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Islamic calendar anomalies: evidence from ubiquitous Tunisian stock market

Anomalies du calendrier islamique : preuves tirées du marché boursier tunisien omniprésent

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Abstarct:

Some financial places worldwide are located in countries with dual cultures, Western and traditional. The ubiquitous participants in these financial markets are influenced by this dual affiliation, which can affect market reactions and efficiency. We analyse the weak form of informational efficiency in the Tunisian financial market, a place known for its cultural diversity. We study the behaviour of daily returns of the Tunis Stock Exchange index (Tunindex) over the period 1998–2019 by examining the effects of the Gregorian and lunar calendars. Next, we study the effects of the Islamic and civil calendars. Finally, we examine the interaction effects between the two types of calendars, which constitutes the originality of this paper.

First, the weekday effect, the month effect, and the pre-holiday effect were analysed according to the Gregorian calendar. Then, the effects of the full and new moon phases and the Islamic months were tested using the lunar calendar. Finally, the effects of the interaction between the January effect and the Islamic months, as well as the effects related to all holidays regardless of their origin (religious or otherwise), were studied. Using both parametric and non-parametric tests, we find evidence of the weekend effect, the January effect, and the pre-holiday effect in the daily returns of Tunindex. Lunar calendar anomalies are detected, including an effect of the full moon (FM) on the returns of Tunindex and a significant positive and high effect of the Hijri month Rabi' al-Thani, followed by the months of Sha'ban and Ramadan. The estimation results also show that the pre-holiday effects of Eid al-Fitr and Eid al-Adha are not significant.

The results of the combined effects reveal the persistence of the Thursday and Friday effect during the new moon phase. Similarly, the overlap of January with the months of Rabi' al-Thani, Ramadan, Sha'ban, and Shawwal eliminated the January effect on the returns of Tunindex, suggesting that the market has become more efficient.

Keywords:

EMH, calendar anomalies, Islamic calendar; weekend effect, January effect, pre-holiday effect, full moon effect, new moon effect, religious holiday effect, Hijri month effect.

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Introduction

Many empirical studies have questioned the Efficient Market Hypothesis (EMH) and the principle of investor rationality (Fama 1969). It has become evident that the dominance of the rational investor and the exclusivity of the classic financial paradigm will have to give way to behavioural factors, especially after the contributions of Kahneman, Riepe (1998), Loewenstein (2000), Daniel, Hirshleifer, Teoh (2002). These non-financial factors influence the decisions of participants in financial markets thus producing irregularities in price movements. Among these factors we find anomalies or calendar irregularities, which are situations in which securities, or the entire stock market, behave differently on a specific date or day or at a specific time. Indeed, several market price anomalies have been observed, such as the January effect (Thaler, 1987), the day-of-the-week effect (Gibbons, Hess, 1981), and the end-of-the-month effect (Lakinoshok, Smidt, 1988). These situations are not explained by the financial theory according to which an investor cannot beat the market and obtain the highest and above-average returns of the market since the prices of securities reflect all available information.

Along the same lines, studies that have examined the effects of lunar calendar anomalies on the financial market have multiplied, including the empirical work of Dichev, Janes (2003) and Yuan, Zheng and Zhu (2006), the work of Herbst (2007), those of Sivakumar and Satyanarayan (2009) and those of Gao (2009).

About the Tunisian financial market, Dhaoui (2011), Bouteska and Boutheina (2017), Chaouachi and Douagi (2014) and Alagidede (2008 and 2013) are cited. As for the effects of the lunar cycle on the stock market returns of the BVMT, we cite the works of Chaouachi (2021), Hammami and Abaoub (2010), Sonjaya & al. (2016), Rehomme and Rejeb (2008).

Indeed, the Tunisian financial market is ubiquitous because it simultaneously adopts the Gregorian calendar for everything concerning civil affairs and the Islamic liturgical calendar organized from the twelve lunations of the lunar year for all religious holidays. In Tunisia, it's noted that we speak about RAMADAN 2024 instead of RAMADAN 1445. This dual use leads us to question the effect of calendar anomalies relating to both the lunar and Gregorian calendars on price movements in the Tunisian financial market.

Thus, the calendar anomalies relating to the Gregorian calendar and those relating to the lunar calendar will forge the theoretical framework of this work. This paper is dedicated to studying the influence of the Western calendar and the effects of the lunar calendar on price movements in the Tunisian financial market. A literature review of the effects studied will be summarized in section 2, then the sample and methodology pursued under sections 3 and 4, move on to the empirical results in section 5, and conclude in the last section.

1. Literature review:

1.1. Anomalies of the Gregorian calendar

Anomalies in financial literacy refer to situations in which stocks or the stock market as a whole behave in ways that cannot be explained by any financial theory (Jebran and Khan

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2014). Profitability anomalies in the equity market are numerous, which contradicts what the efficient market hypothesis, in its semi-strong form, would suggest.

Indeed, a plethora of studies have investigated the presence of anomalies in various developed and emerging stock markets. The most commonly documented calendar effect in the literature is the day-of-the-week effect, where returns vary for different days. For example, studies by French (1980); Jaffe, Westerfield (1985); Gibbons and Hess (1981); Lakonishok and Maberly (1990); Ritter (1988); Lyroudi et al. (2004); Damodaran (1989); Aly et al. (2004); Alagidede (2008); Chukwuogor (2008); Darrat et al. (2013); Seif et al. (2017); and Chaouachi and Douagi (2014) concluded that average stock returns are significantly negative on Mondays and abnormally high on Fridays.

The month-of-the-year effect occurs when stock returns for one specific month are significantly higher than for other months. This anomaly was first identified by Rozeff and Kinney (1976), who studied monthly seasonality patterns on the New York Stock Exchange. Research continued on developed markets, including the works of Lakonishok and Smidt (1988) and Ligon (1997). In the African context, several authors have examined the month effect: Ayadi et al. (1998), Alagidede (2013), Olowe (2009), and Seif et al. (2017). Regarding the Tunisian market, Chaouachi and Douagi (2014) and Bouteska and Boutheina (2017) found positive excess returns during January, August, and September.

In addition to the January and weekday effects, many other calendar effects have been documented in different stock markets, such as the pre-holiday effect, which predicts that returns should be higher on trading days before holidays compared to other days of the year. Several studies, including those by Lakonishok and Smidt (1988), Ariel (1990), and Kim and Park (1994), have confirmed the existence of this effect across various financial markets.

1.2. Lunar calendar anomalies

Since time measurement is essentially astronomical, calendars are based on the moon and the sun. In addition to the Gregorian calendar, other calendars are based on religious beliefs. For example, the Jewish community follows the Hebrew calendar, which is lunisolar; Christianity follows the Gregorian calendar, which is solar-based; Hindu and Chinese cultures follow their calendars; and the Muslim community follows the Islamic calendar, a lunar calendar known as the Hijri calendar. Thus, the division of the calendar into months in many cultures and religions is derived from the lunar cycle.

1.2.1. The Effect of the Lunar Cycle: Full Moon and New Moon

Several studies have highlighted the effect of the lunar cycle, which predicts that returns in financial markets are higher on days preceding and following a new moon and lower on days preceding and following a full moon. The lunar effect was confirmed in the works of Dichev and Janes (2001) and Kathy Yuan et al. (2001). The latter examined the relationship between lunar phases and stock market returns in 48 countries, finding that stock market returns are lower on full moon (FM) days than on new moon (NM) days. Moreover, the lunar effect is independent of other anomalies associated with the Gregorian calendar.

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Yousopa et al. (2014) studied the relationship between the lunar effect and average stock returns in ten emerging countries from January 2004 to December 2010. Their findings show that returns during full moon days were slightly lower than those during new moon days. Similar conclusions were presented by Borowski (2016) regarding returns on Warsaw Stock Exchange indices. On the same market, Lizińska (2017) examined the lunar effect on the Warsaw Stock Exchange portfolio, with additional analysis for the size effect, calendar month effect, and half-month effect. Her main results also confirmed that average returns around full moon dates were significantly lower than returns around new moon dates, even when considering size-based indices.

However, other research supports the idea that markets are generally rational and not influenced by moon phases. For instance, Brahmana et al. (2014) examined the influence of the moon on returns in seven stock markets—Indonesia, Malaysia, the United Kingdom, the United States, the Philippines, Japan, and Thailand—from January 1999 to December 2009. Their research rejects the hypothesis that lunar phases significantly influence market returns.

Additionally, empirical studies on the effect of the full moon and new moon on the Tunisian market are rare. One example is the work of Hammami and Abaoub (2010), who studied the relationship between lunar phases and stock returns using four window specifications ranging from 15 days to 1 day around full moon and new moon dates. The results showed no statistically significant evidence of a full moon or new moon effect on the stock indices examined.

1.2.2. The Hijri month effect

Oğuzsoy and Güven (2004) conducted research on the Istanbul Stock Exchange from 1988 to 1999 and found that returns were significantly higher during the month of Ramadan, concluding the existence of a Ramadan effect on the Turkish stock market. Similar findings were reported by Al-Hajieh, Redhead, and Rodgers (2011). Bialkowski et al. (2011) also studied stock returns for 14 predominantly Muslim countries over the years 1989-2007, finding that returns were nearly nine times higher and less volatile during Ramadan compared to the rest of the year.
In the Pakistani market, Mustafa (2006), Khan et al. (2017), and Hussain (1999) confirmed a Ramadan effect. Hussain noted a positive average return and low volatility during Ramadan in the Karachi stock market.
This phenomenon is observed not only in the Pakistani financial market but also in the Saudi stock market. Seyyed et al. (2005) reported a decrease in volatility and trading activity, including volume and returns, in the Saudi stock market during Ramadan. In Jordan, AlRjoub (2010) found strong evidence of a Ramadan effect during the study period.
Similarly, Shah et al. (2017) explored the effect of Islamic months, particularly Ramadan and Dhu al-Hijjah, on the returns and volatility of global Islamic stock indices. The empirical results revealed a significant negative impact of Dhu al-Hijjah on returns and volatility of these indices, but no significant impact of Ramadan was found.

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The same empirical results were found in the study by Alrashidi et al. (2014), which reported no evidence supporting the effect of Ramadan on the performance of Islamic equity funds, although they did observe a significant decrease in stock return volatility during Ramadan.
Several studies have also confirmed the absence of Hijri month effects on financial market returns. For instance, Öztürk et al. (2018) examined the BIST100 and KAT30 indices and found no evidence of weekday effects, the January effect, or a Ramadan effect. This finding reinforces the hypothesis that the Turkish market is more efficient in this regard, consistent with the Efficient Market Hypothesis.
Regarding the Ramadan effect on the Tunisian market, Rehomme and Rejeb (2008) showed that Ramadan impacts the economy more than other months. Additionally, Sonjaya et al. (2016) found a positive Ramadan effect on market returns. Chaouachi (2021) also reported that the impact of Ramadan on daily returns is positive and statistically significant at the 1% level.

1.2.3. The effect of religious and cultural fests and holy days

Evidence that returns are economically and statistically higher on days preceding secular and religious holidays was first discovered by Fields (1934). Similarly, Chan et al. (1996) considered the holiday effect in a cultural context for the stock markets of Malaysia, Singapore, India, and Thailand. They found a stronger holiday effect around cultural holidays compared to non-cultural holidays.
In the same perspective, Yen et al. (2001) examined the existence or non-existence of the Chinese Lunar New Year effect in Hong Kong, Japan, South Korea, Malaysia, Singapore, and Taiwan from 1991 to 2000. The authors found that cumulative returns based on stock indices of these Asian markets showed a consistent upward trend before or after the Chinese Lunar New Year, demonstrating the continued presence of the Chinese Lunar New Year effect in these six Asian stock markets.
Ali et al. (2017) examined the impact of Muslim holy days on daily stock returns in Asian financial markets over the period from 2001 to 2014. These markets include Pakistan, Bahrain, Saudi Arabia, and Turkey. The study attempted to isolate the effect of Gregorian calendar anomalies from Muslim holy day anomalies, and thus the lunar calendar, to ensure that the observed effect was due to Muslim holy days rather than Gregorian calendar anomalies. The results of the study revealed that Eid-ul-Fitr is the only holy day with a significant positive effect on stock returns in Asian markets, while all other holy days have no effect. Meanwhile, Friday is the only Gregorian calendar anomaly found in Asian markets according to Ali et al. (2017).

Similarly, Al-Ississ (2015) studied the effect of Muslim holy days on daily returns of ten Muslim financial markets from January 1995 to August 2012. The study revealed a statistically significant increase in returns during the last five odd days of the month of Ramadan. Al-Ississ also examined the effect of Ashura, which holds different significance for

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Shia Muslims compared to Ramadan, finding a statistically significant 12.13% decrease in returns for every 1% increase in the proportion of Shias in the population during Ashura.
The study by Majeed et al. (2015) examined anomalies due to five Islamic calendar events—Ramadan, Eid-ul-Fitr, Eid-ul-Adha, Ashura, and Eid Mawlid Nabi—in the Pakistani stock market, using the main stock index, the Karachi Stock Exchange 100-Index (KSE-100 Index), for the period from 2001 to 2012. The study found that Islamic events had a significant impact on stock returns during the studied period, except for the Eid-ul-Adha event. Significant abnormal returns were also noted in the pre-event windows for Ramadan, Ashura, Rabi Awal, and Eid-ul-Fitr. The results further indicated that Muharram and Ramadan had a significant positive effect on the returns of the KSE-100 Index.
In Indonesia, which has a specific calendar system called the Javanese lunar calendar, Robiyanto and Puryandani (2015) examined the impact of the holy days "Kamis Wage" (Thursday Wage) and "Jum'at Kliwon" (Friday Kliwon) on Indonesian stock returns. They found that the Javanese lunar calendar had no impact on Indonesian stock returns but affected the level of investor risk aversion, suggesting that Indonesian investor behavior is influenced by superstition.
Regarding studies on the Bangladeshi stock market, the paper of Hassan et al. (2018) is notable. They examined the returns of two market indices, the DSE General Index (DSEX) and the DSE 30 Index (DS30), from January 2013 to December 2017. Six fixed and two variable national (religious) holidays of Bangladesh were considered: Shaheed (Martyr) Day (February 21), Father of the Nation's Birthday (March 17), Independence Day (March 26), Bengali New Year (April 14), National Mourning Day (August 15), Victory Day (December 16), and the two variable holidays Eid-ul-Adha and Eid-ul-Fitr. The results showed significant differences between pre- and post-holiday returns over the sample period, indicating that DSE returns do not follow a random walk.
Along similar lines, Frieder and Subrahmanyam (2004) examined trading volumes on the S&P 500 Index and the New York Stock Exchange (NYSE) during the Jewish holy days of Rosh Hashanah and Yom Kippur and the Christian holy day of St. Patrick's Day. Their study showed a decrease in trading volume on Rosh Hashanah and Yom Kippur and an increase in prices on the two days preceding Rosh Hashanah and St. Patrick's Day.

1.3. The effect of overlapping calendars

Sathyanarayanan and Sivakumar (2008) examined the full moon (FM) and new moon (NM) effects on Sensex index returns and the combined effect of the day of the week and lunar cycle. They highlighted that returns around FM are lower than those around NM. Similarly, they found that in particular, Thursdays and Fridays have the highest and most significant returns compared to other days of the week, while Tuesdays have the lowest returns.
Similarly, Der-Yuan Yang and Chen-Hsun Lee (2016), using both the solar and lunar calendars, studied the impact of the solar and lunar New Year on the Taiwan stock market. They showed that the lunar effect prevails over the solar effect, though the magnitude of both decreases over the years. Sasikirono et al. (2017) studied the effect of holidays—particularly

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Eid-ul-Fitr, Eid-ul-Adha, Christmas, Easter, and the Chinese Lunar New Year—on the Indonesian stock market. The selection of holidays was made by considering the number of adherents of the three dominant religions in Indonesia. The results showed that average market returns after holidays are four times higher than average returns on other trading days. Additionally, there is a post-holiday effect with various influences: Christmas, Easter, and Eid-ul-Adha have a positive influence, Eid-ul-Fitr has negative effects, while the Chinese Lunar New Year has no effect.
Although the holiday effect is observed in the Indonesian stock market, this anomaly does not fully explain the trend of higher market returns after the holiday.

2. Sample and Data:

Without entering into the controversies linked to Islamic or conventional indexes (see e.g. Touiti & Henchiri 2016), our sample is composed of the daily returns of the TUNINDEX stock index over the period from 01/01/1998 to 31/12/2019, i.e. 22 years. We stopped the study period on this date so as not to suffer data alterations following the covid 19 health crisis.
Our data include the daily closing prices of the Tunisia stock index (Tunindex) of the Tunisian Stock Exchange (BVMT) over the study period (5444 observations). All data was obtained from the BVMT web page (www.bvmt.com.tn).
The daily returns of the TUNINDEX index are calculated based on the following formula:

$$R_t = Ln \frac{I_t}{I_{t-1}} \times 100 \qquad (1)$$

With:
R_t: Index return on date t
I_t: Index price on date t

The following table 1 summarizes the descriptive statistics of the Tunindex return series:

Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
0.036139	0.753835	-0.429631	579.5778	75395230

Table 1: Tunindex descriptive statistics for the period 1998-2019

From Table 1, we find a mean of Tunindex returns of 0.036139 (3.6%) and an empirical standard deviation of 0.753835 over the entire study period. The series is approximately symmetric (left- skewed) and leptokurtic and exhibits excess kurtosis, implying wider tails than a normal distribution.

To test the existence of calendar effects, the following regression model will be used (French 80 model)

$$R_t = \alpha_1 D_t + e_t \qquad (2)$$

Where**:** **Rt** is the return of a stock index,
D_t: is the calendar effect indicator and
ε_t :is the error term.

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3. Methodology

3.1. Gregorian anomalies model:

3.1.1. The weekday effect:

To study the weekday effect, the ordinary least squares (OLS) method is used using the following equation:

$$R_t = \alpha_1 dmon + \alpha_2 dtue + \alpha_3 dwed + \alpha_4 dthu + \alpha_5 dfri + e_t \quad (3)$$

The null hypothesis tested is:

$$H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_3 = \alpha_4 = \alpha_5$$

R_t: Index day return on date t,

dmon, dtue, dwed, dthu and dfri: Dummy variables representing the days of the week: = 1 if the day of the week of day t is Monday to Friday, and 0 otherwise;

The coefficients (α1 - α5) of each of the indicator variables are the estimate of the average returns from Monday to Friday respectively,

e_t: is an error term

Against the alternative that not all αs are equal. If the average of returns is the same for each day, the estimates of α1 through α5 should be equal, and the nonparametric Kruskal-Wallis statistic and the parametric F-statistic should not be significant. The Kruskal-Wallis test, approximated in this case by the chi-square distribution, assumes the null hypothesis that the distribution of stock returns for all months of the year is equal. This hypothesis will be rejected if the calculated value of the test statistic, H, is greater than the critical value at a chosen significance level (Daniel, 1990).

3.1.2. Month effect

To study the returns by month of the year we use the following regression equation:

$$R_t = \alpha_1 djan + \alpha_2 dfeb + \alpha_3 dmar + \cdots .. \alpha_{12} ddec + e_t \quad (4)$$

R_t = index day return at date t,

djan, dfeb, dmar….and ddec: 1 if the month of year t is from January to December,and 0 otherwise;

The coefficients (α(1)…α(12)) of each of the indicator variables are the estimate of the average returns from January to December respectively,

e_t**:** An error term.

3.1.4. Pre-holiday effect

To highlight the pre-holiday effect for public holidays following civil and national holidays on TUNINDEX returns, we use the following regression equation:

$$R_t = \alpha_1 dhol + \alpha_2 dout\ hol + e_t \quad (5)$$

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R_t = daily return of the index on date t
dhol: 1 if the day is before a Gregorian calendar holiday, and 0 otherwise;
dout hol: 1 if the day is not the day before a holiday, and 0 otherwise;
The coefficient (α_1, α_2) of the indicator variables represents the estimation of the average returns, and,
$\mathbf{e_t}$ is an error term.

The included public holidays are:

- New Year: January 1: one day only,
- Revolution and Youth Day: January 14: one day only,
- Independence Day: March 20: one day only,
- Commemoration of Martyrs: April 9: one day only,
- Labor Day: May 1: one day only,
- Republic Day: July 25: one day only,
- Women's Day: August 13: one day only,
- Evacuation Day: October 15: one day only.

3.2. lunar anomalies models

3.2.1. The full Moon (FM) and new Moon (NM) effect

To study the effect of lunar phases, we estimate the coefficients of the FM and NM indicator variables using the ordinary least squares (OLS) method in the following equations:

$$\boldsymbol{R_t = \alpha_1 dFM + \alpha_2 dNM + \alpha_3 dout\ FMNM + e_t} \qquad \textbf{(6)}$$

R_t = daily return of the index on date t
dFM and dNM,: 1 if it is a day of the ¨FM or NM window respectively, and 0 otherwise;
The coefficients (α_1) and (α_2): Of each of the indicator, variables are the estimate of the average returns of the windows respectively,
$\mathbf{e_t}$**:** is an error term.

3.2.2. The Hijri month effect

$$\boldsymbol{R_t = \alpha_1 dmouharrem + \alpha_2 dsafar + \alpha_3 drabia\ al\ awel + \cdots dDhou\ al-hijja + e_t} \qquad \textbf{(7)}$$

R_t = daily return of the index on date t
dmouharrem,dsafar,drabia al awel,…dDhou al-hijja : 1 if the month of the year is the month designated by the indicator variable, and 0 otherwise;

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The coefficients ($\alpha_1 - \alpha_{12}$): of each indicator variable represent the estimated average returns from Muharram to Dhu al-Hijjah, respectively,
e_t: is an error term.

3.2.3. The effect of religious holidays: Eid al-Fitr, Eid al-Adha

To examine the effect of Eid al-Fitr and Eid al-Adha festivals, the ordinary least squares (OLS) method is used using the following equation:

$$R_t = \alpha_1 daid_1 + \alpha_2 daid_2 + \alpha_3 dhors\ aid + e_t \quad (7)$$

R_t = daily return of the index on date t
daid1, daid2: 1 if it is a day before the feast of Eid-el-Fitr or Eid-el-Adha respectively, and 0 otherwise;
The coefficients α_1 and α_2: of each of the indicator variables are the estimate of the average returns of 'a day before the feast of Eid-el-Fitr or Eid-el-Adha
e_t: is an error term.
Our study, which is classic, will now be enhanced by the addition of an approach combining the above effects with the overlap of two calendars.

3.3. combined anomalies models

3.3.1. The weekday and full moon effect

First, we test the effects of the weekdays corresponding to the FM phase on the daily returns of the TUNINDEX, we used the following linear regression considering only the weekdays of FM.

$$R_t = \alpha_1 dmonday * dummyFM + \cdots + \alpha_5 dfriday * dummyFM + \alpha_6 dummy\ days\ out\ FM + e_t \quad (9)$$

R_t = daily return of the index on date t
dmonday*dummyFM….dfriday*dummyFM: indicator variables corresponding to the weekdays j and coinciding at the same time with a day of the FM phase which will have a value of 1 if the day of the week of day t is a FM day, and 0 otherwise;
The coefficients (α_1 - α_5) of each of the indicator variables are the estimate of the average returns from FM Mondays to FM Fridays respectively**,**
e_t is an error term.

3.3.2. The weekday and new moon effect

To test the effects of the weekdays corresponding to the NM phase on the daily returns of the TUNINDEX, the following linear regression was used:

$$R_t = \alpha_1 dmonday * dummyNM + \cdots + \alpha_5 dfriday * dummyNM + \alpha_6 dummy\ jours\ out\ NM + e_t \quad (10)$$

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R_t = daily return of the index on date t
dmonday*dummyNM….dfriday*dummyNM: indicator variables corresponding to the weekdays j and coinciding at the same time with a day of the NM phase which will have a value of 1 if the weekday of day t is a day of NM ,and 0 otherwise;
The coefficients (α_1 - α_5) of each of the indicator variables are the estimate of the average returns from Mondays NM to Fridays NM respectively,
e_t: is an error term.

3.3.3. The January/Rabia al Thani and Ramadan effect

To study the combined effect of the months and to compare their respective effects, we proceed to the regression of the daily returns with the dummy variables where each time the days of January overlap Rabii Athani and Ramadan, and this using the following equation:

$$\boldsymbol{R_t = \alpha_1\, djan * drabia\,2 + \alpha_2\, djan * dramadan + \alpha_3\, dummy\, Jan\, off - combination + e_t} \qquad \textbf{(11)}$$

R_t = daily return of the index on date t
djan*dummyrabi2, djan*dummyramadan: the dummy variables corresponding to the overlap of the two months which will have a value of 1 if the overlap exists, and 0 otherwise;
The coefficients (α_1, α_2, α_3) of the indicator variables are the estimate of the average yield
e_t: is an error term.

3.3.4. The pre-religious and civil holiday effect

In the Tunisian case, the public holiday calendar consists of national, civil and religious holidays. In the previous section, the empirical study focused on the pre-holiday effects of fixed national and civil holidays, and the pre-holiday effects of (variable) religious holidays. At this level, we propose to study the effects relating to all public holidays regardless of their origin (religious or other) and to compare their respective impacts.
To study the effects relating to all holidays without distinction of their origin (religious or other) and to compare their respective impacts, the following equation is used:

$$\boldsymbol{R_t = \alpha_1\, daid1 + \alpha_2\, daid2 + \alpha_3\, dout\, hol + \alpha_4\, dhol_g + e_t} \qquad \textbf{(12)}$$

R_t= daily index return at date t
***daid1, daid2*:** 1 if it is a day before the feast of Eid-el-fitr or Eid-el-Adha respectively, and 0 otherwise;
***$dhol_g$:* 1** if it is a day before a holiday according to the Gregorian calendar and 0 otherwise;
dout hol Indicator variable for non-holiday days.

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The coefficients (α_1, α_2, α_3, α_3) of each of the indicator variables are the estimated average yields for a day before the Eid-el-fitr or Eid-el-adha holiday, non-holiday days and a holiday according to the Gregorian calendar
e_t: is an error term.

4. Empirical results:

4.1. Empirical results and interpretation of Gregorian calendar anomalies study:

We present the results of our models in table 2 below:

Effects		Mean	proba	Proba F-stat	K.W stat
Weekday effect (1)	Monday	0.021979	0.3367	0.0001***	21.86823***
	Tuesday	-0.005408	0.8036		
	wednesday	-0.000866	0.9697		
	thursday	0.080275	0.0005***		
	friday	0.083600	0.0003***		
Month effect (2)	january	0.093540	0.0092***	0.0088***	47.20818***
	february	0.038468	0.2876		
	march	0.057323	0.1070		
	april	0.088212	0.0135**		
	may	0.043195	0.2145		
	june	0.018534	0.5983		
	july	0.049103	0.1628		
	august	0.078236	0.0258**		
	September	-0.008122	0.8196		
	October	-0.030866	0.3751		
	November	-0.011038	0.7568		
	Décember	0.020938	0.5499		
Pre-holiday effect of the Gregorian calendar(3)	*Holydays*	0.126208	0.0460**	0.0007***	20.09405***
	Hors_out holidays	0.033720	0.0011***		

Table 2: Empirical results of the Gregorian models

The results of the regressions about effects are displayed in Table 2. Indeed, the table reveals that the daily average returns are different, demonstrating the existence of calendar anomalies, precisely an effect on Friday and Thursday. However, the daily average returns on Tuesday and Wednesday are negative. The presence of anomalies on the Tunisian market proves its inefficiency. These results are in accordance with those of Chaouachi and Douagi (2014) and Bouteska and Regaieg (2017) but in contrast with those of Bampinas & al. (2012).

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From the results of the estimation of equation 4 (Table 2) of the month effect, we note that the coefficients of the dummy variables for the months of January, April and August are statistically significant. We also note that the parametric Fisher statistic is significant in the sense that all the variables are globally significant. Similarly, for the non-parametric statistic, the null hypothesis is rejected, so H1 is true: this means that the monthly returns during the period are not equal, thereby proving the existence of a month effect, which contradicts the efficient market hypothesis (EMH). In summary, the effect of the month of the year is persistent for the TUNINDEX returns over the period from January 1998 to December 2019.

From Table 2, the pre-holiday effect is significant according to the parametric test, and also according to the Kruskal-Wallis test. Thus, the null hypothesis of the Kruskal-Wallis test is rejected, so H1 is true: this means that there is a pre-holiday effect on stock returns.

These results are consistent with the work of Lobão (2018) who suggested the prevalence of a pre-holiday effect in Tunisia.

4.2. Empirical results and interpretation of the study of lunar calendar anomalies:

The results on Table 3 about returns around the full moon (on a week centered on the day of PL), significant at the 5% threshold, are one and a half times more than those outside the FM and NM phases. We then conclude the persistence of the effect of FM on the returns of TUNINDEX.

The results of the regression summarized in Table 3, reveal that the coefficients of the months of the Islamic calendar: Rabia ath-thani, Chaabane, Ramadan and Shawwal are statistically significant. In addition, the parametric test is significant at the 1% threshold, suggesting that the coefficients of the model are globally significant. Similarly, the non-parametric test confirms the alternative hypothesis and therefore this means that there is an effect of the Islamic month in the stock market returns model precisely an effect of the month of Rabia ath-thani, Chaabane, Ramadan.

Effects		Mean	proba	Proba F-stat	K.W stat
FM / NM effect (4)	NM	0.022256	0.2959	0.0037***	9.652668***
	FM	0.051064	0.0152**		
	Out_FM_NM	0.035634	0.0108**		
Hijri month effect (5)	Mouharrem	0.002852	0.9354	0.0001***	44.79262***
	Safar	0.039748	0.2569		
	Rabii_al_awwel	-0.002347	0.9471		
	Rabii_ath_thani	0.125459	0.0003***		
	Joumada_al_oula	0.020354	0.5650		
	Joumada_al_akhira	0.009740	0.7847		
	Rajab	-0.025804	0.4671		

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	Shaaban	0.122434	0.0005***		
	Ramadan	0.090541	0.0095***		
	Chawwel	0.070921	0.0497**		
	Dhul_qa_dah	-0.026177	0.4485		
	Dhul_hijjah	0.003142	0.9312		
Pre-holiday effect Eids (6)	Aïd-el-fitr	0.219036	0.1635	0.0028***	31.97230***
	Aïd-el-adha	0.111613	0.4777		
	Out aïds	0.035032	0.0006***		

Table 3: Empirical results of the Hijri models

We note that the coefficients of the dummy variables of Eid-el-Fitr and Eid-el-Adha are statistically insignificant. While the Fisher test and the Kruskal-Wallis test reveal that the model is statistically significant at the 1% threshold for the first and that there is a pre-holiday effect of Eid on stock returns according to the second. So we conclude that effect of public holidays following civil and national holidays is significant, contrary to religious holidays in Tunisian financial market.

4.3. Anomalies of combined lunar and Gregorian calendars.

The results, displayed in table 4, show that the effects of FM weekdays are not statistically significant and that the model is not significant overall. Thus, the Friday and Thursday effects disappear when considering these days in the FM phase. On the other hand, the Thursday and Friday effects remain significant when considering the NM phase. The week always ends strongly during the beginning of the lunar months which is proof of the inefficiency of the Tunisian financial market. Nevertheless, the combination of the weekday effect with the effects of the full moon indicates the disappearance of any anomaly relating to this phase of the moon and the weekday and the market then regains its efficiency.

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Effects		Mean	proba	Proba F-stat	K.W stat
The new moon weekday effect (8)	Monday NM	-0.026097	0.5828	0.0000***	21.93032***
	Tuesday NM	-0.039966	0.4040		
	Wednesday NM	-0.099146	0.0362**		
	Thursday NM	0.158291	0.0009***		
	Friday NM	0.124314	0.0090***		
	Days out_NM	0.039278	0.0007		
The full moon weekday effect (9)	Monday FM	0.070959	0.1323	0.1024	6.639539***
	Tuesday FM	0.014669	0.7448		
	Wednesday FM	0.068591	0.1434		
	Thursday FM	0.059632	0.2059		
	Friday FM	0.072850	0.1230		
	Days_out FM	0.009043	0.1575		
The January effect/rabia al thani and ramadan (10)	*Janv_Rabii2*	0.119269	0.2365	0.0000***	11285.87***
	Jan_Ramadan	0.122682	0.3573		
	Janv_Off_Com	0.034753	0.0007		
The pre-religious/civil holiday effect (11)	*Aïd-el-fitr*	0.217889	0.1658	0.0003***	7087.856***
	Aïd-el-adha	0.108173	0.4920		
	Gregorian holiday	0.125172	0.0482**		
	Out Holiday	0.032932	0.0015***		

Table 4: Empirical results of combined anomalies

The results in table 4 show that the pre-holidays effect for all origins is significant at the 5% threshold, which proves first of all its existence on the Tunisian market since the average returns of the days preceding the holidays are almost 4 and a half times the returns of the other days and that without consideration of the origin of the holidays (cultural, civil and national or religious) the effect decreases compared to the effect of holidays following religious fests.
From the table 3, the January effect on daily returns disappeared when it coincides with the months of Ramadan, Rabii-Athani and Ramadan. The overlap of the Islamic months exerted its influence on the January anomaly by eliminating it. The anomaly relating to the month of January becomes absent if the latter coincides with the Hijri months mentioned above. Thus, if the market was considered inefficient following the January effect, it becomes efficient again when January overlaps with the lunar months mentioned above. It seems that investor

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reactions can have an opposite effect that annihilate these anomalies. We have to more deeply study this idea with studies on others ubiquitous markets.

5. Conclusion

This paper focused on the empirical study of calendar anomalies in the Tunisian financial market over the period from January 1998 to December 2019. Using descriptive statistics of TUNINDEX index returns, along with parametric and non-parametric tests, we first examined the effects of Gregorian calendar anomalies. We then studied the impact of full and new moon lunar phases and the Islamic lunar calendar. Finally, we analyzed the effects of interactions between weekend effects and lunar phases, as well as the overlap of January with the months of Ramadan and Rabi' al-Thani.

Regarding the Gregorian calendar, the main results of the empirical study confirm the presence of Thursday and Friday effects, the January effect, and the pre-holiday effect. Similarly, the lunar effect is confirmed for the full moon phase. However, the overlap of the two calendars caused the January effect and weekday effect during the full moon to disappear.

The presence of calendar anomalies in the Tunisian financial market indicates its inefficiency. This study may assist investors and financial market participants in adapting their strategies and employing active management techniques that incorporate the various effects studied in the context of timing arbitrage (market timing).

Future research will further explore anomalies within the framework of the Adaptive Markets Hypothesis (AMH), which could help explain the observed temporal variation in market efficiency by linking the behavior of calendar anomalies over time to specific market conditions.

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