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THE EFFECT OF THE INTRODUCTION OF DERIVATIVES ON THE SYSTEMATIC AND UNSYSTEMATIC RISK IN THE GREEK EQUITY MARKET

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Abstract

This paper contributes to the growing literature on the effects of derivatives on less mature markets by providing evidence on the stabilizing or destabilizing effects of derivatives on a small, less liquid stock market which only recently was removed from the major securities houses emerging markets list. After isolating the effects of derivatives introduction on the structure and characteristics of volatility from other unrelated to derivatives causes, we find clear evidence of a reduction in the systematic risk (beta) of the stocks underlying the futures and options contracts traded in the Greek Derivatives Exchange after derivatives begun trading. The empirical evidence also suggest that the introduction of derivatives had little effect either on the unsystematic risk of stocks or the way volatility reacts to bad or good news.

Key words: Derivatives, systematic risk, unsystematic risk, volatility.
JEL Classification: G13, C13.

1. Introduction

The issue of whether the introduction of derivatives destabilizes the underlying cash market has received considerable attention by practitioners, regulators and academics. The debate intensified after the crash of 1987 with many commentators arguing that derivatives and synthetic portfolio insurance strategies were the main cause behind the large fall in stock prices. Existing theoretical models on the stabilizing or destabilizing effects of derivatives reach contradictory conclusions. The considerable empirical research undertaken during the last twenty years on both futures and options provided inconclusive evidence, with some papers supporting the view that derivatives increase volatility while others reaching the opposite conclusion.

Existing empirical studies on the impact of derivatives on spot volatility concentrate largely on the US and developed capital markets. There is relatively less work on the experience from less developed capital markets where the effects from the establishment of derivative markets in less sophisticated, less liquid and less mature markets might be stronger compared to the developed markets. In Greece, the establishment of the Athens Derivatives Exchange and the introduction of the first derivative instrument on August 1999 coincided with an unusual macroeconomic and market environment. In the process of entering the EMU, in which Greece officially became a member in January 2001, interest rates were reduced from 13% at the start of 1997 to about 3% at the end of 2002. During the 1997-1999 period, the Greek stock market attracted a large number of Greek private investors while the possibility that major international index providers will upgrade the Greek stock market from emerging to developed increased the interest of large institutional foreign funds. As result between January 1997 and August 1999 stock prices increased by 514%. Average stock monthly turnover (defined as turnover divided by market capitalization) during 1999 was almost four times greater than the average stock turnover during the 1990's. The rise in stock prices was also accompanied by a significant increase in market volatility. Market volatility, which averaged 25% during 1990-1996, increased to 38% during 1998 and 39% during 1999 and 2000. The crash of stock prices that begun shortly after the Athens Derivatives Exchange and took the Athens Stock Exchange (ASE) general index from 6500 to 1500, led to a popular belief that the introduction of derivatives had a destabilizing effect on the Greek spot market for stocks. This paper investigates empirically whether the structure of volatility of the stocks underlying the futures and option contacts (the FTSE-20 Athens index) traded in the Athens Derivatives Exchange changed as a result of the introduction of derivative products.

The methodology used in existing papers to test whether the introduction of derivatives changes the structure of the spot asset (index or individual stocks underlying the derivative instruments) volatility, usually compares the volatility after the introduction of derivatives with volatility before. This approach, used by most papers in the literature, does not control for exogenous economic or political events which impact volatility but are unrelated to futures trading. To isolate the effect of the introduction of derivatives on volatility the empirical design should control for other causes of volatility changes. Also focus on the effects on total volatility can miss the possible effects that the introduction of derivatives might have on its components.

The contribution of this study on the existing empirical literature is threefold. First, to isolate the effect of the introduction of derivatives on volatility we use a control methodology in the spirit of that used by Harris (1989) and McKenzie, Brailsford and Faff (2001) by creating a portfolio of non-FTSE20 stocks with similar sector exposure as the FTSE-20 index. Tests on the effect of derivatives on volatility are based on the differences in response of the FTSE-20 index and the non-FTSE-20 portfolio. Second, we provide evidence on the effect of derivatives on the total, systematic and unsystematic risk of the stocks underlying the FTSE-20 index. Our empirical evidence suggests that the introduction of futures lowers the unconditional volatility of the FTSE-20 index. The decrease in volatility is partly due to a decrease in the systematic risk (a reduction of beta) of the FTSE-20 index and partly due to a fall in market wide volatility as measured by the broader ASE sixty stocks index. The unsystematic risk of the FTSE-20 stocks was unaffected by the introduction of futures. Third, our paper contributes to the growing literature on the effects of derivatives on less mature markets by providing evidence on the stabilizing or destabilizing effects of derivatives on a small, less liquid stock market which only recently was removed from the major securities houses emerging markets list.

2. Review of Theoretical and Empirical Research

Derivative products (i.e. futures and options) may strengthen the presence of speculative trading, given the nature of their inherent characteristics. Hence, their potential impact can be considered as very closely related to the fundamental issue of whether speculative trading destabilizes asset prices. The important role that speculators play in stabilizing prices by buying when prices are low and selling when prices are high and therefore have a dampening effect on price fluctuations has been recognized long time ago (Adam Smith, 1776 and John Stuart Mill, 1871). Friedman (1953) argued that profitable speculation is only consistent with stable prices and hence speculators will have a stabilizing effect on prices. Contrary arguments suggesting that speculation can be both profitable and destabilizing can be found in Kaldor (1939), Stein (1961), Baumol (1957), and Farrell (1966)[1].

Cox (1976) and Harris (1989) argue that derivative markets by providing more cost effective tools for trading on information will attract well informed speculative traders, will increase market liquidity and will decrease volatility. The opposite argument usually made in the popular press is that derivatives trading by diverting trading from the underlying market could lead to higher volatility (see Skinner, 1989). Additional well informed traders trading low cost derivative instruments will also increase the information available to market participants. In an arbitrage free economy, Ross (1989) shows that more information should lead to higher price volatility. Antoniou, Holmes and Priestley (1998) argue that the introduction of derivatives may also alter the way by which information is disseminated into prices and hence impact not only the level of volatility but also its structure and characteristics.

There are a considerable number of empirical studies that have examined the impact of futures on the underlying spot stock indices. As the review paper of Mayhew (2000) indicates, most of the papers find no significant change in the volatility of the investigated indices in the cash market. On the other hand, Maberly, Allen and Gilbert (1989), Brorsen (1991), Lee and Ohk (1992), Antoniou and Holmes (1995) and Gulen and Mayhew (2000) have reported a volatility

[1] See Mayhew (2000) for a review of the literature.

increase in highly developed markets such as the United States, United Kingdom and Japan. Evidence for the contrary, a reduction of volatility, can be found in the studies of Antoniou, Holmes and Priestley (1998), Salih and Kurtas (1999). In a comprehensive study of 25 countries, including seven from emerging economies, Gulen and Mayhew (2000) found that for the majority of countries volatility decreased or stayed the same after the introduction of stock index futures (with the exception of USA and Japan). For the seven less developed markets, four showed a statistically significant decrease (Chile, Israel, Malaysia and South Africa), while for the remaining three countries (Hungary, Korea and Portugal) the introduction of futures had an insignificant effect. The review papers of Sutcliffe (1997) and Mayhew (2000) give a more detailed overview of the empirical studies on index futures.

There are two basic methodologies that these papers apply to test the effect of futures on the cash index. In the first approach, used by the majority of papers, the volatility of the index before and after the introduction of futures is compared. The tests use either unconditional or conditional (ARCH/GARCH) models to measure stock volatility. The second approach, exemplified by Harris (1989), Kumar, Sarin and Shastri (1995) and Chang, Cheng and Pinegar (1999), compares the volatility of individual stocks within the index (before and after the introduction of futures contracts) against the evolution of volatility in stocks that do not belong in the index and, therefore, are not expected to be influenced by any potential impact of futures trading. McKenzie, Brailsford and Faff (2001) have extended this control methodology by separating the effect on systematic and unsystematic risk for individual stocks whereas firm specific volatility is estimated by using GARCH type models.

The effect of listing individual equity options on both the volatility and systematic risk (i.e. beta) of the underlying assets has also been investigated in a number of studies (see Mayhew (2000) for a review of the empirical evidence). The empirical evidence shows that only Trennepohl and Dukes (1979) and Chaudhury and Elfakhani (1997) find a significant change in the beta of stocks. Moreover, as far as volatility is concerned, only Wei, Poon and Zee (1997) reported an increase. Most other authors found that volatility decreased. However, Lamoureux and Panikkath (1994), Freund, McCann and Webb (1994) and Bollen (1998) argued that these results can be due to the confounding effects of other market-wide events unrelated to derivatives. As a consequence, the need to control for other factors, as in the case of the second approach applied to future contracts, is of critical importance.

In summary, the predictions of the theoretical research on the issue of the effect of derivatives listing on the underlying cash market volatility are conflicting and ambiguous. On the one hand, destabilizing speculation and evolving arbitrage opportunities may increase the volatility of the underlying cash index, especially if the overall market is not liquid enough. On the other hand, the more complete markets that emerge after the introduction of derivatives and the enhanced investment opportunities that are provided (hedging of risk, less need for dynamic trading in stocks), combined with the low transaction costs that trading in derivatives entails, can smooth out fluctuations of spot prices.

3. Data and Timing of Listings

This study uses the daily closing prices of individual stocks, the FTSE-20 index and the Athens Stock Exchange General Index (ASEGI). Daily logarithmic returns for the period of January 1997 to November 2002 are calculated as $r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$ where P_t and P_{t-1} represent the closing price of the stock index under consideration at time t and t-1 respectively. The date on which each derivative product was listed in the Greek market was provided by the Athens Derivates Exchange[2]. The Athens Stock Exchange provided the names and weights of constituents stocks in the FTSE-20 for the time period after the 24th of September in 1997[3]. For the eight months before Sep-

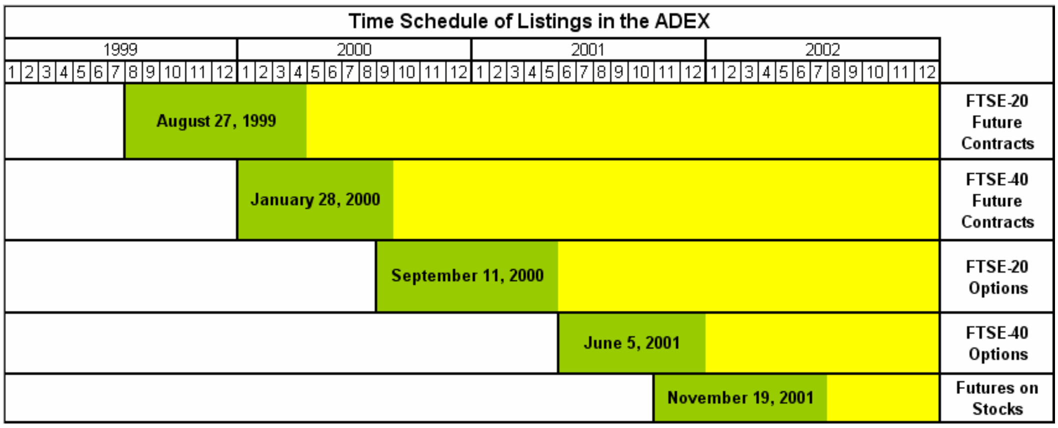
[2] See the ADEX webside (www.adex.ase.gr).
[3] This is the date of the introduction of the FTSE-20 index.

tember 1997 we reconstructed the FTSE-20 index using the weights of the FTSE-20 index as of the 24th of September in 1997. The price data for individual stocks and the sector weights were provided by Effect[4].

The Athens Derivatives Exchange established in 1999, introduced its first product, the FTSE-20 futures contract on the 27th of August 1999. On the 28th of January 2000, the exchange introduced the FTSE-40 futures contract, on the 11th of September 2000 the FTSE-20 options contract and on June 5th 2001 the FTSE-40 options contract. On the 19th of November 2001 it introduced futures contracts on a number of individual stocks. Table 1 shows the time schedule of listing.

Table 1

Time Schedule of Listings in the ADEX



Source: ADEX.

The period under investigation is from January 1997 to November 2002. To study the net effect of derivatives on the underlying index (FTSE-20), the research methodology was designed to control for any other event that might have affected the volatility of the cash market in the same period. In the particular case of Greece, a number of important events that almost coincide with the introduction of derivatives trading, make the importance of creating a control portfolio even more critical.

After the strong stock market performance during 1998 and the first nine months of 1999 the index fell precipitously losing by the end of 2002 more than 75% of its value. In January 2001 Greece entered officially the Euro-zone, switching from Drachmas to € in 2002, and interest rates were reduced considerably. Hence, one might argue that any change in the risk profile (i.e. volatility) of the Athens Stock Exchange, can be partially attributed to these events. Since the FTSE-20 consists of a portfolio of stocks, we follow a similar control methodology to that used by Harris (1989) and McKenzie, Brailsford and Faff (2001).

Our approach is based on the construction of a control portfolio, comprising the largest 120 stocks that were listed in the Athens Stock Exchange and not listed in the Athens Derivatives Exchange, under either future contracts or options. This portfolio is designed to match the FTSE-20 in terms of its exposure to all sectors and is updated on a monthly basis (appendix 1 shows the industrial composition of the nine sectors). Given the large number of stocks included in the portfolio and the importance of sectors in controlling portfolio risk (see Grinold and Kahn, 1999) we expect the portfolio to have minimal tracking error against the FTSE-20 index. This portfolio was used as a benchmark to identify any incremental influence of derivatives trading on the risk of the FTSE-20 stock index. Daily continuously compounded returns are calculated based on the daily returns of all listed stocks and their corresponding (monthly) weight in the portfolio for the entire time period (January 1997 to November 2002).

[4] Effect is a financial information company providing stock market data to Greek and foreign investors.

A few months after the introduction of futures on the FTSE-20, future contracts on the FTSE-40 were also listed. Hence, from January 2000 the control portfolio needed to exclude all constituents stocks of the FTSE-40 so as to ensure that it still controls for any other market-wide movement except the potential impact of futures.

The individual stock weights in the control portfolio were chosen so as to minimize the sum of the absolute differences in sector exposures between the FTSE-20 and the control portfolio:

$$Matching \quad error = \sum_{i}^{factors} | \exp^{i}_{FTSE-20} - \exp^{i}_{control} |, \tag{1}$$

where $\exp^{i}_{FTSE-20}$ represents the exposure of the FTSE-20 to sector *i* and $\exp^{i}_{control}$ the exposure of the control portfolio to sector *i* (for *i*=1 to 9). The control portfolio had to exclude after January 2000 the 60 largest capitalization stocks in the Athens Stock Exchange since the FTSE-40 was also listed in the Athens Derivatives Exchange. The resulting time series of matching errors had an average value of 0.000192 and a standard deviation of 0.000868.

The matching algorithm described above chose predominantly large capitalization stocks. The correlation of the daily control portfolio returns with the FTSE-20 was 0.79 and its daily standard deviation of returns 2.28%. For the same period, the FTSE-20 had a daily standard deviation of 2.04%. We also run the matching algorithm but with the weights in each sector equally weighted. Under this alternative the control portfolio daily returns were slightly more correlated than before with the FTSE-20 (correlation was 0.83) and had a slightly lower daily standard deviation of returns (2.15%). The control portfolio used in this study is based on the second method.

4. Testing Methodology

Following Lee and Ohk (1992), Robinson (1994), Antoniou and Holmes (1995), Pericli and Koutmos (1997), Antoniou, Holmes and Priestley (1998) and McKenzie, Brailsford and Faff (2001) we model conditional volatility as a GARCH process (Engle 1982; Bollerslev, 1986). To allow asymmetric effects of good news and bad news on volatility we use the model developed by Glosten, Jagannathan and Runkle (GJR,1989), a variant of the standard GARCH model, that allows for asymmetric responses of volatility to news. The Glosten, Jagannathan and Runkle (GJR,1989) can be used to test whether total volatility has changed as a whole but also to examine if there is any structural change in the way that information is disseminated into prices. Engle and Ng (1993) claim that the GJR model captures the asymmetries of the Japanese stock index more accurately than the E-GARCH model. Gulen and Mayhew (2000) report superior performance of the GJR model in their study regarding the effect of stock index futures on volatility.

The research methodology is designed to examine two issues: (a) the effect of derivatives on the total volatility of the FTSE-20 index, and (b) the effect of derivatives on the systematic and unsystematic risk of the FTSE-20 index. To accomplish (a) we model the total volatility of both the FTSE-20 and the control portfolio using the GJR model and examine the effect of the introduction of derivatives on the unconditional volatility and asymmetric response to news. Any differences in the results that arise from the two portfolios can be attributed to the introduction of derivatives. To examine (b) we decompose total portfolio variance into its components: beta, market variance and residual variance. This decomposition allows us to test whether and how derivatives trading affects the components of risk.

4.1. Examining Total Volatility

As a first step in our research methodology, we focused on the total volatility of the daily returns of the FTSE-20 stock index and the control portfolio by estimating the GJR model for each portfolio. Following the work of Pagan and Schwert (1990) and Engle and Ng (1993), before applying the GARCH model any predictability associated with lagged returns or day-of-the-week effects was removed by estimating the following multiple regressions:

$$r_t^{FTSE-20} = a_0 + a_1 TUE + a_2 WED + a_3 THU + a_4 FRI + a_5 r_{t-1}^{FTSE-20} + u_t^{FTSE-20} , \quad (2)$$

$$r_t^{Control} = b_0 + b_1 TUE + b_2 WED + b_3 THU + b_4 FRI + b_5 r_{t-1}^{Control} + u_t^{Control} , \quad (3)$$

where $r_t^{FTSE-20}$ and $r_t^{control}$ are the log price relative to the FTSE-20 index and the control portfolio in day t respectively, TUE, WED, THU, FRI are day of the week dummy variables for Tuesday through Friday and $r_{t-1}^{FTSE-20}$ is the lagged log price relative of the FTSE-20 index.

As Lo and MacKinlay (1988) and Nelson (1991) have suggested, in order to correct for any remaining predictability and spurious autocorrelation caused by non-synchronous trading, the following adjustment for autocorrelation was considered:

$$u_t^{FTSE-20} = \alpha_0 + \alpha_1 u_{t-1}^{FTSE-20} + \varepsilon_t^{FTSE-20} , \quad (4)$$

$$u_t^{Control} = \beta_0 + \beta_1 u_{t-1}^{Control} + \varepsilon_t^{Control} . \quad (5)$$

Having filtered both time series, their squared residuals were tested against autocorrelation. The evidence verified the need of applying a GARCH-type process to model total volatility (Lee and Ohk, 1992; Robinson, 1994; Antoniou and Holmes, 1995; Antoniou et al., 1998). To capture any asymmetric reaction to negative shocks, volatility is estimated using the GJR model:

$$h_t^{FTSE-20} = c_0 + c_1 h_{t-1}^{FTSE-20} + c_2 (\varepsilon_{t-1}^{FTSE-20})^2 + c_3 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 + c_4 I + c_5 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 I , \quad (6)$$

$$h_t^{Control} = d_0 + d_1 h_{t-1}^{Control} + d_2 (\varepsilon_{t-1}^{Control})^2 + d_3 \max(0, -\varepsilon_{t-1}^{Control})^2 + d_4 I + d_5 \max(0, -\varepsilon_{t-1}^{Control})^2 I . \quad (7)$$

In (6) and (7), h_t represents the conditional volatility of the time series and models the error term through the product:

$$\varepsilon_t = v_t \sqrt{h_t} . \quad (8)$$

v_t corresponds to a white noise process and is independent of past realizations of ε_t. Under this empirical framework, h_t is modeled as a function of its own lagged value [h_{t-1}], the squared lagged error term [ε_{t-1}^2] and the asymmetric term [$max(0,-\varepsilon_{t-1})^2$]. The dummy variable I takes the value of unity after the introduction of derivatives and the value of zero before that date. The coefficients c_4, c_5 and d_4, d_5 measure respectively the change in unconditional volatility and asymmetry that took place in the post-derivatives period for the FTSE-20 index and the control portfolio. If the introduction of futures did not change the structure of the FTSE-20 index volatility process c_4, will be similar to d_4 , and c_5 similar to d_5 . In other words the effect of derivatives introduction is tested by examining whether the introduction of derivatives changed in the same manner the unconditional volatility and the asymmetry of the FTSE-20 and the control portfolio.

4.2. Decomposition of Risk

According to the market model (see Bodie, Kane and Marcus, 2001) the total risk of a stock portfolio can be decomposed in a systematic and unsystematic component as follows:

$$\sigma_{Total}^2 = \beta^2 \sigma_{Market}^2 + \sigma_{Idiosyncratic}^2 , \quad (9)$$

where β represents the portfolio's beta, σ_{Market}^2 is the market variance and $\sigma_{Idiosyncratic}^2$ corresponds to the unsystematic risk of the portfolio. Any effect on the total volatility of the FTSE-20 index could be attributed to changes in its beta, unsystematic risk, market volatility or a combination of the three.

To test how beta was affected by derivatives trading, we modify the methodology used by McKenzie et al. (2001) and estimate the following regression models:

$$r_t^{FTSE-20} = a_0 + a_1 r_t^{Market} + a_2 r_{t-1}^{Market} + a_3 r_t^{Market} I + a_4 r_{t-1}^{Market} I + u_t^{FTSE-20}, \quad (10)$$

$$u_t^{FTSE-20} = \alpha_0 + \alpha_1 u_{t-1}^{FTSE-20} + \varepsilon_t^{FTSE-20}, \quad (11)$$

$$r_t^{Control} = b_0 + b_1 r_t^{Market} + b_2 r_{t-1}^{Market} + b_3 r_t^{Market} I + b_4 r_{t-1}^{Market} I + u_t^{Control}, \quad (12)$$

$$u_t^{Control} = \beta_0 + \beta_1 u_{t-1}^{Control} + \varepsilon_t^{Control} \quad (13)$$

where r_t^{Market} is the log price relative to the Athens Stock Exchange index, a proxy of the market portfolio consisting of 60 stocks and I is a dummy variable that takes the value of 0 during the period before derivatives introduction and the value of 1 for the period after. The lag in the market portfolio return, r_{t-1}^{Market}, is included to adjust for thin trading (Scholes and Williams, 1977). Equations (11) and (13) are used to further adjust for any first order remaining dependence in regression residuals.

Based on the augmented market model (equations (10) and (12)) the effect of derivatives introduction is captured by the coefficients a_3 and a_4 for the FTSE-20 index and b_3 and b_4 for the control portfolio; positive (negative) values for these coefficients would suggest that the betas of the FTSE-20 index and the control portfolio have increased (decreased) in the post-derivatives period.

The error series ($\varepsilon_t^{FTSE-20}, \varepsilon_t^{Control}$) represent the unsystematic risk of both portfolios. Consistent with the empirical design of total volatility, the GJR model is used to model the unsystematic component:

$$h_t^{FTSE-20} = c_0 + c_1 h_{t-1}^{FTSE-20} + c_2 (\varepsilon_{t-1}^{FTSE-20})^2 + c_3 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 + c_4 I + c_5 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 I, \quad (14)$$

$$h_t^{Control} = d_0 + d_1 h_{t-1}^{Control} + d_2 (\varepsilon_{t-1}^{Control})^2 + d_3 \max(0, -\varepsilon_{t-1}^{Control})^2 + d_4 I + d_5 \max(0, -\varepsilon_{t-1}^{Control})^2 I. \quad (15)$$

The dummy variable I marks the introduction of derivatives while coefficients c_4 and c_5 (d_4 and d_5) capture how unconditional unsystematic volatility and asymmetric response to firm-specific news were altered in the post-derivatives period for the FTSE-20 index (control portfolio). Different values for these coefficients for the FTSE-20 index and the control portfolio could be attributed to the introduction of derivatives on the FTSE-20 stock index.

5. Empirical Results

5.1. Evolution of Total Volatility

The results from filtering the returns of the FTSE-20 index and the control portfolio from any predictability associated with lagged returns and day-of-the-week effects using equations (2) and (3) are shown in Table 2. Examination of the t-statistic for the estimated coefficients suggests that only the correction for lagged returns was significant, while none of the day dummies had any explanatory power on daily returns. The Ljung & Box portmanteau statistics for 8, 16 and 32 lags of the residual error series rejects the hypothesis of autocorrelation in the error terms for both portfolios at the 5% significance level. However, the Ljung&Box test statistic for autocorrelation in the time series of squared residuals was statistically significantly different from zero at the 5% significance level at all lags. The serial dependence in the squared residual series suggests the need of a GARCH-type process to model total volatility.

Table 2

Modelling Total Volatility-Filtering Daily Returns

FTSE-20				Control Portfolio			
Coefficient	Value	t-statistic	Significance Level	Coefficient	Value	t-statistic	Significance Level
a_o	-0.0103	-0.09	0.93	b_o	-0.0089	-0.07	0.94
a_1	-0.1794	-1.27	0.21	b_1	-0.1898	-1.24	0.21
a_2	-0.1136	-0.74	0.46	b_2	-0.0072	-0.05	0.96
a_3	-0.0738	-0.5	0.62	b_3	0.0417	0.28	0.78
a_4	0.2149	1.51	0.13	b_4	0.2427	1.52	0.13
a_5	0.1869	6.29	0.00	b_5	0.1842	6.26	0.00
Ljung & Box statistic (u_t)							
Q(8)	5.2446	-	0.73	-	12.4410	-	0.13
Q(16)	11.5470	-	0.78	-	22.9630	-	0.12
Q(32)	28.2200	-	0.66	-	41.1640	-	0.13
Ljung & Box statistic (u_t^2)							
Q(8)	186.25	-	0.00	-	347.12	-	0.00
Q(16)	195.00	-	0.00	-	373.56	-	0.00
Q(32)	245.05	-	0.00	-	429.06	-	0.00

The table shows the estimated coefficients from the following equations:

$$r_t^{FTSE-20} = a_0 + a_1 TUE + a_2 WED + a_3 THU + a_4 FRI + a_5 r_{t-1}^{FTSE-20} + u_t^{FTSE-20} \text{ and}$$

$$r_t^{Control} = b_0 + b_1 TUE + b_2 WED + b_3 THU + b_4 FRI + b_5 r_{t-1}^{Control} + u_t^{Control}$$

TUE, WED, THU and FRI represent dummy coefficients that take on a value of unity on the corresponding day of the week (Tuesday, Wednesday, Thursday and Friday). The daily return of each portfolio is given by r_t while u_t is the corresponding residual return.

The results from the estimation of the GJR model for total portfolio volatility (eq. (6) and (7)) are presented in Table 3. Coefficients c_1 and d_1 which capture the persistence of past volatility and coefficients c_2 and d_2 which show the effects of news on FTSE-20 index and control portfolio volatility are positive and statistically different from zero at the 5% level of significance. The coefficients measuring the asymmetric effects of bad versus good news on the volatility of both portfolios (c_3 and d_3) are both positive and significantly different from zero. Consistent with other evidence in the literature, these results also suggest that bad news affect more the volatility of the Greek stock market than good news.

The effect of the derivatives introduction on volatility can be tested by comparing the coefficient of the pre-post dummy variable of the volatility of the FTSE-index against the dummy variable coefficient for the control portfolio. The estimates in Table 3 suggest that the introduction of derivatives decreased the volatility of both portfolios. The volatility of the FTSE-20 index was reduced by 0.3305 (significant at the 10% level) while the volatility of the control portfolio was reduced by 0.2345 (statistically significantly different from zero at the 5% level). The results suggest that the reduction in the total volatility of the FTSE-index and the control portfolio after the introduction of futures cannot be attributed to the establishment of the ADEX in Greece. However, it is possible that derivatives trading could have affected either the systematic (market risk) or the unsystematic risk of the FTSE-index stocks. We study the effects of derivatives on the components of total volatility in the next section.

Table 3

The Effect of Derivatives on Total Volatility

FTSE-20				Control Portfolio			
Coefficient	Value	t-statistic	Significance Level	Coefficient	Value	t-statistic	Significance Level
c_o	0.8376	3.67	0.00	d_o	0.5723	4.17	0.00
C_1	0.6318	11.47	0.00	d_1	0.6983	20.23	0.00
C_2	0.1197	2.64	0.01	d_2	0.1292	3.56	0.00
C_3	0.2516	2.54	0.01	d_3	0.1783	2.26	0.02
C_4	-0.3305	-1.76	0.08	d_4	-0.2345	-1.84	0.07
C_5	-0.0865	-0.84	0.40	d_5	-0.0178	-0.23	0.82

The table lists the estimated coefficients for the following equations:

$$h_t^{FTSE-20} = c_0 + c_1 h_{t-1}^{FTSE-20} + c_2 \left(\varepsilon_{t-1}^{FTSE-20}\right)^2 + c_3 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 + c_4 I + c_5 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 I$$

and

$$h_t^{Control} = d_0 + d_1 h_{t-1}^{Control} + d_2 \left(\varepsilon_{t-1}^{Control}\right)^2 + d_3 \max(0, -\varepsilon_{t-1}^{Control})^2 + d_4 I + d_5 \max(0, -\varepsilon_{t-1}^{Control})^2 I$$

where h_t and ε_t represent the conditional variance and the error term (residual return), respectively, on day t. I is a dummy variable that takes the value of unity after the introduction of derivatives.

The effect of derivatives on the way volatility reacts to news can be tested by examining the differences in the asymmetric response of the FTSE-20 index and the control portfolio before and after the introduction of derivatives (coefficient c_5 against d_5). Both coefficients are insignificantly different from zero at the 5% significance level. We conclude that the listing of derivatives had no effect on the way in which information is disseminated into the prices of both portfolios.

5.2. Evolution of Beta and Unsystematic Risk

Equations (10)-(13) are used to estimate the betas of the FTSE-20 and the control portfolios and decompose portfolio returns into a systematic and an unsystematic component. Table 4 shows the results of the mean return equations (eq. (10) and (12)). Given that both residual series ($u_t^{FTSE-20}$, $u_t^{Control}$) exhibited highly significant Ljung & Box test statistics, the residuals are further adjusted using equations (11) and (13).

Table 4

Augmented Market Model Estimation

FTSE-20				Control Portfolio			
Coefficient	Value	t-statistic	Significance Level	Coefficient	Value	t-statistic	Significance Level
$a_o+\phi_o$	0.0006	0.06	0.95	$b_o+\rho_o$	0.0390	1.37	0.17
a_1	1.0141	141.08	0.00	b_1	0.8702	53.28	0.00
a_2	0.0153	1.91	0.06	b_2	-0.0032	-0.16	0.88
a_3	-0.0307	-2.68	0.01	b_3	0.0336	1.36	0.17
a_4	-0.0124	-1.04	0.30	b_4	0.0399	1.46	0.15
ϕ_1	0.1522	5.07	0.00	ρ_1	0.1702	5.59	0.00
Ljung & Box statistic (ε_t)							
Q(8)	0.6707	-	0.99	-	5.5472	-	0.59
Q(16)	11.5310	-	0.71	-	20.8010	-	0.14
Q(32)	37.1410	-	0.21	-	37.9470	-	0.18

Table 4 (continuous)

FTSE-20				Control Portfolio			
Coefficient	Value	t-statistic	Significance Level	Coefficient	Value	t-statistic	Significance Level
Ljung & Box statistic (ε_t^2)							
Q(8)	251.31	-	0.00	-	113.96	-	0.00
Q(16)	263.66	-	0.00	-	149.87	-	0.00
Q(32)	292.23	-	0.00	-	261.29	-	0.00

The table lists the estimated coefficients from the following regressions:

$$r_t^{FTSE-20} = a_0 + a_1 r_t^{Market} + a_2 r_{t-1}^{Market} + a_3 r_t^{Market} I + a_4 r_{t-1}^{Market} I + u_t^{FTSE-20}$$

$$u_t^{FTSE-20} = \phi_0 + \varphi_1 u_{t-1}^{FTSE-20} + \varepsilon_t^{FTSE-20}$$

$$r_t^{Control} = b_0 + b_1 r_t^{Market} + b_2 r_{t-1}^{Market} + b_3 r_t^{Market} I + b_4 r_{t-1}^{Market} I + u_t^{Control}$$

$$u_t^{Control} = \rho_0 + \rho_1 u_{t-1}^{Control} + \varepsilon_t^{Control}$$

The daily return of each portfolio and the market is given by r_t (on day t), u_t is the corresponding residual return without being adjusted for lagged residuals and ε_t is the final error term of the entire mean equation.

The estimated beta of the FTSE-20 index is close to one (1.01) while the beta of the control portfolio is less than one (0.87). The effect of derivatives introduction on portfolio beta can be examined by looking at the differences in the estimated coefficients of the dummy variables (coefficients a_3, a_4 versus b_3, b_4). For the FTSE-20 index, both a_3 and a_4 coefficients are negative while only a_3 was significantly different from zero (1% significance level). On the other hand, the control portfolio exhibited no significant change in its beta as both coefficients b_3 and b_4 were insignificantly different from zero.

The results in Table 4 suggest that, in the post-derivatives period, there is an unambiguous decline in the beta of the FTSE-20 index, while the beta of the control portfolio remained constant. This is clear evidence that the introduction of derivative markets in Greece decreased the systematic risk of the stocks underlying the FTSE-20 index.

Table 5

The Effect of Derivatives on Unsystematic Volatility

FTSE-20				Control Portfolio			
Coefficient	Value	t-statistic	Significance Level	Coefficient	Value	t-statistic	Significance Level
c_o	0.0273	3.01	0.00	d_o	0.0605	2.52	0.01
c_1	0.6938	10.05	0.00	d_1	0.8284	22.38	0.00
c_2	0.1533	2.31	0.02	d_2	0.1015	2.97	0.00
c_3	0.0289	0.33	0.74	d_3	0.0656	1.21	0.23
c_4	-0.0072	-0.92	0.36	d_4	-0.0215	-1.20	0.23
C_5	0.0673	0.64	0.52	d_5	-0.0022	-0.04	0.97

The table lists the estimation results from the following equations:

$$h_t^{FTSE-20} = c_0 + c_1 h_{t-1}^{FTSE-20} + c_2 \left(\varepsilon_{t-1}^{FTSE-20}\right)^2 + c_3 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 + c_4 I + c_5 \max(0, -\varepsilon_{t-1}^{FTSE-20})^2 I$$

$$h_t^{Control} = d_0 + d_1 h_{t-1}^{Control} + d_2 \left(\varepsilon_{t-1}^{Contol}\right)^2 + d_3 \max(0, -\varepsilon_{t-1}^{Control})^2 + d_4 I + d_5 \max(0, -\varepsilon_{t-1}^{Control})^2 I$$

h_t and ε_t represent the conditional unsystematic variance and the error term, respectively, on day t. I is a dummy variable that takes the value of unity after the introduction of derivatives[i].

Table 5 presents the results of the estimation of the conditional unsystematic volatility of the two portfolios under investigation. The evidence in Table 5 on the time series properties of the squared residuals of equations (11) and (13) indicate the presence of conditional heteroskedasticity. The Ljung&Box portmanteau statistic is highly significant for 8, 16 and 32 lags. As in the case of total volatility we use the GJR GARCH-type model. The coefficients of the GARCH and ARCH terms for both portfolios unsystematic volatility are positive and significantly different from zero. Unlike total volatility, the estimated coefficients for the asymmetric effect are not significantly different from zero suggesting the absence of a different response to bad news.

The effect of derivatives introduction on the unsystematic risk and the asymmetric response to news is captured by the estimated coefficient c_4, c_5, d_4 and d_5. As none of those coefficients is statistically significantly different from zero we conclude that the introduction of derivatives had no effect on the unsystematic risk of the stocks underlying the FTSE-20.

6. Conclusions

The main focus in this study was to investigate whether the introduction of derivatives in the Greek capital market affected the volatility of the FTSE-20 index underlying the futures and options contracts listed. The FTSE-20 index contains only a subset of the stocks traded in the Athens Stock Exchange and it is always possible to confound other causes of changes in market-wide volatility with the introduction of derivative instruments. To isolate the effects of the introduction of derivatives trading on the risk of the underlying stocks a control portfolio was created consisting of stocks that do not underlie derivative instruments and tested whether derivatives trading had a differential impact on the volatility of the FTSE-20 index and the control portfolio.

The empirical evidence presented in this paper suggests that after the introduction of derivatives in Greece the total volatility of the FTSE-20 stock index underlying futures and options contracts declined. At the same time the volatility of a portfolio of stocks designed to match the risk characteristics of the FTSE-20 but using stocks that are not underlying derivative instruments also experienced a significant fall, albeit smaller in magnitude than the FTSE-20 index. Taken together these results could be interpreted as suggesting that the volatility reduction was perhaps caused by a systematic factor other than the introduction of derivatives. However, when we decomposed total risk into its systematic and unsystematic component, we found strong evidence of a decline in the beta of the FTSE-20 index while the beta of the control portfolio seems not to have changed. We also found evidence consistent with the hypothesis that the idiosyncratic component $\sigma^2_{Idiosyncratic}$ of both portfolios has not been influenced by the introduction of derivatives.

Although there is evidence of an asymmetric effect of news on FTSE-20 index volatility similar to that found in other markets (see Antoniou, Holmes and Priestley (1998) for a recent study), we found little evidence to suggest that the introduction of derivatives changed the dynamics of the market in the way news impact volatility.

Whether the introduction of derivative instruments stabilizes or destabilize capital markets is still a topic of controversy. This paper's results suggest that the introduction of derivatives in a small capital market had beneficial effects on the risk of the stocks underlying the futures and options contracts traded.

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