Time-varying behavior of long-run among stock markets in Western Europe

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Abstract: - This paper aims to investigate the potential time-varying behavior of long-run stock market relationship in Western Europe Markets (DAX, FTSE100 and CAC40). To do this we apply the Engle-Granger methodology with and no structural breaks. It is shown that indices from these three markets are cointegrated and the change in long-term relationship between them is more unstable for DAX/FTSE100. Also we identified that there is an opposite relationship in long-term changes in these markets, i.e., when the relationship between DAX/CAC40 weakens the relationship between DAX/FTSE100 intensifies.

Key-Words: cointegration, stock markets, structural breaks, Engle-Granger, long-rum, crisis.

1 Introduction

The 2007-2008 sub-prime financial crisis raised again concern on international market integration. This crisis has challenged the perceptions of investors about stock investments. The sub-prime crisis has driven down equity levels across the globe mainly sector and industry. As result some investors have been questioning previously held beliefs about the risk of equity investing and the benefits of global diversification [2].

Events of global importance tend to have a significant impact on the stock markets. Empirical studies show that the comovement patterns of national stock markets change significantly after major economic events like crises. Some authors have evidenced that comovement or cointegration among stock markets of other countries increases drastically during crisis periods [1, 7, 8].

Li and Majerowska [10] examined the linkages between the two emerging markets in Warsaw and Budapest and the developed markets in Frankfurt and the U.S. by applying a multivariate asymmetric GARCH approach to the daily stock indices from January 1998 to December 2005. They found that the emerging markets are weakly linked to the developed markets.There are uni-directional return spillovers from the S&P 500 index to the indices of WIG, BUX and DAX respectively, uni-directional return spillovers from DAX to BUX and from BUX to WIG and bi-directional return spillover between DAX and WIG. In the aspect of volatility linkages, there are uni-directional volatility spillovers from the DAX and S&P 500 indices to the indices of WIG and BUX and bi-directional spillovers between DAX and S&P 500 and between WIG and BUX. They suggest potential benefits for international portfolio diversification into the emerging markets in Central and Eastern Europe.

Guidi and Gupta [4] examined the linkages between the German and the CEE emerging equity markets using Multivariate cointegrating methodologies to detect long run relationships among these markets. The data consists of daily stock market prices, they use daily returns of the DAX Index and the Czech, Hungarian, and Polish equity markets for the period 2 January 1999 to 9 January 2009.Results from a Granger causality tests suggest that the German market prices Granger-cause the prices on the CEE markets where as the results from the more sophisticated tests of cointegration find no cointegration in these markets, while taking into account the possibility of a structural shift there are evidence of long run relationships. Moving to the BEKK GARCH models results they highlight that the conditional correlation seem to vary strongly over time, although in the last period they observed German and CEE equity markets have increased their correlation.

Horvath and Petrovski [6] examined the international stock market co-movements between Western Europe vis-à-vis Central (Czech Republic,

Hungary and Poland) and South Eastern Europe (Croatia, Macedonia and Serbia) using multivariate GARCH models in the period 2006–2011. Comparing these two groups, they found that the degree of co-movements is much higher for Central Europe and correlation of South Eastern European stock markets with developed markets is essentially zero. They highlight that all stock markets fall strongly at the beginning of the global financial crisis and we do not find that the crisis altered the degree of stock market integration between these groups of countries.

This paper aims to investigate the potential time-varying behavior of long-run stock market relationships among stock markets in Western Europe. In order to do that we apply the Engle-Granger methodology with and no structural breaks. We will investigate the major market index of Frankfurt (DAX), London (FTSE100) and Paris (CAC40). It is considered a period which includes recent financial crises of 02/01/2009 to 02/08/2013, the so-called Euro crisis.

2 Methodology

The data used in this study consist of the daily closing index price of three broader Western Europe indexes, the DAX, FTSE100, and CAC40 from 02/01/2009 to 02/08/2013. DAX measures the development of the 30 largest and best-performing companies on the German equities market. It represents around 80% of the market capital authorized in Germany includes the top 30 stocks with reference to capitalization and trading volume. FTSE100 index includes the 100 stocks selected on the basis of capitalization representing approximately 80% of the U.K. market and the amount of freely negotiated shares. CAC40 includes the 40 most significant stocks in terms of liquidity. It was selected to represent the various sectors according to the weight that they assume within the French economy.

We use the Engle-Granger approach to cointegration and we assumed the possibility of structural breaks as proposed by Zeileis, Shah and Patnaik [11]. Initially, it was checked the individual price index series in natural log levels and integration order. The three indices logs were tested for unit roots using the KPSS and ADF-GLS. The test results were not presented here due to scarce space, but indicate that the null hypothesis cannot be rejected for each one of three price series. Unit root tests were performed on each of the price index series in log first differences. The null hypothesis of a unit root could be rejected for each time series.

3 Empirical Results

Table 1 provides the descriptive statistics and the correlation coefficients of the daily market returns in our database that were originated between 2009 and 2013. The three indices had very similar minimum return. The CAC40 has the highest return and also the lowest average return which indicates it is the most risky of the three markets. DAX and FTSE100 exhibit positive skewness and all three markets exhibit excess kurtosis. The correlation coefficient identifies strong positive contemporary linear association between the markets.

Table 1. Basic statistics and correlations coefficients for daily log-returns multiplied by 100

Basic Statistics	DAX	CAC40	FTSE100
Observations	1152	1152	1152
Minimum	-0.692	-0.699	-0.667
Maximum	0.705	1.127	0.587
Mean	0.005	0.002	0.003
Variance	0.029	0.035	0.019
Standard deviation	0.171	0.190	0.138
Skewness	-0.148	0.027	-0.197
Excess Kurtosis	2.110	2.423	2.283
Correlations			
DAX	1.000		
CAC40	0.933	1.000	
FTSE100	0.884	0.907	1.000

Usually, the traditional analysis checks for long-term relationship between a set of macroeconomic variables without considering structural breaks. Generically, it was considered that there is a balanced long-term relationship between two series that are cointegrated in first order (I1) if the error o of these two variables is considered stationary (I0). Table 2 and Table 3 show the estimated results through the procedure of Engle-Granger cointegration for the relationship (level) of the market index DAX/CAC40 and DAX/FTSE100.

The residue of long-term relationship analysis identified the presence of unit root. The results show no evidence of cointegration between the markets for the entire sample. There is no cointegration between DAX/CAC40 and DAX/FTSE100 because error correction term (ECT) has a unit root. The presence of unit root was identified by test results

KPSS [9] and Elliot, Rothenberg and Stock [3] – ADF-GLS. For DAX/CAC40 the KPSS stationary test has a value of: 0.983 (critical value 0.05 = 0.146). ADF-GLS unit root test of type detrending of series with intercept and trend presents a value of: -2.543(critical value 0.05 = -2.890). For DAX/FTSE100 the KPSS stationary test has a value of: 0.648 (critical value 0.05 = 0.146). ADF-GLS unit root test of type detrending of series with intercept and trend presents a value of: -2.932 (critical value 0.01 = -3.480).

Table 2. Estimation Results of long-term relationship DAX/CAC40 without considering structural breaks.

	Estimate	Standard Error	t-value	Pr(>|t|)	R^2
Intercept	-0.111	0.304	-0.368	0.713	
CAC40	1.084	0.037	29.182	0.000	0.425

DF-GLS = -2.543 (5% = -2.890) and KPSS=0.983 (5% = 0.146)
M-fluctuation test = 14.877, p-value < 0.000

Table 3. Estimation Results of long-term relationship DAX/FTSE100 without considering structural breaks

	Estimate	Standard Error	t-value	Pr(>|t|)	R^2
Intercept	-2.505	0.092	-27.070	0.000	
FTSE100	1.307	0.010	121.620	0.000	0.928

DF-GLS = -2.932 (1% =-3.480; 5% = -2.890) and KPSS=0.648 (5% = 0.146)
M-fluctuation test = 7.325, p-value < 0.000

An alternative option to check if there is a long-term stable relationship is to use the structural stability test. The generalized fluctuation tests advocate that the null hypothesis of "no structural change" should be rejected when the fluctuation of the empirical process for greater than fluctuation of theoretical limit (see Zeileis, Shah and Patnaik [11]. More formally, M-fluctuation test is $S_{dmax} = 14.877$(p-value < 0.000) for DAX/CAC40 and is $S_{dmax} = 7.325$ (p-value <0.05) for DAX/FTSE100.

Nevertheless, the multivariate fluctuation process is interesting as a visualization of the changes in the different parameters estimated. The Figure 1 identifies the instability in parameter estimation (intercept, CAC40 impact, FTSE100 impact and Variance) and shows that all were exceeded 5% level boundaries.

Following Zeileis, Shah and Patnaik [11] we conducted a dating procedure for $m = 1,...,5$ breaks and a minimal segment size of $n_k = 78$ observations. The Figure 2 shows the results. We observed five breaks under the negative log-likelihood.

The modified Schwarz information criterion (LWZ) suggests four breaks in both cases. We choose five segments with four breaks in order to ensure a greater number of observations in each segment. The corresponding segments and parameter estimates were reported in Table 4 and Table 5. The visualization of breaks in the long-term and short-term was highlighted in Figures 3 and 4.

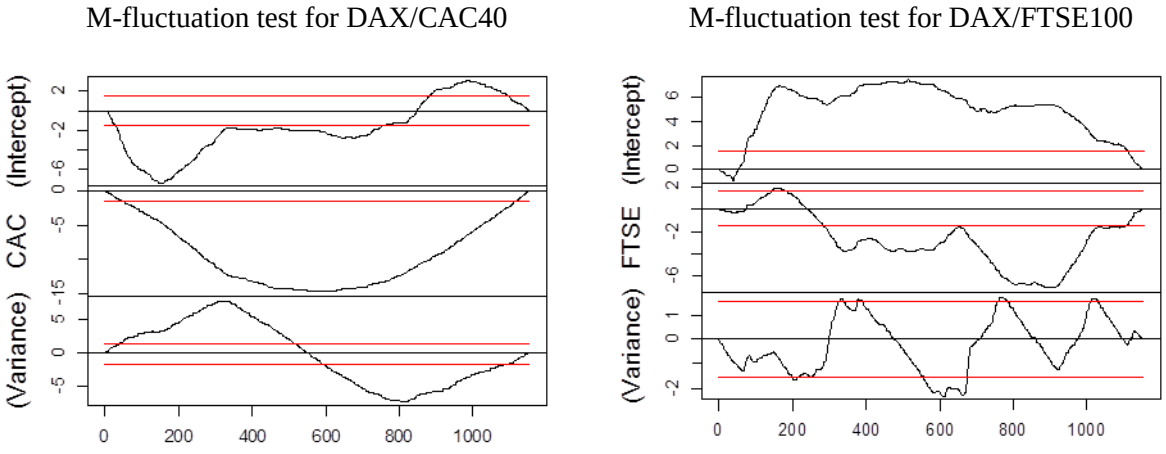

Figure 1.Historical fluctuation process for DAX/CAC40 and DAX/FTSE100 indexes (from 02/01/2009 to 02/08/2013)

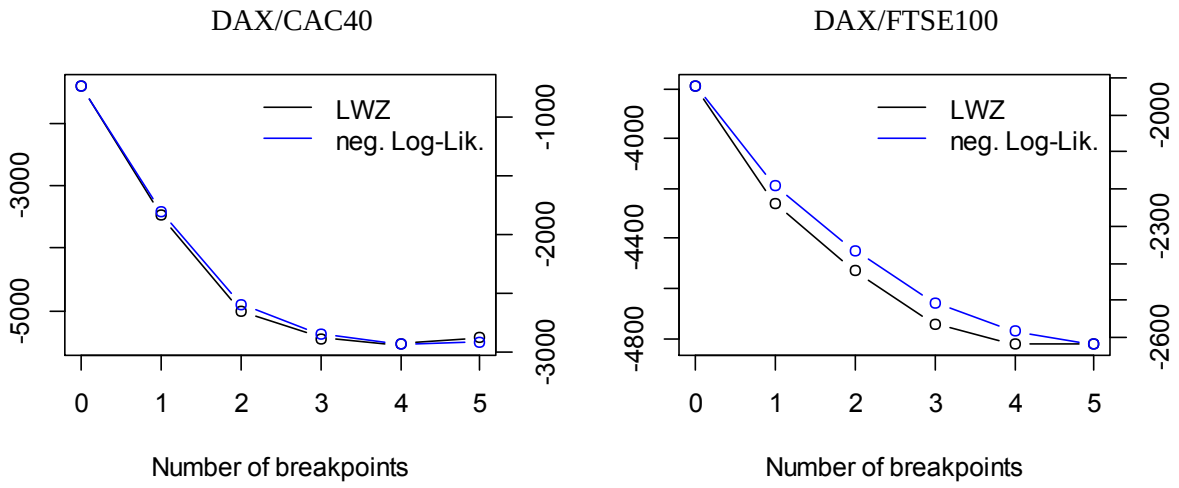

Figure 2.Negative log-likelihood and LWZ information criterion for DAX/CAC40 and DAX/FTSE100 indexes (from 02/01/2009 to 02/08/2013)

Table 4.Estimation results of long-term relationship segmented for DAX/CAC40

	Estimate	Standard Error	t-value	Pr(>|t|)	R^2
02/01/2009-26/04/2010					
Intercept	-0.287	0.060	-4.737	0.000	
CAC40	1.085	0.007	145.505	0.000	0.985
27/04/2010-15/04/2011					
Intercept	-1.747	0.276	-6.329	0.000	
CAC40	1.278	0.033	38.149	0.000	0.855
16/04/2011-13/01/2012					
Intercept	0.821	0.130	6.305	0.000	
CAC40	0.975	0.016	60.820	0.000	0.952
16/01/2012-19/09/2012					
Intercept	2.152	0.236	9.091	0.000	
CAC40	0.821	0.029	28.109	0.000	0.822
20/09/2012-02/08/2013					
Intercept	1.103	0.131	8.377	0.000	
CAC40	0.955	0.016	59.579	0.000	0.942

DF-GLS = -6.675 (5% = -2.890)and KPSS =0.063 (5% = 0.146)

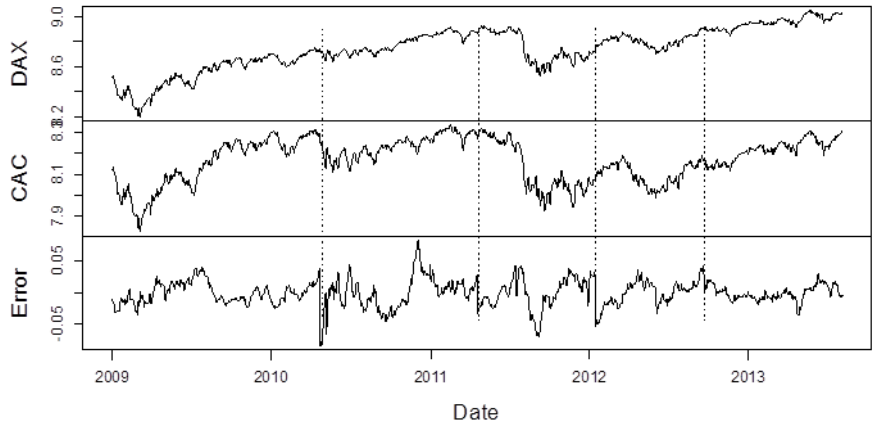

Figure 3. Identification of structural breaks in the long-term and short-term

Table 5. Estimation results of long-term relationship segmented for DAX/FTSE100

	Estimate	Standard Error	t-value	Pr(>|t|)	R^2
02/01/2009-09/09/2009					
Intercept	-2.382	0.2370	-10.050	0.000	
FTSE100	1.296	0.0283	45.720	0.000	0.925
10/09/2009-04/05/2010					
Intercept	1.384	0.3158	4.385	0.000	
FTSE100	0.848	0.0368	23.064	0.000	0.758
05/05/2010-11/08/2011					
Intercept	-1.682	0.234	-7.183	0.000	
FTSE100	1.214	0.027	44.797	0.000	0.867
12/08/2011-30/08/2012					
Intercept	-6.403	0.436	-14.690	0.000	
FTSE100	1.756	0.050	34.730	0.000	0.821
31/08/2012-02/08/2013					
Intercept	0.949	0.211	4.489	0.000	
FTSE100	0.916	0.024	37.845	0.000	0.861

DF-GLS = -5.222 (5% = -2.890)and KPSS =0.068 (5% = 0.146)

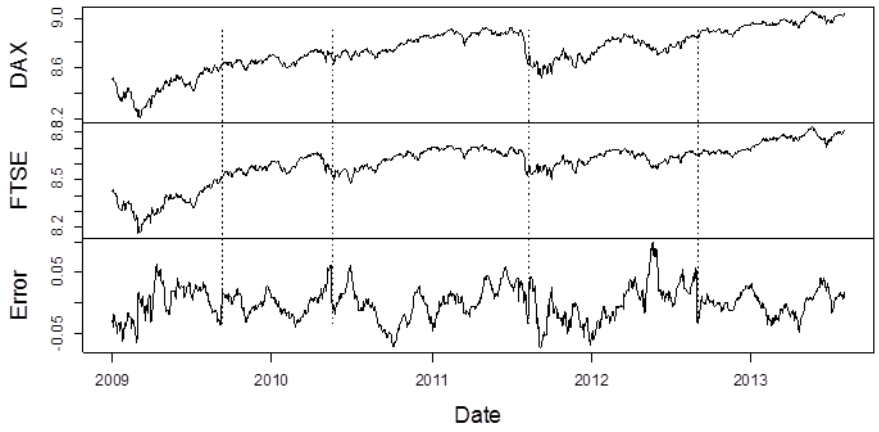

Figure 4. Identification of structural breaks in the long-term and short-term

The estimated results for each segment (Tables 3 and 4) suggest the existence of significant long-term equilibrium relationship between these three markets. However, there are parameters associated with the FTSE100 index exhibit variation over the segments, but for the CAC40 index the relationships more solid (see Figure 5). Also we identified is a relationship opposite of long-term changes in the markets, i.e., when the relationship between DAX/CAC40 weakened the relation between DAX/FTSE100 intensifies.

After estimating the segmented long-term relationship we need to verify that there is due of this relationship has stationary behavior. With the long-term relationship residue analysis it was identified the presence of stationarity. The results show that there is evidence of cointegration between the markets for the sample period. There is cointegration between DAX/CAC40 and DAX/FTSE100 because the error correction term (ECT) has no a unit root.

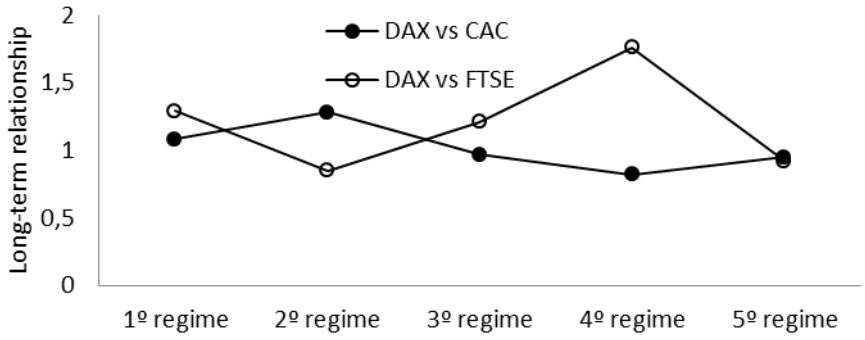

Figure 5. Change in long-term relationship between markets

The absence of unit roots identified by results of tests KPSS and ADF-GLS for unit root. The KPSS unit root test has a value of: 0.063 (critical value 0.05 = 0.146). The ADF-GLS unit root test of type detrending of series with intercept and trend presents a value of: -6.675 (critical value 0.05 = -2.890) for DAX/CAC40. In the case of the relationship DAX/FTSE100, the results are similar for both tests.

3.1Some economic facts associated with breaks

02/01/2009-09/09/2009. This time interval would be the beginning of the European crisis (see Honkapohja [5]. Just before the end of 2009 it would be disclosed the difficulties Greece was going through. Greek Government admitted that would not be able to firm debt appointments. With this episode the investors acted quickly, demanded higher rates for debt funds. This escalated government spending and forced the European Union (EU) and the European Central Bank (ECB) to intervene.

02/01/2009-26/04/2010. On the 23rd of April 2010 the Greek Government was forced to ask for another loan of € 100 billion from the European Union. Also, effective in March 2010 the country has adopted an austerity package to control government spending. Some measures have caused social unrest and contributed to the overall uncertainty. In the beginning of 2010 Portugal and Ireland were affected by the crisis (see Honkapohja [5].

10/09/2009-04/05/2010. The European Union and the IMF agreed to a rescue package of 750 billion Euros to avoid that the crisis spread to the entire euro zone. To this measure was added the creation of a stabilization fund to the Eurozone, in March 10th.

05/05/2010-11/08/2011. In the summer of 2012 (June to August) the last country affected by the crises came about, Cyprus (see Hokapohja [5].

16/04/2011-13/01/2012. In January 2012 nine countries have their debt bonds downgraded by Standard and Poor's. This evaluation placed those bonds in a risky position and the Germany emitted titles with negative rates. After that the European Central bank announced a new loan in order to attempt to stabilize these economies. And the Germany president was forced to resign due to fraud investigation.

16/01/2012-19/09/2012. In September 2012, the BCE presented proposals to try to rescue Spain and Italy. In September 2012 the BCE presented proposals to try to rescue Spain and Italy. In this month the PMI (an index that evaluates industrial production in Greece) reached its lowest point since 2009, fueled by decreasing oil prices. Other European countries also presented lower PMI. Furthermore, the budget forecast in Spain for 2013 affected negatively the markets.

4 Conclusion

This paper investigated the relationship of long-run equilibrium among the three major stock markets of the Western Europe in the period of great turbulence associated with the Greek crisis. Specifically, we examined whether stock prices in the three indexes (DAX/CAC40 and DAX/FTSE100) are cointegrated. By employing the analysis of Engle-Granger cointegration with structural breaks in the long-run and the error correction model. We found that the indices of the three markets are cointegrated and that the change in long-term relationship between in markets is more unstable for DAX/FTSE100.

The existence of cointegration means that there is a linear combination of the indexes that forces the balance of long-term implying that the indexes are highly correlated in the long-run. However, due to the existence of structural breaks this relationship makes possible for the investor to get benefits through diversification in these three stock markets. Also identified is a relationship opposite of long-term changes in the markets, i.e., when the relationship between DAX/CAC40 weakens the relation between DAX/FTSE100 intensifies.

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