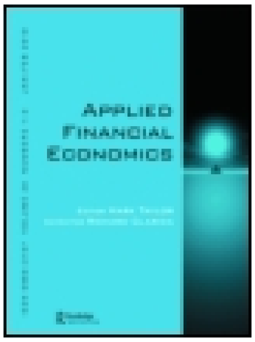

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Day of the week effect in emerging Asian stock markets: evidence from the GARCH model

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This paper investigates the day of the week effect on seven emerging Asian stock markets returns and conditional variance (volatility). The empirical research was conducted using the GARCH model and daily returns from India, Indonesia, Malaysia, Philippines, South Korea, Taiwan, and Thailand from January 1990 to June 1995. Results obtained indicate the significant presence of the day of the week effect on both stock returns and volatility, though the result involving both the return and volatility are not identical in all seven cases. Results also show that these effects may be due to a possible spill-over from the Japanese stock market.

I. INTRODUCTION

According to French (1980) stock prices should rise higher on Mondays than on other days because the time between the close of trading on Friday and the close of trading on Monday is three days, rather than the normal one day between other trading days. Accordingly, Monday returns should be three times higher than other weekday returns. But results from empirical studies have documented that the average return on Friday is abnormally high, and the average return on Monday is abnormally low.[1] Jaffe and Westerfield (1985) and Keim and Stambaugh (1984) claim this anomalous empirical finding to be one of the most puzzling phenomena in finance. This documented high Friday return and low Monday return has been dubbed the 'day of the week' effect and the 'weekend (Monday) effect'.

In this paper, we investigate the day of the week effect in seven emerging Asian stock markets. A large part of the empirical work in this field has been conducted using data from the United States and other developed countries. The use of stock market data from countries other than the United States in the study of specific time periods anomalies such as day of the week effect has been advocated by Bowers and Dimson (1988) and Lakonishok and Smidt (1988). According to these studies more proof for or against specific time periods anomalies can only be obtained by investigating markets other than the United States during different time periods. According to Jaffe and Westerfield (1985, p. 433) the use of data from countries other than the United States may provide support for or against the proposition that these anomalies are a world wide phenomenon and are not due to specific institution arrangements in the United States. The seven emerging Asian markets used in this paper are India, Indonesia, Malaysia, Philippines, South Korea, Taiwan, and Thailand.[2]

This paper also investigates the day of the week effect on the conditional variance (volatility) of the stock return in the seven markets. As indicated by Ho and Cheung (1994) a formal test on the variations of volatility across days of the week is interesting because it is important to know if the higher return on a particular weekday is just a reward for higher risk on that day. Study of the effects of any seasonality on variance has been limited.[3] Significant effects of weekdays on the conditional variance of stock

[1] See Agrawal and Tandon (1994) and Mills and Coutts (1995) for excellent surveys of the papers investigating the effects of day of the week and the weekend on stock returns.

[2] Stock markets from these countries were selected based on the availability of the data, trading hours, etc. and the small amount of previous research involving them, especially India and Indonesia. Of course there have been other studies involving emerging Asian stock markets, such as Aggarwal and Rivoli (1989), Wong *et al.* (1992) and Chang *et al.* (1993).

returns may also indicate possible structural shifts in the unconditional variance due to these anomalies. According to Lamoureux and Lastrapes (1990) significant structural shifts in unconditional variance may reduce the measure of persistence of shocks to volatility (conditional variance).

The empirical investigation is conducted using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model and not the usual linear regression method.[4] The GARCH models are capable of capturing the three most empirical features observed in stock return data: leptokurtosis, skewness and volatility clustering. Since the studies of Mandelbrot (1963) and Fama (1965), empirical research has found evidence of volatility clustering and kurtosis in changes in stock prices. Connolly (1989, p. 134) showed that there is much evidence that stock returns have time varying volatility and studies of stock market anomalies usually fail to take that into consideration. What is not known, according to Connolly, is whether inferences are sensitive to alternative heteroscedasticity corrections. Further, as indicated by Connolly (1989) and de Jong *et al.* (1992) most empirical studies dealing with stock market anomalies are usually carried out under the assumption that the error term, and hence the returns, follow a normal distribution with constant variance. Also, according to Connolly (1989), the error term from regressions involving stock returns is almost certainly not normally distributed. The problem created by fat tailed distribution is that test statistics based on nonrobust standard error estimates cannot be interpreted in the usual way.[5] The GARCH model applied here (GARCH-*t*) is capable of dealing with non-normal error terms and make the interpretation of the *t*-statistics more robust. Further, the GARCH model may be applied to study the direct effect of events on stock return volatility. Connolly advocates the use of the GARCH models in the study of anomalies in the stock markets.[6]

Theories of the day of the week effect on stock market returns and volatility

Several theories have been put forward regarding specific time periods anomalies in the stock market. The day of the week effect has been explained by examining various kinds of measurement errors: the delay between trading and settlements in stocks and in clearing cheques; specialist related biases; the distinction between trading and nontrading periods; the timing of corporate and government news releases; and time zone differences between relevant countries and markets.[7] Fortune (1991, p. 23) provides a plausible explanation of the weekend effect; he suggest(s) that firms and governments release good news during market trading, when it is readily absorbed, and store up bad news after the close on Friday, when investors cannot react until the Monday opening. Another reason suggested for the Monday effect is the measurement error in the portfolio returns. According to Keim and Stambaugh (1984, p. 820) if the low Monday returns are even partially due to the positive errors in prices on Friday, and if these errors vary over time, then higher than average errors on Friday would tend to produce lower than average returns on Monday. According to Keim (1989) the weekend effect may also be related to systematic movements within the bid–ask spread.

Along with stock returns, Godfrey *et al.* (1964), Fama (1965), and Gibbons and Hess (1981) have shown that return variance is higher on Mondays for the United States. In other words, these studies claim that the day of the week also has an effect on the conditional variance of stock returns. According to these studies information that accumulates when financial markets are closed is reflected in prices after the market reopens. If, for example, information accumulates at a constant rate over calendar time, then the variance of returns over the period from the Friday close to Monday close should be three times the variance from the Monday close to the Tuesday close. Assuming that private information is received throughout the week, while public information is received only on weekdays, French and Roll (1986), Barclay *et al.* (1990) and Foster and Viswanathan (1990) claim that stock return variance should be highest on Mondays, when the informed trader has maximum information advantage. Variance should decline through the week with the arrival of public information, and the decrease in the advantage of the private information leads to lower returns variance on Fridays. Thus, in a situation when private information is available throughout the week while public information is

[3] Agrawal and Tandon (1994) and Barclay *et al.* (1990) also provide an empirical study of the effect of anomalies on variance. Ho and Cheung (1994) study the day of the week effect on nine Asian stock market volatilities. In their study volatility is simply defined as the standard deviation of the returns.

[4] All the papers cited earlier apply the standard linear regression method. To our knowledge no one has applied the GARCH model in the study of day of the week and the weekend effects in emerging stock markets.

[5] As indicated by Connolly (1989) appropriate adjustment for heteroscedasticity, autocorrelation and/or leptokurtosis greatly reduces the significance of regressions *F*- and *t*-statistics. Thus, application of the GARCH model may cast doubt on the statistical significance of the day of the week effect and the weekend effect found so commonly by means of ordinary regressions.

[6] Connolly (1989) and de Jong *et al.* (1992) apply the GARCH model in their investigation of the day of the week effects in the United States and the Dutch markets, respectively. Najand and Yung (1994) apply the GARCH model in the study of the weekend effect in the S&P 500 index futures.

[7] See Gibbons and Hess (1981), Keim and Stambaugh (1984), Rogalski (1984), Jaffe and Westerfield (1985), Fortune (1991).

available only during weekdays, traders are more sensitive to changes in order flow at the beginning of the week. Consequently, the variance of price changes would be higher at the beginning of the week than at the end of the trading week. Foster and Viswanathan theory is based on that of Kyle (1985), who provides a structural link between the volume of trading and stock return variance. Kyle models the trading strategy of uniformed liquidity traders and traders with private information, and shows that variance is caused by private information revealed through trades. Another probable explanation for volatility variation is the existence of noise traders who do not trade according to the fundamental value of stocks but would trade for liquidity needs (Ho and Cheung, 1994); noise traders prefer to trade in markets that are liquid.

II. THE DATA

Log of daily stock prices from January 1990 to June 1995 are applied in this paper. The daily return data are the first difference of the log of stock prices. According to Mills and Coutts (1995, p. 81) lack of information about dividends payments in the daily return series does not invalidate the results. Lakonishok and Smidt (1988) claim that their conclusion of anomalies remains unchanged irrespective of whether the dividend adjusted data was used or not. Similarly, Fishe *et al.* (1993) claim that not using dividend adjusted return series creates negligible bias in the anomalies study results. All the data used in this paper were obtained from *DATASTREAM*. The actual stock indices used in the paper are: India, Bombay stock exchange 100; Indonesia, Jakarta composite index; Malaysia, Kuala Lumpur stock exchange composite index; Philippines, Manila stock exchange composite; South Korea, Korea south composite; Taiwan, Taiwan stock exchange index; and Thailand, Securities exchange of Thailand index.

Table 1 presents the basic statistics of the returns series from all seven countries. All series are leptokurtic, especially that of India, that is, all series have a thicker tail and a higher peak than a normal distribution. So it is not surprising that all seven returns are found to be non-normal using the Jarque–Bera test. Apart from Malaysia, Philippines, and Taiwan, significant skewness is found in all other series. Table 2 shows the mean and standard deviation of stock return for each working day of the week. Mean returns for Mondays are negative in all cases except for India, and Taiwan, but only in the case of Malaysia is the mean significantly different from zero. Similarly, most of the series also show negative means on Tuesdays. All means on Fridays are positive and significant in the case of India, Indonesia, Malaysia, and Thailand. Friday also provides the highest mean for all cases except Philippines, and Taiwan. The highest standard deviation on Mondays is found in all cases except Indonesia. The lowest standard deviation is found on Fridays in all cases except India and Malaysia.

Table 1. *Basic statistics for stock returns*

Returns	Mean	S.D.	Kurtosis	Normality	Skewness
India	0.00019[c]	0.0190	33.81[a]	67 891.01[a]	0.852[a]
Indonesia	0.00015	0.0990	19.62[a]	23 472.76[a]	1.688[a]
Malaysia	0.00042	0.0125	7.206[a]	3071.51[a]	−0.027
Philippines	0.00064[a]	0.0164	3.468[a]	710.11[a]	0.032
S. Korea	−0.00003	0.0146	3.041[a]	566.04[a]	0.293[a]
Taiwan	−0.0004	0.0237	2.728[a]	439.15[a]	−0.023
Thailand	0.00032	0.0173	5.580[a]	1865.98[a]	−0.324[a]

Notes: [a], [b] and [c] imply significance at 1%, 5% and 10% level respectively.
S.D. = standard deviation.
Normality is checked by means of the Jarque–Bera test.

III. METHODOLOGY

The GARCH Model

According to the generalized ARCH(p,q) model also known as the GARCH(p,q) model the conditional variance of a time series depends upon the squared residuals of the process (Bollerslev, 1986). The GARCH model has

Table 2. *Mean and standard deviation based on day of the week*

	Monday		Tuesday		Wednesday		Thursday		Friday	
Returns	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
India	0.0009	0.021	0.001	0.020	−0.0005	0.016	0.001	0.020	0.0019[c]	0.019
Indonesia	−0.0002	0.010	−0.0009[c]	0.009	0.0005	0.011	0.0004	0.010	0.001[c]	0.009
Malaysia	−0.0016[c]	0.014	0.0005	0.011	0.0013[c]	0.012	0.0002	0.013	0.0017[b]	0.012
Philippines	−0.000003	0.018	−0.0002	0.015	0.001	0.018	0.0014	0.015	0.001	0.014
S. Korea	−0.0002	0.021	−0.0005	0.013	0.0002	0.012	−0.00007	0.013	0.00039	0.012
Taiwan	0.00095	0.030	−0.00027[b]	0.022	−0.0012	0.021	0.0003	0.023	0.0007	0.021
Thailand	−0.0015	0.020	−0.0015	0.017	0.0008	0.017	0.0006	0.018	0.003[a]	0.014

Notes: [a], [b] and [c] imply significance at 1%, 5% and 10% level respectively.
S.D. = standard deviation.

the advantage of incorporating heteroscedasticity into the estimation procedure.[8] The GARCH model provides a more flexible framework in order to capture various dynamic structures of conditional variance and it allows simultaneous estimation of several parameters of interest and hypothesis. The GARCH(p, q) model that is applied to study the day of the week effect and the weekend effect on stock returns and volatility is as follows:

$$y_t = \delta_1 D_{1t} + \delta_2 D_{2t} + \delta_3 D_{3t} + \delta_4 D_{4t} + \delta_5 D_{5t} + \varepsilon_t \quad (1)$$

$$\varepsilon_t / \Psi_{t-1} \sim \text{t.d.}(0, h_t, v) \quad (2)$$

$$h_t = \gamma_1 D_{1t} + \gamma_2 D_{2t} + \gamma_3 D_{3t} + \gamma_4 D_{4t} + \gamma_5 D_{5t} + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{j=1}^{\alpha} \alpha_j \varepsilon_{t-j}^2 \quad (3)$$

where y_t is the stock return considered to be linearly related to a vector of explanatory dummy variables (D_t) and an error term (ε_t) which depends on past information (Ψ_{t-1}); h_t is the conditional variance. The error terms are assumed to follow a conditional student-t density (t.d.) with v degrees of freedom.[9] As Bollerslev (1987) notes, the t-distribution approaches a normal distribution with variance (h_t) as $1/v$ approaches zero. Thus, in this model the error distribution may be conditionally heteroscedastic and non-normal. According to Connolly (1989) this is useful because the unconditional leptokurtosis may be traced to non-normality in the conditional error distribution and/or to time varying heteroscedasticity. If the estimate of v is greater than thirty but α_j, β_j are positive, time varying heteroscedasticity accounts for the non-normal error distribution. If the v estimate is less than ten and α_j, β_j are positive, both non-normality and time-varying heteroscedasticity produce the fat tailed error distribution. Significance of α_j implies the existence of the ARCH process in the error term. Economic interpretation of the ARCH effects has been provided within both the micro and macro framework. According to Bollerslev *et al.* (1992, p. 32) and other studies the ARCH effect could be due to clustering of trade volumes, nominal interest rates, dividend yields, money supply, oil price index, etc.

The dummy variables (D_{dt}) in the returns and variance equations represent the five working days of the week.[10] In other words, D_{dt} is equal to one if the day t is a Monday $(d = 1)$, and otherwise it is a zero. Similarly, D_{dt} is equal to one or otherwise zero if the day t is a Tuesday $(d = 2)$, and so on. The coefficients δ_1 to δ_5 in Equation 1 represent the size and the direction of the effect of each working day of the week on stock returns. In other words, coefficients δ_1, δ_2, δ_3, δ_4 and δ_5 represent the Monday effect, the Tuesday effect, the Wednesday effect, the Thursday effect and the Friday effect on stock returns respectively. Similarly, coefficients γ_1 to γ_5 represent the size and direction of the day of the week effect on volatility. Given the general empirical findings of papers investigating effects of weekdays and weekend in stock markets the expected sign on the coefficient on the Monday dummy (δ_1) should be negative and significantly different from zero. Some studies indicate that the coefficient on the Friday dummy (δ_5) in Equation 1 should be positive (Keim and Stambaugh, 1984 and Agrawal and Tandon, 1994). Similarly, based on French and Roll (1986) and Foster and Viswanathan (1990) theory of availability of information the expected sign of the significant Monday dummy coefficient (γ_1) in the volatility equation is positive, and negative for the Friday effect (γ_5).

IV. EMPIRICAL RESULTS

Table 3 presents results from the GARCH(1,1) model that investigates the day of the week effect on stock returns and volatility.[11] As Table 3 shows, the ARCH process (volatility clustering) is significant in all seven residuals. Since the size of the ARCH coefficient (α_1) is less than unity in all cases, the shocks to conditional variance are not explosive. As stated earlier, expected returns are not affected by volatility if shocks to volatility are transitory. In all seven tests, the estimate of v is significant and less than ten implying that both fundamental non-normality and heteroscedasticity are responsible for the kurtosis in the unconditional

[8] This feature of the GARCH model is desirable because Hodrick and Srivastava (1984) have shown that the forecast error using financial data is heteroscedastic.

[9] As advocated by Bollerslev (1987) if the series possesses substantial kurtosis, it can be more appropriate to use a conditional student-t density than a conditional normal distribution. The GARCH-t model is able to provide a more robust interpretation of the t-statistics. According to de Jong *et al.* (1992, p. 17) the t-distribution is more likely to generate larger errors than the normal distribution. Thus, using the t-distribution implies that the outliers are given smaller weights in the estimates and test statistics. And, as indicated by Fama (1965), stock returns tend to exhibit nonnormal unconditional sampling distribution in the form of excess kurtosis and skewness. The seven return series under study in this paper are found to be leptokurtic and skewed (Table 1).

[10] As stated by Connolly (1989) and de Jong *et al.* (1992) by adding dummy variables in the GARCH equations effect(s) of any periodic event may be tested on stock returns and volatility.

[11] In a GARCH(p, q) model different combinations of p and q may be applied but as indicated by Bollerslev *et al.* (1992, p. 10) $p = q = 1$ is sufficient for most financial series. Bollerslev (1988) provides a method of selecting the size of p and q in a GARCH model. Tests in this paper were also conducted with different combinations of p and q with $p = q = 2$ being the maximum lag length. Results based on log-likelihood function and likelihood ratio test that indicate the best combination is $p = q = 1$ in all seven cases. These results are available on request.

error distribution. To assess the general descriptive validity of the model, a battery of standard specification tests is employed. Specification adequacy of the first two conditional moments is verified through a serial correlation test of white noise. These tests employ the Ljung–Box Q statistics on the nonstandardized residuals (ε_t), standardized residuals ($\varepsilon_t/h_t^{1/2}$) and squared standardized residuals ε_t^2/h_t). All three series except the non-normalized residuals from the Taiwan test are found to be free of serial correlation (at the 5% level). Absence of serial correlation in the standardized squared residuals implies the lack of need to encompass a higher order ARCH process. According to Hsieh (1989) with a correctly specified conditional variance, the excess kurtosis in standardized residuals cannot exceed the excess kurtosis in the nonstandardized residuals. Only in the case of South Korea are the nonstandardized residuals less leptokurtic than the standardized residuals, though the difference is small. All residuals series are found to be leptokurtic and most to be significantly skewed.

The day of the week effect test shows that in three out of the seven markets Monday (δ_1) imposes a significant negative effect on stock return, and in the remaining cases the effect is insignificant; significant negative Monday effects

Table 3. *Day of the week effect – GARCH Model*

Coefficient	India	Indonesia	Malaysia	S. Korea	Philippines	Taiwan	Thailand
δ_1	0.00060	−0.0007[c]	−0.0012[b]	0.00008	−0.0003	0.00120	−0.0016 [b]
	(0.90)	(−1.94)	(−2.23)	(0.09)	(−0.40)	(1.04)	(−2.00)
δ_2	−0.00012	−0.00050	−0.00016	−0.0014[a]	0.00003	−0.0016[b]	−0.0012[c]
	(−0.83)	(−1.49)	(−0.31)	(−2.39)	(0.05)	(−2.29)	(−1.93)
δ_3	−0.0005	0.0003	0.0012[b]	−0.0003	0.00140[c]	−0.00016	0.0028[a]
	(−0.99)	(0.79)	(2.46)	(−0.48)	(1.89)	(−0.05)	(4.00)
δ_4	0.00011	0.00015	0.0006	−0.00057	0.00077	−0.00005	0.0015[b]
	(0.18)	(0.48)	(1.08)	(−0.91)	(1.06)	(−0.06)	(2.35)
δ_5	0.00260[a]	0.00050	0.00130[a]	0.00013	0.00110[c]	0.00122	0.0028[a]
	(4.04)	(1.55)	(2.78)	(0.21)	(1.84)	(1.38)	(4.56)
γ_1	0.00005	0.00003[a]	0.00004[b]	0.00027[a]	0.00009[a]	0.00027[a]	0.00011[a]
	(0.88)	(3.72)	(2.36)	(2.55)	(3.31)	(3.80)	(4.04)
γ_2	−0.00004	0.00001[b]	−0.00001	−0.00015[a]	−0.000005	−0.0003[a]	−0.00004
	(−0.94)	(2.32)	(−0.75)	(−4.92)	(−0.16)	(−4.86)	(−1.50)
γ_3	−0.00004	0.00002[a]	0.00002[c]	0.00003[c]	0.00003	0.00030	0.00006[b]
	(−1.37)	(3.15)	(1.75)	(1.92)	(0.88)	(−1.38)	(2.29)
γ_4	0.00012[b]	0.00001[c]	0.00006[a]	0.00003[b]	0.000005	0.000004	−0.0000008
	(2.37)	(1.68)	(3.10)	(2.10)	(0.89)	(0.18)	(−0.03)
γ_5	0.00005	0.000007[c]	−0.00001	0.00002	−0.00004[c]	0.00006[c]	0.0000002
	(1.02)	(1.74)	(−0.75)	(1.20)	(−1.89)	(1.89)	(0.009)
α_1	0.256[a]	0.665[a]	0.297[a]	0.186[a]	0.180[a]	0.135[a]	0.238[a]
	(2.98)	(5.86)	(4.79)	(5.73)	(5.36)	(5.86)	(5.71)
β_1	0.787[a]	0.376[a]	0.651[a]	0.633[a]	0.789[a]	0.858[a]	0.684[a]
	(27.46)	(7.64)	(15.76)	(12.55)	(27.28)	(49.22)	(17.31)
v	2.612[a]	3.500[a]	3.420[a]	7.184[a]	4.335[a]	4.451[a]	4.540[a]
	(11.17)	(10.56)	(8.06)	(4.97)	(7.14)	(6.34)	(7.29)
L	4919.86	5814.16	5343.98	5044.65	4838.57	4499.24	4896.74
Non-standardized residuals – ε_t							
Sk	0.85[a]	1.70[a]	−0.004	0.27[a]	0.04	−0.04	−0.27[a]
Ku	34.45[a]	19.81[a]	7.25[a]	3.08[a]	3.55[a]	2.72[a]	5.74[a]
L–B(9)	7.47	8.69	6.92	8.86	8.10	16.74[a]	4.58
Standardized residuals – $\varepsilon_t/h_t^{1/2}$							
Sk	3.34[a]	4.47[a]	0.33[a]	0.60[a]	0.05	−1.37[a]	0.11[c]
Ku	29.23[a]	16.34[a]	4.04[a]	4.06[a]	2.54[a]	1.29[a]	3.63[a]
L–B(9)	4.94	6.49	6.91	8.20	9.11	8.40	5.06
Standardized squared residuals – ε_t^2/h_t							
Sk	33.03[a]	24.62[a]	5.42[a]	4.71[a]	6.35[a]	4.68[a]	6.61[a]
Ku	1182.69[a]	673.17[a]	43.59[a]	32.68[a]	62.99[a]	31.17[a]	65.00[a]
L–B(9)	0.41	0.80	9.99	8.44	8.66	9.34	5.55

Notes: [a], [b], [c] imply significance at 1%, 5% and 10% level respectively, t-statistics in parentheses.
$\delta_1, \delta_2, \delta_3, \delta_4, \delta_5$ and $\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5$ present effects of Monday, Tuesday, Wednesday, Thursday and Friday on returns and volatility respectively.
L = log-likelihood function value; v = degrees of freedom; Sk = Skewness of residuals; Ku = Kurtosis of residuals.
L–B(9) = Ljung–Box statistics for serial correlation at the 5% level of the order 9 lags.

are found in the markets of Indonesia, Malaysia and Thailand.[12] In absolute value Monday has the largest effect on the Thai stock return. A significant negative Tuesday effect (δ_2) is found only in the cases of Korea, Taiwan and Thailand. Of the five days, Thursday (δ_4) imposes a significant effect in only one market, Thailand. Of the seven markets, only returns from Thailand are affected by all five days. This confirms the notion that day of the week effect and the Monday effect are not just features of the stock markets of the United States and other developed countries but also of the emerging markets. Results from the GARCH model and the mean returns based on day of the week (Table 2) are not identical but similar. The size and sign on the Monday, Wednesday and Friday coefficients are similar to the mean returns. Of course, only in the case of Malaysia were the Monday mean returns found to be significant (Table 2). The largest difference is found in the case of Thursday.[13]

Results in Table 3 also show significant effect of Monday (γ_1) on conditional variance (volatility). Significant positive Monday effect on volatility is found in all markets except India. Significant positive effect implies that Monday increases stock return volatility, although the sizes of the coefficient (γ_1) are very small. A significant positive influence by Monday on volatility provides some evidence in favour of the information oriented theories of French and Roll (1986) and Foster and Viswanathan (1990). Of the five days, Monday (γ_1) influence the largest number of volatility, six. In the case of Friday, significant negative effect is found only in the case of Malaysia and this provides some support to the information availability theory of Foster and Viswanathan (1990). A negative effect indicates that Friday reduces the volatility. Volatilities from the Indonesian market is affected by all five days. Volatility in the market of India is affected by only one single day. Thus, our results provide ample evidence of day of the week effect on stock market volatility. As stated earlier, a significant effect of the different day of the week on volatility may indicate a possible structural shift of the unconditional variance.

Attempts have been made to explain the day of the week effect on stock return based on settlement procedures. Settlement procedure is the time lag between trading and the payment. Agrawal and Tandon (1994) provide a detailed analysis of the effects of the settlement period on stock returns per day of the week. For example in countries where the settlement period is two days expected returns on Thursday would be higher. An individual buying on Wednesdays close and selling at Thursdays close pays cash on Friday and receives cash the following Monday. Since the cash payment occurs three days before the cash receipt, countries with two-day settlement periods should experience high expected returns on Thursdays to compensate for the loss of an additional two day's interest. In the seven countries under consideration South Korea and Taiwan have a two-day settlement period.[14] We fail to find significant high Thursdays returns (δ_4) in South Korea and Taiwan. Based on a similar analysis, a three-day settlement period as in the case of Thailand would imply high expected returns on Wednesday. The results indicate positive and significant returns on Wednesday (δ_3) in the case of Thailand, which suggest some evidence in favour of the settlement period hypothesis. The four-days settlement period in Indonesia and Philippines imply higher expected returns on Tuesdays (δ_2) but results indicate insignificant positive returns in the case of Philippines and insignificant negative effect in the case of Indonesia. Malaysia's six-day settlement period should result in high expected returns on Friday and results do confirm a significant and positive Friday effect. It is difficult to carry out similar analyses for India where the settlement period ranges from one to fourteen days. Day of the week effect results presented in the majority of cases could not be explained by the settlement period hypotheses. Our results seem to back the claim of Jaffe and Westerfield (1985) and Agrawal and Tandon (1994) that it is hard for differences in the settlement periods to explain the consistent negative pattern on Monday or Tuesday.

According to Jaffe and Westerfield (1985) the day of the week effect around the globe may be due to a spill-over effect from the United States market or other large markets. In other words, weekday and weekend effects in international stock markets may not be dependent on the United States or some other large market(s). According to Wong *et al.* (1992) and Agrawal and Tandon (1994) the United States stock market has been suggested as a contributor to the day of the week effect of the Asian stock markets. In this paper, we also study a possible spill-over from the United States market and/or the Japanese market to the seven Asian markets.[15] First,

[12] Lack of significant Monday effect on returns in the remaining markets may be due to thin trading effect. According to Wong *et al.* (1992) within an index, thin (infrequent) trading acts as a stabilizer to the index. Since movements in prices of very thinly traded stocks are minimal, they average out the greater movements of the actively traded stocks. Thus, the impact of thin trading may reduce the observed specific time periods anomalies in an index that include a large number of stocks.

[13] These day of the week effects were also checked by means of the standard regression method and the F-test. Results indicate significant effect of the weekday in the cases of Malaysia and Thailand. In the case of Indonesia, the regression test fails to indicate a significant effect. This is somewhat in line with the GARCH model result. Using the GARCH test only a weak evidence (at 10% level) of a significant weekend (Monday) effect in the case of Indonesia was indicated. No other day seem to influence the Indonesian return.

[14] Settlement periods for all seven countries were obtained from the stock exchange authorities of the respective countries.

[15] The Japanese stock market is applied here because it is the largest market (by trade volume) in the region.

both the United States and the Japanese stock markets were checked for the weekday effects by means of the GARCH-t model. Results show a significant weekday and weekend effect in the Japanese market but not in the case of the United States. This is true both in the case of return and volatility. These results are not provided to save space but are available on request. Since only the Japanese data indicate significant results, the spill-over effect is investigated using the Japanese market only. Also, since only the markets of Indonesia, Malaysia and Thailand show any true effects of weekdays and the weekend on returns and volatility, the spill-over test is only conducted using these three markets. Two different tests are conducted to check for a possible spill-over effect. First, correlation based on day of the week between the returns from the Japanese and the other three markets are investigated. Then a more precise test of the daily seasonal independence is conducted by looking at the direct effect of each day on the difference between returns in Japan and the other markets. In the second test, GARCH-t model of Equations 1, 2 and 3 are used, where now difference between returns from Japan and the other three Asian markets are used.

Table 4 presents the correlation based on the day of the week between the Japanese returns and returns in the Indonesian, Malaysian and the Thai markets. Strong and significant correlation is found between the Japanese market and the markets in Malaysia and Thailand. Thus, the correlation results provide some evidence of possible spill-over from the Japanese stock market. Strong correlation is found between the Malaysian and the Japanese returns for all five days. On the average the highest correlation is found on Monday and the lowest on Friday. Table 5 presents the spill-over test results using the GARCH model. In these tests significant effects of the day dummies implies independent daily seasonality; in other words lack of a spill-over from the Japanese market. Results from these tests also provide evidence of a possible spill-over from Japan to Malaysia and Thailand. Both the Malaysian and the Thai returns indicate a spill-over weekend effect. Once again the Indonesian return fail to indicate a dependent daily seasonality. Thus, both spill-over tests provide some evidence of a possible dependent daily seasonality in two of these markets. The weekend effect on volatility is found to be independent in all three markets.[16]

Table 4. *Correlation between Japanese stock returns and other Asian stock returns*

	Monday	Tuesday	Wednesday	Thursday	Friday
Indonesia	0.0948	0.0433	0.0056	0.1019*	−0.0671
Malaysia	0.4217*	0.2694*	0.3061*	0.3449*	0.1836*
Thailand	0.2664*	0.2748*	0.0992	0.2540*	0.0704
Average	0.2610	0.1958	0.1370	0.2336	0.0623

V. CONCLUSION

This paper provides a study of day of the week effect in seven Asian emerging stock markets using the GARCH model. Application of the data from emerging Asian stock markets and the GARCH model makes this paper unique in the field of stock market anomalies. The day of the week effect on both the mean and conditional

Table 5. *Day of the week effect on return difference*

Coefficient	Indonesia	Malaysia	Thailand
δ_1	0.00195[b]	0.00117	0.00098
	(2.563)	(1.488)	(0.981)
δ_2	0.00032	0.00079	−0.00072
	(0.486)	(1.171)	(−0.825)
δ_3	0.00155[b]	0.00162[b]	0.0032[a]
	(2.238)	(2.341)	(3.286)
δ_4	−0.0018	−0.000123	0.00027
	(−0.272)	(−0.162)	(0.313)
δ_5	0.00084	0.00192[a]	0.0032[a]
	(1.300)	(2.656)	(3.688)
γ_1	0.00007[a]	0.000064[a]	0.000091[b]
	(2.993)	(2.678)	(2.500)
γ_2	−0.000007	−0.000016	−0.00001
	(−0.326)	(−0.683)	(−0.305)
γ_3	0.000037[c]	0.000033	0.000096[b]
	(1.786)	(1.631)	(2.737)
γ_4	0.000014	0.000054[b]	−0.000026
	(0.702)	(2.320)	(−0.776)
γ_5	0.000015	0.000008	−0.000052[c]
	(0.800)	(0.350)	(1.724)
α_1	0.2417[a]	0.1616[a]	0.2136[a]
	(5.846)	(4.879)	(5.631)
β_1	0.6695[a]	0.7101[a]	0.6863[a]
	(15.112)	(14.288)	(15.108)
v	5.185[a]	6.285[a]	7.065[a]
	(7.087)	(6.009)	(5.636)
L	4934.68	4937.48	4578.70
Non-standardized residuals – ε_t			
Sk	0.107[c]	−0.255[a]	−0.860[a]
Ku	7.998[a]	3.335[a]	3.027[a]
L–B(9)	9.73	6.67	3.24
Standardized residuals – $\varepsilon_t/h_t^{1/2}$			
Sk	0.385[a]	0.021	−0.311[a]
Ku	2.991[a]	1.948[a]	1.756[a]
L–B(9)	2.314	3.49	6.31
Standardized squared residuals – ε_t^2/h_t			
Sk	8.338[a]	6.400[a]	19.50[a]
Ku	108.133[a]	67.590[a]	72.627[a]
L–B(9)	12.27	5.56	4.27

[16] Spill-over between Indonesia, Malaysia and Thailand were also checked. Results fail to show any significant dependent daily seasonality in returns and volatility. These results are available on request.

variance (volatility) of stock returns are studied in this paper. Daily stock returns during January 1990–June 1995 from India, Indonesia, Malaysia, Philippines, South Korea, Taiwan and Thailand are applied in the empirical work. Results obtained indicate significant presence of the day of the week in some of the markets considered and they also show significant Monday effect on both stock returns and conditional variance. This confirms the notion that day of the week effect and the Monday effect are not just features of the stock markets of the United States and other developed countries but also of the emerging markets.

The significant day of the week effect on returns results found in this paper cannot be explained based on the settlement procedure but results do indicate some evidence of a possible spill-over from the Japanese market. But the significant day of the week effect on volatility maybe in line with the information availability theory. These results clearly indicate the need for more research in the field of specific time periods anomalies in the stock markets of different countries, including other emerging markets and during different time periods.

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