"Day Of The Week" And Its Effect On Stock Market Volatility: Evidence From An Emerging Market

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ABSTRACT

This paper investigates the "day of the week" effect in the volatility of the Saudi Stock Exchange during the period between January 7, 2007 and April 1, 2013. Using a conditional variance framework, we find that the "day of the week" effect is present in the volatility. Our results show that the lowest volatility occurs on Saturdays and Sundays. We argue that due to the closure of international markets on Saturdays and Sundays, there is not enough activity in the Saudi Stock Exchange. As a result, the volatility is the lowest on these days. Our results also show that the highest volatility occurs on Wednesdays. We argue Wednesday, being the last trading day of the week, corresponds with the start of four non-trading days (Thursday through Sunday) for foreign investors. Fearing that they will be stuck up with stocks in case some unfavorable information enters the market, foreign investors tend to exit the market on Wednesdays. As a result of excessive trading, there is high volatility on Wednesdays.

Keywords: Day of the Week; Stock Market Volatility; Emerging Markets; Conditional Heteroskedasticity

1. INTRODUCTION

The "day of the week", an important calendar anomaly, is a common feature in most stock markets. It is defined as the situation when there are abnormally high stock market returns on Fridays followed by negative returns on the following Mondays without a specific cause (Rogalski, 1984; Keim and Stambaugh, 1984; Aggarwal and Rivoli, 1989; Solnik and Bousquet, 1990; Barone, 1990).[1] Given that returns and risk are the two sides of the same coin, it is intuitive to believe that the "day of the week" anomaly should also hold in volatility. Kiymaz and Berument (2003) document that stock markets exhibit the highest volatilities on Fridays in Canada. This result is consistent with the "day of the week" anomaly in returns. The highest returns on Fridays are accompanied by the highest volatilities on Fridays. However, in some other markets, the highest volatilities are observed in days other than Fridays. Kiymaz and Berument (2003), for example, report that the highest volatility is observed on Thursdays in the UK and on Mondays in Germany and Japan.

In this paper, we extend the prior literature by documenting the "day of the week" anomaly in the Saudi Stock Exchange during the period between January 7, 2007 and April 1, 2013. Given that the trading week in the Saudi Stock Exchange is different from the rest of the world, it is interesting to see how asynchronous trading week affects the "day of the week" anomaly in Saudi Arabia. Our results show that the volatility is the lowest on weekends – Saturdays and Sundays. We argue that reduced information spillovers due to the closure of international markets on Saturdays and Sundays lead to lower volatility on these days (Abraham and Seyyed, 2006). Furthermore, exclusion of foreign investors from trading may also deter local investors from trading, thereby lowering the volatility on weekends (Dichev et al., 2011). Our results also show that the highest volatility occurs on Wednesdays.

[1] Prior literature argues that increased selling activity on Mondays and market settlement procedures are some of the main reasons behind this anomaly (Lakonishok and Maberly, 1990; Keim and Steimbaugh, 1984). None of these explanations, however, hold global appeal.

Wednesday corresponds to the start of four non-trading days for foreign investors. On Thursday and Friday, the Saudi Stock Exchange is closed and on Saturday and Sunday, the international markets are closed. We argue that, faced with four consecutive non-trading days, foreign investors tend to exit on Wednesdays. Excessive trading caused by foreign investors leads to increased volatility on Wednesdays.

One of the benefits of studying the "day of the week" effect in Saudi Arabia is that it allows us to come up with testable hypotheses – volatility is low on Saturdays and Sundays and high on Wednesdays. Most of the prior literature on the "day of the week" effect does not provide any argument regarding why one day should have higher volatility than the other day. Prior literature, for instance, shows that volatility is high in some countries on some day and high in some other countries on some other day. Kiymaz and Berument (2003), for instance, document that the highest volatility occurs on Mondays in Germany and Japan, on Fridays in Canada and the United States, and on Thursdays in the United Kingdom.

This paper also shows that differences in volatility across different days also translate into differences in the dynamics of volatility behavior – leverage effect, memory, and reaction to shocks. Our results show that lower volatility on weekends translates into the least reaction to recent shocks by volatility and the shortest memory of volatility on weekends. We also show that recent negative shocks do not increase volatility on weekends. Our results also show that higher volatility on Tuesdays and Wednesdays translates into increasing volatility in response to recent negative shocks.

The remainder of the paper is organized as follows. Section 2 briefly develops the hypotheses for this study. Section 3 describes the data and provides descriptive statistics. Section 4 provides details of estimation procedure and presents results. Section 5 discusses implications of our results and the paper concludes with Section 6.

2. HYPOTHESES DEVELOPMENT

Saudi Arabia, custodian of the holiest places of Islam and home to one of the largest oil reserves, commands significant importance in political as well as economic affairs of the world. Fueled by petro dollars, the Saudi Stock Exchange has emerged as the biggest stock exchange of the MENA region. By the end of 2009, it had market capitalization of more than $300 billion, while the Kuwait Stock Exchange, the second largest stock exchange in the region, had market capitalization of less than $100 billion at that time. Given the importance of the Saudi Stock Exchange in the MENA region, it is worthwhile to examine its volatility behavior. This paper is an attempt to document an important stylized characteristic of volatility, the "day of the week" effect, in the Saudi Stock Exchange. The "day of the week" effect is a phenomenon that arises when volatility on a certain day is consistently different from other days. Given that risk constitute an important factor in the decision making of any rational investor, it is important to document whether there exists any pattern in the volatility behavior. Identifying such patterns in volatility may enable investors to make value relevant decisions (for hedging or speculative purposes) by accounting for these patterns. Engle (1993) argues that investors who dislike risk may adjust their portfolios by reducing their investments in those assets whose volatility is expected to increase.

This paper argues that the Saudi Stock Exchange possesses a very unique characteristic – a distinctive trading week – that makes it very interesting to investigate the "day of the week" effect. The trading week starts on Saturday in Saudi Arabia and ends on Wednesday. Therefore, trading on Saturdays and Sundays at the Saudi Stock Exchange is characterized by the fact that international financial markets are closed on these days. Furthermore, Monday trading at the Saudi Stock Exchange corresponds to the fact that international investors are entering the market after a gap of four days – Thursday and Friday when the Saudi Stock Exchange is closed and Saturday and Sunday when the international markets are closed. By extension, it also means that trading on Wednesdays corresponds with the fact that foreign investors will not be able to enter the market for the next four days. We argue that this characteristics – asynchronous trading week – may have significant implications for volatility in general and the "day of the week" effect in particular.

An important impact of asynchronous trading week on the volatility behavior is that, relative to other days, we should observe lower volatilities on Saturdays and Sundays. We argue that due to closure of international

financial markets on Saturdays and Sundays, the volatility should be low in the Saudi Stock Exchange for, at least, two reasons.

- First, there should be lower amount of trading volume on Saturdays and Sundays as it excludes foreign investors from trading activity. Absence of foreign investors may also discourage local investors from trading due to the fact that foreign investors, being more diversified, are exposed to lower risk and therefore are willing to pay higher prices for the stocks. As a result, local investors may want to wait till Monday (when foreign investors enter the market) for trading their stocks.[2] Prior literature suggests that lower trading volume translates into lower volatility. In a recent study, Dichev et al. (2011) document a positive link between high trading volume and the volatility of stock prices. They document that volume alone accounts for approximately 25% of stock price volatility, and an even greater proportion at the highest trading volumes.[3] This result can be especially true for our case because the Saudi Stock Exchange is dominated by less sophisticated noise traders who can easily lead prices away from the fundamentals.
- Second, the closure of international markets on Saturdays and Sundays reduces information spillovers. Prior literature argues that lower information spillovers result in lower volatility. Abraham and Seyyed (2006), for instance, examine the flow of information between Saudi Arabia and Bahrain and find that excess volatility in Bahrain translates into excess volatility in Saudi Arabia. Given that Gulf investors are allowed to invest in Saudi Arabia, it is not surprising to see the volatility in Bahrain Stock Exchange to affect the volatility in Saudi Stock Exchange. Consistent with Abraham and Seyyed (2006), Yu and Hassan (2008) find large and predominantly positive volatility spillovers between the MENA region and the world stock markets. Chou et al. (1999) suggest that greater spillovers from international markets, usually, increase volatility in emerging markets. Using daily data from the US and Taiwan, they document that increase in volatility in the US causes increase in volatility in Taiwan.

Given the above arguments, we hypothesize that volatility on Saturdays and Sundays is significantly lower than volatility on other days.

H1: Volatility on Saturdays and Sundays is significantly lower than volatility on other days

Another noteworthy impact of asynchronous trading week on the volatility behavior is that, relative to other days, we should observe higher volatilities on Mondays. We argue that closure of the Saudi Stock Exchange on Thursdays and Fridays, effectively, keeps foreign investors away from trading for four days – Thursday and Friday when the Saudi Stock Exchange is closed and Saturday and Sunday when the international markets are closed. Therefore, when international investors enter the market on Monday, they have, at least, four days of information that they need to incorporate into the prices. Assuming that four days of unincorporated information needs time to be understood and interpreted, we should expect greater divergence in investors' opinion on Mondays. It will, therefore, cause volatility to go up significantly on Mondays. Our arguments are consistent with Andersen (1996) who suggests that the variance of returns at a given interval is proportional to the rate of information arrival. He considers the amount of information as an important determinant of stock return volatility. In another related study, Kalev et al. (2004) documents a positive and a significant impact of the arrival rate of the news on the conditional variance of stock returns. They show that the positive relationship holds even after controlling for the trading volume. Given that Monday signifies the day when foreign investors have to trade on accumulated information of four days, it is expected that volatility on Mondays is significantly higher than volatility on other days.

H2a: Volatility on Mondays is significantly higher than volatility on other days

However, there can be arguments that suggest the highest volatility should be on Wednesdays. Trading on Wednesdays correspond with the start of four non-trading days (Thursday through Sunday) for foreign investors.

[2] The Saudi Stock Exchange is dominated by the retail investors. In November 2009, for instance, 88% of the trade was carried out by the retail investors. The figure was almost the same a year earlier as well.

[3] These findings are against the theoretical arguments that consider higher investor participation and trading volume to be associated with better price discovery and therefore to prices that are closer to fundamental values. As a result, it should reduce estimation noise and result in lower volatility of returns.

Given that the Saudi Stock Exchange is still not as efficient as one would expect, it is very much possible that foreign investors do not want to get stuck with stocks for the next four days without the ability to trade in case some unfavorable information arrives. Consequently, they will exit stocks more on Wednesdays. We argue that excessive trading on Wednesdays may lead to higher volatility.

H2b: Volatility on Wednesdays is significantly higher than volatility on other days

3. DATA

This paper documents the "day of the week" effect in the Saudi Stock Exchange using the daily closing values of Tadawul All Share Index (TASI), the main benchmark index of the Saudi Stock Exchange. The period of analysis is between January 7, 2007 and April 1, 2013. The evolution of TASI during our sample period is shown in Figure 1. The figure shows that the Saudi Stock Exchange experienced sustained downward movement during 2008, most probably due to the global financial crisis. During this year, TASI fell from around 11000 points to less than 5000 points. Starting 2009, the decline stopped and the market settled to a low level. The figure also shows that the market has yet to recover and reach the pre-crisis levels.

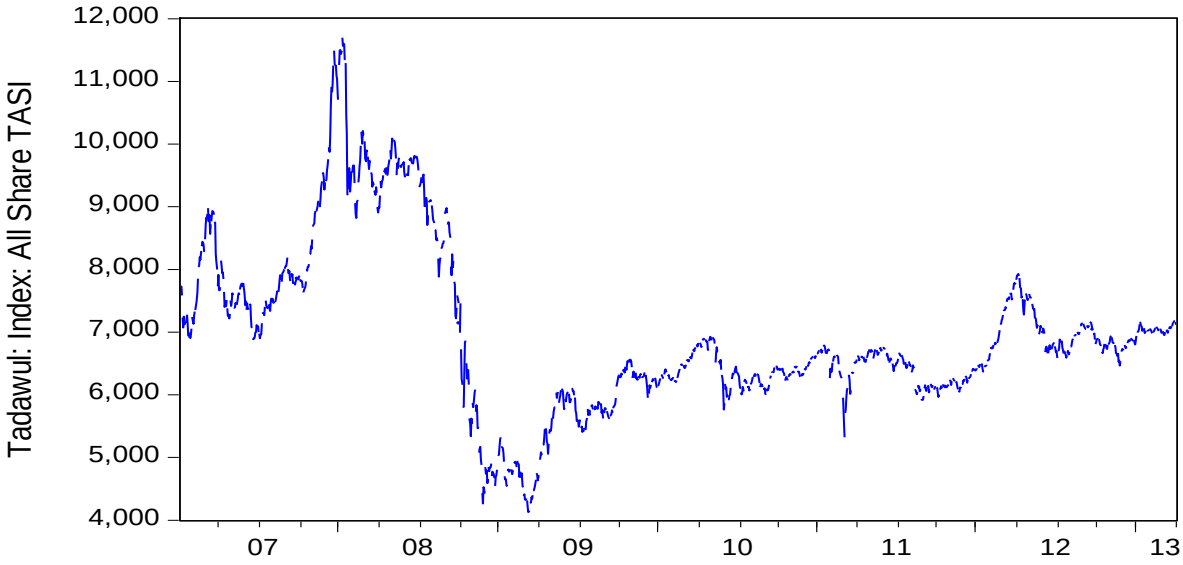

Figure 1: Evolution of TASI during the Period between January 7, 2007 and April 1, 2013

3.1 Classification of Days

This paper classifies any given week into three distinct groups – WEEKEND, MONDAY, and WEDNESDAY. WEEKEND comprises of Saturdays and Sundays. On these two days, the Saudi Stock Exchange is open, while the international markets are closed. MONDAY comprises of Mondays. It is the first day when the international markets and the Saudi Stock Exchange open on the same day. It also corresponds with the fact that foreign investors enter the market after the gap of four days – Thursday and Friday when the Saudi Stock Exchange is closed and Saturday and Sunday when the international markets are closed. WEDNESDAY comprises of Wednesdays. It is the last day of trade in the Saudi Stock Exchange. After it, market closes for Thursdays and Fridays.

3.2 Descriptive Statistics

The daily return series (RET_t) is generated as follows. In the following equation, $TASI_t$ represents the closing values of Tadawul All Share Index (TASI) on the day t.

$$RET_t = \log\left(\frac{TASI_t}{TASI_{t-1}}\right) \quad (1)$$

The return series in Equation (1) is the time series of continuously compounded daily returns. We would like to mention that the series is adjusted neither for dividends nor for risk-free interest rate. Nelson (1991) mentions that ignoring dividends and interest rates do not cause any significant errors while forecasting volatility of market indices. Summary statistics for our return series, as given in Equation (1), are shown in Table 1. Our results suggest that the average and median returns are positive during our sample period. We report daily average and median return of 0.01% and 0.07% per day, respectively. Our results also show that the average returns are positive for WEEKEND, MONDAY and WEDNESDAY. We report an average return of 0.04% for WEEKEND, 0.05% for MONDAY, and 0.06% on WEDNESDAY during our sample period. The statistics also show that returns are negatively skewed during our sample period. The negative skewness implies that the return distribution of the shares traded in the Saudi Stock Exchange has a higher probability of earning negative returns. The value of the kurtosis is greater than 3 for the entire sample, and for all sub-samples (WEEKEND, MONDAY, and WEDNESDAY). It signifies that the distribution has a heavier tail than the standard normal distribution. The Jarque-Bera test statistic provides evidence to reject the null hypothesis of normality for the unconditional distribution of daily returns.

Table 1: Descriptive Statistics of TASI during the Period between January 7, 2007 and April 1, 2013

Statistics	Full Sample	WEEKEND	MONDAY	WEDNESDAY
Mean	0.0001	0.0004	0.0005	0.0006
Median	0.0007	0.0009	0.0003	0.0011
Maximum	0.0951	0.0951	0.0946	0.0318
Minimum	-0.0981	-0.0919	-0.0981	-0.0439
Standard Deviation	0.0153	0.0176	0.0142	0.0104
Skewness	-0.6292	-0.4092	-0.4369	-0.6344
Kurtosis	11.8218	9.055	18.5122	5.5095
Observations	1560	621	315	312
Jarque-Bera	5676.0090***	2888.7420***	3396.9190***	1050.5860***

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level

4. METHODOLOGY

In order to determine whether the "day of the week" effect exists in Saudi Arabia or not in daily return series and taking into account the time varying property of volatilities, we use the following GJR model (Glosten et al., 1993). In the following model, WEEKEND is a dummy variable that takes the value of 1 if the observation is from Saturdays and Sundays and 0 otherwise. MONDAY is a dummy variable that takes the value of 1 if the observation is from Mondays and 0 otherwise. WEDNESDAY is a dummy variable that takes the value of 1 if the observation is from Wednesdays and 0 otherwise. Also, D_{t-1} takes a value of 1 if the innovation (ε_{t-1}) is negative (bad news) and 0 otherwise.

$$RET_t = \psi_0 + \psi_1(RET_{t-1}) + \psi_2(\varepsilon_{t-1}) + \psi_3(WEEKEND_t) + \psi_4(MONDAY_t) + \psi_5(WEDNESDAY_t) + \varepsilon_t \quad (2)$$

$$(\sigma_t)^2 = \alpha_0 + \alpha_1(\varepsilon_{t-1})^2 + \alpha_2(\sigma_{t-1})^2 + \alpha_3\left[D_{t-1}(\varepsilon_{t-1})^2\right] + \alpha_4(WEEKEND_t) + \alpha_5(MONDAY_t) + \alpha_6(WEDNESDAY_t)$$

The results of our analysis are reported in Table 2. Consistent with our expectations, our results show that volatility is the lowest on weekends. We report significant and negative coefficient estimate of WEEKEND. Our results show that the coefficient estimate of WEEKEND is smaller than the coefficient estimate of MONDAY and the coefficient estimate of WEDNESDAY. We argue that presence of homogeneous trading agents (mostly local

investors) on weekends result in lower stock return volatility. Furthermore, our results also indicate that volatility is the highest on Wednesdays. The coefficient estimate of WEDNESDAY is larger than the coefficient estimate of MONDAY and the coefficient estimate of WEEKEND. We argue that Wednesdays correspond to the start of four non-trading days for foreign investors. Fearing that they will be stuck up with stocks in case some unfavorable information enters the market, foreign investors tend to exit the market on Wednesdays. We argue that excessive trading on Wednesdays result in high volatility. Some of the other findings presented in Table 2 are:

- Our results indicate that the highest volatility on Wednesdays is accompanied by the highest returns on Wednesdays. The coefficient of returns on Wednesdays is the highest one.
- Reaction to the recent shocks is represented by the coefficient estimate of $(\varepsilon_{t-1})^2$. Our results show that volatility increases in response to recent shocks. The coefficient estimate representing reaction to recent shocks is significant and positive with a magnitude of 0.068493.
- Persistence in volatility is represented by the coefficient estimate of $(\sigma_{t-1})^2$. Our results indicate relatively long memory of volatility during our sample period. We report that the coefficient estimate representing persistence is significant and positive with a magnitude of 0.852639. Persistence or long memory in volatility has important implications for the ability of stock market participants to predict future volatility.
- The leverage effect is captured by the coefficient estimate of $D_{t-1}(\varepsilon_{t-1})^2$. Our result indicates the presence of leverage effect in volatility in Saudi Arabia. We report significantly positive coefficient estimate of $D_{t-1}(\varepsilon_{t-1})^2$. The positive coefficient of $D_{t-1}(\varepsilon_{t-1})^2$ indicates that stock market volatility increase more in response to negative shocks.

Table 2: "Day of the Week" Effect in Volatility in Saudi Arabia

		Coefficient	z-Statistic	Probability
Return	$WEEKEND_t$	0.001261	2.079840	0.0375
	$MONDAY_t$	0.000597	0.984173	0.3250
	$WEDNESDAY_t$	0.003246	4.104591	0.0000
	RET_{t-1}	-3.02E-07	-0.004099	0.9967
	ε_{t-1}	0.090989	2.980808	0.0029
	Constant	-0.000869	-1.775544	0.0758
Volatility	$WEEKEND_t$	-3.37E-05	-6.008423	0.0000
	$MONDAY_t$	-1.25E-05	-2.502829	0.0123
	$WEDNESDAY_t$	3.69E-05	5.999550	0.0000
	$(\varepsilon_{t-1})^2$	0.068493	5.839341	0.0000
	$(\sigma_{t-1})^2$	0.852639	79.96565	0.0000
	$D_{t-1}(\varepsilon_{t-1})^2$	0.134887	6.289137	0.0000
	Constant	1.23E-05	2.847370	0.0044
	No. of Observations		1560	

5. DISCUSSION OF RESULTS

Our results have shown significantly lower volatility on weekends and significantly higher volatility on Wednesdays. We argue that this difference in volatility should have significant implications for the volatility behavior. In order to test this conjecture, we estimate the following model – a variation of Equation (2).

$$RET_t = \psi_0 + \psi_1(RET_{t-1}) + \psi_2(\varepsilon_{t-1}) \\ \psi_3(WEEKEND_t) + \psi_4(MONDAY_t) + \psi_5(WEDNESDAY_t) + \varepsilon_t$$

$$\begin{aligned}(\sigma_t)^2 &= \alpha_0 + \alpha_1(\varepsilon_{t-1})^2 + \alpha_2(\sigma_{t-1})^2 + \alpha_3\left[D_{t-1}(\varepsilon_{t-1})^2\right] \\ &+ \alpha_4\left[(\varepsilon_{t-1})^2 * WEEKEND_t\right] + \alpha_5\left[(\sigma_{t-1})^2 * WEEKEND_t\right] \\ &+ \alpha_6\left[D_{t-1}(\varepsilon_{t-1})^2 * WEEKEND_t\right] \\ &+ \alpha_7\left[(\varepsilon_{t-1})^2 * MONDAY_t\right] + \alpha_8\left[(\sigma_{t-1})^2 * MONDAY_t\right] \\ &+ \alpha_9\left[D_{t-1}(\varepsilon_{t-1})^2 * MONDAY_t\right] \\ &+ \alpha_{10}\left[(\varepsilon_{t-1})^2 * WEDNESDAY_t\right] + \alpha_{11}\left[(\sigma_{t-1})^2 * WEDNESDAY_t\right] \\ &+ \alpha_{12}\left[D_{t-1}(\varepsilon_{t-1})^2 * WEDNESDAY_t\right]\end{aligned} \quad (3)$$

The results of our analysis are reported in Table 3. Some of the more important findings of Table 3 are as follows:

- As was shown earlier, the returns are the highest on Wednesdays.
- The results show that the shortest memory of volatility is on Mondays. Our results indicate that memory on Mondays is 0.481245 (= 0.846291 – 0.365046). Shorter memory on Mondays may not allow investors to better forecast volatility on Mondays. We also show that there is no significant difference in memory on all other days. We report insignificant coefficient estimates of $(\sigma_{t-1})^2$*WEEKEND$_t$ and $(\sigma_{t-1})^2$*WEDNESDAY$_t$.
- Our results show that the leverage effect is the most on weekends. We report that leverage effect is 0.539842 (= –0.149889 + 0.689731) on weekends. It indicates that volatility increases in response to recent negative shocks on weekends. We also report that the leverage effect is least on Tuesdays (–0.149889).
- We also show that the volatility react the least to recent shocks on weekends. Our results indicate that the effect of recent shocks on volatility is 0.013606 (= 0.357179 – 0.343573) on weekends. Our results also indicate that reaction to recent shocks is the most on Tuesdays.

Table 3: Implications of "Day of the Week" Effect for Stylized Characteristics of Volatility in Saudi Arabia

		Coefficient	z-Statistic	Probability
Return	$WEEKEND_t$	0.001365	2.080465	0.0375
	$MONDAY_t$	0.000929	1.390238	0.1645
	$WEDNESDAY_t$	0.002579	4.035508	0.0001
	RET_{t-1}	3.30E-07	2.970846	0.0030
	ε_{t-1}	0.090743	2.839333	0.0045
	Constant	-0.000646	-1.256055	0.2091
Volatility	$(\varepsilon_{t-1})^2$	0.357179	4.741334	0.0000
	$(\sigma_{t-1})^2$	0.846291	10.66759	0.0000
	$D_{t-1}(\varepsilon_{t-1})^2$	-0.149889	-1.665691	0.0958
	$(\varepsilon_{t-1})^2$*$WEEKEND_t$	-0.343573	-4.149411	0.0000
	$(\sigma_{t-1})^2$*$WEEKEND_t$	0.041213	0.408503	0.6829
	$D_{t-1}(\varepsilon_{t-1})^2$*$WEEKEND_t$	0.689731	5.746318	0.0000
	$(\varepsilon_{t-1})^2$*$MONDAY_t$	-0.260462	-2.830990	0.0046
	$(\sigma_{t-1})^2$*$MONDAY_t$	-0.365046	-3.508889	0.0004
	$D_{t-1}(\varepsilon_{t-1})^2$*$MONDAY_t$	0.341052	2.884765	0.0039
	$(\varepsilon_{t-1})^2$*$WEDNESDAY_t$	-0.295694	-3.141269	0.0017
	$(\sigma_{t-1})^2$*$WEDNESDAY_t$	0.113481	0.734766	0.4625
	$D_{t-1}(\varepsilon_{t-1})^2$*$WEDNESDAY_t$	0.204471	2.020976	0.0433
	Constant	5.02E-06	8.948437	0.0000
	No. of Observations		1560	

6. CONCLUSION

The "day of the week" effect anomaly is documented extensively in both equity and non-equity markets. The "day of the week" effect patterns in return and volatility might enable investors to take advantage of relatively regular shifts in the market by designing trading strategies, which account for such predictable patterns. This study investigates the "day of the week" effect on stock market volatility in Saudi Arabia using a conditional variance methodology. The data covers the period between January 7, 2007 and April 1, 2013. Findings indicate that the "day of the week" effect is present in volatility. We observe the least volatility on Saturdays and Sundays and the highest volatility on Wednesdays. The findings of this paper support our hypothesis which suggests that due to closure of international markets on Saturdays and Sundays, there is not enough activity in the Saudi Stock Exchange. As a result, the volatility is the lowest on Saturdays and Sundays. Our results also show that the highest volatility is on Wednesdays. Wednesday, being the last trading day of the week, corresponds with the start of four non-trading days for foreign investors. Fearing that they will be stuck up with stocks in case some unfavorable information enters the market, foreign investors tend to exit the market on Wednesdays. We argue that excessive trading on Wednesdays result in high volatility. Furthermore, our results show that the highest volatility on Wednesdays also translate into highest returns on Wednesdays.

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