Spill Over Effects of Futures Contracts Initiation on the Cash Market: A Comparative Analysis

Karathanassis, George and Sogiakas, Vasilios

Athens University of Economics and Business

26 November 2007

Spill Over Effects of Futures Contracts Initiation on the Cash Market: A Comparative Analysis

G.A. Karathanassis
Athens University of Economics and Business. Department of Business Administration,
Patision 76, 10434, Athens, Greece. E-mail: gkarath@aueb.gr

V.I. Sogiakas
Athens University of Economics and Business. Department of Business Administration,
Patision 76, 10434, Athens, Greece. E-mail: sogiav@aueb.gr

Abstract

This paper investigates possible spill over effects on the Spot Market due to the initiation of Futures contracts in three different financial markets. According to many analysts there still exists a puzzle regarding the stabilization or destabilization effects of futures contracts. Although the speculative forces (uninformed investors) tend to destabilize the market, rational hedging strategies and the transition of risk allow for stabilization shift. In order to investigate this issue, many researchers during the last decade, have utilized the GARCH framework enriched to capture many stylized financial features, such as the asymmetric response to news and leptokurtosis. However, in this paper the GARCH framework is extended to allow for skewness in the distribution of returns and to examine the timing of possible structural changes, while the conditional mean of the process is adjusted to account for time-varying risk premia and for the day of the week effects decomposition. Furthermore, the distinguishing feature of this paper is the SWARCH econometric model, which enables a dynamic regime shifting through a Markov Chain transition matrix. According to the empirical findings for the UK, Spanish and Greek Capital markets, there exist a significant stabilization effect either in the long run or in the short run, which is negatively associated with the level of efficiency and completeness of these capital markets.

Keywords: Index Futures Contracts, AP-GARCH-M, SWARCH-L.

JEL Classification: C22, C52, C53, G15.

1. Introduction

Research on the relationship between Futures and Cash markets goes on unabated. Initially attention was centered on the commodities futures whilst, for the past 25 years the financial futures markets have captured the attention of researchers. Initially the relevant research concentrated on the USA Financial System, but as of late researchers used similar and/or new approaches with data from many other parts of the world.

The objective of this paper is to investigate the effect of the introduction of financial index futures on the volatility of the cash market using data from three Capital Markets which are different in terms of capitalization, efficiency and completeness: the London Stock Exchange, the Spanish Stock Exchange and the Athens Stock Exchange.

2. Financial Considerations

Insights regarding the relationship between the Cash and Futures Markets are offered from the workings of well-functioning, perfect and complete capital markets. In such markets the net cash flows from any new security can be replicated using existing comparable securities. In such cases all existing fundamental information is impounded in current market prices which may change with changes in information regarding those variables affecting the value of securities.

Can the introduction of a new derivatives market (or a new derivative product) affect the volatility of the underlying securities quoted on the cash market? Since both markets are connected by arbitrage if the futures current price is different from that expected from the equilibrium relationship between the two markets the reactions of arbitrageurs will restore the equilibrium relationship to a level which would not permit the realization of abnormal earnings. Active, well functioning and efficient markets do not permit abnormal earnings consistently over time. We should therefore expect that the introduction of a new Futures Market would have no effect on the volatility of the Cash Market.

An alternative view holds that Futures trading may change the information available in a Capital Market (**Cox 1976**) mainly because the futures market attracts more participants and that transaction costs are lower in the futures market as compared to those ruling in the Cash Market. The additional traders attracted to the futures market may increase the liquidity in the cash market and result in less volatility, unless the futures (or derivatives in general) market is swamped by uninformed speculators who destabilize the spot market.

Ross (1976) suggests that derivatives may actually, reduce the variability of the cash market. Ross argues that derivatives improve the efficiency of incomplete capital markets by increasing the investment opportunities set to investors. Further, **Ross (1989)** has argued that whether or not derivatives increase or decrease the volatility of the cash market depends on the flow of information. In addition, **Merton (1995)** maintains that the introduction of futures trading can improve informational efficiency by reducing asymmetric responses to information.

From the above discussion we derive three alternative economic hypotheses:

a) If the Capital Market is deemed to be a perfect and complete market the concomitant arbitrage-free economy would not be affected by the presence of derivatives markets.

b) In incomplete capital markets the additional traders attracted to futures markets may increase the informational efficiency of the cash market and result in lower variability in the returns of the underlying assets.

c) Lastly, the leverage inherent in the futures market may reduce the liquidity in the cash market and increase its variability.

3. A Brief Review of the Empirical Literature

The issue of whether the Futures Markets (or Derivatives in general) causes neutrality, stability or instability in the cash markets has been investigated by many for virtually all parts of the world in which derivatives markets operate.

Figlewski (1981) analyzed the impact of futures trading in Government National Mortgage Association (GNMA) and concluded that volatility in the cash market was positively related not only to the introduction of futures trading and activity but also to other factors such as the GNMA price levels, volatility in related markets and liquidity. **Ma and Rao (1988)** focused on the asymmetry results of options trading and claimed that while uninformed hedgers tend to stabilize and reduce noise in cash market, informed speculators tend to generate noise. **Conrad (1989)** considered the influence of stock options on cash prices of the underlying securities traded on the Chicago and American Stock Exchanges. The results showed a positive price influence on the underlying securities but a negative influence on volatility. **Harris (1989)** concluded that there was no significant economic effect between the volatility in S&P 500 stocks compared to the volatility observed for a comparable sample of the non-S&P 500 stocks. **Bansal (1989)** and **Skinner (1989)** found evidence that option trading reduces volatility. **Bechetti et. al. (1990)** reported no relation between futures trading and cash market volatility. **Bessembinder (1992)** provides evidence suggesting that active futures markets were related with decreased cash market volatility. **Pericli and Koutmos (1999)** and **Dennis et.al. (1999)** found that futures trading had no significant impact on cash market activity. For the United Kingdom **Antoniou and Holmes (1995)** reported that trading on the FTSE 100 Index resulted in increased variability in the cash market. **Butterworth (2000)** found that the quantity of information increased after the introduction of the FTSE 250 Futures Index. **Yu (2001)** found no change in the volatility of cash market following the onset of futures index.

For other European countries **Bologna and Cavallo (2002)**, for the Italian cash market, found that the introduction of stock index futures trading resulted in a reduction in the volatility. For Spain, **Pilar and Rafael (2002)** found similar results as those reported by Bologna and Cavallo for Italy. Opposite results were reported in a study constructed by **Illuenca and Lafuente (2003)** in that their results show no change in the volatility of the cash market following the introduction of the Spanish IBEX 35 Index. For France, **Yu (2001)** found a significant increase in volatility in stock returns. **Spyrou (2005)** found that in Greece the onset of futures trading has had no significant effect on the variability of the cash market.

Equally controversial results were reported by works concerning other parts of the world. Specifically, **Yu (2001)** found no changes in the volatility of the Hong Kong underlying cash markets. **Chiang and Wang (2002)** found conflicting results on two futures indices for Taiwan. Thus, whereas the trading of TAIEX futures has a pronounced effect on cash price variability, the Morgan Stanley Capital International (MSCI) futures index trading had no effect. **Lee and Ohk (1992)** on examining the effects of the introduction of stock index futures on the variability found no significant changes in volatility for Australia and Hong Kong but significant effects for Japan and the United Kingdom. Finally contradictory results were reported by **Gullen and Mayhew (2000)** who examined data from twenty five countries all over the world found either no significant effect or a volatility dampening, with an exception for the United States and Japan where the conditional volatility has increased since the introduction of futures markets.

Clearly the results of extant papers cannot be said to have settled the issue of the relationship between the volatility in the cash and derivatives markets. The results appear a) to be country sensitive and b) to depend on the econometric methods used. Most researchers modeled their data on specific versions of the GARCH family specifications, including the multivariate case. Some used either SEM type methodology or Cointegration and Common Trends methodology, with VAR models, to account for simultaneous effects between the two markets.

It is obvious that if the introduction of derivatives markets alters the structure of the cash market it leads to new regime situations and thus, a new econometric approach is required to account for the new dynamic relationships. Such an approach was suggested by **Hamilton and Susmel (1994)**, and has been utilized by the present study.

4. Sources of Data and Research Methodology

For the purposes of this paper, we utilize one index from the U.K. Stock Exchange, the FTSE All Shares[1], one from the Spanish Stock Exchange, the Ibex-35 and two indices from the Athens Stock Exchange, the General and the FTSE-20. The data correspond to the daily closing prices, covering, for U.K. the period from 02/01/78 to 03/09/90, for Spain from 07/01/1987 to 31/01/1997 and for Greece from 30/12/1994 to 23/11/2005, summing up to 3306, 2628 and 2722 daily (returns) observations, respectively. All data were drawn from Datastream. The time horizon is chosen so as to reduce any sample imbalances between the two sub periods (pre and post futures onset).

[1] The FTSE-100 futures contract as well as its underlying index (FTSE-100) were initiated simultaneously on 03/05/1984 and, hence, for the purposes of our analysis, we follow Antoniou et.al.1998 using the FTSE All Share Price Index among other alternatives (FT-500 and FT-30)

Empirically the paper focuses on a number of points. Initially, it examines the structural shifts in volatility and other fundamental features of spot market (such as the conditional distribution of returns; i.e. leptokurtosis and skewness), with respect to the futures onset. In addition, it considers the extension of possible spill over effects and their dynamics. Then, it applies the technique of rolling sample window, in order to detect the timing of structural changes. Finally, it proposes use of a methodology to control such structural changes allowing for Markov-Switching volatility processes.

Throughout our analysis, we consider many alternative approaches, concerning the mean equation, the volatility specification and the conditional distribution.

First, we follow **Engle and Ng (1993)** who isolated the unexpected from the expected component of returns by introducing several dummy variables, corresponding to daily effects, as regressors for the underlying asset in order to eliminate the impact on the spot market caused by several exogenous market wide factors. Furthermore, the lagged one returns and the time-varying returns' volatility are used as proxies for the mean equation of the Index returns. In addition, in the case of the Greek Market, we consider also the General Index as a proxy for the market effect. The autoregressive part of the mean equation owes its existence to the autocorrelation that is inherent in most financial time series[2] (**Bologna and Cavallo 2002**). The time-varying volatility part of the return is better captured by a time-varying risk premium, as **Engle et. al. (1987)** proposed, rather than a constant one (**Sharpe 1964**). Finally, use of the General Index returns captures the wide market factors and is in line with **Conrad (1989)** and **Powers (1970)** who stated that further research should be focused not only on the random component but also on the systematic one.

Then the resulting residuals are allowed to follow GARCH (**Bollerslev 1986**) and AP-GARCH[3] (**Ding et. al. 1993**) volatility specifications. In this connection, a dummy variable is introduced to account for the futures onset with respect to the whole parameter space, as shown in the tables 3.1 and 3.2 below:

[2] Cambell and MacKinlay 1997 argues that this is a common fact in most financial data with no implication in the efficiency of the underlying markets

[3] Its dynamics are based on the Box-Cox transformation, and embodies many ARCH specifications as special cases; the Leverage effect is captured by positive values of the parameter 'γ'

Table 3.1 Mean equations

AR-GARCH with Market Effect	$y_t = (c_0 + c_{0d} \cdot d) + (\phi + \phi_d \cdot d_t) \cdot y_{t-1} + (c_1 + c_{1d} \cdot d_t) \cdot x_t + \varepsilon_t$
AR-GARCH-M	$y_t = (c_0 + c_{0d} \cdot d) + (\phi + \phi_d \cdot d_t) \cdot y_{t-1} + (c_2 + c_{2d} \cdot d_t) \cdot \log(h_t) + \varepsilon_t$
AR-GARCH-M with Market Effect	$y_t = (c_0 + c_{0d} \cdot d) + (\phi + \phi_d \cdot d_t) \cdot y_{t-1} + (c_1 + c_{1d} \cdot d_t) \cdot x_t + {} + (c_2 + c_{2d} \cdot d_t) \cdot \log(h_t) + \varepsilon_t$
GARCH-M with Day Effect	$y_t = (d_{Mo} + d_{Mod} \cdot d) \cdot y_t + (d_{Tu} + d_{Tud} \cdot d) \cdot y_t + (d_{We} + d_{Wed} \cdot d) \cdot y_t + {} + (d_{Th} + d_{Thd} \cdot d) \cdot y_t + (d_{Fr} + d_{Frd} \cdot d) \cdot y_t + (c_2 + c_{2d} \cdot d_t) \cdot \log(h_t) + \varepsilon_t$

Table 3.2 Volatility specifications

$\varepsilon_t = z_t \cdot \sqrt{h_t}$, $z_t \sim F$ d^stb^ , F: either <u>Normal</u> or <u>Student-t</u> or <u>Skewed-t</u> distribution	
GARCH	$h_t = (a_0 + a_{0d} \cdot d_t) + (a_1 + a_{1d} \cdot d_{t-1}) \cdot \varepsilon_{t-1}^2 + (\beta_1 + \beta_{1d} \cdot d_{t-1}) \cdot h_{t-1}$
APGARCH	$h_t = \left[(a_0 + a_{0d} \cdot d_t) + (a_1 + a_{1d} \cdot d_{t-1}) \cdot \left(\lvert \varepsilon_{t-1} \rvert - (\gamma + \gamma_d \cdot d_{t-1}) \cdot \varepsilon_{t-1} \right)^{\delta + \delta_d \cdot d_{t-1}} + (\beta_1 + \beta_{1d} \cdot d_{t-1}) \cdot h_{t-1}^{\frac{\delta + \delta_d \cdot d_{t-1}}{2}} \right]^{\frac{2}{\delta + \delta_d \cdot d_{t-1}}}$

The conditional distribution is either a symmetric (Normal or Student's t) or a non-symmetric one (Skewed t of **Hansen (1994)** or **Lambert and Laurent (2003)**) as presented in the following table:

Table 3.3 Skewed Conditional Distribution Forms in the GARCH framework

Skewed-t of Hansen	$f_y(y_t/n, \lambda) = \begin{cases} b \cdot c \cdot \left(1 + \frac{1}{n-2} \cdot \left(\frac{b \cdot y_t + a}{1 - \lambda} \right)^2 \right)^{-\frac{n+1}{2}} & , y_t < -\frac{a}{b} \\ b \cdot c \cdot \left(1 + \frac{1}{n-2} \cdot \left(\frac{b \cdot y_t + a}{1 + \lambda} \right)^2 \right)^{-\frac{n+1}{2}} & , y_t \geq -\frac{a}{b} \end{cases}$ where $2 < n < \infty$, $-1 < \lambda < 1$, $a = 4 \cdot \lambda \cdot c \cdot \left(\frac{n-2}{n-1} \right)$, $b^2 = 1 + 3 \cdot \lambda^2 - a^2$, $c = \frac{\Gamma\left(\frac{n+1}{2} \right)}{\sqrt{\pi \cdot (n-2)} \cdot \Gamma\left(\frac{n}{2} \right)}$

Skewed-t of Lambert and Laurent	$f\left(y_t/n,\xi\right)=\begin{cases}\dfrac{\Gamma\left(\dfrac{n+1}{2}\right)}{\Gamma\left(\dfrac{n}{2}\right)\cdot\sqrt{\pi\times(n-2)}}\cdot\dfrac{2\cdot s}{\xi+\dfrac{1}{\xi}}\cdot\left(1+\dfrac{s\cdot\left(y_t\right)+m}{n-2}\cdot\xi\right)^{-\frac{n+1}{2}}, y_t < -\dfrac{m}{s} \\ \dfrac{\Gamma\left(\dfrac{n+1}{2}\right)}{\Gamma\left(\dfrac{n}{2}\right)\cdot\sqrt{\pi\times(n-2)}}\cdot\dfrac{2\cdot s}{\xi+\dfrac{1}{\xi}}\cdot\left(1+\dfrac{s\cdot\left(y_t\right)+m}{n-2}\cdot\xi^{-1}\right)^{-\frac{n+1}{2}}, y_t \geq -\dfrac{m}{s}\end{cases}$ $\dfrac{P\left(x\geq 0 \mid \xi\right)}{P\left(x<0 \mid \xi\right)}=\xi^2$, $\xi>0$, $m=\dfrac{\Gamma\left(\dfrac{n-1}{2}\right)\cdot\sqrt{n-2}}{\Gamma\left(\dfrac{n}{2}\right)\cdot\sqrt{\pi}}\cdot\left(\xi-\dfrac{1}{\xi}\right)$, $s^2=\xi^2+\dfrac{1}{\xi^2}-m^2-1$

The models investigated comprise two stages that are estimated jointly, as shown in the first and second moment models, presented in Tables 3.1 and 3.2, respectively.

Furthermore, we extend our analysis to examine the timing of the spill over effects. This is achieved through the rolling sample window analysis. For the purposes of this technique we consider a constant sample size, approximately equal to two years (500 daily observations).

The novelty of this study is associated with the application of the Markov Switching ARCH-L[4] (**SWARCH-L**) model of **Hamilton and Susmel (1994)**. Its main philosophy is that the structural break point, which governs the process, is not known a priori as deterministic event but there exist some imperfectly predictable forces that affect the parameters of the model, producing more accurate estimations and forecasts than other conventional models do. Thus, we allow the model to choose its volatility level (among three levels: low, medium and high) making easier the interpretation regarding market price volatility of the FTSE-20 Index during the examined sample time horizon. Let y_t denote the daily returns, while S_t is a latent variable (unobserved random variable) of the form $S_t=\{1\ or\ 2\ or\ 3\}$. The latent variable S_t corresponds to the 'State' or 'Regime' that the ARCH process is at time t and can be described by a Markov Chain, as follows:

$$\mathrm{P}\left(S_t=j \mid S_{t-1}=i,\ldots,y_{t-1},y_{t-1},\ldots\right)=\mathrm{P}\left(S_t=j \mid S_{t-1}=i\right) \text{ for i,j=1,2,3}$$

[4] **Glosten et.al. (1989)** considered the ARCH-L model which captures the leverage effect

The transition matrix P $\{p_{ij}\}$ of the above states is: $P = \begin{bmatrix} p_{11} & p_{21} & p_{31} \\ p_{12} & p_{22} & p_{32} \\ p_{13} & p_{23} & p_{33} \end{bmatrix} \sum_{j}^{3} p_{ij} = 1$

For reasons of simplicity we restrict our analysis so as not to allow state 2 to come after state 1 (p_{12}), and state 1 to come after state 3 (p_{31}): $P = \begin{bmatrix} p_{11} & 0 & p_{31} \\ p_{12} & p_{22} & p_{32} \\ 0 & p_{23} & p_{33} \end{bmatrix}$.

The mean equation is: $y_t = \phi_0 + \phi_1 \cdot y_{t-1} + u_t$ or $y_t = \phi_0 + \phi_1 \cdot y_{t-1} + c_1 \cdot x_t + u_t$, where x_t stands for the returns of the GI, and the residuals u_t are allowed to follow an ARCH-L process with regime shifting:

$u_t = \sqrt{g_{S_t}} \cdot w_t$, where g_1 is normalized to unity, and

$w_t \sim ARCH - L(2)$ process i.e. $w_t = z_t \cdot \sqrt{h_t}$, $z_t \sim Student - t(d.f)$

$h_t = a_0 + a_1 \cdot w_{t-1}^2 + a_2 \cdot w_{t-2}^2 + \xi \cdot w_{t-1}^2$, resulting in 16 parameters for estimation of the 3-state, 2nd-order Markov-Switching ARCH-L model.

With respect to the U.K market Antoniou et.al. (1998), Antoniou and Holmes (1995), Butterworth (2000), Kyriacou and Sarno (1995) and Yu (2001) have found significant structural changes in the dynamics of the cash market volatility due to the initiation of the futures contracts, using either simple GARCH process, or GJR-GARCH, or SEM or GARCH with moving average errors. Furthermore, with respect to the Spanish market Antoniou et.al. (1998) and Pilar and Rafael (2002), have found either a significant structural changes in the dynamics of the cash market volatility or a significant decline. Finally, according to Spyrou (2005), under the Exponential GARCH process and assuming a student's-t distribution, there is a reduction on the spot market volatility of the Greek market after the initiation of futures contracts, which is not significant. According to Gullen (2000), who analyzed all these markets utilizing the GJR-GARCH model, there exists a volatility dampening effect, after the futures contracts onset.

Our methodology is enriched with the Asymptotic Power GARCH model, which embodies ARCH, GARCH, log-ARCH, NARCH, T-GARCH and GJR-GARCH as special cases, classifying it on a higher level for its flexibility to capture many stylized financial features. Furthermore, the conditional distribution is allowed to take into account the return's asymmetry[5], a fact, with many applications in financial time series, which arbitrarily are assumed to be symmetric. Moreover, the timing of possible spill over effects is examined through the use of rolling sample techniques. Finally, the application of Markov-Switching volatility models in such research fields has three main advantages:

a) First, as pointed out by **Hamilton and Susmel (1994)**, SWARCH-L models produce better results in terms of both statistical fit and predictive power, compared with conventional ARCH models with Gaussian, Student-t and GED innovations, a fact which was also verified by **Chen and Lin (1999).**

b) Second, there is a tendency of ARCH models to imply too much volatility persistence after sudden shocks (i.e. during a speculative attack) and therefore, ARCH models tend to produce overestimations of the true variance of the process. SWARCH-L methodology is the appropriate one that allows for explosive shifts found in the mean of the variance process of the underlying returns.

c) Finally, when utilizing dummy variables in order to investigate structural break points (introduction of futures contracts), the analysis is constrained to account only for possible structural shifts that have taken place on the introduction date of futures contracts. However, this is not the case at all times, since these hypothetical spill over effects may lead up or delay for a short period of time. Again, SWARCH-L methodology overcomes such difficulties and limitations.

5. Empirical Results

The returns of the FTSE All Share, Ibex-35 and FTSE-20 Indices are shown in Figures 5.1.a, 5.1.b and 5.1.c of the appendix where the time varying volatility phenomenon as well as the volatility clustering are apparent, verifying the empirical findings of **Mandelbrot (1963a,b, 1967)** and **Fama (1965)**. Another point that Figure 5.1.c shed light on is that the spot prices and returns of the FTSE-20 and GI indices

[5] It is achieved with both Hansen's 1994 and Lambert and Laurent's 2003 distributional forms

seem to share many characteristics and features, implying that the GI would be a useful proxy in order to eliminate the systematic variability of the FTSE-20 Index.

In Figures 5.2 and 5.3 of the appendix we present the histograms of the daily returns of the FTSE All Share, Ibex-35 and FTSE-20 Indices, for the whole time horizon and for the two sub-periods regarding the futures onset. All financial time series (FTSE All Share, Ibex-35 and FTSE-20) seem to exhibit some leptokurtosis a fact that is verified by the Jarque-Bera statistic (Table 5.1 of the appendix) which casts doubts on the validity of the normality assumption, while the distribution of the FTSE All Share returns is more leptokurtic than Ibex-35 and FTSE-20, respectively. Considering the two sub-periods, it is obvious that the unconditional volatility is slightly reduced for all markets during the second sub-period, except from the U.K. market, where, there is no change, while, the skewness parameter becomes more negative for the U.K. market, less negative for the Spanish market, and finally, in the case of the Greek market, it turns from right to left.

The first part of the analysis deals with the whole time horizon, as shown in Tables 5.2.a, 5.2.b and 5.2.c of the appendix, providing a perspective of the dynamics of the FTSE All Share, Ibex-35 and FTSE-20, respectively. The Autoregressive effect is statistically significant and positive for all markets and especially for U.K and Spain. In the case of the Greek market, the Market Effect parameter is above unity classifying the FTSE-20 Index as an aggressive portfolio. The day effect is very interesting since Fridays give a high boost to the mean equation of the U.K. and Greek market, in contrast with to the Spanish market where Mondays play a key role in the mean equation. The arrival of new information is not always significant and occupies a low level, with high persistence of volatility shocks. The conditional distribution of the returns is leptokurtic (low degrees of freedom) for all financial markets with negative skeweness for the FTSE All Share and Ibex-35 Indices, and positive for the FTSE-20. It is worth mentioning that in the case of the FTSE-20 Index, parameterizations that allow for Market Effect in the mean equation result in left asymmetry, which is explained by the fact that this regressor is negatively skewed.

The second step of our analysis, as shown in Tables 5.3.a 5.3.b and 5.3.c of the appendix, deals with the two sub-periods, testing for structural shifts through a Likelihood Ratio Test. The values of the autoregressive parameters are lower after the futures onset. Furthermore, in the case of the Greek financial market the increased parameter ‘Beta’ signifies a more aggressive presence of the FTSE-20 Index in the second sub-period. There is a slight reduction in the unconditional volatility but the dynamics of volatility have substantially changed with an exception for the FTSE All Share case where the results give an equivocal meaning depending on the model specification. The rate of anticipated information is reduced and the persistence of stocks to volatility is increased, as implied by parameters α_1 and β_1, respectively. The leverage effect is present in most cases and tends to be higher after the futures onset for all markets, evidence of the presence of well informed investors since the introduction of the futures markets. The asymptotic power coefficient δ becomes lower for the second sub-period, in the case of the Ibex-35 index, verifying the aforementioned results about the increased persistence in volatility, and increases for the second sub-period, in the case of the FTSE-20 index, without substantial changes in the FTSE All Share index. Although the degrees of freedom of the conditional distribution are increased in all model specifications for the Spanish and Greek markets, with an exception for the U.K. case, they remain at low levels for all capital markets, indicating that the Quasi Maximum Likelihood estimation procedure underperforms. The skewness parameter of the conditional distribution for the FTSE All Share Index becomes more negative in the second sub-period, for the FTSE-20 is positively higher in the second sub-period, while in the case of the Ibex-35 conditional distribution it turns from left to right after the introduction of Futures contracts. Finally, the Likelihood Ratio Statistic of the structural changes in the volatility dynamics cast doubts of their significance, as evidenced by the estimated high p-values.

An alternative way to examine for structural shifts is to apply the aforementioned models enriched with dummy variables to account for the futures effect in the whole parameter space. From Table 5.4 of the appendix the values of the autoregressive parameters are decreased significantly for the Spanish and Greek cases and insignificantly for the U.K. case. The FTSE-20 Index is undoubtedly more aggressive in the second sub-period. The information arrival process is reduced and the persistence in volatility is increased according to parameter ‘β’, after the introduction of Futures contracts for the Spanish and Greek cases, while, opposite results are obtained for the FTSE All Share Index. The leverage effect which is not significant in the FTSE All Share Index, is apparent in the FTSE-20 index, while, in the Ibex-35 case, is significant with higher values after the Futures onset. Finally, the conditional distributions of the returns of all the examined indices seem to be the same regarding the sub-periods before and after the Futures introduction.

The next part of our analysis deals with the timing of the regime shifting in the dynamics of mean and volatility equations, as well as the dynamics of higher moments of the conditional distribution. The computational complexity increases as this methodology demands many recursive estimations with rolling sample windows of size 500, resulting in 2806, 2128 and 2222 recursive estimated parameters for the FTSE All Share, the Ibex-35 and the FTSE-20 Indices, respectively. Figure 5.4 of the appendix represents the rolling estimations of the AR parameter 'φ' for all financial markets, showing a reduction in its value immediately after the introduction of futures contracts. The rolling sample estimates of the Beta parameter of the FTSE-20 Index (Figure 5.5) indicate that the futures onset has affected negatively the systematic risk of the FTSE-20 Index in the short term and positively in the long run horizon. The GARCH-M rolling estimations, as illustrated in Figure 5.6 of the appendix have no clear structural change for the FTSE All Share with higher values for the Ibex-35 and lower for the FTSE-20 regarding futures onset. Figure 5.7 shows the ARCH parameter '$\alpha 1$', which is responsible for the rate of the accumulated information. It is obvious that the level of accumulated information is reduced immediately after the introduction of futures for Ibex-35 and FTSE-20 Indices, with no structural change in the FTSE All Share. From Figure 5.8 of the appendix we conclude that in the case of the FTSE All Share the GARCH parameter 'β' remains the same. However in the case of the FTSE-20, it is increased immediately after the futures onset, in contrast to the Ibex-35 Index where there exists a reduction in the short term horizon followed by an increment in the long term horizon. The leverage effect, as shown in Figure 5.9, increases after the futures introduction, especially for the Ibex-35 Index. As Figure 5.10 shows, there appears a slight decrease in the leptokurtosis (higher degrees of freedom) in the case of the Ibex-35 and FTSE-20, while the skeweness (Figure 5.11) becomes more negative in the case of the FTSE All Share and turns from left to right after the futures introduction for Ibex-35 and FTSE-20 Indices. In the case of the FTSE-20 Index the results regarding skewness rolling estimators are opposite when the mean Market Effect is omitted from the mean equation.

Finally, the Markov Switching Methodology verifies many of the aforementioned empirical results, but also casts doubts on their robustness according to different parameterizations, providing evidence of stabilization effects. For the purposes of this part of the analysis we examine the three financial markets under consideration, with two alternatives for the Greek capital market depending on the presence or not of the Market Effect in the mean equation, as shown on Table 5.5 of the appendix. All approaches suggest three levels of conditional volatility with a ratio of 1:17:2, 1:3:2 and 1:2:8 (approximately), for U.K., Spain and Greece, respectively. From Figure 5.12 of the appendix, where the time-varying probabilities of volatility levels are shown for the FTSE-20 Index, it is assumed that the conditional volatility has decreased stochastically (about 50%), after the introduction of futures, in the long run. However, immediately after the onset date the third regime (high volatility) dominates the whole process for approximately two months. Figure 5.13 of the appendix, presents time-varying probabilities of volatility levels for the Ibex-35 Index, where it is obvious that the volatility has decreased stochastically (about 66%) immediately after the futures onset. From Figure 5.14 of the appendix, where the time-varying probabilities of volatility levels are shown for the FTSE-20 Index, it is assumed that the conditional volatility has decreased stochastically (about 75%), after the introduction of futures, in the long run. However, immediately after the onset date the third regime (high volatility) dominates the whole process for approximately one month. Finally, figure 5.15 of the appendix, which shows time-varying probabilities for the FTSE-20 Index, when the Market Effect is considered, in the mean equation, strongly suggests a high volatility scheme that is unaffected by the futures onset. This tends to weaken the stabilization argument of the introduction of derivative products in the Greek Market. However, there is evidence that in the long term there exists a stabilization effect in Greek Capital Market, since the second regime is apparent more often.

6. Conclusions and Implications for further Research

According to the results obtained, there exist some potential stabilization effects on the Spot Market, as a result of the introduction of futures. These spill over effects take place with a lag of one to two months, with an exception in the Spanish market, and seem to be robust under many alternative parameterizations.

A very interesting result, derived from our analysis is the comparative performance of futures markets in different capital markets. Thus, the U.K. capital market, which is supposed to be the most efficient among the markets examined, has been affected at a lower level, followed by the Spanish market, verifying the conclusion of the theoretical framework mentioned in section 2.

In any case, our results should be thought of as being tentative in that they apply to the SWARCH model which might have some drawbacks as **Haas et.al. (2004)** has suggested. Thus, further econometric research is required to shed more light into this important topic.

References

Antoniou, A. and P. Holmes (1995), 'Futures Trading, Information and Spot Price Volatility: Evidence from the FTSE 100 Stock Index Futures Contract using GARCH', Journal of Banking and Finance, 19(1): 117-129

Antoniou et.al. (1998), 'The effects of stock index futures trading on stock index volatility: an analysis of the asymmetric response of volatility to news', Journal of Futures Markets, 18, 151-166.

Bessembinder, H. and Seguin P.J. (1992), 'Futures-Trading Activity and Stock Price Volatility', The Journal of Finance, Vol. 47, No. 5, 2015-2034

Bollerslev T. (1986), 'Generalized Autoregressive Conditional Heteroskedasticity', Journal of Econometrics, 31, 307-327

Bologna, P. and L. Cavallo (2002), 'Does the Introduction of Index Futures Effectively Reduce Stock Market Volatility? Is the Futures Effect Immediate? Evidence from the Italian Stock Exchange Using GARCH', Applied Financial Economics, 12(3) 183-192

Butterworth, D. (2000), 'The Impact of Futures Trading on Underlying Stock Market Volatility: The case of the FTSE Mid 250 Contract, Applied Economics Letters, 7(7): 439-442

Bansal, Pruitt and Wei (1989), 'An empirical re-examination of the impact of CBOE option initiation on the volatility and trading volume of the underlying equities: 1973-86', Financial Review 24, 19-29

Bechetti S. and Roberts D.J. (1990), 'Will increased regulation of stock index futures reduce stock market volatility? Federal Reserve Bank of Kansas City Economic Review, 33-46

Cambell L. A. Lo and MacKinlay A.C (1997), 'The Econometrics of Financial Markets', New Jersey, Princeton University Press.

Chen Shyh-Wei and Lin Jin-Lung (1999), 'Switching ARCH Models of Stock Market Volatility in Taiwan', Working Paper

Chiang M-H and C-Y Wang (2002), "The Impact of futures trading on spot Index volatility: evidence for Taiwan Index futures," Applied Economics Letters, 9, 381-385

Conrad Jennifer (1989), 'The price effect of Option Introduction', The Journal of Fianance, Vol. 44, No. 2, 487-498

Cox Charles C. (1976), 'Futures Trading and Market Information', The Journal of Political Economy, Vol. 84, No. 6, 1215-1237

Ding Z., Granger C. W. J. and Engle R. F. (1993), 'A long memory property of stock market returns and a new model', Journal of Empirical Finance, 1, 83-106

Dennis, S. A., & Sim, A. B. (1999), 'Share price volatility with the introduction of individual share futures on the Sydney Futures Exchange', International Review of Financial Analysis, 8, 153–163

Engle R. F., Lilien D. M. and Robins R. P. (1987), 'Estimating Time Varying Risk Premia in the Term Structure: The ARCH-M Model', Econometrica, 55, 391-407

Engle R.F., and Ng, V.K., (1993), 'Measuring and testing the impact of news on volatility, Journal of Finance, 48, 1749-78

Engle R. F., (2001), 'Dynamic Conditional Correlation – a simple class of multivariate GARCH models', UCSD

Fama E.F. (1965), 'The Behaviour of Stock Market Prices', Journal of Business, 38, 34-105

Figlewski Stephen (1981), 'Futures Trading and Volatility in the GNMA Market', The Journal of Finance, Vol. 36, No.2, 445-456

Glosten, Jagannathan and Runkle, (1989), 'Relationship between the expected value and the volatility of the nominal excess return on stocks, Mimeo. (Northwestern University, Evanston, IL)

Gullen, H., & Mayhew, S. (2000), 'Stock index futures trading and volatility in international equity markets. Journal of Futures Markets, 20, 661–685

Haas M., Mittnik S., Paolella M.S. (2004), 'A New Approach to Markov-Switching GARCH Models', Journal of Financial Econometrics, 2004, Vol. 2, No. 4, 493-530

Hamilton James D., and Susmel R. (1994), "Autoregressive conditional heteroskedasticity and changes in regime", Journal of Econometrics, 64, 307-333

Hansen Bruce E., (1994), 'Autoregressive Conditional Density Estimation' International Economic Review, Vol. 35, No. 3, 705-730

Harris, L. (1989), 'S&P 500 cash stock price volatilities', Journal of Finance, 48, 1749-78

Kyriacou and Sarno (1999), 'The Temporal Relationship Between Derivatives Trading and Spot Market Volatility in the U.K.: Empirical Analysis and Monte Carlo Evidence', The Journal of Futures Markets, Vol. 19, No.3, 245-270

Lambert P., and Laurent S. (2001), 'Modelling financial time series using GARCH-type models and a skewed Student density', Mimeo, University de Liege

Lee S.B. and Ohk K.Y. (1992), 'Stock Index Futures Listing and Structural Change in Time-Varying Volatility', Journal of Futures Markets, 12, 493-509

Ma, C., & Rao, R. (1988), 'Information asymmetry and option trading', Financial Review, 23, 39–51

Mandelbrot, B. (1963a), 'The Variation of certain speculative prices', Journal of Business, 36, 394-19

_____ (1963b), 'New methods in statistical economics', Journal of Political Economy, 71, 421-40

_____ (1967), 'The variation of some other speculative prices', Journal of Business,40,393-13

Merton, R. C. (1995), 'Financial Innovation and the Management and Regulation of Financial Institutions,' *Journal of Banking and Finance,* 19:461–481

Perikli A., and Koutmos G. (1997), 'Index futures and options and stock market volatility', Journal of Futures Markets, 17, 957-74

Pilar Corredor and Santamaria Rafael (2002), "Does derivatives trading destabilize the underlying assets? Evidence from the Spanish stock market", Applied Economics Letters, 9, 107-110

Powers, M. J. (1970), 'Does futures trading reduce price fluctuations in the cash markets?', *American Economic Review*, 60, 460-4

Ross, S.A., (1976), 'Options and efficiency', Quart. J. Econ. 90, 75-90

_____ (1989), 'Information and volatility: The no-arbitrage martingale approach to timing and resolution irrelevancy', Journal of Finance 44, 1-17

Sharpe W., (1964), 'Capital Asset Prices. A theory of Market equilibrium under conditions of risk', Journal of Finance

Skinner D. (1989), 'Options Markets and Stock Return Volatility', Journal of Financial Economics 23, 61-78

Spyrou S.I. (2005), ‘Index Futures Trading and Spot Price Volatility: Evidence from an emerging Market’, Journal of Emerging Market Finance, 4, 151-167

Yu, S.W. (2001), ‘Index Futures Trading and Spot Price Volatility’, Applied Economics Letters, 8(3) 183-186

Appendices

Tables

Table 5.1 Descriptive Statistics for FTSE-20, GI and Ibex-35 Indices + FTSE_AllSha

	FTSE All Share			Ibex-35			FTSE-20			General
	All	**pre-Futures**	**post-Futures**	**All**	**pre-Futures**	**post-Futures**	**All**	**pre-Futures**	**post-Futures**	**Index**
N	3306	1653	1653	2628	1309	1319	2722	1162	1560	2722
Mean	0,000	0,001	0,000	0,000	0,000	0,001	0,001	0,002	0,000	0,001
Median	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,001	0,000	0,000
Max	0,057	0,047	0,057	0,086	0,086	0,047	0,087	0,077	0,087	0,077
Min	-0,119	-0,048	-0,119	-0,089	-0,089	-0,054	-0,096	-0,082	-0,096	-0,096
Std.deviation	0,009	0,009	0,009	0,011	0,012	0,010	0,017	0,019	0,015	0,016
Skewness	-1,540	-0,086	-2,620	-0,506	-0,651	-0,200	0,074	-0,027	0,129	-0,063
Kurtosis	21,067	4,267	32,149	11,480	13,884	4,834	6,790	6,144	7,181	7,016
Jargue-Bera	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*

** p-value for the Jargue-Bera test of normality*

Tables 5.2.a Parameter Estimation for the whole time horizon of the FTSE All Share

Parameter Estimation for the whole Time Horizon												
parameters	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
φ	0,164	0,165	0,160	0,160	x	x	x	x	x	x	x	x
c0	0,045*	0,023*	0,052*	0,045*	0,044	x	0,057	x	0,090	x	0,041	x
c2	-0,024*	-0,051*	-0,018*	-0,026*	-0,031	-0,032	-0,020	-0,047	-0,047	-0,048	-0,037	-0,038
dMo	x	x	x	x	x	-0,085	x	-0,040	x	-0,038	x	-0,088
dTu	x	x	x	x	x	0,091	x	0,135	x	0,138	x	0,087
dWe	x	x	x	x	x	0,099	x	0,143	x	0,145	x	0,095
dTh	x	x	x	x	x	0,006	x	0,053	x	0,053	x	0,003*
dFr	x	x	x	x	x	0,102	x	0,148	x	0,149	x	0,099
α0	0,048*	0,000*	0,039*	0,029*	0,039*	0,038*	0,122	0,026	0,039*	0,038*	0,032	0,032
α1	0,088*	0,090*	0,085*	0,084	0,082	0,081	0,123	0,080	0,082	0,081	0,082	0,080
γ	x	0,171	x	0,056*	x	x	0,012	-0,024	x	x	0,014	0,016
β	0,846	0,897	0,857	0,869	0,861	0,861	0,729	0,874	0,861	0,862	0,870	0,869
δ	x	1,862	x	1,971	x	x	1,872	2,033	x	x	1,982	1,984
df	x	x	12,126	12,206	12,761	12,248	10,862	12,222	12,767	12,244	12,746	12,238
λ	x	x	x	x	-0,132	-0,133	-0,022	-0,131	x	x	x	x
ξ	x	x	x	x	x	x	x	x	0,875	0,875	0,877	0,876

Model 1	Gaussian AR-GARCH-M
Model 2	Gaussian AR-AP-GARCH-M
Model 3	Student-t AR-GARCH-M
Model 4	Student-t AR-AP-GARCH-M
Model 5	Skewed-t of Hansen GARCH-M
Model 6	Skewed-t of Hansen GARCH-M with Day Effect
Model 7	Skewed-t of Hansen AP-GARCH-M
Model 8	Skewed-t of Hansen AP-GARCH-M with Day Effect
Model 9	Skewed-t of Laurent & Lambert GARCH-M
Model 10	Skewed-t of Laurent & Lambert GARCH-M with Day Effect
Model 11	Skewed-t of Laurent & Lambert AP-GARCH-M
Model 12	Skewed-t of Laurent & Lambert AP-GARCH-M with Day Effect

** not significant parameters at 5% statistical significance level*

Tables 5.2.b Parameter Estimation for the whole time horizon of the Ibex-35

Parameter Estimation for the whole Time Horizon												
parameters	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
φ	0,189	0,198	0,184	0,189	x	x	x	x	x	x	x	x
c0	0,057	0,030	0,049	0,028	0,057	x	0,071	x	0,035	x	0,038	x
c2	0,054	0,004	0,011	-0,021	0,021	0,018	0,017	0,012	0,019	0,018	-0,028	-0,036
dMo	x	x	x	x	x	0,129	x	0,122	x	0,108	x	0,119
dTu	x	x	x	x	x	0,075	x	0,050	x	0,054	x	0,040
dWe	x	x	x	x	x	-0,033	x	-0,052	x	-0,054	x	-0,062
dTh	x	x	x	x	x	0,048	x	0,032	x	0,027	x	0,028
dFr	x	x	x	x	x	0,069	x	0,056	x	0,048	x	0,055
α0	0,051*	0,000*	0,025*	-0,016	0,027*	0,026*	0,086	-0,013	0,027*	0,026*	-0,016	-0,018
α1	0,093	0,082	0,126	0,125	0,114	0,115	0,144	0,108	0,116	0,116	0,115	0,116
γ	x	0,244	x	0,094	x	x	0,033	0,078	x	x	0,088	0,099
β	0,864	0,929	0,859	0,913	0,868	0,868	0,760	0,917	0,866	0,867	0,921	0,922
δ	x	1,901	x	1,883	x	x	1,945	2,109	x	x	1,889	1,886
df	x	x	5,568	5,617	5,425	5,361	10,666	5,411	4,185	4,136	5,667	5,596
λ	x	x	x	x	-0,012	-0,018	-0,013	-0,011	x	x	x	x
ξ	x	x	x	x	x	x	x	x	0,989	0,984	0,995	0,990

Model 1 Gaussian AR-GARCH-M
Model 2 Gaussian AR-AP-GARCH-M
Model 3 Student-t AR-GARCH-M
Model 4 Student-t AR-AP-GARCH-M
Model 5 Skewed-t of Hansen GARCH-M
Model 6 Skewed-t of Hansen GARCH-M with Day Effect
Model 7 Skewed-t of Hansen AP-GARCH-M
Model 8 Skewed-t of Hansen AP-GARCH-M with Day Effect
Model 9 Skewed-t of Laurent & Lambert GARCH-M
Model 10 Skewed-t of Laurent & Lambert GARCH-M with Day Effect
Model 11 Skewed-t of Laurent & Lambert AP-GARCH-M
Model 12 Skewed-t of Laurent & Lambert AP-GARCH-M with Day Effect

** not significant parameters at 5% statistical significance level*

Tables 5.2.c Parameter Estimation for the whole time horizon of the FTSE-20 Index

Parameter Estimation for the whole Time Horizon														
parameters	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**	**Model 13**	**Model 14**
φ	0,018	0,185	0,018	0,018	0,188	0,018	0,020	0,020	X	X	X	X	X	X
c0	0,008	0,032	-0,043	0,009	0,012	-0,032	-0,040	-0,034	-0,040	X	X	0,020	X	X
c1	1,033	X	1,033	1,033	X	1,033	1,034	1,034	1,037	X	X	1,037	X	X
c2	X	0,045	-0,018	X	0,028	-0,015	-0,018	-0,016	-0,018	0,074	0,026	-0,141	0,031	0,037
dMo	X	X	X	X	X	X	X	X	X	-0,070	-0,086	X	-0,097	-0,055
dTu	X	X	X	X	X	X	X	X	X	-0,011	-0,053	X	-0,038	-0,021
dWe	X	X	X	X	X	X	X	X	X	-0,009	-0,029	X	-0,038	0,005*
dTh	X	X	X	X	X	X	X	X	X	-0,007	-0,041	X	-0,035	-0,010
dFr	X	X	X	X	X	X	X	X	X	0,165	0,145	X	0,137	0,178
α0	0,003*	0,041*	0,003*	0,000*	0,000*	-0,003	0,004	0,000	0,003*	0,066*	-0,018	0,003*	0,063*	-0,013
α1	0,117	0,127	0,118	0,118	0,134	0,119	0,148	0,140	0,136	0,148	0,146	0,139	0,146	0,147
γ	X	X	X	-0,057	0,127	-0,043	X	-0,025	X	X	0,135	X	X	0,124
β1	0,857	0,866	0,855	0,822	0,906	0,797	X	0,789	0,835	0,837	0,920	0,831	0,840	0,916
δ	X	X	X	1,927	1,938	1,869	0,817	1,904	X	X	2,106	X	X	1,909
df	X	X	X	X	X	X	7,762	8,078	7,921	5,913	6,127	7,849	5,912	6,103
λ	X	X	X	X	X	X	X	X	-0,041	0,034	0,045	X	X	X
ξ	X	X	X	X	X	X	X	X	X	X	X	0,960	1,036	1,046

Model 1 Gaussian AR-GARCH with Market Effect
Model 2 Gaussian AR-GARCH-M
Model 3 Gaussian AR-GARCH-M with Market Effect
Model 4 Gaussian AR-AP-GARCH with Market Effect
Model 5 Gaussian AR-AP-GARCH-M
Model 6 Gaussian AR-AP-GARCH-M with Market Effect
Model 7 Student-t AR-GARCH-M with Market Effect
Model 8 Student-t AR-AP-GARCH-M with Market Effect
Model 9 Skewed-t of Hansen GARCH-M with Market Effect
Model 10 Skewed-t of Hansen GARCH-M with Day Effect
Model 11 Skewed-t of Hansen AP-GARCH-M with Day Effect
Model 12 Skewed-t of Laurent & Lambert GARCH-M with Market Effect
Model 13 Skewed-t of Laurent & Lambert GARCH-M with Day Effect
Model 14 Skewed-t of Laurent & Lambert AP-GARCH-M with Day Effect

** not significant parameters at 5% statistical significance level*

Tables 5.3.a Parameter Estimation for the sub-periods before and after derivatives onset for the FTSE All Share

Parameter Estimation for the sub-periods before and after derivatives onse

parameters	**Model 1**		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**		**Model 7**		**Model 8**		**Model 9**		**Model 10**		**Model 11**		**Model 12**	
sub-period	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**
φ	0,175	0,149	0,176	0,149	0,177	0,137	0,178	0,137	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	0,857		0,923		0,920		0,922																	
c0	0,045*	0,043*	0,036*	0,005*	0,042*	0,063*	0,035*	0,046*	0,054	0,034	x	x	0,068	0,071*	x	x	0,045	0,099	x	x	0,051	0,032	x	x
c2	-0,006*	-0,049*	-0,027*	-0,085*	-0,014*	-0,025*	-0,031	-0,045	-0,009*	-0,046	-0,024	-0,031	-0,009*	-0,034*	0,011*	-0,045	0,019*	-0,063	0,001*	-0,056	-0,014*	-0,050	-0,024*	-0,042
	0,865		0,976		1,000		1,000		0,982		1,000						0,972		0,980					
dMo	x	x	x	x	x	x	x	x	x	x	-0,051	-0,113	x	x	-0,044	-0,069	x	x	-0,039	-0,061	x	x	-0,049	-0,120
											0,975								0,992					
dTu	x	x	x	x	x	x	x	x	x	x	0,123	0,058	x	x	0,126	0,102	x	x	0,130	0,109	x	x	0,122	0,051
											0,975								0,992					
dWe	x	x	x	x	x	x	x	x	x	x	0,084	0,115	x	x	0,082	0,160	x	x	0,091	0,167	x	x	0,082	0,108
											1,000								0,888					
dTh	x	x	x	x	x	x	x	x	x	x	0,018	0,003*	x	x	0,022*	0,048	x	x	0,028	0,054	x	x	0,018	-0,004*
											0,975								0,989					
dFr	x	x	x	x	x	x	x	x	x	x	0,058	0,149	x	x	0,061	0,194	x	x	0,067	0,201	x	x	0,058	0,143
											0,975								0,930					
α0	0,039*	0,050*	0,000*	0,000*	0,037*	0,041*	0,004*	0,042*	0,043*	0,037*	0,041*	0,036*	0,238	0,127*	0,015*	0,034	0,044*	0,036*	0,042*	0,035*	0,036	0,036	0,029	0,038
α1	0,077*	0,100*	0,079*	0,101*	0,074*	0,094*	0,075	0,086	0,073*	0,085*	0,072*	0,086*	0,147	0,116	0,071	0,087	0,074*	0,085*	0,072*	0,086*	0,074	0,085	0,073	0,085
	0,974		0,979		0,948		0,989		0,986		1,000						0,988		0,984					
γ	x	x	0,008*	0,343	x	x	0,001*	0,124*	x	x	x	x	0,007*	0,003*	-0,013*	-0,020	x	x	x	x	0,006*	0,009*	-0,008*	0,024
			0,918				0,972																	
β1	0,867	0,836	0,909	0,884	0,873	0,843	0,908	0,842	0,868	0,858	0,871	0,854	0,555	0,705	0,894	0,856	0,865	0,860	0,868	0,855	0,874	0,860	0,883	0,852
	0,972		0,973		0,978		0,965		0,992		0,964						1,000		0,992					
δ	x	x	1,887	1,840	x	x	1,904	1,996	x	x	x	x	1,915	1,869	2,079	2,006	x	x	x	x	1,981	1,997	1,966	2,003
			0,976				0,972																	
df	x	x	x	x	29,999	8,881	30,000	9,018	17,000	9,662	16,994	9,518	10,851	10,851	26,999*	9,468	25,000	9,650	24,990	9,500	25,000	9,657	25,000	9,521
					0,894		0,897		0,949		0,950						0,921		0,919					
λ	x	x	x	x	x	x	x	x	-0,041	-0,232	-0,051	-0,228	-0,006	-0,012	-0,050	-0,224	x	x	x	x	x	x	x	x
									0,901		0,903													
ξ	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	0,960	0,789	0,952	0,793	0,961	0,791	0,952	0,795
																	0,801		0,802					

Model 1	Gaussian AR-GARCH-M
Model 2	Gaussian AR-AP-GARCH-M
Model 3	Student-t AR-GARCH-M
Model 4	Student-t AR-AP-GARCH-M
Model 5	Skewed-t of Hansen GARCH-M
Model 6	Skewed-t of Hansen GARCH-M with Day Effect
Model 7	Skewed-t of Hansen AP-GARCH-M
Model 8	Skewed-t of Hansen AP-GARCH-M with Day Effect
Model 9	Skewed-t of Laurent & Lambert GARCH-M
Model 10	Skewed-t of Laurent & Lambert GARCH-M with Day Effect
Model 11	Skewed-t of Laurent & Lambert AP-GARCH-M
Model 12	Skewed-t of Laurent & Lambert AP-GARCH-M with Day Effect

** not significant parameters at 5% statistical significance level*

Note that the estimated parameters are enriched with the p-values of a LRS for structural shifts

Tables 5.3.b Parameter Estimation for the sub-periods before and after derivatives onset for the Ibex-35 Index

Parameter Estimation for the sub-periods before and after derivatives onse

parameters	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8		Model 9		Model 10		Model 11		Model 12	
sub-period	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
φ	0,254	0,126	0,278	0,130	0,249	0,127	0,254	0,125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	0,9159		0,905		0,785		0,914																	
c0	0,043	0,058	_0,002*	0,043	0,012	0,061	0,006	0,041	0,024	0,074	x	x	0,000	0,094	x	x	0,010	0,089	x	x	0,009	0,050	x	x
c2	0,069	0,008*	_0,003*	-0,069	-0,020	-0,033	-0,031	-0,059	0,008	-0,031	0,000	-0,033	-0,022	-0,002	0,012	-0,044	0,016	-0,010	0,012	-0,012	-0,030	-0,105	-0,056	-0,100
	0,981		0,986		0,996		0,992		0,9887		1,000		0,992		0,9840		0,992		0,9920		0,920		0,989	
dMo	x	x	x	x	x	x	x	x	x	x	0,256	-0,030	x	x	0,245	0,023	x	x	0,247	-0,012	x	x	0,235	-0,041
											0,906				0,9489				0,9377				0,911	
dTu	x	x	x	x	x	x	x	x	x	x	-0,013	0,133	x	x	-0,019	0,161	x	x	-0,021	0,151	x	x	-0,047	0,103
											0,950				0,9563				0,9403				0,952	
dWe	x	x	x	x	x	x	x	x	x	x	-0,037	-0,044	x	x	-0,046	_0,003*	x	x	-0,045	-0,026	x	x	-0,074	-0,066
											1,000				0,9887				1,000				1,000	
dTh	x	x	x	x	x	x	x	x	x	x	-0,032	0,123	x	x	-0,039	0,158	x	x	-0,039	0,141	x	x	-0,055	0,097
											0,950				0,9528				0,9563				1,000	
dFr	x	x	x	x	x	x	x	x	x	x	-0,039	0,167	x	x	-0,045	0,205	x	x	-0,049	0,184	x	x	-0,049	0,147
											0,933				0,9414				0,9310				0,936	
α0	0,049*	0,000*	0,000	0,000	0,000*	0,039*	-0,014	-0,019	0,025*	0,039*	0,023*	0,034*	-0,006	0,244	-0,004	-0,020	0,025*	0,038*	0,024*	0,034*	-0,012	-0,033	-0,014	-0,053
α1	0,110	0,039*	0,092	0,068*	0,163	0,088*	0,174	0,086	0,138*	0,086*	0,139	0,082*	0,121	0,161	0,137	0,076	0,140	0,086*	0,140	0,081*	0,147	0,089	0,146	0,085
	0,904		0,976		0,950		0,944		0,9626		0,956		0,920		0,9542		0,962		0,9571		0,956		0,9549	
γ	x	x	0,325	0,251	x	x	0,003*	0,280	x	x	x	x	0,108	0,045	-0,009	0,191	x	x	x	x	-0,011	0,291	0,040	0,269
			0,988				0,943						0,310		0,9571						0,938		0,953	
β1	0,858	0,964	0,926	0,933	0,874	0,875	0,883	0,939	0,853	0,877	0,852	0,884	0,889	0,587	0,887	0,937	0,851	0,878	0,850	0,885	0,900	0,952	0,899	0,976
	0,898		0,990		0,994		0,986		0,9862		1,000		0,003				0,986		0,9805		1,000		0,981	
δ	x	x	1,911	1,854	x	x	1,885	1,838	x	x	x	x	2,089	1,918	2,079	2,164	x	x	x	x	1,901	1,800	1,902	1,774
			0,974				1,000						0,984		0,9887						1,000		0,982	
df	x	x	x	x	4,272	8,144	4,479	8,066	4,369	7,927	4,184	7,670	5,509	10,81	4,211	7,583	3,508	5,821	3,370	5,640	4,444	8,357	4,278	8,089
					0,924		0,931		0,9403		0,938		0,916		0,9113		0,920		0,9176		0,917		0,916	
λ	x	x	x	x	x	x	x	x	-0,036	0,003*	-0,053	_0,002*	-0,036	_0,006*	-0,052	0,013	x	x	x	x	x	x	x	x
									0,9887		1,000		0,992		0,9805									
ξ	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	0,967	1,002	0,952	0,998	0,965	1,022	0,951	1,016
																	0,905		0,9048		0,651		0,653	

Model 1	Gaussian AR-GARCH-M
Model 2	Gaussian AR-AP-GARCH-M
Model 3	Student-t AR-GARCH-M
Model 4	Student-t AR-AP-GARCH-M
Model 5	Skewed-t of Hansen GARCH-M
Model 6	Skewed-t of Hansen GARCH-M with Day Effect
Model 7	Skewed-t of Hansen AP-GARCH-M
Model 8	Skewed-t of Hansen AP-GARCH-M with Day Effect
Model 9	Skewed-t of Laurent & Lambert GARCH-M
Model 10	Skewed-t of Laurent & Lambert GARCH-M with Day Effect
Model 11	Skewed-t of Laurent & Lambert AP-GARCH-M
Model 12	Skewed-t of Laurent & Lambert AP-GARCH-M with Day Effect

** not significant parameters at 5% statistical significance level*

Note that the estimated parameters are enriched with the p-values of a LRS for structural shifts

Tables 5.3.c Parameter Estimation for the sub-periods before and after derivatives onset for the FTSE-20 Index

Parameter Estimation for the sub-periods before and after derivatives onse

parameters	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
sub-period	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
φ	0,024	0,012	0,240	0,139	0,024	0,012	0,024	0,013	0,243	0,136	0,024	0,013	0,027	0,013
	0,030		*0,943*		*0,859*		*0,877*		*0,939*		*0,638*		*0,867*	
c0	0,009	0,004	0,050	0,024	-0,054	-0,031	0,011	0,006	0,038	0,005	-0,042	-0,004	-0,054	-0,031
c1	1,029	1,040	X	X	1,030	1,039	1,029	1,041	X	X	1,029	1,041	1,033	1,040
	0,895				*0,908*		*0,369*				*0,730*		*0,932*	
c2	X	X	0,065	0,007*	-0,024	-0,012	X	X	0,062	-0,036	-0,020	-0,003	-0,027	-0,012
			0,988		*0,947*				*0,977*		*0,282*		*0,929*	
dMo	X	X	X	X	X	X	X	X	X	X	X	X	X	X
dTu	X	X	X	X	X	X	X	X	X	X	X	X	X	X
dWe	X	X	X	X	X	X	X	X	X	X	X	X	X	X
dTh	X	X	X	X	X	X	X	X	X	X	X	X	X	X
dFr	X	X	X	X	X	X	X	X	X	X	X	X	X	X
α0	0,020*	0,000*	0,036*	0,055*	0,020*	0,000*	0,000	0,000	0,000	0,000	-0,005	_0,001*	0,017	0,000
α1	0,310	0,035*	0,159	0,106*	0,309	0,038*	0,281	0,029*	0,162	0,122	0,275	0,020	0,283	0,037
	0,527		*0,977*		*0,529*		*0,520*		*0,814*		*0,319*		*0,626*	
γ	X	X	X	X	X	X	-0,058	-0,230	0,056	0,222	_0,013*	-0,273	X	X
							0,892		*0,948*		*0,287*			
β1	0,512	0,956	0,846	0,873	0,511	0,953	0,514	0,952	0,889	0,920	0,521	0,955	0,570	0,954
	0,472		*0,994*		*0,474*		*0,467*		*0,978*		*0,423*		*0,573*	
δ	X	X	X	X	X	X	1,537	1,987	1,944	1,906	1,492	1,974	X	X
							0,456		*0,977*		*0,447*			
df	X	X	X	X	X	X	X	X	X	X	X	X	6,535	11,853
													0,876	
λ	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ξ	X	X	X	X	X	X	X	X	X	X	X	X	X	X

parameters	Model 8		Model 9		Model 10		Model 11		Model 12		Model 13		Model 14	
sub-period	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
φ	0,026	0,013	X	X	X	X	X	X	X	X	X	X	X	X
	0,898													
c0	-0,055	-0,006	-0,038	-0,037	X	X	X	X	0,025	0,010	X	X	X	X
c1	1,032	1,041	1,038	1,042	X	X	X	X	1,038	1,043	X	X	X	X
	0,966		*0,959*						*0,955*					
c2	-0,027	-0,004	-0,020	-0,014	0,151	-0,028	0,051	-0,043	-0,141	-0,093	0,048	-0,006	0,143	-0,137
	0,952		*0,974*		*0,951*		*0,957*		*0,970*		*0,951*		*0,941*	
dMo	X	X	X	X	0,112	-0,165	0,054	-0,106	X	X	0,067	-0,167	0,112	-0,125
					0,948		*0,973*				*0,959*		*0,955*	
dTu	X	X	X	X	_0,013*	_0,002*	-0,077	0,044	X	X	-0,060	_0,005*	-0,025	0,028
					1,000		*0,979*				*0,989*		*0,989*	
dWe	X	X	X	X	0,002	0,004*	-0,059	0,068	X	X	-0,050	0,000*	0,000*	0,058
					1,000		*0,978*				*0,990*		*0,989*	
dTh	X	X	X	X	-0,070	0,077	-0,129	0,103	X	X	-0,123	0,074	-0,072	0,097
					0,972		*0,960*				*0,966*		*0,966*	
dFr	X	X	X	X	0,186	0,181	0,125	0,243	X	X	0,131	0,178	0,185	0,229
					1,000		*0,980*				*0,990*		*0,992*	
α0	-0,003	0,000	0,015*	0,000*	0,054*	0,106*	0,018	-0,129	0,015*	0,000*	0,050*	0,111*	0,026	-0,115
α1	0,244	0,024	0,271	0,036*	0,196	0,115*	0,193	0,109	0,271	0,034*	0,185	0,118*	0,196	0,106
	0,620		*0,256*		*0,971*		*0,049*		*0,306*		*0,974*		*0,955*	
γ	0,042	-0,252	X	X	X	X	0,082	0,160	X	X	X	X	0,047	0,215
	0,108						*0,980*						*0,963*	
β1	0,571	0,954	0,600	0,956	0,811	0,838	0,852	1,055	0,606	0,957	0,820	0,833	0,843	1,045
	0,558		*0,569*		*0,992*		*0,049*		*0,573*		*0,995*		*0,961*	
δ	1,601	1,978	X	X	X	X	2,047	2,291	X	X	X	X	1,961	1,777
	0,148						*0,960*						*0,962*	
df	6,716	14,049	6,814	12,082	5,619	5,842	5,743	6,265	6,674	12,007	5,756	5,847	5,677	6,134
	0,275		*0,937*		*0,922*		*0,912*		*0,884*		*0,905*		*0,913*	
λ	X	X	-0,060	-0,041	0,020	0,041	0,021	0,055	X	X	X	X	X	X
			0,981		*0,986*		*0,980*						*0,087*	
ξ	X	X	X	X	X	X	X	X	0,941	0,959	1,020	1,042	1,025	1,056
									0,655		*0,927*		*0,670*	

Model 1 Gaussian AR-GARCH with Market Effect
Model 2 Gaussian AR-GARCH-M
Model 3 Gaussian AR-GARCH-M with Market Effect
Model 4 Gaussian AR-AP-GARCH with Market Effect
Model 5 Gaussian AR-AP-GARCH-M
Model 6 Gaussian AR-AP-GARCH-M with Market Effect
Model 7 Student-t AR-GARCH-M with Market Effect
Model 8 Student-t AR-AP-GARCH-M with Market Effect
Model 9 Skewed-t of Hansen GARCH-M with Market Effect
Model 10 Skewed-t of Hansen GARCH-M with Day Effect
Model 11 Skewed-t of Hansen AP-GARCH-M with Day Effect
Model 12 Skewed-t of Laurent & Lambert GARCH-M with Market Effect
Model 13 Skewed-t of Laurent & Lambert GARCH-M with Day Effect
Model 14 Skewed-t of Laurent & Lambert AP-GARCH-M with Day Effect

** not significant parameters at 5% statistical significance level*

Note that the estimated parameters are enriched with the p-values of a LRS for structural shifts

Table 5.4 Parameter Estimation for the Switching GARCH models

Parameter Estimation for the Switching GARCH models

parameters	**Model 1**		**Model 2**		**Model 3**		**Model 4**		**Model 5**	**Model 6**		**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**
Country	*UK*	*Spain*	*UK*	*Spain*	*UK*	*Spain*	*UK*	*Spain*	*Spain*	*UK*	*Spain*			*Greece*		
φ	0,175	0,252	0,178	0,246	0,180	0,255	x	x	x	x	x	0,024	0,028	0,027	0,026	X
φd	_0,025*	-0,120	_0,034*	-0,123	_0,040*	-0,132	x	x	x	x	x	-0,013	-0,013	-0,014	-0,014	X
c0	0,044*	0,045	0,068	0,044	0,033	0,004	0,043	0,035	x	x	x	-0,058	0,015	-0,054	-0,049	X
c0d	0,004*	0,015	0,029*	0,034	0,009*	0,042	0,002*	0,037	x	x	x	0,036	0,025	0,035	0,034	X
c1	x	x	x	x	x	x	x	x	x	x	x	1,030	1,051	1,032	1,032	X
c1d	x	x	x	x	x	x	x	x	x	x	x	0,010	0,019	0,008	0,009	X
c2	_0,008*	0,073	0,165*	0,084	_0,038*	-0,031	-0,012	0,015	x	-0,025	0,024	-0,025	0,006	-0,026	-0,024	0,151
c2d	_0,030*	-0,116	_0,273*	0,280	_0,004*	-0,016	-0,030	-0,038	x	-0,021	-0,055	0,017	-0,007	0,018	0,017	-0,175
dMo	x	x	x	x	x	x	x	x	x	-0,053	0,263	X	X	X	X	0,100
dMod	x	x	x	x	x	x	x	x	x	-0,050	-0,279	X	X	X	X	-0,230
dTu	x	x	x	x	x	x	x	x	x	0,115	-0,005	X	X	X	X	-0,024
dTud	x	x	x	x	x	x	x	x	x	-0,061	0,125	X	X	X	X	_0,001*
dWe	x	x	x	x	x	x	x	x	x	0,074	-0,013	X	X	X	X	0,001*
dWed	x	x	x	x	x	x	x	x	x	0,047	-0,031	X	X	X	X	_0,011*
dTh	x	x	x	x	x	x	x	x	x	_0,002*	-0,014	X	X	X	X	-0,031
dThd	x	x	x	x	x	x	x	x	x	0,004*	0,116	X	X	X	X	0,103
dFr	x	x	x	x	x	x	x	x	x	0,050	-0,018	X	X	X	X	0,189
dFrd	x	x	x	x	x	x	x	x	x	0,089	0,183	X	X	X	X	-0,020
α0	0,038	0,050	0,036*	0,021	0,006*	-0,008	0,044	0,024	0,022	0,046	0,024	0,020	-0,002	0,016	0,013	0,052
α0d	0,013*	0,011	0,003*	0,029	0,038*	0,006*	-0,006	0,024	0,031	-0,006	0,025	-0,019	0,000	-0,016	-0,013	0,073
α1	0,077	0,109	0,073	0,152	0,074	0,160	0,073	0,127	0,137	0,073	0,130	0,296	0,257	0,272	0,272	0,188
α1d	0,025*	-0,032	0,017*	-0,042	0,010*	-0,054	0,013	-0,024	0,000	0,016	-0,026	-0,270	0,071	-0,245	-0,242	-0,063
γd	x	x	x	x	_0,008*	0,015	x	x	x	x	x	X	-0,032	X	-0,037	X
γ	x	x	x	x	0,142*	0,275	x	x	0,066	x	x	X	0,002	X	-0,120	X
β1	0,868	0,856	0,879	0,834	0,911	0,872	0,870	0,852	0,851	0,868	0,849	0,521	0,640	0,574	0,583	0,819
β1d	_0,036*	0,004	_0,034*	0,020	_0,072*	0,039	-0,021	0,011	-0,012	-0,023	0,012	0,446	-0,007	0,393	0,376	0,003*
δ	x	x	x	x	1,924	1,913	x	x	2,032	x	x	X	1,890	X	1,966	X
δd	x	x	x	x	0,077*	-0,040	x	x	x	x	x	X	0,032	X	0,026	X
df	x	x	12,071	5,471	12,044	5,584	12,643	5,475	4,984	12,253	5,315	X	X	9,078	9,488	5,787
dfd	x	x	12,071	5,472	12,044	5,584	12,643	5,475	x	12,253	5,315	X	X	9,078	9,488	5,787
λ	x	x	x	x	x	x	-0,135	-0,018	x	-0,137	-0,035	X	X	X	X	0,031
λd	x	x	x	x	x	x	-0,135	-0,018	x	-0,137	-0,035	X	X	X	X	0,031
ξ	x	x	x	x	x	x	x	x	0,963	x	x	X	X	X	X	X
ξd	x	x	x	x	x	x	x	x	x	x	x	X	X	X	X	X

FTSE All Share & Ibex-35	**Model 1**	Swithcing Gaussian AR-GARCH-M
	Model 2	Switching Student-t AR-GARCH-M
	Model 3	Switching Student-t AR-AP-GARCH-M
	Model 4	Switching Skewed-t of Hansen GARCH-M
	Model 5	Switching Skewed-t of Lambert & Laurent GARCH-M
	Model 6	Switching Skewed-t of Hansen GARCH-M with Day Effect
FTSE-20	**Model 7**	Swithcing Gaussian AR-GARCH-M with Market Effect
	Model 8	Swithcing Gaussian AR-AP-GARCH-M with Market Effect
	Model 9	Switching Student-t AR-GARCH-M with Market Effect
	Model 10	Switching Student-t AR-AP-GARCH-M with Market Effect
	Model 11	Switching Skewed-t of Hansen GARCH-M with Day Effect

** not significant parameters at 5% statistical significance level*

Table 5.5 SWARCH models

	FTSE All Share		Ibex-35		FTSE-20			
Hamilton & Susmel 94'	**Markov-Switching AR-ARCH-L**		**Markov-Switching AR-ARCH-L**		**Markov-Switching AR-ARCH-L**		**Markov-Switching AR-ARCH-L-ME**	
	parameters	**std.errors**	**parameters**	**std.errors**	**parameters**	**std.errors**	**parameters**	**std.errors**
p11	0,996	0,004	0,994	0,006	0,999	0,001	0,999	0,001
p31	0,019	0,019	0,994	0,988	0,002	0,002	0,003	0,004
p12	0,004	0,003	0,006	0,006	0,001	0,001	0,001	0,003
p22	0,805	0,195	0,994	0,006	0,980	0,020	0,982	0,021
p32	0,000	0,000	0,000	0,000	0,029	0,029	0,026	0,022
p23	0,195	0,191	0,006	0,000	0,020	0,019	0,018	0,026
p33	0,981	0,019	0,006	0,994	0,968	0,032	0,972	0,029
φ_0	0,001	0,006	0,000	0,009	0,000	0,002	0,000	0,001
φ_1	0,157	0,029	0,018	0,029	0,176	0,007	0,175	0,005
g2	17,457	0,000	3,813	0,004	2,148	0,746	2,351	0,824
g3	2,194	0,008	2,084	0,000	7,926	1,865	8,015	1,342
α_0	0,000	0,108	0,000	0,059	0,000	0,076	0,000	0,053
α_1	0,012	0,013	0,087	0,033	0,071	0,008	0,076	0,023
α_2	0,045	0,018	0,112	0,026	0,137	0,001	0,121	0,005
ξ	0,071	0,050	0,081	0,006	0,068	0,005	0,058	0,003
d.f.	48,475	1,205	5,586	0,005	9,100	0,923	9,822	1,242

Figures

Figure 5.1.a Spot Prices and Returns of the FTSE All Share Index

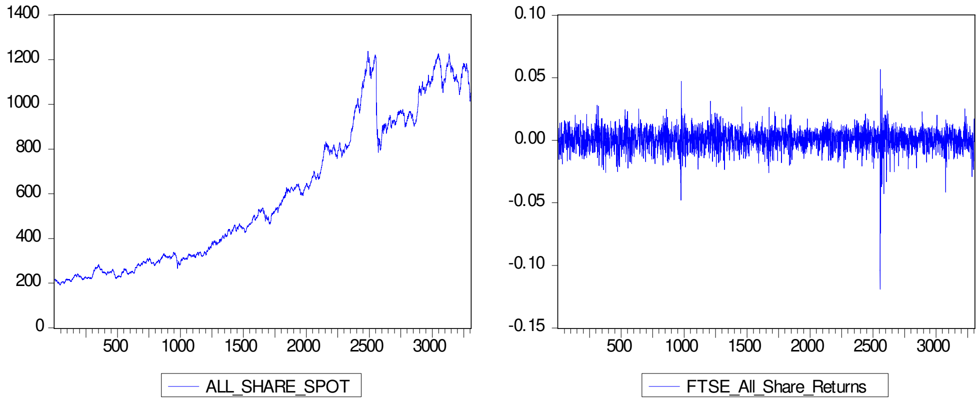

Figure 5.1.b Spot Prices and Returns of the Ibex-35 Index

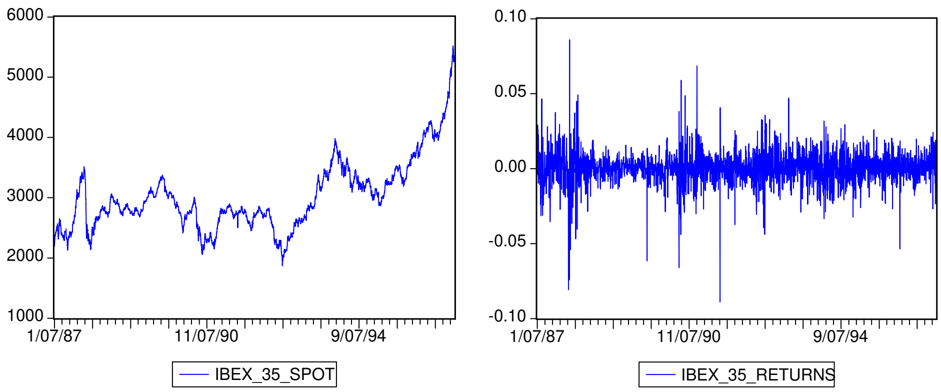

Figure 5.1.c Spot Prices and Returns of the General Index and the FTSE-20 Index

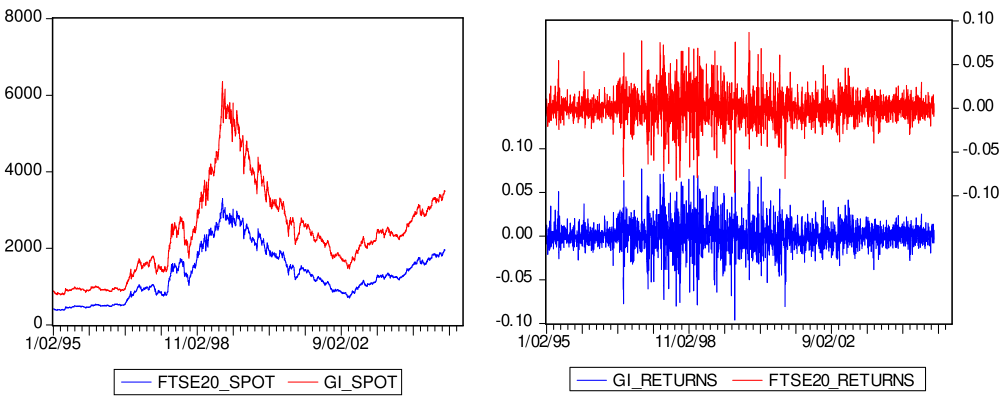

Figure 5.2. Histograms of the returns of the FTSE_All_Share, the Ibex-35 and the FTSE-20 Indices

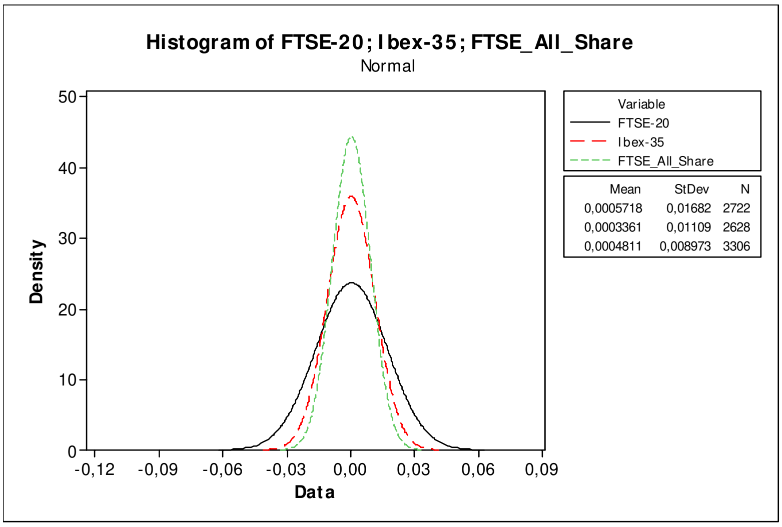

Figure 5.3 Histograms of the returns of the FTSE-20 and Ibex-35 Indices for the two sub-periods, pre and post futures onset

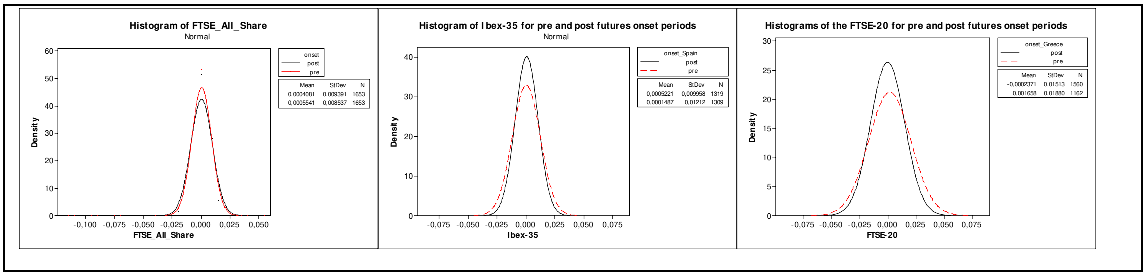

Figure 5.4 Rolling AR parameters for the FTSE All Shares, the Ibex-35 and the FTSE-20 Index

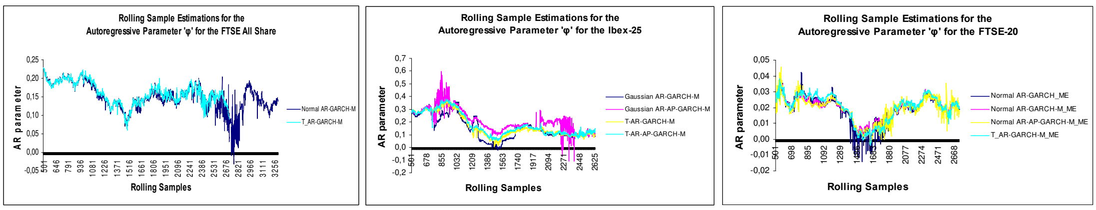

Figure 5.5 Rolling Beta parameters for the FTSE-20 Index

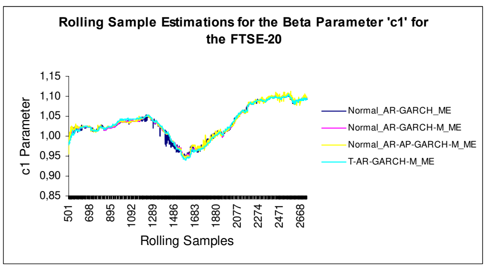

Figure 5.6. Rolling GARCH-M parameters for the FTSE All Shares, the Ibex-35 and the FTSE-20 Index

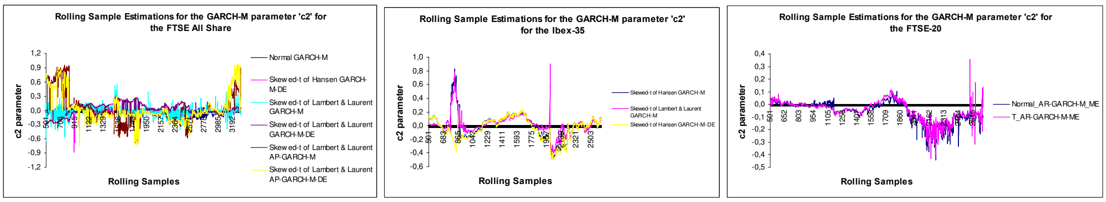

Figure 5.7 Rolling ARCH parameters for the FTSE All Shares, the Ibex-35 and the FTSE-20 Index

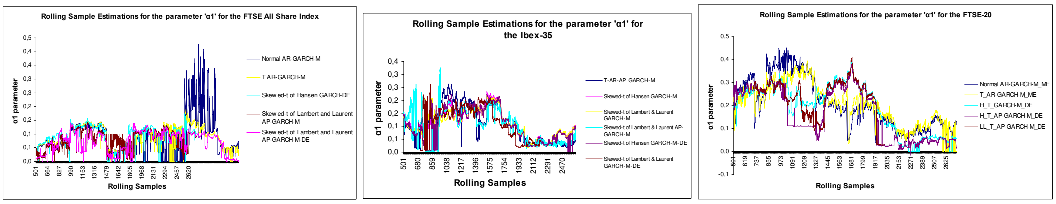

Figure 5.8 Rolling GARCH parameters for the FTSE All Share, the Ibex-35 and the FTSE-20 Index

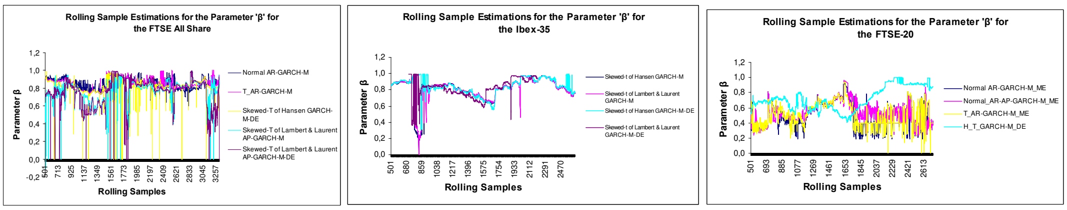

Figure 5.9 Rolling Leverage parameters for the FTSE All Share, the Ibex-35 and the FTSE-20 Index

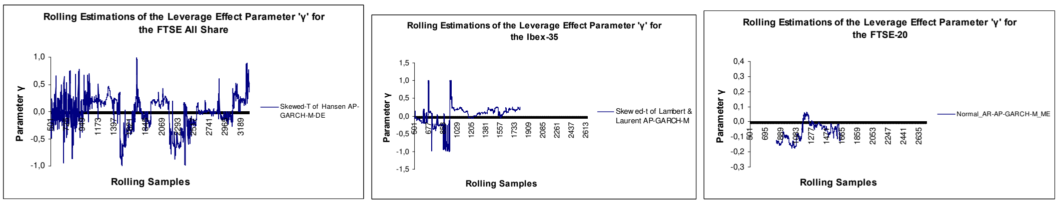

Figure 5.10 Rolling d.f. parameters for the Ibex-35 and the FTSE-20 Index

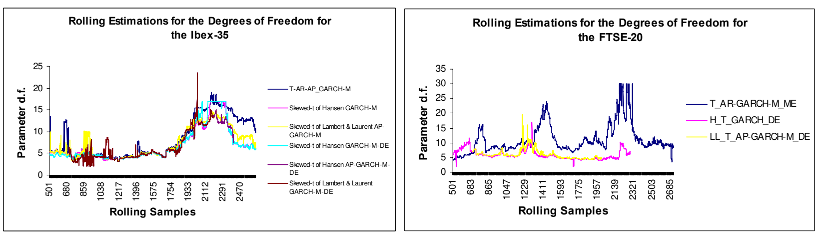

Figure 5.11 Rolling Skeweness parameters for the FTSE All Share, the Ibex-35 and the FTSE-20 Index

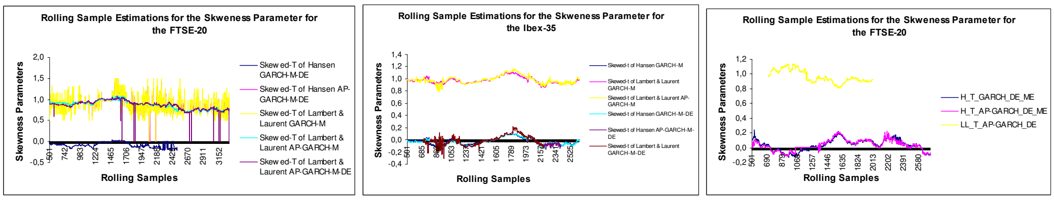

Figure 5.12 Time-Varying Regime Probabilities using MS-AR-ARCH-L model for the FTSE All Share Index

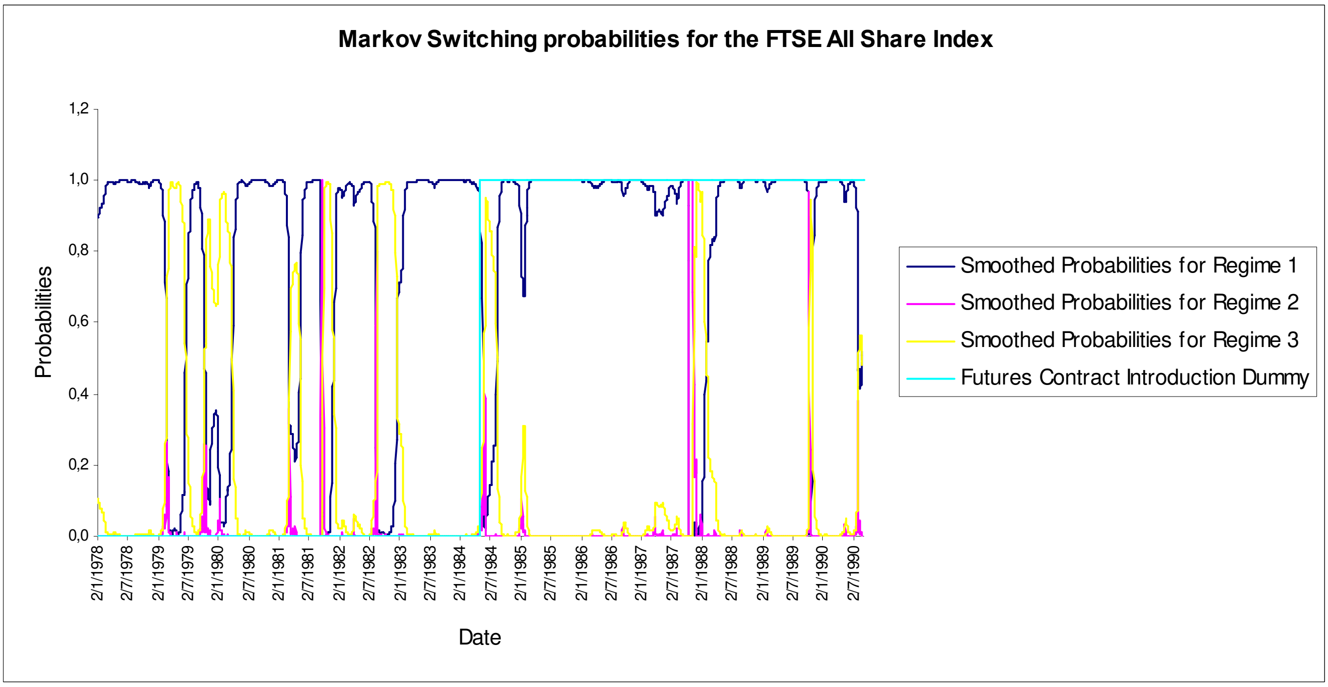

Figure 5.13 Time-Varying Regime Probabilities using MS-AR-ARCH-L model for the Ibex-35 Index

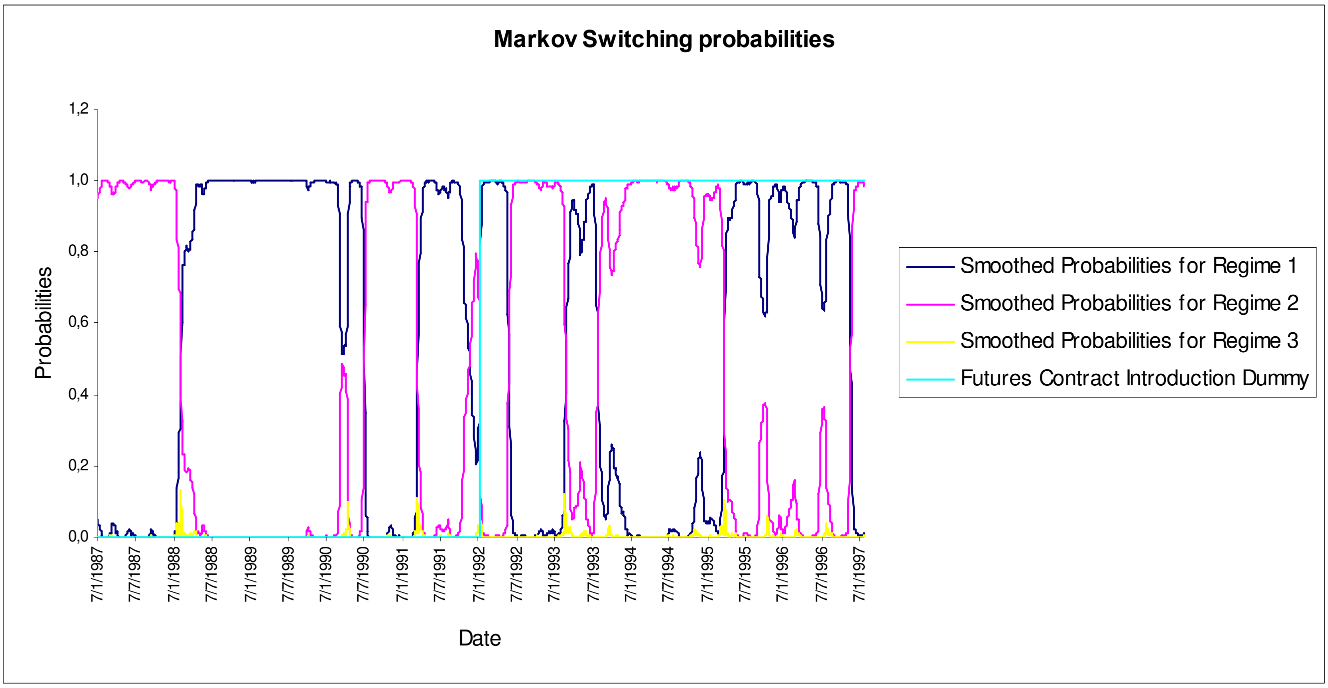

Figure 5.14 Time-Varying Regime Probabilities using MS-AR-ARCH-L model for the FTSE-20 Index

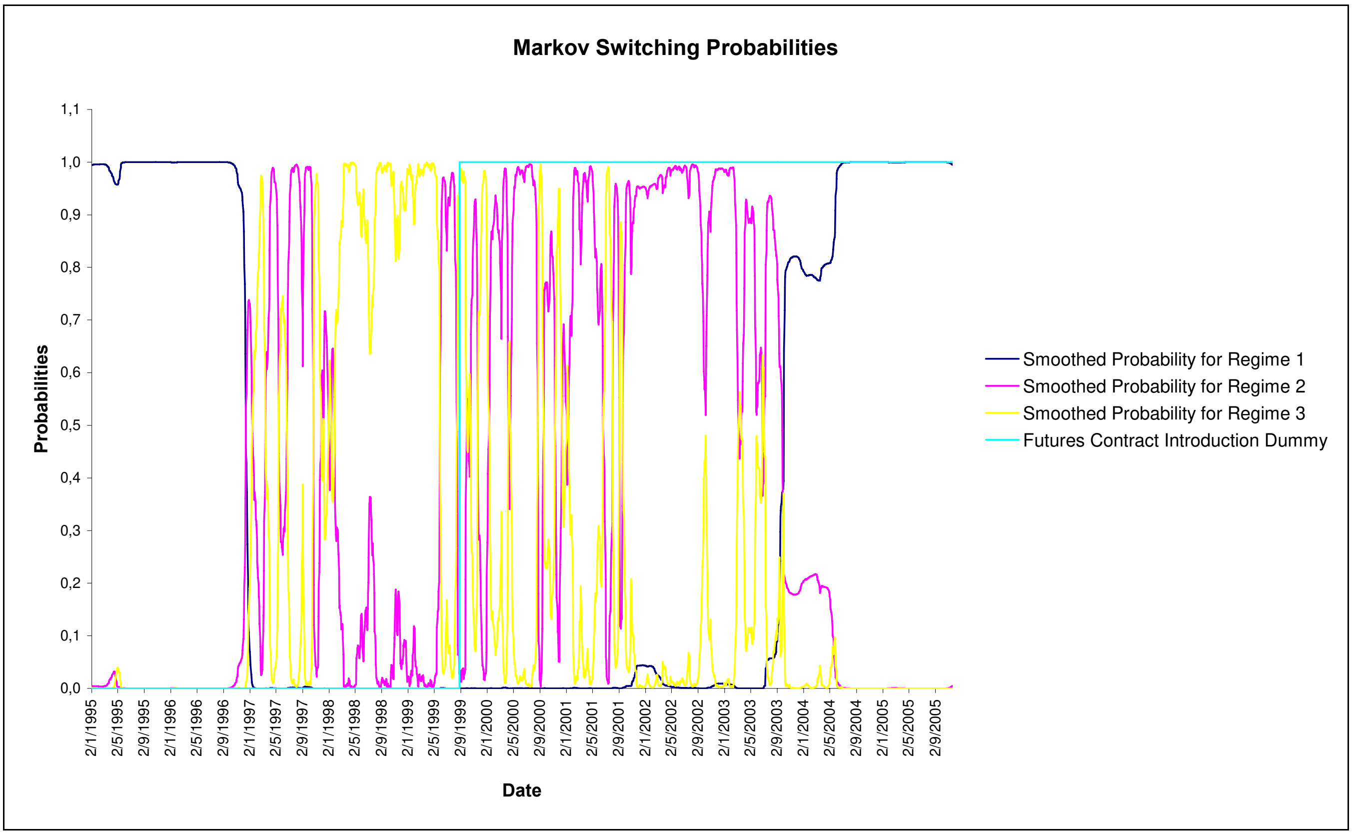

Figure 5.15 Time-Varying Regime Probabilities using MS-AR-ARCH-L-ME model for the FTSE-20 Index