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Time-Varying Dynamics in the Greek Stock Market Integration with the EMU Stock Markets

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Abstract: - In this study we examine the degree of integration of the Greek stock market with the traditional and non-traditional European stock markets during the period 1994-2004, using monthly data. We use the French stock market as a proxy of the traditional stock markets and the Portuguese stock market as a proxy for the non-traditional ones. We divide our data into three sub-periods, from 1994:04 to 1999:12, from 2000:01 to 2002:12 and from 2003:01 to 2004:12. Using Granger Cointegration method and Error Correction Model we find evidence that the Greek stock market is exhibiting long run relationship with the Portuguese and the French stock market, although with different influences. Until 1999 the Greek stock market is showing evidence of integration with both markets. In the second period integration exists only with Portugal and in the third period only with France. Another finding is that Portugal and France are acting as one month leading indicators of the Greek market.

Key-Words: - Stock market integration, Granger Cointegration, Error Correction Model, EMU, Greek stock market

1 Introduction

Since the introduction of EMU in 1999 many authors have attempted to find evidence regarding a possible relationship among the European stock markets. A similar strand of studies has also been conducted between the European stock markets and the rest of the world on the rationale of economic interdependencies between EMU and the rest of the world, proxied mainly by the US and the Japan stock markets.

A key concept in these studies is integration. Stock markets integration can be defined as the degree of co-movement in asset prices. According to Bekeart and Harvey (1995), the degree of integration (or, its opposite, of segmentation) of a market with world capital markets is greatly influenced by the economic and financial policies followed by its government or other regulatory institutions. In other words, the degree of economic integration affects the degree of capital integration. A high degree of economic integration tends to coexist with high degree of capital integration. An implication of this definition is that stock markets are subjected to the same set of risk factors (Ahlgren and Antell, 2004; Tahai et al, 2004).

For exposition purposes one can divide the existing literature on financial integration into three sections. First, integration studies solely regarding the EU and EMU. Second, studies regarding the EU and world stock markets, and, finally, studies regarding the new member countries of the EU.

The existing studies regarding solely the EU and EMU are concerned with the issue of integration before and after EMU. The findings of these studies indicate that there is an increased integration after the EMU, and this integration is not limited only in the traditional stock markets of Europe such as

Germany, France and UK, but is extended in all 15 member countries (Hardouvelis et al, 2001; Pascual, 2003; Friedman and Shachmurove, 2005; Kearney and Poti, 2005; Hardouvelis et al, 2006). Friedman and Shachmurove (1997), in one of the earlier studies back in 1997, showed that the mature markets of Europe were actually integrated even since that date and showed significant evidence of co-movements, whereas the smaller markets of Europe seemed to be segmented. This is an interesting finding as it is indicative of the kind of trends that is expected in Europe after the EMU, i.e. the increased integration among the stock markets of the member countries. Masih and Masih (2004) argue that European Union membership, institutional agreements of the EU concerning equity markets, the growth of Euro-equity market, the EMU, the common monetary policies, as well as other global trends, explain European stock markets integration. Finally, Andren and Kjellson (2005) argue that the only stock market which became fully regionally integrated after the introduction of EMU was Greece, whereas the remaining stock market exhibited partial integration.

The second strand of studies, i.e. this concerning the relationship of the European Union stock markets with the world stock markets, such as US, Canada, Australia and Japan, suggests that European stock markets tend to exhibit greater integration with the world stock markets after the introduction of EMU (Fratzscher, 2001; Melle, 2002; Kim et al, 2005). Davies et al (2005) show that the US market had little or no influence on the European stock markets prior 1999, where, at the same period, the UK stock market was the most important market in Europe. Yet, after 1999, UK seemed to have less influence on Europe, whereas the US market showed a significantly higher influence.

Finally, research concerning integration process of the Central European countries (Czech Republic, Poland and Hungary) and Russia has also been conducted. See, for example, Voronkova, 2004; Voronkova and Lucey, 2005; Gilmore et al, 2005; Chelley-Steeley, 2005. Their findings show that these new members of the European Union demonstrate a steady increase in their integration level with the traditional markets of Europe, such as Germany, France and UK. Russia also shows a high integration with the mature markets of Europe, yet it shows no regional integration with Hungary, Poland and Czech Republic. Voronkova (2004) has also identified that the Central European countries have become more integrated with the global markets, proxied by the US market.

To our knowledge, the literature on the issue of stock market integration of Greece with the other European countries is limited. We would like to contribute to this research by posing the question of the integration degree of the Greek stock market with the traditional and non-traditional markets of Europe before and after the EMU.

The paper is organized as follows. Section 2 is concerned with the statistical methodology, Section 3 refers to our statistical estimates and findings and Section 4 concludes our paper.

2 Data and Methodology

Our statistical data include the closing prices of the Greek (ATHEX composite index), French (SBF price index) and Portuguese (PSI general index) stock markets indices, on monthly basis and cover the period 1994:4 – 2004:12. The statistical foundation of our study is that of the cointegration theory (Engle and Granger, 1987) which is a suitable method for statistically estimating parameters in a non-stationary setting. We use this approach because, as it will be shown below, all data series are non-stationary. In such a setting, an appropriate model should take into account both any long run relationships and short run disequilibria.

Our estimable model belongs to the class of Error Correction Models (ECM) which, in a non-stationary environment, assumes necessarily cointegration. Our preliminary tests, based on the correlation coefficient matrix of growth rates (Table 1) of the Greek stock market with other 13 European stock markets with no and one lag, show that growth rates of the Greek stock market reveal high correlation with the growth rates of Portugal (0.46) and France (0.49) with one lag.

Of course, due to evolving integration of the European capital markets, Greece is highly correlated with other developed countries, especially with Germany (0.50), UK (0.47) and Belgium (0.48). However, this high correlation does not allow to measure partial independent effects of these markets on Greece, due to multicollinearity problems. Therefore, given this constraint, we decide to use the French and the Portuguese stock markets with one lag, as proxies of the traditional and the non-traditional stock markets, respectively.

This choice is also based on the finding that French and Portuguese markets with one lag are the only ones who form a cointegrating vector for the whole period 1994:4 - 2004:12.

Table 1: Correlation estimates of the Greek stock market growth rates with the European stock markets growth rates

Countries	Full Sample 94-04		Period 1 94-99	Period 2 00-02	Period 3 03-04
	No lags	One lag	One lag	One lag	One lag
Aus	-0,02	0,40	0,47	0,31	0,40
Bel	0,03	0,48	0,46	0,34	0,72
Bul	0,21	0,31	0,30	0,33	0,23
Cze	0,11	0,26	0,24	0,38	0,28
Fra	0,05	0,49	0,41	0,41	0,85
Ger	-0,04	0,50	0,45	0,42	0,87
Ire	0,08	0,36	0,34	0,36	0,53
Ita	0,05	0,46	0,41	0,55	0,59
Por	0,15	0,46	0,43	0,53	0,26
Slo	0,11	0,09	0,18	-0,10	0,07
Swe	0,09	0,44	0,44	0,50	0,46
Uk	-0,07	0,47	0,42	0,39	0,68

If the index of the Greek stock market forms a linear long run relationship with one month lag indices of the French and the Portuguese stock markets, a possible structure is the following long run equilibrium model:

$$GRE_t = \theta'_0 + \theta'_1 FRA_{t-1} + \theta'_2 POR_{t-1} + \varepsilon_t \qquad \textbf{(1)}$$

Next, we assume that short run dynamic adjustments are possible with the following restricted autoregressive distributed lag disequilibrium model:

$$GRE_t = \alpha + \beta_1 FRA_{t-1} + \beta_2 FRA_{t-2} + \gamma_1 POR_{t-1} + \gamma_2 POR_{t-2} + \lambda GRE_{t-1} + \xi_t. \qquad \textbf{(2)}$$

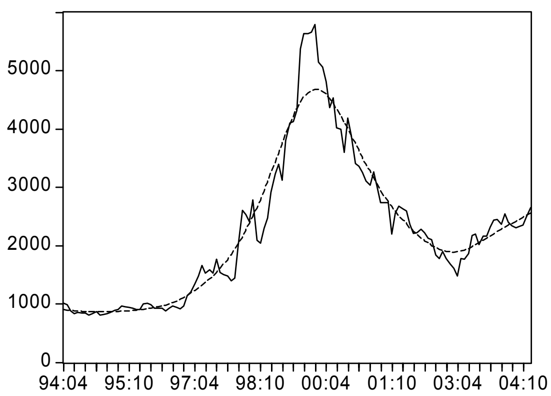
However, given the non-stationarity of the series, a possibly estimable model in the analysis of the Greek stock market is one of the error correction form. This is known in the literature as the Granger Representation Theorem (Engle and Granger, 1987). This estimable form is the ECM, which is a reparameterization of the disequilibrium model taking into account the long run model **(1)**. In particular, in a dynamic setting governed by possible non-stationarity and provided that cointegration exists, the ECM avoids the issues of spurious regression and multicollinearity (due to high correlation between, e.g. POR_{t-1} and POR_{t-2} which would be present if we had estimated equation **(2)** directly) and allows parameters estimation in a statistically valid fashion. Subtracting GRE_{t-1} from the left and the right hand sides of equation **(2)**, adding and subtracting FRA_{t-2} and POR_{t-2}, collecting similar terms and suitably rearranging, we end up with the ECM which takes the form:

$$\Delta GRE_t = a + \beta_1 \Delta FRA_{t-1} + (\beta_1 + \beta_2) FRA_{t-2} + \gamma_1 \Delta POR_{t-1} + (\gamma_1 + \gamma_2) POR_{t-2} + (\lambda - 1) GRE_{t-1} + u_t. \qquad \textbf{(3)}$$

where GRE, FRA and POR are the Greek, French and Poruguese stock indices, respectively. Δ is the difference operator and $a, \beta_1, \beta_2, \gamma_1, \gamma_2, \lambda$ are short run parameters to be estimated. The parameters $\beta_1, \gamma_1,$ are the first interim multipliers. Solving equation (2) for its static equilibrium, we obtain the long run parameters. The long run parameters, obtained from the ECM, are denoted by $\theta_0, \theta_1, \theta_2$ and are computed as $\frac{\alpha}{1-\lambda}$, $\frac{\beta_1 + \beta_2}{1-\lambda}$, $\frac{\gamma_1 + \gamma_2}{1-\lambda}$, respectively. In all these models we assume that the stochastic disturbances ε_t, ξ_t and u_t are i.i.d processes with zero mean and finite variance. Given these assumptions, the estimates from the ECM are consistent and asymptotically efficient. All variables in the estimations are expressed in their logarithms. Therefore, the expression $\Delta(Variable)$ is approximately the growth rate of the involved variable. Under the assumption that cointegration indeed exists in equation **(1)**, then the estimated $\theta'_0, \theta'_1, \theta'_2$ parameters should be close to $\theta_0, \theta_1, \theta_2$, computed from the ECM.

The examination of the dynamic properties of the involved series is already a common practice among researchers. Our question is whether our series are stationary or not, and if not, what their data generating processes are. We have divided the sample in three periods, namely 1994:4 – 1999:12, 2000:1 – 2002:12 and 2003:1 – 2004:12, a division which reflects significant changes in the behaviour of the Greek stock market (Fig. 1).

Fig. 1: ATHEX Composite index prices and its long run trend



Note: For estimating the long run trend we use the Hodrick-Prescott filter with smoothing parameter μ = 14400.

We employ the ADF (Dickey and Fuller, 1979) formal unit roots tests in all periods (Table 2) from which we conclude that all series are unit root processes, a necessary but not sufficient condition for cointegration. The SIC (Schwartz Information Criterion) is used for the determination of the optimal lag length in the unit roots test.

Table 2: Unit Root Tests

Variable	Period 1	Period 2	Period 3
	94-99	00-02	03-04
GRE	-1.95	-1.23	-2.55
POR(-1)	-1.73	-0.96	-2.85
FRA(-1)	-2.97	-1.12	-2.33

Note: All ADF t statistics are insignificant at the conventional significance levels (5% and 10%). All the series are non-stationary with one unit root. The SIC has been employed for the determination of the optimal lag length.

A next step in the analysis is to see if these series are cointegrated, that is, if GRE forms a stable long run linear relationship with FRA and POR variables. It is only in this case that ECM provides statistically sound and economically interpretable parameters estimations. On the basis of cointegration tests (Table 3) and the Granger critical values (Engle and Granger, 1987; Engle and Yoo, 1987), it turns out that regression of all periods form a stable long run linear relationship at 5% significance level. This is a sufficient condition to proceed to the estimation of the ECM.

Table 3: Cointegration tests

Period	t statistic
94-99	-4.70*
00-02	-4.95*
03-04	-4.11*

Note: All t statistics are significant at the conventional significance levels (5% and 10%). Regression equations are balanced since no unit roots govern their residuals. The SIC has been employed for the determination of the optimal lag length.

ECM and cointegration estimates are given in the next Section.

3 Statistical Estimates and Findings

Tables 4 and 5 present the parameters estimates from ECM and cointegrating equations, respectively.

Table 4: ECM estimates

ECM	Period 1	Period 2	Period 3
Short-run parameters	94-99	00-02	03-04
a	-2.30	-0.44	-2.52
β_1	0.66	0.20	1.70
β_2	0.01	-0.22	-0.77
γ_1	0.21	0.67	-0.44
γ_2	-0.40	-0.29	0.32
λ	0.78	0.73	0.45
Long-run parameters			
θ_0	-10.54	-1.63	-4.58
θ_1	3.04	-0.11	1.69
θ_2	-0.86	1.40	-0.21
Diagnostic tests			
$Adj\ R^2$	0.29	0.42	0.78
DW	1.84	2.28	1.64
$WH\ F$	1.77	1.18	0.92
	[0.08]	[0.34]	[0.54]
$BG\ LM(2)\ F$	0.32	1.31	0.48
	[0.72]	[0.28]	[0.63]
$ARCH\ LM(2)\ F$	0.05	0.08	0.10
	[0.95]	[0.91]	[0.90]
$J-B$	1.06	0.60	0.66
	[0.58]	[0.74]	[0.71]

Note: In brackets are the actual significance levels (ASL).

As a general finding, the hypothesis that a linear relationship among the Greek, French and Portuguese stock markets cannot be rejected. Having established a sound statistical background from the cointegration analysis, the estimation of the ECM, along with various diagnostic tests, provides economically meaningful results.

Table 5: Cointegrating equation estimates

CE estimates	Period 1	Period 2	Period 3
Long-run parameters	94-99	00-02	03-04
θ'_0	-7.91	-2.60	-4.62
θ'_1	2.57	-0.14	1.70
θ'_2	-0.70	1.53	-0.20

All the Error Correction models are well-behaved in terms of their statistical properties. No lack of normality, autocorrelation, heteroskedasticity or ARCH effects are present, based on the Jarque-Berra test (J-B), Durbin-Watson (DW) and Breusch-Godfrey Lagrange Multiplier with 2 lags (BG LM(2)), White heteroscedasticity (WH) and ARCH Lagrange Multiplier with 2 lags (ARCH LM(2)), (Table 4). In addition, on the basis of the CUSUM test, parameters remain constant for all periods, especially for periods 1 and 3 (Fig.2, Fig.3 and Fig.4).

Fig. 2: Period 1 (1994-1999) - Structural stability

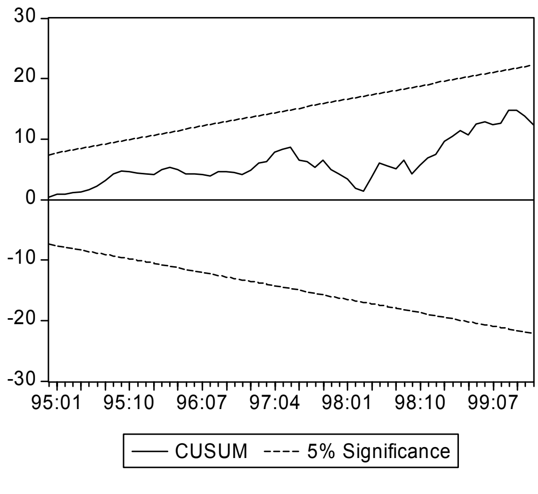


Fig. 3: Period 2 (2000-2002) - Structural stability

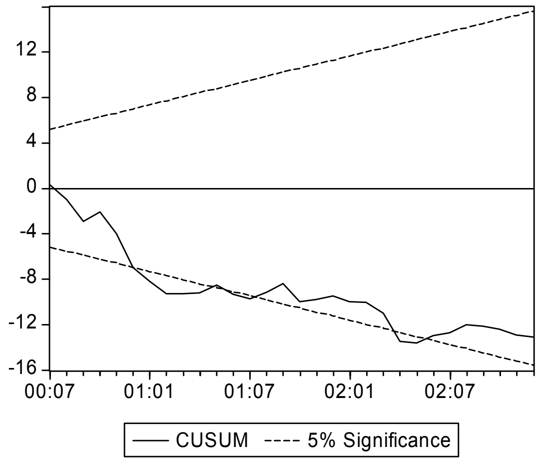
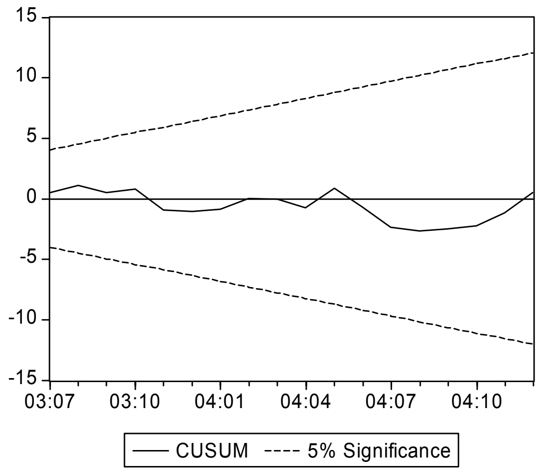


Fig. 4: Period 3 (2003-2004) - Structural stability



Further, the adjusted R square, although not particularly high in the first period (0,29) becomes satisfactory in the second period (0.42). In the third period the adjusted R square becomes actually high (0.79). This increase in the adjusted R square, along with the desired statistical properties of the ECM which are maintained in all three periods, reflects the fact that Greek stock market responds more clearly and with less noise as we move along from the past periods to the present (Fig.5, Fig.6 and Fig.7).

Fig. 5: Period 1 (1994-1999) - Fitting

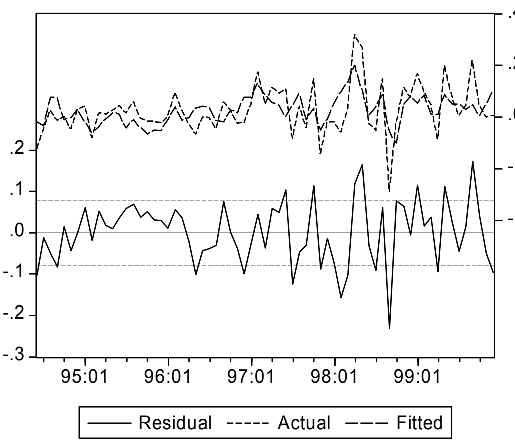


Fig. 6: Period 2 (2000-2002) - Fitting

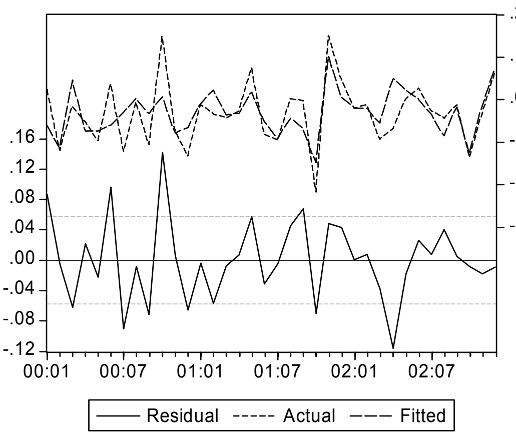
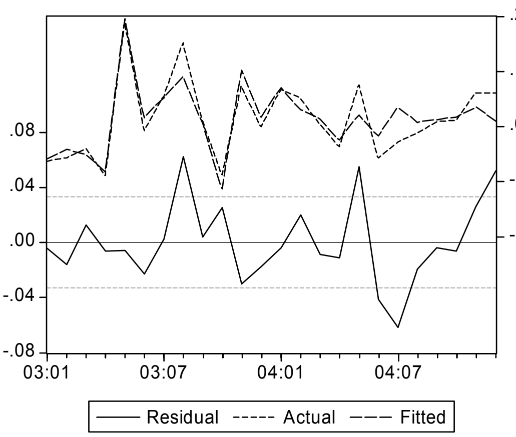


Fig. 7: Period 3 (2003-2004) - Fitting



This is an indication of greater degree of financial integration among these three stock markets. However, the effects of the French and the Portuguese stock markets are shifting over time. In particular, during period 1 (1994:4-1999:12), the Greek stock market response, as measured by the long run multipliers, to the French market, is high and positive (θ_1=3.04), as opposed to the response to the Portuguese market, being moderate and negative (θ_2=-0.86). In the second period (2000:1-2002:12) the role of France becomes negligible (θ_1=-0.11), whereas Portugal exercises a moderate and positive influence (θ_2=1.40). Finally, in period 3 (2003:1-2004:12), Portugal has almost zero effect (θ_2=-0.22) and the French market exhibits an almost high positive effect (θ_1=1.69).

Although the magnitude of the response of the Greek stock market becomes lower as we move over time, dynamic convergence to equilibria becomes faster. This is shown by λ estimates, which become smaller over time (Period 1: 0.78, Period 2: 0.72, Period 3: 0.45). It is worth noting that estimates from the ECM are close to the estimates of the cointegrating equations and this becomes even more clear in the third period (θ'_1=1.70, θ'_2=-0.20). On statistical ground this reflects the fact that the long run equilibrium is stronger and, because of this, the ECM captures more adequately this long run relationship. Indeed, long run estimates from the ECM and the cointegrating equation are identical, in period 3. Beyond the long run estimates, it is also apparent that short run parameters $\beta_1, \beta_2, \gamma_1, \gamma_2, \lambda$ do change over the periods of consideration, a fact that gives support to the hypothesis of successive structural changes in the dynamics of the system.

The above findings correspond to the three main phases of the Greek stock markets. Until 1999 all EU member countries, including Greece, were preparing themselves to join EMU. Therefore, some degree of integration was expected among Greece, France and Portugal. This is supported by our cointegration evidence, although with noisy signals (low adjusted R squares). Then a period of adaptation starts for Greece (2000-2002) due to two main reasons. First, the adoption of the common currency in 2001 and, second, the promotion of the Greek stock market to the mature ones, in 2001, as well. This shift of the regime in 2001 created a status of insecurity for the Greek market, which lasted until the end of 2002. The long run relationship during 2000-2002 with the Portuguese market may be explained on the basis that Portugal experiences similar economic and financial climate and this can further explain the almost zero influence of France. Finally, after 2003, when Greece is already a full member of EMU and its stock market behaves in a mature fashion, subjected no longer in extreme shocks, shows a stronger relationship with France, an already mature and traditional market of Europe.

Furthermore, given that long run equilibrium among Greece, France and Portugal is established with one time lag in France and Portugal, we may conclude that these two stock markets act as leading indicators of the Greek market. That is, news stemming from France and Portugal affect Greece one month later. This finding could spur discussions for predicting the Greek stock market fluctuations.

4 Conclusion

The aim of the study is to identify the degree of integration of the Greek stock market with the traditional and non-traditional markets of Europe, using France and Portugal as proxies for the traditional and non-traditional market, respectively. Using cointegration and Error Correction methods, we have documented that until 1999, Greece was integrated with both the traditional and the non-traditional markets of Europe. This relationship is changing during the second and the third period of our study. The second period (2000:01 to 2002:12) was a period of adaptation for Greece due to the fact that it joined EMU in 2001 and at the same year the Greek stock market was promoted to the mature markets. Therefore, Greece is exhibiting a higher integration with Portugal and no integration with France. However, in the third period (2003:01 to 2004:12) where the Greek market approaches the behaviour of mature markets, it seems that it is integrated with the French stock market and it shows no integration with Portugal.

Our results confirm the general findings about the increasing degree of integration between Greece and the traditional markets. They also show the time-varying dynamics of the non-traditional, proxied by Portugal, and traditional markets, proxied by France. In our paper we find that the influence of Portugal diminishes over time. On the other hand, the influence of France on Greece does exist in both periods 1 (1994-1999) and 3 (2003-2004), except from the period 2 (2000-2002). However, this influence does not remain constant in periods 1 and 3. In period 1 France exercises higher influence (in terms of the long run multipliers) but the dynamic adjustment is relatively slow. On the other hand, in period 3 France shows lower influence than in period 1 but faster dynamic adjustment. This means that news from the traditional markets are incorporated faster in period 3, an indication of higher degree of integration.

Finally, our results indicate that both French and Portuguese stock markets are acting as one month leading indicators of the Greek market, i.e. any information from these stock markets is transferred to the Greek market one month later.

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