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Abstract

Calendar anomalies in stock returns are well documented. Less obvious is the existence of seasonality in return volatility associated with moving calendar events such as the Muslim holy month of Ramadan. Using a GARCH specification and data for the Saudi Arabian stock market – now the largest stock market in the Muslim world – this paper documents a systematic pattern of decline in volatility during Ramadan, implying a predictable variation in the market price of risk. An examination of trading data shows that this anomaly appears to be consistent with a decline in trading activity during Ramadan. Evidence of systematic decline in volatility during Ramadan has significant implications for pricing of securities especially option-like products and asset allocation decisions by investors in the Islamic countries.

JEL classification: G12; G14

Keywords: Calendar anomaly; Moving calendar event; Ramadan effect

1. Introduction

Over the past three decades, many empirical studies have provided evidence about the presence of calendar anomalies in stock market returns. Seasonal patterns in the form of the

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January effect and the day of the week effect are well documented anomalies (Cross, 1973; French, 1980; Gibbsons and Hess, 1981; Keim, 1983; Tinic and West, 1984, among others). The January effect states that stock returns are higher in January than any other month of the year, especially of smaller firms. A variety of explanations have been offered to account for the excess returns during the month of January. Some of the more frequently cited reasons for the January effect include the tax-loss selling hypothesis, window dressing by institutional investors and undefined small-firm risk factors. The January effect is found in several countries around the world. The day of the week effect studies on the U.S. markets report that the average return on Monday is significantly less than on other days of the week. Day of the week effect is also reported for other international equity markets (Jaffe and Westerfield, 1985; Solnik and Bousquet, 1990, among others).

The persistence of seasonality in stock market returns has prompted several researchers to investigate seasonal volatility patterns to explain seasonal returns by using variations of the generalized autoregressive conditional heteroskedasticity (GARCH) models. The results of these studies are somewhat mixed. French et al. (1987) and Campbell and Hentschel (1992) find that increase in stock market volatility raises required stock returns, lowering stock prices. On the other hand, Glosten et al. (1993) report that positive (negative) unanticipated returns lead to reduction (increase) in conditional volatility. Beller and Nofsinger (1998) find that much of the abnormal return in January cannot be entirely attributed to higher systematic risk or higher risk premium. These findings have serious implications for financial markets in which the trade-off between risk and return generally forms the basis for financial decisions.

Unlike the fixed calendar events (January effect and the day of the week effect), which have been extensively examined, the effect of moving calendar events (such as Ramadan) on risk and return have not received much attention. Major moving calendar events such as Ramadan can potentially have significant effects on economic and financial variables. Alper and Arouba (2001), using macroeconomic time series data for Turkey show that conventional methods to deseasonalize moving events data do not remove all deterministic seasonal components. They demonstrate that further deseasonalizing using specific categorical moving event variables is required to remove the residual seasonality.

The financial markets in the Islamic countries around the globe experience noticeable changes in their trading activities (with reduced banking and working hours) and greater religious orientation of the market participants during the fasting month of Ramadan. Most Islamic countries use both the Gregorian and the Islamic lunar calendars. The Islamic calendar predominantly marks the religious activities and holidays, whereas the Gregorian calendar is used by businesses and governments. The holy month of Ramadan, the ninth month of the Islamic calendar, is a month of fasting, spiritual training and discipline. As part of a lunar calendar, Ramadan moves slightly each year beginning about 10 days earlier. The month of Ramadan presents a unique opportunity to examine and determine any predictable patterns in the behavior of stock returns and volatility relative to other months of the year. The findings should be of interest to both regulators and participants in the financial markets of Islamic countries in the Middle East, the Far East and elsewhere.

Why would one anticipate the stock market return or its volatility to change during the month of Ramadan? Throughout the Muslim world, the holy month of Ramadan is observed with great zeal and enthusiasm. Changes in the social and economic life of individuals are quite significant and visible. Ramadan fast is one of the five pillars of Islam, and is mandatory

for all adult Muslims who are not infirm or subject to other permissible exemptions. Muslims fast each day from dawn until sundown with total abstinence from food or drink and are encouraged to devote themselves to acts of piety, prayers and charity. A Ramadan fast is a spiritual act to turn hearts towards Allah and away from worldly concerns, as stated in the Qur'an, so that believers will acquire self restraint (Al-Qur'an 2:183). In practice, a Ramadan fast is punctuated with ritual prayers, recitation from the holy Qur'an and other acts of piety leading to a marked spiritual orientation among average Muslims. Refraining from participating in religiously prohibited "haram" activities is stressed.

The economic activities in general tend to slow down with reduced working hours in virtually all sectors. Despite the fast, however, grocery sales go up during the month thanks to the evening "iftar" feasts. Similarly, electricity consumption is reported to rise as a result of increase in late night socio-religious activities and shopping. Trading in securities is likely to decline as many Muslims consider speculative trading a form of gambling, which is prohibited by Islam. Similarly, use of leverage (margin trading) or trading in interest-based securities may decline during the month of Ramadan in view of strict prohibition against the use of interest or "Riba". Husain (1998) examines the effects of Ramadan on mean return and returns volatility in the Pakistani equity market. The results indicate no significant change in mean return during Ramadan, however, return volatility declines significantly. The Ramadan month pricing of risk anomaly found in the Pakistani equity market provided the initial impetus for the present investigation.

This paper examines the effect of Ramadan on weekly stock returns and volatility of the overall Saudi stock market and its six constituent sectors using the conditional variance GARCH model. The evaluation is conducted on the Saudi stock market which is the largest equity market in terms of market capitalization (US$ 236,128 millions as of October 2004) in the Middle East and the Muslim world. Unlike the January effect, which has been extensively tested, the impact of Ramadan on financial markets remains mostly overlooked. The present investigation will add to the current literature on stock market seasonality. Its findings have notable implications for market participants as well as regulators of the financial markets in Islamic countries.

2. Overview of the Saudi Arabian stock market

The Saudi stock market with a capitalization of US$ 236.13 billions (October 2004) is the largest equity market in the Middle East and the Muslim world surpassing the Malaysian equity market capitalization of US$ 169.50 billions. Based on capitalization, it ranks among the top 25 equity markets in the world. Table 1 presents a summary of Stock Market Statistics (2003) of the major Islamic countries in the world. The total capitalization for the 16 markets was US$ 686 billions with Saudi Arabia accounting for nearly one-fourth of the total. In 2003, the Saudi stock market ranked second in terms of market capitalization, first in average company capitalization and third in turnover value among the emerging markets of Islamic countries. The turnover ratio which has significantly improved in recent years indicates good liquidity compared to other emerging markets. The turnover ratio is good for a market in which nearly 54% of the total value of shares is held by government or semi-government entities, foreign partners and other companies limiting the available float

Table 1
Islamic countries Stock Market Statistics (2003)

Rank	Market	Market capitalization (US$ millions)	Total value traded (US$ millions)	Turnover ratio (%)	Number of listed companies	Average capital
1	Kuala Lumpur (Malaysia)	160970	52233	32.4	902	178.5
2	Saudi Market (Saudi Arabia)	157302	159059	101.1	70	2247.2
3	Istanbul (Turkey)	68379	98160	143.6	285	239.9
4	Kuwait Stock Exchange (Kuwait)	59528	54651	91.8	108	551.2
5	Jakarta (Indonesia)	54659	14652	26.8	333	164.1
6	Abu Dhabi Market (UAE)	30363	1004	3.3	30	1012.1
7	Tehran (Iran)	27544	4668	16.9	345	79.8
8	Doha Securities Market (Qatar)	26702	3220	12.1	28	953.6
9	Egypt Stock Market (Egypt)	25984	4503	17.3	978	26.6
10	Karachi Stock Exchange (Pakistan)	16637	67748	407.2	701	23.7
11	Dubai Financial Market (UAE)	14284	1027	7.2	13	1098.8
12	Casablanca Stock (Morocco)	13258	6158	46.4	53	250.2
13	Amman Stock Exchange (Jordan)	10986	2399	21.8	157	70.0
14	Bahrain Stock Exchange (Bahrain)	9708	271	2.8	44	220.6
15	Muscat Securities (Oman)	7246	1540	21.3	103	70.3
16	Tunis Stock Exchange (Tunis)	2440	187	7.7	45	54.2
	Average	42874	29468	68.7	262	453

for trading. In addition, the turnover ratio is reasonable for a market that is closed to direct foreign investment and allows access and trading to Saudi and GCC nationals only. However, foreign investors are allowed to invest indirectly through mutual funds. Share trading can only be done though the ten local banks which subscribe to the computerized trading network maintained by SAMA (Saudi Arabian Monetary Agency—the Saudi Central Bank). In 1998, IFC launched a Saudi market index in its series of emerging market indices. The index included 21 stocks with a market capitalization of US$ 35 billions in 1998.

The total number of companies listed at the end of 2003 stood at 70 comprising seven major sectors. The sector-wise composition in terms of total market capitalization was: Banking (28.8%), Industrials (23%), Services (3.7%), Cement (7.4%), Electricity (14.8%), Agriculture (0.3%) and Telecommunication (21.9%). The Saudi Telecommunication Company (STC)—the largest company in the Middle East was listed for trading in 2002.

The Saudi stock market started in 1952 with only one company and remained virtually unregulated until 1984 when SAMA assumed the regulatory role, entrusting trading function to the commercial banks in the country. In 1990, an electronic trading system was established (ESIS) consisting of a central clearing mechanism connected via central trading units (CTU) to the commercial banks in the Kingdom. Orders to buy or sell are entered by bank employees manning these CTUs. The trading day is broken into two 2 h sessions (10:00–12:00 noon and 4:30–6:30 pm), Saturday to Wednesday and one 2 h session on Thursday. During the month of Ramadan, the second 2 h trading session is scheduled between 9:00–11:00 pm. The minimum tick size is one Saudi Riyal (approximately US$ 0.26) and transaction costs start from a minimum of SR25. Only limit orders are accepted by the system, where the typical order must specify the price and the quantity intended for purchase or sale.

Table 2
Descriptive statistics of saudi stock market weekly index return (%) by sector February 1985–April 2000

Description	Overall market index	Sector indices					
		Banking	Industrials	Services	Cement	Electricity	Agriculture
Observations	734	734	734	734	734	734	734
Mean	0.0688	0.2111	0.1380	−0.1219	0.0328	−0.0462	−0.1319
Median	0.0984	0.1935	0.1025	−0.1516	0.0056	−0.0164	−0.1623
Standard deviation	1.7876	2.4821	2.9366	2.2496	2.1724	2.3119	2.3461
Skewness	0.0073	0.0506	−0.6884	0.3188	−0.0474	2.5477	−0.5621
Kurtosis	6.2804	7.3041	41.8075	6.1661	4.8450	30.3323	9.0270
Minimum	−8.6666	−12.5093	−33.9091	−10.356	−8.8030	−9.9735	−15.6361
Maximum	7.9402	12.1377	28.3341	12.6448	8.5513	26.0668	9.7252

3. Data

The data used in this study consist of weekly index values for the overall Saudi stock market and sector indices for each of the six major sectors in the economy. The sectors are: Banking, Industry, Cement, Electricity, Agriculture and Services. (The Telecommunications sector consisting of one stock is not included in the study as this stock came into existence only in 2002.) The return data covers the period February 1985 through April 2000. The indices are value weighted and maintained by the statistical analysis department at SAMA. The weekly returns for the overall market and the six sectors are computed as the difference in the natural logarithm of the closing index values for each of the consecutive weeks. Table 2 reports the descriptive statistics of the weekly returns for the overall market index and the six sector indices over the entire study period. The weekly return data summarized in Table 2 indicate significant departure from normality both for the overall index as well as the constituent sectors over the study period. The skewness (both positive and negative) statistics are not too large, but all the kurtosis values are significantly larger than 3, indicating fat tails compared to a normal distribution. The Jarque-Berra test statistics for normality (not reported) reject the normality of returns at the 5% level. SAMA started systematic compiling of stock market transactions data in 1989. Hence, the empirical tests on trading activity were conducted on the available weekly transactions data starting November 1989 through April 2000.

4. Methodology

Engle (1982) proposed the Autoregressive Conditional Heteroskedastic (ARCH) model that allows the forecast variance of return to vary systematically over time. The model assumes that the conditional variance, h_t, depends on the lagged squared residuals of returns. The basic ARCH model for returns allows the data to determine the best weights to use in forecasting the changing conditional variance. Bollerslev (1986) extended the ARCH specification by making the conditional variance h_t a function of lagged values of h_t in addition to the lagged values of squared residuals. This form of the model is known as

generalized ARCH (GARCH), which has been extensively used to model financial time series and has proven to be very successful in predicting conditional variances. The most common formulation of GARCH asserts that the best predictor of the variance in the next period is a weighted average of the long-run average variance, the variance predicted for this period and the most recent squared residuals capturing any new information, with declining weights assigned to past squared residuals.

The effect of Ramadan on weekly returns and volatility for the overall market and the six sectors are examined using the GARCH specification. The following return Eq. (1) is used to estimate the Ramadan effect, modeled as a dummy variable (D_{Ramadan}). The lagged values of the return variable and the lagged error values capture the auto regressive (AR) and moving averages (MA) effects respectively. The AR and MA terms of order k are included in the equation to eliminate autocorrelated residuals. Ljung-Box test statistics is used to evaluate the order of ARMA components.

$$r_t = \mu_0 + \alpha_t D_{\text{Ramadan}} + \sum_{i=1}^{k} \phi_i r_{t-i} + \sum_{j=1}^{k} \theta_j \varepsilon_{t-j} + \varepsilon_t \tag{1}$$

where $(D_{\text{Ramadan}}) = 1$ for weekly returns during the month of Ramadan, and 0 for other months.

The time-varying volatility is modeled as a GARCH (p, q) process to estimate the parameters of the variance equation (2). The orders of p and q in conditional variance are a linear function of past squared error and lagged variance. Equations (1) and (2) are estimated jointly using the Full Information Maximum Likelihood procedure to determine the effect of Ramadan on return and volatility.

$$h_t = \nu_0 + \beta_t D_{\text{Ramadan}} + \sum_{i=1}^{p} \gamma_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \delta_j h_{t-j} \tag{2}$$

where $\nu_0, \gamma_i, \delta_j$ each is a non-negative parameter to be estimated, while $p > 0$ and $q \geq 0$ define the order of the process and β_t in the equation captures the Ramadan effect on returns volatility. The non-negativity of the estimated parameters is required to obtain positive conditional variances. In addition, the restriction $\sum \gamma_i + \sum \delta_j < 1$ must be satisfied to ensure that the conditional variance is non-explosive and stationary. If the summation equals 1 or is near unity $(\sum \gamma_i + \sum \delta_j = 1)$ then the shocks to the current volatility are permanent (i.e., the volatility variable is non-stationary) and the time series exhibit presence of strong persistence. However, if the summation is less than unity, shocks to volatility are temporary and the volatility variable is stationary.

To explore the effect of Ramadan on trading activity, the available weekly transaction data over November 1989 through April 2000 are examined. The following OLS regression equation with Ramadan dummy variable is used to estimate the impact of Ramadan on trading activity.

$$\text{Transactions}\,(T)_t = b_0 + b_1 (D_{\text{Ramadan}})_t + \varepsilon_t \tag{3}$$

where T is the number of weekly transactions (D_{Ramadan}) = 1 for transactions during the month of Ramadan, and 0 for other months, the intercept of the regression equation b_0 is the average weekly transactions during non-Ramadan months and b_1 reflects the marginal effect of Ramadan on trading activity.

5. Empirical results

Table 3 reports the estimation results of the GARCH (1, 1) model for the return (1) and volatility (2) equations separately for the overall Saudi stock market index and the six sectors. The first two columns report the return equation results with the Ramadan dummy variable. None of the dummy coefficients are statistically significant, implying that the Saudi stock market weekly returns are not significantly different during the month of Ramadan from the other months.

The last four columns of Table 3 report the estimation results of the conditional variance (h_t) equation. Unlike the impact of Ramadan on weekly returns, the effect on conditional volatility is significant and pronounced. The results indicate significant reduction in volatility of weekly returns during the month of Ramadan for the overall market and the constituent sectors, except electricity and agriculture. The reduction in volatility for the overall market is significant at the 5% level. The volatility effects are significant at the 1% level for all the market sectors expect agriculture, which represents only about 1% of the total market capitalization. The overall results of our study are consistent with those reported by Husain (1998) for the Pakistani stock market leading to the conclusion that the observed phenomenon is not limited to any one market.

The drop in return volatility during the month of Ramadan may be due to reduced trading activity or change in investor behavior stemming from a variety of factors. Some of the factors contributing to the change in investor behavior during the month of Ramadan are: reduced banking hours, Islam's prohibition against speculation and use of interest which would affect margin trading, greater religious orientation of the market participants leading to lower interest in trading, among others. The impact is most noticeable in the banking sector which according to the strict interpretation of Islamic injunctions deal in religiously prohibited interest-based products. The increase in volatility of the electricity sector may be due to the consolidation of the utility companies followed by an IPO that coincided with the month of Ramadan.

The conditional volatility coefficients for the overall market as well as the sectors satisfy the non-negativity condition. Furthermore, the sums of coefficients are all less than unity. The results suggest that the GARCH (1, 1) process is stationary and the impact of volatility reduction during Ramadan is transient. The results are entirely consistent with the expectation, given the nature of the shock.

Table 4 reports the regression results of transaction data for the overall market and by sectors. The results show reduction in trading activity during the month of Ramadan for the overall market and all the sectors except electricity. The effect is most acute on the banking sector of the market. The impact is statistically significant at the 5% level for both the banking and agriculture sectors, and moderately significant (10% level) for the overall market. The results of the transaction data analysis further corroborate the finding

Table 3
Estimated returns and conditional variance—GARCH (1, 1) model with Ramadan month dummy variable

Description	Return (r_t)		Conditional variance (h_t)			
	Constant (c)	Ramadan (dummy)	Constant (c)	Ramadan (dummy)	$\gamma(\varepsilon_{t-1}^2)$	$\delta(h_{t-1})$
Overall market index	0.056 (0.122)	0.154 (0.249)	1.058*** (0.128)	−0.289** (0.145)	0.394*** (0.061)	0.303*** (0.065)
Sector indices						
Banking	0.144 (0.222)	−0.335 (0.314)	2.155*** (0.378)	−0.833*** (0.304)	0.252*** (0.050)	0.403*** (0.090)
Industrials	0.266 (0.180)	−0.166 (0.269)	6.871*** (0.824)	−4.912*** (0.574)	0.232*** (0.047)	0.076*** (0.104)
Services	−0.075 (0.128)	−0.097 (0.222)	2.078*** (0.280)	−0.989*** (0.324)	0.306*** (0.045)	0.316*** (0.070)
Cement	−0.073 (0.121)	0.481 (0.284)	1.830*** (0.401)	−0.802*** (0.309)	0.204*** (0.045)	0.425*** (0.107)
Electricity	−0.067 (0.060)	0.220 (0.643)	0.650*** (0.085)	5.891*** (0.621)	0.343** (0.054)	0.530*** (0.040)
Agriculture	−0.054 (0.061)	−0.183 (0.247)	0.339*** (0.069)	0.255 (0.220)	0.287*** (0.042)	0.680*** (0.037)

The return equation is: $r_t = \mu_0 + \alpha_t D_{\text{Ramadan}} + \sum_{i=1}^{k} \phi_i r_{t-i} + \sum_{j=1}^{k} \theta_j \varepsilon_{t-j} + \varepsilon_t$. The variance equation is: $h_t = \nu_0 + \beta_t D_{\text{Ramadan}} + \sum_{i=1}^{p} \gamma_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \delta_j h_{t-j}$. Standard errors of the parameter estimates are given in parentheses.

** Significant at 5% level.

*** Significant at 1% level.

Table 4
Analysis of transactions data with Ramadan month dummy variable (November 1989–April 2000)

OLS estimates	Overall market	Sector indices					
		Banking	Industries	Service	Cement	Electricity	Agriculture
Constant (c)	6018 (162)	1924 (61)	1646 (52)	1509 (53)	508 (23)	128 (16)	304 (10)
Ramadan (dummy)	−1019* (608)	−458** (230)	−246 (194)	−256 (199)	−91 (88)	113 (60)	−81** (36)

Transactions $(T)_t = b_0 + b_1(D_{\text{Ramadan}})_t + \varepsilon_t$. Standard errors of the estimates are given in parentheses.
* Indicate significance at 10% levels.
** Indicate significance at 5% levels.

of volatility reduction during the month of Ramadan. The electricity sector exhibits increase in trading activities during the month of Ramadan due to the recent consolidation of the electric utility companies in Saudi Arabia. The evidence of heightened activity in this sector supports the finding of increased volatility.

6. Conclusions

Much has been documented about various calendar anomalies in stock market returns. In this paper, we present an equally curious phenomenon—a price of risk anomaly. Specifically, we examine return data during the Muslim month of Ramadan for the Saudi Equity Market (the largest equity market in the Middle East and the Islamic world). Using a GARCH specification we show that, whereas average rates of return are unaffected during the month of Ramadan, there is a significant decline in volatility, implying predictable changes in the price of risk. This pattern is observed for the overall market as well as for the major constituent sectors of the economy.

As much of the time during the month of Ramadan is devoted to socio-religious activities, one would expect a slow down in market activity. An examination of transactions data shows that the number of transactions declines during the holy month. The observed decline in volatility therefore appears consistent with this decreased market activity.

These findings have important implications for market participants and regulators in the many Islamic markets in the Middle East, the Far East and elsewhere. The volatility effects of moving events that is demonstrated in this paper, can be critically important to applications that use forecast variance as an input such as options and option-like products. While stock options do not trade on the Saudi stock market, a wide variety of OTC options are available through commercial banks. An example is a bull CD which promises to pay a threshold interest rate plus a payoff proportional to the market index, contingent on the index crossing a minimum level. Fund managers for instance may want to alter their asset allocation strategies to respond to this systematic shift in volatility to generate better risk adjusted performance.

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