australia, Switzerland, United Kingdom and U.S. are not correlated in returns with Sweden, but are weakly correlated in squared returns.

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