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CALENDAR ANOMALIES IN THE MALAYSIAN STOCK MARKET

Summary

This study examines the calendar anomalies in the Malaysian stock market. Using various generalized autoregressive conditional heteroskedasticity models; this study reveals the different anomaly patterns in this market for before, during and after the Asian financial crisis periods. Among other important findings, the evidence of negative Monday returns in post-crisis period is consistent with the related literature. However, this study finds no evidence of a January effect or any other monthly seasonality. The current empirical findings on the mean returns and their volatility in the Malaysian stock market could be useful in designing trading strategies and drawing investment decisions. For instance, as there appears to be no month-of-the-year effect, long-term investors may adopt the buy-and-hold strategy in the Malaysia stock market to obtain normal returns. In contrast, to obtain abnormal profit, investors have to deliberately looking for short-run misaligned price due to varying market volatility based on the finding of day-of-the-week effect. Besides, investors can use the day-of-the-week effect information to avoid and reduce the risk when investing in the Malaysian stock market. Further analysis using EGARCH and TGARCH models uncovered that asymmetrical market reactions on the positive and negative news, rendering doubts on the appropriateness of the previous research that employed GARCH and GARCH-M models in their analysis of calendar anomalies as the later two models assume asymmetrical market reactions.

1. Introduction

In the past twenty years or so, a number of studies had been conducted to study the calendar anomalies in the Malaysian stock market (among others, Nassir and Mohammad, 1987a, b; Wong *et al*., 1992; Davidson and Peker, 1996; Clare *et al*., 1998; Foo and Kok, 2000; Kok (2001), Brooks and Persand, 2001; Kok and Wong, 2004a, b; Goh and Kok, 2004). Particularly, Nassir and Mohammad (1987a) and Wong *et al*. (1992) investigated the day-of-the-week effect in the Malaysian stock market. Consistent with previous studies in developed countries (French, 1980; Rogalski, 1984), which had found significant negative returns on Mondays, Nassir and Mohammad (1987a) and Wong *et al*. (1992) reported a negative mean return on Monday for the case of Malaysia. Besides, Wong *et al*. (1992) also found that a high positive mean return on Friday in the same market. This finding is in unison with Gibbons and Hess (1981) and Jaffe and Westerfield (1985), which had reported positive returns on other days in addition to the finding of negative returns in developed countries. Moreover, some evidences of day-of-the-week effect were also provided by other recent researches such as Clare *et al*. (1998), Foo and Kok (2000), Kok (2001), Brooks and Persand (2001) and Kok and Wong (2004a), which had either focused solely on Malaysia or included Malaysia as one of the countries in their study.

Apart from that, there is some evidence of a monthly effect in the Malaysia stock returns. In this regards, Nassir and Mohamad (1987b) and Wong *et al*. (1990) had documented significantly higher returns in January, whereas Ho (1990) found that there is a February effect in the Malaysian stock returns. Ho (1990) and Wong *et al*. (1990) attributed these calendar anomalies in Malaysia to the Chinese New Year, which normally falls within the these two months, rather than the tax-loss selling hypothesis, which is put forward to explain the January effect in developed countries (see for instance, Choudhry, 2001).

These findings of the existence of long-term historical anomalies in the Malaysian stock market seem to contradict the weak-form Efficient Market Hypothesis (EMH)[1]. The weak form EMH states that the market is efficient in past price and volume information and thus stock movements cannot be predicted using this historical information (Fawson *et al.*, 1996; Niarchos and Alexakis, 2003). As such, the findings of calendar anomalies including day- of-the-week and month-of-the-year effects appear to contradict the EMH since they imply that investors could design specific trading strategies to reap abnormal profit from these seasonal regularities. Hence, identifying the nature of calendar anomalies, if any, is of great importance to the participants of the Malaysian stock market.

It is important to point out that while earlier studies of calendar anomalies had been commonly examined by regressing return on daily or monthly dummies, few of the above-mentioned studies had made an improvements in employing the more recently formulated generalized autoregressive conditional heteroskedasticity (GARCH) models to account for the time varying volatility of the Malaysia stock returns. For examples,

[1] Nonetheless, not all empirical evidences on the Malaysian stock market are supportive of the calendar anomalies. For instance, Davidson and Peker (1996) failed to provide significant evidence with day-of-the-week in Bursa Malaysia (formerly known as Kuala Lumpur Stock Exchange, KLSE) during the period 1986-1993. Recently, the failure to detect any time-of-the-month effect for Malaysia had also been reported in Kok and Wong (2004b).

Davidson and Peker (1996) used the GARCH model, Clare *et al*. (1998), Foo and Kok (2000), Kok (2001) and Kok and Wong (2004a) used a GARCH-M model in their studies.

GARCH models have an advantage over the ordinary least squares (OLS) regression in the sense that it takes into consideration of not only the mean but also the risk or volatility of return. As such, both the risk and return, which constitute the fundamentals of investment decision process, are accounted for. In this respect, a better decision may be reached if an investor has prior knowledge of whether there are variations in stock returns by the calendar effects and whether a high daily or monthly return can be attributed to the correspondingly high volatility. Moreover, revealing the specific volatility patterns in returns might also benefit investors in risk management and portfolio optimization.

Nevertheless, the GARCH models adopted in Davidson and Peker (1996), Clare *et al*. (1998), Foo and Kok (2000), Kok (2001) and Kok and Wong (2004a) assume symmetrical behavior of market reactions towards positive and negative news, whereas in reality, it is commonly observed that the negative returns are followed by a higher volatility than the positive returns. Thus, it is interesting to re-examine the calendar anomalies in the Malaysia stock market by taking asymmetrical market reactions into consideration. Motivated by the aspiration to link this literature gap, the current study attempts to examine the possible presence of the day-of-the week effect and monthly effect in the Malaysia stock market, using the Threshold and Exponential GARCH or

TGARCH and the Exponential GARCH or EGARCH models, which are capable of capturing the possible asymmetry stock market behavior.

This paper is organized as follows. The next two sections describe the empirical methodology and data of this study respectively. Section 4 then presents and discusses the findings of this study, while some concluding remarks are given in Section 5.

2. Empirical Methodology

A standard methodology is initially employed to test for daily seasonality and month-of-the-year effect or the January effect in stock market adjusted returns by estimating the following regression formula:

$$R_t = \sum_{k=1}^{K} \alpha_t \delta_{kt} + \varepsilon_t \tag{1}$$

where R_t is the logarithmic return of the market index; α_t is parameters; ε_t is an error term; δ_{kt} is dummy variables for daily effect and monthly effect. For daily effect, *K*, which is the maximum of *k* is 5, which corresponds to 5 trading days in a week. In this case, δ_{kt} =1 if day *t* is a Monday, 0 otherwise, δ_{kt} = 1 for Tuesday and 0 otherwise, and so on). For monthly effect, *K* is 12, which corresponds to 12 months in a year. In this case, δ_{kt} = 1 if month *t* is January and zero otherwise, δ_{kt} =1 for February and 0 otherwise, and so on.

While this model is used to characterize the mean return, GARCH model may be adopted to capture the time-varying volatility in the return series. According to the GARCH model of order *p* and *q*, which is denoted as the GARCH (*p*, *q*) model, the conditional variance of a time-series depends upon the squared residuals of the process[2]. The GARCH (*p*, *q*) model suitable for the studying of calendar anomalies is defined as:

$$R_t = \sum_{k=1}^{K} \mu_k \delta_t^k + \xi_t \tag{2}$$

where ξ_t is an error term with zero mean and conditional variance σ_t^2, which is in turn specified as:

$$\sigma_t^2 = \beta_0 + \sum_{j=1}^{p} \gamma_j \sigma_{t-j}^2 + \sum_{i=1}^{q} \beta_i \xi_{t-i}^2 + \sum_{k=1}^{K} \mu_k^* \delta_t^k \tag{3}$$

where β_0 is constant; β_t, γ_j, μ_k and μ_k^* are constant to be estimated; δ_t^k [(for daily data, $k = 1(\text{Monday}),...,5(\text{Friday})$, whereas for monthly data, $k = 1(\text{January}),...,12(\text{December})$)] is the set of deterministic daily seasonal and monthly dummies.

Alternatively, the GARCH – M model allows for the conditional variance to have mean effects. This study adopts the following GARCH – M model that allows one to examine the calendar effect under varying return volatility of stock market:

[2] *p* is the order of ARCH terms and *q* is the order of GARCH terms, with the values $p \geq 0$ and $q \geq 0$ (Choudhry, 1995; Hentschel, 1995).

$$R_t = \alpha_0 \sigma_t^2 + \alpha_1 R_{t-1} + \sum_{k=1}^{K} \mu_k \delta_t^k + \xi_t \tag{4}$$

where α_0 measures the reward to risk ratio (Kok and Wong, 2004), ξ_t is an error term with zero mean and conditional variance σ_t^2 , which is in turn specified as:

$$\sigma_t^2 = \beta_0 + \sum_{j=1}^{p} \gamma_j \sigma_{t-j}^2 + \sum_{i=1}^{q} \beta_i \xi_{t-i}^2 + \sum_{k=1}^{K} \mu_k^* \delta_t^k \tag{5}$$

It is noteworthy that the GARCH model assumes that upward and downward movements in the market will cause the same magnitude of volatilities implying symmetrical behaviour of market reactions towards positive and negative news. However, it is commonly observed that the negative returns are followed by a higher volatility than the positive returns. Besides, Engle and Ng (1993) also points out that the market reaction on bad and good news tends to be asymmetry in nature. To incorporate the possible asymmetry effect of the stock market behaviour, the Threshold ARCH or TARCH (due to Zakoian, 1994 and Glosten *et al.*1993) and the Exponential GARCH or EGARCH (due to Nelson, 1991) models are also estimated in this study.

After incorporating the daily or monthly effect in the TARCH model, the conditional volatility of the error term in Equation (3) may be specified as:

$$\sigma_t^2 = \beta_0 + \sum_{j=1}^{p} \gamma_j \sigma_{t-j}^2 + \sum_{i=1}^{q} \beta_i \xi_{t-j}^2 + \phi \xi_{t-1}^2 N_{t-1} + \sum_{k=1}^{K} \mu_k^* \delta_t^k \tag{6}$$

where $N_t = 1$ for good news ($\xi_t < 0$), and 0 otherwise.

In this specification, ϕ is use to capture the asymmetrical effect of good news and bad news ($\xi_t < 0$), as reflected by the differential effects on the conditional variance. In particular, good news has an impact of β_i, while bad news has an impact of ($\beta_i + \phi$). Besides, if $\phi \neq 0$, the news impact is asymmetric. Moreover, positive value of ϕ indicates the existence of a leverage effect in that bad news increases volatility. Remarkably, the additional parameters, μ_k^*, which makes this specification different from the original TGARCH model, are employed to capture the daily or monthly effects.

On the other hand, the EGARCH specification of the conditional volatility utilized in this study may be expressed as:

$$\log \sigma_t^2 = \beta_0 + \sum_{j=1}^{p} \gamma_j \log \sigma_{t-j}^2 + \sum_{i=1}^{q} \left(\beta_i \left| \frac{\xi_{t-i}}{\sigma_{t-i}} - \sqrt{\frac{2}{\pi}} \right| + \psi_i \frac{\xi_{t-i}}{\sigma_{t-i}} \right) + \sum_{k=1}^{K} \mu_k^* \delta_t^k \tag{7}$$

Note that the left-hand side is the logarithm of the conditional variance. This implies that the leverage effect is exponential, rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative. In this case, the presence of leverage effects can be tested by the hypothesis that $\psi_i > 0$, whereas the impact is asymmetric if $\psi_i \neq 0$.

In this study, if the mean returns or coefficients of the daily dummy variables and monthly dummy variables are found to be significant through the OLS method, then they are used as explanatory variables in the GARCH, GARCH – M, TGARCH and EGARCH models[3]. If the included dummy variables are still significant in the mean equation, it may be concluded that the calendar effect is not due to the variation in the equity risk. If the dummy variables are insignificant in the mean equation but significant in the variance equation, it can be concluded that there is calendar effect in market risk (Lucey, 2000).

The Schwarz Information Criterion (SIC) is used to determine the appropriate orders of p and q. That because SIC is consistent and it penalizes most heavily for degrees of freedom as compared to Mean Squared Error (MSE) and Akaike Information Criterion (AIC)[4]. The highest order of p and q considered in this study is 5. The SIC is based on the following formula:

$$SIC = 1 + \log(2\pi) + \log(\frac{ESS}{n}) + \frac{k \log n}{n} \tag{8}$$

where ESS is the sum-of-squared residuals of the regression in which k parameters are estimated using n observations. The model chosen is the one associated with the smallest SIC (Kok and Wong, 2004a).

[3] This approach was adopted by Kok and Wong (2004a) in their GARCH-M analysis of day-of-the-week effect.
[4] Apart from that, SIC is more consistent than AIC, which also tends to select the models that are too large (Lutkepohl, 1991).

3. Data of Study

The data used in the study are the daily closing values of the Bursa Malaysia Composite Index over the period of 2 December 1993 to 10 October 2005. The data were obtained from the World Development Indicator database issued by the World Bank and Monthly Statistical Bulletin published by Bank Negara Malaysia (the Malaysia's central bank). For the examination of the day-of-the-week effect, three periods are identified in this study: 2 December 1993 to 31 May 1997, 1 June 1997 to 30 January 1998, and 1 February 1998 to 10 October 2005. In relation to the Asian financial crisis, these 3 periods correspond approximately to the pre-crisis period, the crisis period, and the post-crisis period, respectively[5]. As for the monthly data, the corresponding pre–crisis period (December 1993 – May 1997), and post–crisis period (February 1998 – October 2005) are considered in the examination of the month-of-the-year effect. An adjusted return was used in testing seasonal daily anomalies and is calculated as:

$$R_t = \ln(I_t / I_{t-1}) \times 100 \tag{9}$$

which is the logarithmic difference[6]. In the case of a day following a non-trading day, the return is calculated using the closing price indices of the latest trading day.

[5] These dates are chosen based on the studies of Mishkin (1999), Johnson *et al*. (2000) and Jang and Sul (2002).

[6] Out of curiosity, this study also examines the return calculated from alternative formula, R_t = $(I_t - I_{t-1}) \times 100 \div I_{t-1}$ and found that both versions of return lead to consistent ultimate conclusion. The corresponding results are available upon request.

4. Empirical Results and Discussions

The OLS Models

Table 1 presents the OLS results of month-of-the-year effect in the Malaysian stock markets for each of the two periods. The results in pre-crisis period and post-crisis period show the non-existence of January effect in the Malaysian stock markets. In fact, none of the 12 monthly estimates is significantly different from zero, indicating the absence of any of month-of-the-year effect in both periods. This finding is superimposed by the Wald test of restriction results (with p-value > 0.10). The ARCH-LM and Ljung-Box Q^2 statistics suggest the presence of remaining ARCH effects in the model for the post-crisis period, implying OLS is inadequate in the modeling of the monthly returns in the Malaysian stock market.

[Table 1 about here]

Table 2 presents the OLS results of the day-of-the-week effects in the Malaysian stock markets for each of the three periods. The results for the pre-crisis period show that the day-of-the-week effect exists in the Malaysian stock markets, as significant daily seasonal anomalies are observed in this period, with a negative Monday effect and positive effect for Wednesday and Friday. Besides, Wednesday records the highest percentage of anomaly in stock returns followed by Friday. However, these patterns of daily seasonal anomaly have changed substantially in the crisis period. In particular, the Monday effect disappears completely, so have the Wednesday and Friday anomalies. Instead, Tuesday and Thursday anomalies are prevalent. The result also shows that Thursday presented the highest negative returns followed by Tuesday. As for the post-crisis period, a significant negative Monday effect is once again observed. Empirically, this suggests that the Asian financial crisis has certainly altered the patterns of the daily seasonal effect in the Malaysian stock markets.

[Table 2 about here]

The results obtained so far are based on the OLS method, which does not take into account the varying daily volatility in the market returns. In fact, the ARCH-LM and the Ljung-Box Q^2 Statistic in Table 2 reveal the inadequacy of OLS model as there are remaining ARCH effects due to the untreated volatility of the returns in the models for various periods of study. Such volatility needs to be modeled in order to provide a clearer picture of the daily seasonal anomalies in the equity markets in Malaysia. Various GARCH (p, q) models are estimated for this purpose. In this analysis, the days with significant mean returns obtained by the OLS method as reported in Table 2 are included as part of the explanatory variables in the GARCH models. The objective of this analysis is to determine whether the day-of-the-week effect could be due to the varying volatility in the market returns. As for the monthly data, GARCH model is not estimated for these periods because monthly seasonal anomalies are not present during this period. As for the selection of the best fit GARCH (p, q) models, out of the various combinations of p and q, which range from 1 to 5 in both cases, the model with minimum SIC is chosen[7].

[7] From our estimation (not reported here), it is observed that the SIC and AIC generally select the same model. In cases where they don't, the selection is based on SIC because the model is more parsimonious.

The GARCH Models

The results of the mean returns and variance equations of GARCH model for the pre-crisis period, crisis period and post-crisis period for day-of-the-week effect are presented in Table 3. It can be seen from the left panel of Table 3 that, GARCH (1, 1), GARCH (2, 2) and GARCH (3, 1) models are respectively selected for the pre-crisis, crisis and post-crisis period based on the SIC.

[Table 3 about here]

From the results, Monday and Wednesday still remains significant in the stock returns of Malaysia during the pre-crisis period. However, the previously significant Friday effect is no more significant under the GARCH estimation. Nonetheless, Friday effect is present (and is significant at 10% level) in the return's volatility. Combining the results from the two estimations, it can be said that the Friday effect detected in the OLS model is due to the market volatility. During the crisis period, Thursday remains significant in the stock returns but not Tuesday. Therefore, the Tuesday effect as identified in the OLS model can be explained by the varying market volatility because it became not significant when the volatility are taken into account. As for the post-crisis period, the results in general show that the day-of-the-week effect in Malaysia stock market is no longer significant. Again, this reversal of significance in Malaysia may be explained by the varying market volatility under different economic conditions. Diagnostic test results show that there is no remaining ARCH effect in all the estimated GARCH models.

The GARCH – M Models

The results of the mean returns and variance equations of GARCH – M model for the pre-crisis period, crisis period and post-crisis period for day-of-the-week effect are presented in the right panel of Table 3. Based on the selection using the SIC, pre-crisis period chosen GARCH (1, 1) – M model, crisis period chosen GARCH (2, 1) – M model and post-crisis period chosen GARCH (3, 4) – M model. From the results, Monday still remains significant in the stock returns of Malaysia during the pre-crisis period. However, the non-significance of the previously significant Wednesday and Friday effect suggests that they may be explained by the varying market volatility. During the crisis period, Thursday remains significant in the stock returns but not Tuesday, implying that Tuesday effect can be explained by the varying market volatility because it became insignificant when the volatility are taken into account. Finally, the post-crisis period showed that day-of-the-week effect in Malaysia is significant for Monday and it showed a negative return. Interestingly, it is observed from the estimates of α_0 that the risk premium is positive in all cases but is only significant for the post-crisis period. Diagnostic test results show that there is no remaining ARCH effect in all the estimated GARCH-M models.

The EGARCH Models

The results of the mean returns and variance equations of EGARCH (3, 3), EGARCH (1, 1) and EGARCH (3, 4) models for the respective pre-crisis, crisis and post-crisis periods for day-of-the-week effect are presented in the left panel of Table 4. The leverage effect terms, ψ_i, for i = 1, 2, 3 are all statistically different from zero, indicating the appearance of the asymmetrical stock returns during the pre-crisis period. Similar asymmetrical stock returns are also detected for the crisis and post-crisis periods. This amounts to the evidence of asymmetrical market reactions towards the positive and negative news, which are reflected by the presence of asymmetrical stock returns in Malaysia. However, the negative Monday returns as well as the positive Wednesday and Friday returns remain significant in the pre-crisis period. Meanwhile, these calendar anomalies do not contribute to the future volatility in the same period, as can be observed from the non-significant estimates for the dummies during these three days. Hence, it may be concluded that the day-of-the-week effect for the pre-crisis period cannot be explained by the varying market volatility. On the other hand, the Tuesday effect in the crisis period had disappeared although the Thursday effect in the mean equation remained in the system after taking into the account of volatility. This suggests that during the crisis period, Tuesday effect but not Thursday effect was due to the varying market volatility. As for the post-crisis period, the negative Monday return was not caused by the market volatility as the negative return in the mean equation was maintained after adjusting for volatility. Moreover, this negative Monday return was found to have significantly raised the market volatility for the next Monday as revealed by the estimate of μ_1^*.

[Table 4 about here]

The TGARCH Models

The results of the mean returns and variance equations of TGARCH (1, 1), TGARCH (1, 3) and TGARCH (3, 1) models for the respective pre-crisis, crisis and post-crisis periods for day-of-the-week effect are presented in the right panel of Table 4. Diagnostic test results show that there is no remaining ARCH effect in all the estimated EGARCH models. The leverage effect term, ϕ is statistically different from zero for all periods, indicating the existence of the asymmetrical stock returns in the Malaysian stock market and thereby may be regarded as cross-validation of the evidence of asymmetrical market reactions towards the positive and negative news as revealed by the EGARCH models.

With respect to the day-of-the-week effect, only the Monday negative return appeared to be significant in the mean equation for the pre-crisis period. Thus, the positive returns for Wednesday and Friday, which disappeared after adjusting for volatility, can be attributed to the market volatility. However, this negative Monday return was found to have significantly reduced the market volatility for the next Monday as revealed by the estimate of μ_1^*. During the crisis period, the Tuesday effect in the crisis period had disappeared although the Thursday effect in the mean equation remained in the system after adjusting for volatility. In addition, the future volatility are found to be affected substantially by the past day-of-the-week effect. Regarding the negative Monday return in the post-crisis period, the estimated TGARCH suggests that it was not due to varying market volatility.

5. Conclusion, Policy and Recommendation

This study examines the existence of a daily pattern of calendar anomalies in the Malaysian stock market using Ordinary least Squares (OLS), GARCH and GARCH – M, EGARCH and TGARCH models applied to capture the different behavior of the time-varying volatility in the return series of the Bursa Malaysia Composite Index, for the various sample periods. The OLS results reveal no month-of-the-year effect in both the pre- and post-crisis period. However, different patterns of day-of-the-week effect were revealed in Malaysia equity markets for pre-, during- and post-crisis periods. Generally, the Monday and Friday effects feature predominantly during the pre-crisis period.

However, when the time-varying volatility in the market returns is taken into account by the GARCH and GARCH – M, EGARCH and TGARCH models, some of the anomalies had become insignificant, implying that they are due to the varying market volatility. Further analysis using EGARCH and TGARCH models uncovered that there appear asymmetrical market reactions on the positive and negative news, rendering doubts on the appropriateness of the previous research that employed GARCH and GARCH-M models in their analysis of calendar anomalies as the later two models assume asymmetrical market reactions.

It is believed that the empirical results detecting significant and different daily patterns of mean returns and their volatility in stock market terms have useful implications for trading strategies and investment decision. For instance, as there appear to be no month-of-the-year effect but day-of-the-week effect is prevalent, long-term investors may just adopt the buy-and-hold strategy in the Malaysia stock market to obtain normal returns. In contrast, to obtain abnormal profit, those active investors may deliberately look for short-run misaligned price due to varying market volatility based on the findings of day-of-the-week effect. Besides, investors can use the day-of-the-week effect information to avoid and reduce the risk when investing in the Malaysian stock market.

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Table 1: OLS Results for Month-of-the-year Effect

Parameter (Month)	Pre-crisis	Post-crisis
α_1 (January)	-4.8741 (-1.4700)	4.3585 (1.2986)
α_2 (February)	4.7678 (1.4379)	2.9988 (0.9552)
α_3 (March)	-3.9992 (-1.2061)	-2.2257 (-0.7089)
α_4 (April)	-0.1008 (-0.0304)	-0.6559 (-0.2089)
α_5 (May)	0.4952 (0.1493)	-1.4963 (-0.4766)
α_6 (June)	-0.2965 (-0.0775)	-1.0429 (-0.3322)
α_7 (July)	-0.4654 (-0.1216)	-0.0937 (-0.0298)
α_8 (August)	3.2542 (0.8500)	-3.3181 (-1.0569)
α_9 (September)	0.0080 (0.0021)	-2.7253 (-0.8681)
α_{10} (October)	-1.1303 (-0.2952)	4.2604 (1.3571)
α_{11} (November)	-1.5953 (-0.4167)	2.8764 (0.8571)
α_{12} (December)	0.3900 (0.1019)	4.3849 (1.3065)
Wald Test (p-value)		
F-statistic	0.8554	0.6462
Chi square	0.8755	0.6477
ARCH-LM Statistic (p-value)		
5 lags	0.4902	0.0083
10 lags	0.9234	0.0000
Ljung-Box Q^2 Statistic (p-value)		
5 lags	0.9310	0.0000
10 lags	0.9860	0.0000

Notes: *, ** and *** denote significant at 1, 5 and 10% level. Numbers in parentheses depict t statistics. ARCH-LM and Ljung-Box Q^2 statistics refer to the Engle's (1982) LM test and Ljung-Box Portmanteau test for presence of remaining ARCH effects.

Table 2: OLS Results for Day-of-the-week Effect

Parameter (Day)	Pre-crisis	Crisis	Post-crisis
α_1 (Monday)	-0.2394* (-2.5931)	0.0463 (0.0920)	-0.1514***(-1.8443)
α_2 (Tuesday)	0.0086 (0.0931)	-0.9243*** (-1.8032)	0.0758 (0.9235)
α_3 (Wednesday)	0.1993** (2.1585)	-0.1263 (-0.2464)	0.0748 (0.9107)
α_4 (Thursday)	-0.0785 (-0.8526)	-1.2154** (-2.3361)	0.0412 (0.5017)
α_5 (Friday)	0.1666*** (1.8093)	0.2337 (0.4558)	0.0816 (0.9942)
Wald Test (*p*-value)			
F statistic	0.0092	0.1161	0.2764
Chi square	0.0088	0.1096	0.2760
ARCH-LM statistic (*p*-value)			
5 lags	0.0000	0.0868	0.0000
10 lags	0.0000	0.3736	0.0000
Ljung-Box Q^2 Statistic (*p*-value)			
5 lags	0.0000	0.0110	0.0000
10 lags	0.0000	0.0860	0.0000

Table 3: Estimated GARCH and GARCH-M Models

Parameter	GARCH Model			GARCH – M Model		
	Pre-crisis	Crisis	Post-crisis	Pre-crisis	Crisis	Post-crisis
(p, q)	(1, 1)	(2, 2)	(3, 1)	(1, 1)	(2, 1)	(3, 4)
Mean Equation						
α_0	-	-	-	0.0325 (0.2682)	0.0026 (0.9194)	0.0267** (0.0356)
α_1	-	-	-	0.1414* (0.0001)	0.2528* (0.0001)	0.1363* (0.0000)
μ_1	-0.1846* (0.0038)	-	-0.0469 (0.2550)	-0.2211* (0.0010)	-	-0.1041** (0.0299)
μ_2	-	-0.3543 (0.2724)	-	-	-0.2649 (0.3481)	-
μ_3	0.1186*** (0.0839)	-	-	0.1018 (0.1604)	-	-
μ_4	-	-0.6103* (0.0000)	-	-	-0.5326* (0.0046)	-
μ_5	0.1097 (0.1563)	-	-	0.0801 (0.3285)	-	-
Variance Equation						
β_0	0.1481** (0.0169)	0.5889*** (0.0842)	0.0001 (0.9833)	0.1336** (0.0270)	1.9819** (0.0396)	-0.0353* (0.0000)
γ_1	0.0739* (0.0000)	0.1686 (0.1352)	0.1809* (0.0000)	0.0786* (0.0000)	0.1480 (0.2185)	0.1303* (0.0000)
γ_2	-	0.2547** (0.0498)	0.0159 (0.6582)	-	0.3755* (0.0025)	0.0430* (0.0000)
γ_3	-	-	-0.1209* (0.0000)	-	-	-0.1720* (0.0000)
β_1	0.9137* (0.0000)	0.4633 (0.2763)	0.9158* (0.0000)	0.9079* (0.0000)	0.4245* (0.0004)	0.4728* (0.0000)
β_2	-	0.2074 (0.5393)	-	-	-	0.9907* (0.0000)
β_3	-	-	-	-	-	0.0208 (0.1046)
β_4	-	-	-	-	-	-0.4860* (0.0000)
μ_1^*	-0.2502** (0.0253)	-	0.0718*** (0.0796)	-0.2626** (0.0193)	-	0.1774* (0.0000)
μ_2^*	-	-1.0929 (0.2515)	-	-	-0.2427 (0.8771)	-
μ_3^*	-0.2274 (0.1241)	-	-	-0.1757 (0.2311)	-	-
μ_4^*	-	-1.3069*** (0.0989)	-	-	-3.5022* (0.0039)	-
μ_5^*	-0.1736*** (0.0977)	-	-	-0.1322 (0.1904)	-	-
Wald Test (*p*-value)						
F-statistic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Chi square	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ARCH-LM (p-value)						
5 lags	0.9059	0.4272	0.9679	0.8947	0.5148	0.2736
10 lags	0.9820	0.4590	0.9668	0.9817	0.8027	0.7815
Ljung-Box Q^2 Statistic (*p*-value)						
5 lags	0.9040	0.3120	0.9690	0.8910	0.3670	0.2660
10 lags	0.9810	0.3640	0.9680	0.9810	0.6990	0.7230

Table 4: Estimated EGARCH and TARCH Models

Parameters	EGARCH			TARCH		
	Pre-crisis	**Crisis**	**Post-crisis**	**Pre-crisis**	**Crisis**	**Post-crisis**
(p, q)	**(3, 3)**	**(1, 1)**	**(3, 4)**	**(1, 1)**	**(1, 3)**	**(3, 1)**
Mean Equation						
μ_1	-0.2411* (0.0000)	-	-0.0798*** (0.0896)	-0.1951* (0.0021)	-	-0.0630 (0.1356)
μ_2	-	-0.2930 (0.2487)	-	-	-0.4797 (0.1262)	-
μ_3	0.1460* (0.0003)	-	-	0.0904 (0.1914)	-	-
μ_4	-	-0.7590* (0.0027)	-	-	-0.6640* (0.0009)	-
μ_5	0.1084* (0.0001)	-	-	0.0982 (0.2168)	-	-
Variance Equation						
β_0	-0.4087* (0.0000)	0.1364 (0.1710)	-0.1555* (0.0000)	2.7935* (0.0000)	2.7935* (0.0000)	0.0105 (0.2612)
γ_1	0.0019 (0.8973)	-0.1943* (0.0000)	-0.0797* (0.0002)	0.0489* (0.0000)	0.1645 (0.1025)	0.1337* (0.0000)
γ_2	-0.0759* (0.0001)	-	0.0836** (0.0246)	-	-	0.0252 (0.4832)
γ_3	-0.0669* (0.0000)	-	-0.0055 (0.8120)	-	-	-0.1018* (0.0002)
β_1	-0.6192* (0.0000)	0.9890* (0.0000)	1.0823* (0.0000)	0.9162* (0.0000)	0.6400** (0.0332)	0.9011* (0.0000)
β_2	0.6166* (0.0000)	-	0.4864* (0.0000)	-	-0.1647 (0.5424)	-
β_3	0.9558* (0.0000)	-	-0.3940* (0.0038)	-	0.1628 (0.4152)	-
β_4	-	-	-0.1750** (0.0166)	-	-	-
ϕ	-	-	-	0.0485* (0.0015)	0.3642*** (0.0624)	0.0667* (0.0000)
ψ_1	0.2415* (0.0000)	-0.0882*** (0.0798)	0.2372* (0.0000)	-	-	-
ψ_2	0.3155* (0.0000)	-	0.0715 (0.1305)	-	-	-
ψ_3	0.0624** (0.0156)	-	-0.3113* (0.0000)	-	-	-
μ_1^*	-0.2261 (0.1328)	-	0.7856* (0.0000)	-0.2332** (0.0348)	-	0.0432 (0.3455)
μ_2^*	-	-0.3871 (0.2609)	-	-	-4.7540* (0.0000)	-
μ_3^*	0.1420 (0.1227)	-	-	-0.1380 (0.3627)	-	-
μ_4^*	-	0.0986 (0.6197)	-	-	-5.3453* (0.0000)	-
μ_5^*	-0.2360 (0.1167)	-	-	-0.0707 (0.5201)	-	-
Wald Test (*p*-value)						
F statistic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Chi square	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ARCH-LM statistic (*p*-value)						
5 lags	0.4292	0.2323	0.4791	0.7087	0.5624	0.9155
10 lags	0.7173	0.5598	0.7317	0.8935	0.8038	0.9260
Ljung-Box Q^2 Statistic (*p*-value)						
5 lags	0.3960	0.1890	0.4780	0.7040	0.4100	0.9200
10 lags	0.7000	0.3270	0.7100	0.8840	0.6780	0.9320