«ΣΠΟΥΔΑΙ», Τόμος 57, Τεύχος 2ο, (2007) / «SPOUDAI», Vol. 57, No 2, (2007), University of Piraeus pp. 119-135

IMPACT OF INTERNATIONAL VOLATILITY AND THE INTRODUCTION OF INDIVIDUAL STOCK FUTURES ON THE VOLATILITY OF A SMALL MARKET

By

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Abstract

This study analyzes the effect of individual share futures as well as the international volatility spillover on the Greek market. We have found that individual share futures have had a beneficial effect on the volatility of the underlying stocks in various ways. We have also concluded that stock returns in the Greek market receive a mean spillover effect from the major markets of the European Union, from the U.S. and Japan markets and volatility spillover only from the major markets in the E.U. The methodology employed is the capturing asymmetries model proposed by Glosten et al. (1989) (GJR) and the period analyzed covers from August 1997 to January 2006.
JEL Classifications: G14, G15, C22.
Keywords: volatility, futures, spillover effects.

1. Introduction

The issue of stock price volatility has been the object of extensive research in the recent years in all major markets. However, we are not aware to what extent the results deriving from studies concerning big and highly liquid markets may be applicable to small size ones as the Greek market. Moreover, most of the research, focusing on index analyses resulting in not taking into consideration the special characteristics of specific shares, which very likely play a significant role in the formation of their volatility. In this article, we try to raise some analytical and methodological issues concerning the volatility study of particular shares. We also analyze the effect of derivatives on the FTSE/ASE 20 volatility, in order to obtain comparative results and to better comprehend the role of individual share futures (ISF).

The international literature references to the individual stock future (ISF) effects on the volatility of the underlying stocks are limited because their introduction as financial tools took place recently beginning in May 1994 in the Australian market, while the countries which have adopted them up to now are only five (Australia, U.K., Hong Kong, Sweden and Greece). Lee and Tong (1998) analyzed the effect of seven ISF contracts in the Sydney Futures Exchange (SFE) in their underlying shares for the period 1990-1995. The results of the study showed that the role of the ISF contracts was beneficial for the SFE market. In fact, they noticed an increase in the trading of the ISF underlying shares whereas they presumed that their volatility rather decreased than increased after the ISF introduction. Following them Dennis and Sim (1999) examined the role of nine ISF contracts of SFE for shorter period through 1993- 1995. From their study results, it is concluded that the volatility remains unaffected by the introduction of the ISF[1]. For the same market Mckenzie et al. (2001) studied the ISF impact for the period 1990-1998 and claimed that their introduction decreased the unconditional volatility of the underlying shares while the conclusions for the asymmetry were contradictory. Finally, Mazouz and Bowe (2005) investigated twenty one (21) ISF contracts in the LIFFE (London International Financial Futures and Options Exchange) for the period 2001 – 2002 (400 data) and reached similar conclusions with the above researchers. In fact they supported that the ISF introduction not only lowered the volatility of the underlying shares but yielded more rapid and effective valuation at the same time.

The contribution of this study to the international literature is attributed to the following. Firstly, the greatest part of the international literature renders conclusions for the large international markets (U.S., U.K., Japanese, German, etc.) while our study concerns a small European market with the particular characteristics of this category (liquidity, market depth, size, etc). Secondly, the majority of researchers has examined the volatility indexes while the present study concerns the company volatility with specific characteristics which probably play a determining role in the volatility formation. Furthermore, the stock futures[2] in such a small market are analyzed for the first time and consequently useful conclusions can be drawn for their actual effects[3] on other small markets as well. Lastly, the analysis in a share level renders a different dimension to the futures effect, as the underlying asset is traded in the underlying market in contrast to the future index.

2. Data – Variables

The Greek derivatives market began its operations in 1999. In the mid-2002, Athens Derivatives Exchange S.A. (ADEX) and Athens Stock Exchange S.A. (ASE) merged thus forming Athens Exchange S.A. ADEX (Athens Exchange Derivatives Market) which is the fully electronic derivatives market of Greece. The product range of the ADEX includes index futures and options on the blue chip FTSE/ASE-20 and the mid-cap FTSE/ASE Mid 40 stock indices, stock futures, stock repo and stock reverse repo contracts and repurchase agreements. The FTSE/ASE-20 index includes the twenty shares with the highest capitalization trading in the Athens Stock Exchange. It is the first index that has been used as the underlying instrument for futures and options trading in the ADEX. The FTSE/ASE-20 stock index futures have been launched in ADEX on August 27, 1999. It is a broad-based index, with emphasis on banking stocks *(Table 1)*. The ASE currently has ISF contracts trading on 21 individual stocks, which fulfill certain free float and turnover criteria, as defined by the Derivatives Market. Each ISF contract represents 100 shares of the underlying stock. Three expirations are always available for trading, from the March, June, September and December cycle. Expiration day is the 3rd Friday of the expiration month. In November 2001 ISF trading was introduced in the underlying shares of the National Bank of Greece (ETE), the Hellenic Telecommunication Organization (OTE), the Coca Cola EEE S.A. (EEEK) and the Panafon S.A.(PANF). In April 2002 ISF trading began in two more shares of the Alpha Bank S.A. (ALPHA) and the Intracom S.A. (INTKA), and finally in 2004 and 2005 ISF trading in 15 other stocks was introduced. These last 15 shares were exempted from the analysis as the available data were very limited. Besides, PANF was also exempted because its withdrew from the ASE in 2004.

The data concern the daily prices of the ETE, OTE, EEEK, ALPHA and INTKA shares *(Table 2)*, and cover the period from 23 August 1997 to 17 January 2006. They are all constituents covering over 45% of the FTSE/ASE-20 index.

Also, we analyzed the daily prices of the FTSE/ASE 20 index for comparison with the under study shares. In addition indexes DAX30, CAC40, DJ and NIKKEI 300 were used for isolating the impact of international systematic factors. DAX30 and CAC40 indexes were used to isolate the systematic factors which concern the E.U., while DJ and NIKKEI300 indexes were used to isolate general international factors. In the continuation of the analysis we concluded, as it was expected, that the two indexes DAX30 and CAC40, correlate to a great extent and as a result the use of both does not offer any additional information. The data of the under research stocks had a “slightly” better respond to the CAC40 index, therefore, the DAX index was not used to reach the final conclusions. Moreover, in a preliminary examination of the simple returns of the DAX30, CAC40 and NIKKEI300 indexes, we ascertained an effect of their contemporaneous returns on the returns of the above mentioned stocks, while for the DJ index a lag effect was ascertained.

Furthermore, concerning the equation of variance, we found that the volatility of the underlying shares was significantly affected by the volatility of the CAC40 index whereas it did not correlate to the respective ones of the DJ and NIKKEI300 indexes. It should be noted that in a 5 % significance level we could not reject the assumption of zero mean for the return series of CAC40[4], a fact implying $\sum(R_i - \overline{R})^2 = \sum R_i^{\ 2}$. Therefore, the squared returns of the CAC, CAC2, for the estimation of the impacts of the international systematic factors[5].

The data were obtained from the Comstock database and the ASE, while the daily returns are defined as the natural logarithm of the ratio of the daily closing prices Rit = ln (pt /pt-1).

3. Methodology

Table 3 presents the basic statistics of the returns series from all five stocks and the FTSE/ASE 20 index used for the examination of the deviation from normality in the unconditional distribution and the indication of the amount of dependence in the first and second conditional moments. The mean returns of all series of returns are statistically not different from zero. All series are leptokurtic denoting that all series have a thicker tail and a higher peak than a normal distribution. FTSE/ASE 20 presents the highest kurtosis price while INTKA the lowest one, though higher than the fairly kurtosis of the normal distribution and therefore, the prices of the Jarque–Bera statistics are also high indicating the rejection of the normal distribution for all the series. Regarding asymmetry, it was observed in all series, especially in the series of ETE, ALPHA and INTKA. The Ljung-Box statistic for 6 and 12 lags applied on returns and squared returns indicate that significant linear and nonlinear dependencies exist. Also, the hypothesis of a unit root in the return series is strongly rejected by the Dickey Fuller test. Therefore, return series follow a stationary process even though they fail to be i.i.d. because of the presence of first and second moment dependencies.

The model we suggest is the autoregressive conditional heteroskedasticity (ARCH) family, introduced by Engle (1982) and its extension to the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) (Bollerslev, 1986) as it imposes an autoregressive structure on the conditional variances allowing volatility shocks to persist over time. An important weakness of the ARCH and the GARCH model though, is that they are accounting for the volatility reactions in positive and negative changes (shocks) in a symmetric way. A solution was given by the asymmetric models which are capable of capturing the asymmetric features of the data. The asymmetric model we employed to carry out our analysis is the GJR-GARCH by Glosten et al. (1993). The GJR-GARCH model was used not only for the study of the stock index volatility (Engle and Ng, 1993[6]; Brailsford and Faff, 1993; Antoniou et al., 1998; Pan and Hsueh, 1998; Gulen and Mayhew, 2000[7]; Tay and Zhu, 2000; Pillar and Rafael, 2002; Bologna and Cavallo, 2002) but also of individual stocks (Mckenzie et al., 2001; Lien and Yang, 2003; Mazouz and Bowe, 2005; Connolly and Stivers, 2005). The specification suggested for the definition of the mean equation is:

$$R_{it}=b_1D_M+b_2D_{TU}+b_3D_w+b_4D_{TH}+b_5D_{FR}+b_6R_{it-1}+b_7CAC_t+b_8DJ_{t-1}+b_9NI_t+u_t$$

Appropriate specification of the augmented GJR-GARCH(p,q) model was based on the LR test[8] and the preliminary analysis of the under study returns series.

The augmented GJR-GARCH(p,q) model was initially specified as

$$\sigma_{it}^2 = a_0 + a_1u_{t-1}^2 + a_2S_{t-1}^-u_{t-1}^2 + a_3\sigma_{t-1}^2 + c_1ISF_t + c_2ISF_tu_{t-1}^2 + c_3ISF_tS_{t-1}^-u_{t-1}^2 + c_4ISF_t\sigma_{t-1}^2 + \gamma_1CAC_t^2$$

$u_t \sim GED(0, \sigma_t^2)$,

$S_{t-1}^- = 1$ if $u_{t-1}<0$

$S_{t-1}^- = 0$ otherwise

where i=FTSE/ASE 20, ETE, OTE, EEEK, ALPHA and INTKA

where $ISF_t=D_t$ for the FTSE/ASE 20

The total variables and parameters used for the definition of the mean and variance equations are

- D_M, D_{TU}, D_w, D_{TH} and D_{FR} dummy variables for the daily seasonality test in the mean equation.
- CAC^t a variable reflecting the returns of the French market and indirectly the European systematic factors, while at the same time it represents the information received by the investors in the Greek market from the contemporaneous price variations in the main markets of European Union (EU).

- DJ_{t-1} a variable which reflects the returns of the U.S. leading market in the international financial fixation and represents the information the investors receive from the closing of the U.S. market the previous day.
- NI_t a variable which reflects the returns of the Japanese leading market in Asia and represents the information the investors receive from its closing before the opening of the ASE.
- b_i constant parameters.
- u_t residuals we assume follow the GED (generalized error distribution). We employ GED because of its ability to accommodate fatter tails and peakedness.
- u^2_{t-1} information regarding to the volatility of the previous period.
- $S^-_{t-1}u^2_{t-1}$ information regarding to the leverage ($\alpha 3>0$) and the asymmetry ($\alpha 3 \neq 0$).
- σ^2_{t-1} volatility estimation of the t-1 period with the adopted model.
- α_0 the permanent variance component or long term average volatility.
- α_1 the coefficient which correlates the price variation of the present day to the price variation of the previous day and therefore reflects the information (news) impact of the previous day.
- α_2 the coefficient that allows the conditional variance to respond asymmetrically to positive and negative values. If the volatility is differentiated significantly due to the negative returns, the coefficient α_2 will be statistically important.
- α_3 the coefficient that indicates the effect of σ^2_{t-1} conditional volatility at the time t-1 on σ^2_{t-1} at time t. The volatility σ^2_{t-1} in the GARCH model is a function of residuals u_{t-2},u_{t-3} ... which meaning that older news than that of the previous day.
- ISF_t a variable which estimates the relative ISF significance on the trading of the underlying shares in the spot market. At the time we have ISF trading the variable equals the ISF volume quotient to the volume of the underlying shares in the spot market. In this way we have the relative significance of the futures, a fact consistent to Aggarwal (1988) and Rahman's (2001) view that the futures impact possibly doesn't take place in the first period of their trading, due to relatively low volume of trading. As far as the FTSE/ASE 20 index is concerned, the futures impact was measured with a simple dummy variable (Dt) because there is a variety of products in the FTSE/ASE 20 (options, futures and ISF in most shares in the index) with different introduction dates.

- c_1 the coefficient that indicates the change in the mean level of volatility after the stock index derivatives and individual share future (ISF) are listed respectively. The negative sign is interpreted as a decrease at the unconditional volatility due to futures impact news and ISF respectively.
- c_2 the coefficient that indicates the structural change in the first autoregressive structure of the squared residuals of returns volatility after the introduction of ISF. The positive coefficient is interpreted as a higher speed incorporation of recent news into the share prices.
- c_3 the coefficient that correlates the alteration of asymmetry due to the introduction of derivatives into the index and the introduction of the ISF into the shares.
- c_4 the coefficient that indicates the structural change in the effect of σ^2_{t-1} conditional volatility at time t-1 on σ^2_{t-1} at time t. If the coefficient appears with a negative sign then the conclusion is that volatility shocks are more quickly digested and reflected in the stock market after the introduction of ISF. If c4 is interpreted as the impact of old news on the stock price, then if ISF increases the speed at which the price adjusts to information, we expect ISF to reduce uncertainty concerning old news and, consequently, to reduce the impact of old news on today's price change. The stock market has become more efficient because volatility shocks (information packets) are more quickly assimilated.
- CAC_t^2 the variable which reflects the French market volatility and indirectly the news volatility that the investors in the Greek market receive from the volatility in the main EU stock markets.

In *Table 4,* concerning the conditional mean equation, we observe the day of the week effect in all return series apart from the one that concerns the ALPHA company, specifically significant negative Monday effects are found in the returns of the FTSE/ASE 20, OTE, EEEK and the INTKA while significant positive effects are found for Wednesday in the returns of the FTSE/ASE 20, ETE and EEEK, for Thursday in the returns of the EEEK and INTKA and for Friday in the returns of the FTSE/ASE 20, ETE, OTE and INTKA. Evidence of seasonality in the Athens Stocks Exchange have been found by many researchers (Alexakis and Xanthakis, 1995; Coutts et al., 2000; Mills et al., 2000; Drimbetas et al., 2007). We also observe statistically significant positive autocorrelation in the first lag of return series of the FTSE/ASE 20, ETE, ALPHA and INTKA. In addition, regarding the impact of the European market-wide trends, we observe a positive contemporaneous mean spillovers from the markets of the European

Union (coefficient of CAC) in the returns of all series. Finally, the results for the other systematic factors indicate positive contemporaneous mean spillovers from Japan (coefficient of NIKKEI) to all returns series and positive but with lag mean spillovers from the markets of the U.S. (coefficient of DJ 0.174) again to all returns series.

In *Table 5*, we present the parameters of variance equation which proved to be statistically significant during the estimation process; insignificant terms of the augmented GJR-GARCH(1,1) are eliminated. We observe that the $\alpha 1$ coefficient, which relates the impact of yesterday news on today's price, ranges between 0.086 and 0.2787, prices relatively lower than those of the $\alpha 3$ coefficient (0.54 - 0.87) which is interpreted as the impact of old news on the stock price, thus the Greek market is characterized from slow information (news) incorporation in the stock prices. The α_2 coefficient, which captures the asymmetry, appeared statistically significant only for the returns of the FTSE/ASE 20 and INTKA revealing that negative and positive shocks have the same effect on the returns volatility of the ETE, OTE, EEEK and ALPHA and therefore they are satisfactorily described with the GARCH(1,1) model. The coefficients c_1, c_2, c_3 and c_4 measure the impact of derivatives in the case of the FTSE/ASE 20 and the specific ISF in the case of stocks. The coefficient c_1, which measures the differential impact of derivatives and ISF on the mean level of conditional volatility, is negative for the FTSE/ASE 20, OTE and ALPHA providing evidence that the mean level of their conditional volatility decreases after the introduction of derivatives and ISF respectively. Consequently their role may be characterized as stabilizing and therefore beneficial. The coefficient c_2, which tests for changes in the size of previous residuals, has not been found statistically significant in any case. The coefficient c_3, which measures the change in asymmetries, was tested only for the FTSE/ASE 20 and INTKA which presented evidence of asymmetric responses of volatility to news (significant coefficient α_3). The results showed that the value of the c_3 coefficient is statistically significant only for the INTKA where the decrease of volatility was certainly substantial. Also, the statistical significance of the negative coefficient c_4 for the ETE and EEEK stocks means that the volatility shocks are more quickly digested and reflected in the stocks after the ISF are introduced[9]. Finally, the coefficient γ, which captures the European Union market volatility spillover effect, as it is reflected in the CAC[2] in the Greek market, is statistically significant in all cases, thus, the CAC index returns shocks appear to contain important incremental information not only for market level but also for stock level conditional volatility. The major markets of the EU (France, Germany) start trading before the opening of the ASE and close after its closing and consequently the information the investors in the Greek market receive about the fluctuations in the EU markets is dynamic over time resulting in volatility spillovers from these European Union markets to the Greek market. On the contrary, the U.S. and Japanese markets close before the ASE opening, as a result the information received by investors in the Greek market, is static and consequently it only affects the mean equation.[10]

From the residuals diagnostic test it is ensued that the GARCH model which we adopted in each case, can satisfactorily describe the first and second moments of the return series under examination. The Ljung – Box test statistics of the standardized and squared standardized residuals denoted by LB(12) and $LB^2(12)$, are lower by their critical values at the five percent level *(Table 6)* a fact that allows us to conclude that there was no autocorrelation left after the adoption of the AR(1) in the mean equation and at the same time the autocorrelation of the second moment disappears when the conditional variance is assumed to follow appropriate specified GARCH(p,q) process. Furthermore, absence of serial correlation in the standardized squared residual implies the lack of need to encompass a higher order ARCH process verifying the LR test for the employment of the appropriate GJR-GARCH(p,q) model. Furthermore, the correct specification of the conditional variances equation is tested by the Lagrange multiplier test on the squared residuals for 4 lags showing again no ARCH remaining structure *(Table 7)*. Finally, the estimation of the tail thickness regulator for the under examination returns series with prices $v<1.5$ (parameter v for tail thickness with standard error around 0.065), clearly indicates the rejection of the normal assumption (i.e $v=2$)[11] and proves the financial theory about thick tails in the stocks returns and thus the adoption of GED residuals.

4. Conclusion – Discussion

The present study aims at the analysis of the effects of the ISF introduction on the volatility of the underlying shares of the Greek market in the international environment of mean and volatility spillover from major markets to small ones. The application of the GJR-GARCH (1,1) model, showed that daily stock returns at both the index and firm level exhibit conditional heteroskedasticity. In fact, it was observed that the impact of 'old' news (α_3) is higher than the current news (α_1) on conditional volatility. As regards that asymmetry though, it was observed only in the index level and as well as in the INTKA share which has the lowest capitalization of all the examined ones. Presumably, the strong interest of foreign and Greek institutional investors in the biggest companies

(ETE, OTE, ALPHA, EEEK, *Table 8*), reduce the percentages of noise traders, the majority of which are Greek small investors, resulting in the more rational handling of news and therefore the asymmetry elimination. Besides, Antoniou et al. (1998) applying the GJR-GARCH (1,1) model claimed that in countries where the participation of foreign investors is lower, the asymmetries are higher (Japan, Germany and Switzerland in relation to UK and US), behind the same rationale shares attracting a keen interest of foreign investors present a limited asymmetry compared to the others.

Thereinafter of the study, we examined the impact of ISF on the volatility of the underlying shares. For the reliability of the conclusions we modified the dummy variable so that it depends on the relative volume of ISF[12]. ISF constituted an innovative product for the ASE and many market participants doubted for their effectiveness in a small market. Nevertheless, the empirical conclusions in part III showed that the role of ISF was beneficial. Specifically, the mean level of volatility decreased in the OTE, ALPHA and FTSE/ASE 20. In addition, the introduction of ISF rendered the shares of ETE and EEEK more efficient because volatility shocks (information) are more quickly assimilated to these stocks.[13] Eventually, in regard to the asymmetric reaction in volatility to positive and negative shocks of the FTSE/ASE 20 and INTKA, the results showed that the derivatives did not change it on the index level whereas the ISF lowered it in the case of INTKA. Overall, the introduction of ISF has had a stabilizing impact on the Greek market and has improved its valuation. This result can be attributed not only to the potentialities offered by the specific characteristics of ISF but also to the information which the investors of the underlying market possibly obtain from their trading. The well informed investors, as well as the insiders, are possibly stronger participants in ISF as they are firstly given the opportunity to increase their leverage[14] and secondly to take short positions[15] thus exploiting their information to utmost. Lastly, we concluded that the volatility in the Greek market depends on the shocks of the major markets in the EU. The dissemination of volatility from market to market and obviously to the shares respectively was satisfactorily explained by King and Wadhwani (1990), who attributed it to the fact that the investors have access to various information and consequently are in a position to draw useful information from the price volatilities in other markets. The news for the course of global economy is better reflected in the financial indexes of the U.S., however, with the operation closing of its markets and the opening of the main Asiatic stock markets, Japan (NIKKEI) takes the lead and reflects with the best possible way the news of the global economy, and certainly the opening of the EU major' markets and their fluctuations reflect the impact of volatility of global economy's information (news). The returns of the Greek market are naturally affected by the systematic factors of the global economy but its volatility is merely affected by the volatility of the major markets of the EU. The consequences of the fluctuations of the main EU stock markets to the ASE is attributed mostly to the almost common trading hours and are applified by the fact that their economies are considered more representative for the European Union fundamentals as leading economies in the Eurozone.

Notes

1. Specifically, Dennis and Sim found volatility due to ISF, increased for two shares, decreased for one and unaffected for six.

2. The rest of the markets including stock futures trading, are those of Australia, U.S., U.K., Hong Kong, Sweden, etc.

3. Options are not traded in the underlying shares of Greek stock futures.

4. Many researchers agree on the hypothesis of zero mean (Day and Lewis, 1992; Chan et al., 1995; West and Cho, 1995; Brooks 1998) however, the volatility estimation does not depend to a great extent on the mean because bias is respective to the $\frac{(\hat{\mu}-\mu)^2}{N^2}$ which is equal with a small value, especially in the case where the mean estimation doesn't include a significant error and the data is extensive (Figlewski 1997).

5. Volatility estimation with the particular technique is consistent with the international literature (Brooks, 1998; Cristensen et al., 2002)

6. According to Engle and Ng (1993), who analyzed various models for the daily Japanese stock returns, the best parametric model is the GJR-GARCH one.

7. Gulen and Mayhew (2000) examined different GARCH models using data of 25 markets and concluded that GJR-GARCH model was the optimum one.

8. The GJR-GARCH model, before being adopted, was tested with alternative GJR-GARCH(p,q) using the likelihood ratio (LR) test. Complete estimation results are available upon request from the authors.

9. The Conditional volatility σ^2_t is based upon the conditional volatility σ^2_{t-1} which is function of (residuals) u_{t-2},u_{t-3}..., previous information packets meaning that its reduction is interpreted as a reduction of volatility persistence.

10. Further test in order to ascertain the spillover effect from those markets to the OTE share found negative. Complete estimation results are available upon request from the authors.

11. A LR test of the restriction v=2 against the unrestricted model, according to Table 7, clearly supports this conclusion.

12. The use of simple dummy variables always includes the risk to reflect reactions of other events (for example derivatives on index) that may taken place a little before or a little after the even in question.

13. The application of the GARCH-GJR(1,1) model in the EEEK just for the ISF trading period from November 2001 – January 2006 resulted in a statistically significance of the u^2_{t-1} only but in on significance GARCH σ^2_{t-1} term.

14. The value of position is almost 5.5 times the spent leverage margin.

15. Short selling presupposes the share loan through reverse repo, which entails the demand of the margin up to 150% of the value of position and the payment of a daily interest which reduce the final profit.

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Appendix

TABLE 1

Percentage of participation in the FTSE/ASE 20 index

Name	% Weight in the Index
Agricultural Bank of Greece	1.48
Alpha Bank AE	12.762
Coca-Cola Hellenic Bottling Co SA	3.495
Cosmote Mobile Telecommunications SA	3.64
EFG Eurobank Ergasias SA	11.075
Emporiki Bank of Greece SA	3.947
Folli - Follie SA	0.58
Germanos SA	1.544
Hellenic Duty Free Shops SA	0.36
Hellenic Petroleum SA	1.963
Hellenic Telecommunications Organization	9.664
Hyatt Regency SA	0.694
Intracom Holdings SA	0.809
Motor Oil Hellas Corinth Refineries SA	1.393
National Bank of Greece SA	19.529
OPAP SA	11.297
Piraeus Bank SA	7.597
Public Power Corp	3.132
Titan Cement Co SA	3.276
Viohalco	1.766

TABLE 2

Symbol and Activity Sector των ISF στο Χ.Α.

Symbol	Stock name	Activity Sector
ALPHA	Alpha Bank S.A. (CR)	Banks
EEEK	Coca-Cola Hellenic Bottling Company S.A. (CB)	Beverages
ETE	National Bank of Greece S.A. (CR)	Banks
OTE	Hellenic Telecommunications Organization S.A. (CR)	Telecommunications
INTKA	Intracom S.A. (CR)	Electronic equipment

TABLE 3

Sample statistics for daily returns

	FTSE 20	ETE	OTE	EEEK	ALPHA	INTKA
Mean	0.000373	0.00067	-0.000016	0.00017	0.0004	0.000044
Std. Dev.	0.0178	0.0229	0.0210	0.0223	0.0228	0.0290
Skewness	0.0720	0.3475	0.0593	0.0418	0.3339	0.1454
Kurtosis	6.2780	5.4688	5.1335	5.6108	5.0894	4.4289
Jarque-Bera	932.59	569.79	395.50	591.04	416.79	184.19
Augmented Dickey-Fuller	-38.83	-37.65	-41.43	-41.77	-40.02	-41.11
LB(6)	55.563	92.841	21.551	36.339	40.183	25.155
LB(12)	61.555	103.19	30.917	39.345	49.548	29.548
$LB^2(6)$	420.16	331.9	88.595	403.73	392.03	235.44
$LB^2(12)$	513.01	388.35	107.66	487.05	475.19	291.54

LB(6) and LB(12) are the Ljung-Box statistics applied on returns and squared returns.
H LB(n) follow the X^2 (chi-square) distribution with n degrees of freedom.
The sample concerns 2079 daily returns. The basic assumption of white noise is rejected.

TABLE 4

Mean Equations

$Rit=b_1D_M+b_2D_{TU}+b_3D_W+b_4D_{TH}+b_5D_{FR}+b_6Rit\text{-}1+b_7CACt+b_8DJt\text{-}1+b_9NIt+ut$

	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9
FTSE 20	-0.0009***	0.00065	0.0013***	0.0013	0.0022*	0.1015*	0.1727*	0.3014*	0.0632*
	(0.0005)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0216)	(0.0277)	(0.0209)	(0.0199)
ETE	-0.00098	0.00015	0.0018***	0.0010	0.002***	0.12*	0.278*	0.235*	0.073*
	(0.00079)	(0.00110)	(0.0011)	(0.0011)	(0.0011)	(0.02)	(0.027)	(0.0356)	(0.027)
OTE	-0.00214*	0.00145	0.0017	0.0018	0.0032*	0.0334	0.2513*	0.2317*	0.0934*
	(0.00083)	(0.00115)	(0.0012)	(0.0011)	(0.0012)	(0.0210)	(0.0295)	(0.0378)	(0.0282)
EEEK	-0.00138**	0.00062	0.0021**	0.0022**	0.0014	0.0184	0.2577*	0.1449*	0.0421**
	(0.00076)	(0.00106)	(0.0011)	(0.0011)	(0.0010)	(0.0221)	(0.0227)	(0.0333)	(0.0244)
ALPHA	-0.00090	0.00022	0.0013	0.0008	0.0018	0.0840*	0.3309*	0.2053*	0.0728*
	(0.00082)	(0.00115)	(0.0012)	(0.0012)	(0.0012)	(0.0216)	(0.0279)	(0.0353)	(0.0282)
INTKA	-0.00331*	-0.00006	0.0018	0.0034**	0.0054*	0.0526**	0.3548*	0.2197*	0.1284*
	(0.00113)	(0.00159)	(0.0016)	(0.0016)	(0.0016)	(0.0222)	(0.0343)	(0.0478)	(0.0383)

Notes: Standards errors are shown in parenthesis.
* indicates statistical significance at the 1% level.
** indicates statistical significance at the 5% level.
*** indicates statistical significance at the 10% level.

TABLE 5

Variance Equation

	α_0	α_1	α_2	α_3	c_1	c_2	c_3	c_4	γ
FTSE20	0.000038*	0.1045*	0.094*	0.7758*	-0.0000294*	-	-	-	0.024*
	(0.000009)	(0.0205)	(0.03)	(0.0268)	(0.0000077)	-	-	-	(0.008)
ETE	0.000016*	0.0879*	-	0.871*	-	-	-	-0.253***	0.0220**
	(0.0000053)	(0.017)	-	(0.0229)	-	-	-	(0.14)	(0.010)
OTE	0.0000282*	0.0948*	-	0.8093*	-0.000035***	-	-	-	0.0565*
	(0.0000084)	(0.0206)	-	(0.0364)	(0.00002)	-	-	-	(0.0195)
EEEK	0.0000889*	0.2787*	-	0.5392*	-	-	-	-0.757*	-
	(0.0000142)	(0.0458)	-	(0.0531)	-	-	-	(0.0692)	-
ALPHA	0.0000327*	0.1614*	-	0.7558*	-0.000058*	-	-	-	0.0398**
	(0.0000084)	(0.0238)	-	(0.0310)	(0.000021)	-	-	-	(0.0157)
INTKA	0.0000713*	0.0860*	0.123*	0.7791*	-	-	-0.38*	-	-
	(0.0000175)	(0.0220)	(0.04)	(0.0384)	-	-	(0.12)	-	-

Notes: Standards errors are shown in parenthesis.
* indicates statistical significance at the 1% level.
** indicates statistical significance at the 5% level.
*** indicates statistical significance at the 10% level.

TABLE 6

Diagnostics on standardized and squared standardized residuals

Statistics	FTSE 20	ETE	OTE	EEEK	ALPHA	INTKA
LB(12)	13.291	19.865	17.67	15.661	11.191	11.165
$LB^2(12)$	6.9647	11.397	9.6457	13.671	8.2734	3.7824
N^*R^2 (ARCH–LM Test)	2.410028	3.662814	5.808919	3.530162	0.83946	0.798842

Notes: LB(12) and LB2(12) are the 12th-lag Ljung-Box test statistics applied to the original and squared standardized residuals. The ARCH–LM Test concerning four lags in the residuals of the means equation.

TABLE 7

Estimation results for GED parameter

	FTSE 20	ETE	OTE	EEEK	ALPHA	INTKA
GED parameter	1.47	1.24	1.34	1.24	1.45	1.40
Standard errors	0.057	0.0569	0.05	0.047	0.059	0.054

TABLE 8

FTSE/ASE index by capitalization 17/01/2006

Name	Capitalization
National Bank of Greece SA	12,662,856,073 €
OPAP SA	9,991,080,000 €
EFG Eurobank Ergasias SA	9,833,642,526 €
Hellenic Telecommunications Organization	8,732,375,246 €
Alpha Bank AE	8,369,191,694 €
Cosmote Mobile Telecommunications SA	6,476,642,220 €
Coca-Cola Hellenic Bottling Co SA	6,070,868,087 €
Agricultural Bank of Greece	4,943,726,664 €
Public Power Corp	4,565,760,000 €
Piraeus Bank SA	4,237,244,958 €
Hellenic Petroleum SA	3,795,828,283 €
Emporiki Bank of Greece SA	3,770,509,009 €
Titan Cement Co SA	2,533,118,412 €
Motor Oil Hellas Corinth Refineries SA	2,457,166,496 €
Viohalco	1,635,687,546 €
Germanos SA	1,344,364,240 €
Hyatt Regency SA	932,400,000 €
Intracom Holdings SA	916,186,229 €
Hellenic Duty Free Shops SA	859,656,000 €
Folli - Follie SA	773,592,625 €