Detecting Islamic Calendar Effects on U.S. Meat Consumption: Is the Muslim Population Larger than Widely Assumed?

Moayedi, Vafa

Sharif University of Technology - International Campus

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Is the Muslim Population Larger than Widely Assumed?

Vafa Moayedi*

Abstract

By employing a parsimonious econometric approach, based on an ARIMA model, this study detects significant Islamic calendar effects on U.S. meat consumption. This surprising finding strengthens the assumption that the size of the Muslim community is considerably larger than assumed by U.S. authorities and NGOs. This study fills a gap in the existing literature which has not addressed this issue with such an approach before. Furthermore, this study suggests considering Islamic festivities for the seasonal adjustment of U.S. time series data.

Keywords: ARIMA, Calendar Effects; Islamic Festivities, Muslims, Seasonal Adjustment

JEL classifications: C22, E27

* PhD, Assistant Professor of Economics

Sharif University of Technology-International Campus, Persian Gulf, Kish-Island, IRAN

Tel.: ++98 764 442 2299 (extension # 314); Fax: ++98 764 442 1628

E-mail: moayedi@sharif.edu, vafa.moayedi@gmail.com

I. Introduction

Muslim Americans have been shaping U.S. society since the 19th century. As Diouf (1998) states, many slaves deported to North-America were of Muslim religion. Koszegi and Melton (1992) estimate that more than the half of all deported slaves were from areas where Islam was present. According to their research, the immigration of Muslims from the Middle East began in 1840 and has continued since then.

There are historical reports about Muslims who fought during the American Revolution, the Civil War, the first and second World War.[2] Today, American celebrities such as Muhammad Ali and Kareem Abdul-Jabbar are internationally famous and highly respected, regardless of their religious beliefs. Indeed, American Muslims such as Muhammad Ali and Malcolm X were among the first to regard Islam as the religion of their enslaved ancestors and advocated the return to Islam by other Black Americans. Since the 1930s, anti-White propaganda spread by members of the Nation of Islam has raised much concern among White Americans and Islam has been evaluated more as a political ideology than a religion with a non-discriminating character. This period may be seen as the starting point for when Islam was evaluated negatively by members of the Christian majority in the United States.

After the 9/11 terror attacks, rapidly growing anti-Islam sentiments in the U.S. have led to controversial debates about Muslim Americans' role in society. Oswald (2005) reports a massive increase in anti-Muslim attacks in 2001 following 9/11.

[2] See Gomez (1994).

A Pew Research Center survey[3] carried out from 2003 to 2005 reports that in 2005 36% of Americans had an unfavorable view of Islam. Interestingly, it also states that 55% of non-Muslims had a favorable opinion of Muslim Americans. Furthermore, according to a 2007 Newsweek survey[4], 64% of non-Muslim Americans would not allow their child to date a Muslim. When summarizing several survey and poll findings, the critical way in which non-Muslims in the U.S. regard their Muslim fellows becomes apparent. However, Muslims are part of U.S. society and have an economic impact regardless of anti-Islamic sentiments and discrimination by non-Muslims.

For example how significant is the Muslim impact on the demand for goods and services, respectively? Answering this question would be simple if reliable demographic data were available. Notably, the U.S. Census Bureau does not collect demographic data sorted by religious identification. In fact, there are no official numbers about the size of the Muslim population which are accepted by all researchers. While the CIA World Factbook[5] reports a Muslim population of 1.8 million in 2010, the Pew Research Center[6] presents a much higher estimation of 2.5 million for the year 2009. The Council of American-Islamic Relations' estimation[7] in 2011 is higher still at 2.7 million. Nevertheless, all of these estimations represent less than 1% of the U.S. population, which is currently estimated to be greater than 300 million[8], and might appear relatively insignificant (at first sight) when evaluating the impact of Muslim Americans on the overall economy. But is this really the case? If the estimated population numbers are close to the

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[3] http://pewforum.org/uploadedfiles/Topics/Religious_Affiliation/Muslim/myslims-survey-2005.pdf, accessed: March 3, 2012
[4] http://www.prnewswire.com/news)releases/newsweek)poll)americans)are)mixed)on)us)muslims)52756242.html, accessed: March 3, 2012
[5] https://www.cia.gov/library/publications/the)world)factbook/geos/us.html, accessed: March 3, 2012
[6] http://pewforum.org/newassets/images/reports/Muslimpopulation/Muslimpopulation.pdf, accessed: March 3, 2012
[7] http://www.cair.com/AboutIslam/IslamBasics.aspx, accessed: March 3, 2012
[8] http://www.census.gov/main/www/popclock.html, accessed: March 3, 2012

actual size, we can assume this minority has no significant overall economic impact with regard to consumption figures for an everyday commodity such as meat. Put differently, the number of Muslims may be greater than assumed by current studies if significant demand effects for an ordinary good such as meat are detected.[9]

How can we test whether Muslims in the U.S. have a significant demand effect on meat consumption figures? The most convenient way is to explore whether Islamic festivities cause significant changes in meat consumption. Indeed, in Islamic countries meat dishes are often donated by wealthy Muslims to all members of the community, especially during festivities. Generally, meat is served during almost all religious festivities and occasions. Therefore, we can let the data speak for themselves by searching for significant calendar effects caused by Islamic festivities.

U.S. time series data, especially when referring to consumer goods and services, are usually affected by seasonality effects caused by religious festivities and public holidays according to the Gregorian calendar. The Gregorian calendar is also widely known as the Christian calendar as it was introduced by Pope Gregory XIII in the 16th century. Nevertheless, a significant seasonal effect induced by Islamic festivities would be a very surprising result since the vast majority of the U.S. population is represented by non-Muslims. Such a result would imply that the Muslim population in the U.S. may be significantly higher than so far assumed.

The elimination of calendar effects is a particularly important element of seasonal adjustment. Riazuddin and Khan (2005) emphasize that all commonly used methods and programs account

[9] In this study, the word meat is used to refer to all kind of red meat.

for Gregorian calendar effects, but not Islamic ones. In their pioneering study, they introduce an ARIMA model capable of detecting the significant effect of Islamic festivities on the demand for domestic currency in Pakistan. Recently, Bukhari et al. (2011) re-examine the above study in order to account for the effect of business cycles. They also detect significant calendar effects induced by Islamic festivities in Pakistan. In this study, Riazuddin and Kahn's (2005) model is modified and employed for time series data on meat consumption in the U.S. Relevant data are gathered for the period 1989/Q1 to 2010/Q4 from the United States Department of Agriculture's (USDA) website[10].

Interestingly, the introduced model identifies significant Islamic calendar effects and its stability is confirmed by relevant diagnostics tests.

The following section introduces the model while data and findings are presented in section 3. Section 4 contains a discussion of the results which leads to concluding remarks in section 5.

II. Methodology

Riazuddin and Khan (2005) develop a parsimonious ARIMA model which aims to detect Islamic calendar effects by employing festivity dummy variables in order to account for the effect of Islamic calendar months. Simultaneously, dummy variables are integrated into the equation to account for Gregorian calendar effects.

Their model takes the following form:

$$Log(y_t) = \alpha_0 + \sum_{i=1}^{11} \beta_i D_i + \sum_j \gamma_j F_{ji} + \varepsilon_i + \sum_{p=1}^{m} \delta_p \log(y_{t-p}) + \sum_{q=1}^{n} \eta_q \varepsilon_{t-q} \tag{1}$$

Contrary to the Gregorian calendar dummy variables, Islamic calendar effects are represented through fractional dummy variables which account for the fact that the dates of some festivities

[10] http://www.ers.usda.gov/Publications/ldp/LDPTables.htm, accessed: March 3, 2012

tend to fall into two neighboring months. The fractional dummy variable F_{ji} is designed as follows:

$$F_{ji} = \frac{n_{ji} + n_{ji+1}}{n_j} \qquad (2)$$

Naturally, this dummy variable can either take the value 0 or 1. Nevertheless, if an Islamic calendar month falls into two Gregorian calendar months, F_{ji} will take two fractional values, summing to one. The meanings of both equation variables are listed in Table 1, which is taken from Riazuddin and Khan (2005, p.27). The Islamic months considered are Muharram, Ramadan, Shawwal, and Dhu al-Hijjah, which are the most important Islamic months for the majority of Islamic countries. Table 1 provides concise explanations of these months.

In order to apply the model, Islamic calendar months, which follow the so-called Hijri calendar, are converted to Gregorian calendar dates. As Riazuddin and Khan (2005) point out, this conversion can either be done by consulting old newspapers or by utilizing certain algorithms which are easier to use, but can produce errors of up to two days.

Because time series data on U.S. meat consumption are provided with quarterly frequency, equation (1) is transformed into the following version:

$$Log(y_t) = \alpha_0 + \sum_{i=1}^{3} \beta_i D_i + \sum_j \gamma_j F_{ji} + \varepsilon_i + \sum_{p=1}^{m} \delta_p \log(y_{t-p}) + \sum_{q=1}^{n} \eta_q \varepsilon_{t-q} \qquad (3)$$

The ARIMA model employed is represented by equation (3) in order to explore Islamic calendar effects on meat consumption figures for the U.S. Findings are presented in the following section.

III. Data and Findings

As mentioned in the introduction, data are gathered for the period 1989/Q1 to 2010/Q4 from the USDA. Since this institution does not distinguish between slaughter methods, the available data include meat slaughtered using both halal and non-halal methods. Therefore, the data are suitable for exploring Islamic calendar effects on meat consumption. Notably, it is not clear whether halal meat production exceeds non-halal meat production since reliable public data are not available. Interestingly, one may assume that non-Muslims consume halal meat without knowing as slaughter methods are not disclosed to the consumer. As Muslims tend to purchase their meat from Muslim butcher shops, this does not affect the analysis.

Before introducing the ARIMA model, as shown in equation (3), we test for the presence of seasonality by observing the plot of the dependent variable, shown in Figure 1. Indeed, meat consumption appears to be non-stationary, while spikes imply seasonal patterns in the data. The Augmented Dicky-Fuller (ADF) and the KPSS unit-root test identify the variable as non-stationary at the 5% significance level. Notably, the DF-GLS unit-root test only confirms the data to be integrated by order one (I(1)) at a 10% significance level if it is assumed to have trending data. A trending time series is observed in Figure 1 and thus the results presented in the third column of Table 3 are of main interest. According to all three kind of unit-root tests, the (trending) data are first-difference stationary and I(1), respectively. Graphically, this assumption is confirmed by Figure 2.

Nevertheless, it is noteworthy that seasonality-affected time series data may yield more than one frequency of seasonality, meaning that there might be seasonal unit-roots in addition to the common unit-root case. Thus, following Depalo's (2009) suggestion and approach[11], this study also consults the HEGY test (developed by Hylleberg et al (1993)), which confirms the existence of a seasonal unit-root at one frequency. Table 2 presents the test results.

Therefore, this study continues to explore the impact of festivities on meat consumption by estimating the appropriate ARIMA model according to equation (3).

The estimated ARIMA (*9,1,6*) model is appropriate as confirmed by its Akaike Information Criterion value which was calculated for up to 10 lags. This model shows an adjusted R-square value of 0.78 and an F-statistic value of more than 13. Hence, this model fits the data well. Unsurprisingly, all four seasonal quarters show significant calendar effects, as presented in Table 5. Meat consumption decreases in the first quarter of the year and starts increasing from the second until the last quarter of the year. This observation is not surprising since several Christian festivities (e.g. Easter, Thanksgiving, Christmas) are celebrated from the second to the fourth quarter of the year. When investigating the Islamic months, very surprising results are observed. According to the selected model, meat consumption decreases on average by 0.4 pounds per capita during Muharram, at a 10% significance level. Furthermore, we observe a statistically significant average increase in consumption of 0.5 pounds per capita (at a 5% significance level) during Shawwal. Significant effects cannot be identified for Ramadan and Dhu al-Hijjah.

With regard to the stability of this model, appropriate tests for serial correlation and Hetersoskedasticity are conducted using the LM and Breusch-Pagan-Godfrey tests respectively. The test results confirm the model's stability and are presented in Table 6 and 7, respectively.

[11] We employ STATA's SROOT-command, introduced by Depalo (2009).

IV. Discussion

The presented findings clearly indicate the significant calendar effects of Islamic festivities on meat consumption in the U.S. General seasonal adjustment of time series data may not be sufficient to remove movements caused by Islamic festivities. The quarterly frequency of the data makes detecting these effects even more surprising. Unfortunately, monthly time series data were not available from the USDA meaning it was not possible to estimate the model with monthly frequency. Nevertheless, it is assumed that monthly data would show the effect of Islamic festivities more clearly, although more empirical studies with different kinds of time series data are necessary in order to explore the general effect. Accordingly, the author recommends checking U.S. time series data not only for regular, seasonal (Gregorian) calendar effects but also for possible seasonal movements caused by Islamic festivities, for instance by utilizing the ARIMA model introduced here. Unfortunately, even modern seasonal adjustment software such as ARIMA-X12 and TRAMO/SEATS does not account for Islamic calendar effects.

Despite Muslims being estimated to represent less than 1% of the total population, the observed results show that two Islamic festivities have a significant effect on consumption. Hence, it appears unlikely that the estimated population figures are accurate since such a significant impact could only be created by a much larger Muslim population.

The insignificant effect of Ramadan may appear surprising. However, empirical findings for Islamic countries also demonstrate varied results. For instance, while Bonato (2008) detects no significant effect of Ramadan on money demand (M1) in Iran, Riazuddin and Khan (2002) and Bukhari et al. (2011) observe the opposite to be true for currency demand in Pakistan. With regard to food prices in Turkey, Yucel (2005) detects a highly significant effect at Ramadan. Notably, the most reliable studies have only analyzed monetary-related data, such as money supply figures and price levels. In the case of the U.S., this study assumes that the quarterly frequency of the data dampened the effect of Ramadan due to meat consumption by non-Muslims. Nevertheless, supplying the model with monthly data would be the best way to confirm this assumption.

V. Concluding Remarks

The true size of the Muslim population in the U.S. is debatable since several polls and estimations suggest different figures. On the one hand, non-Muslim groups may be interested in underestimating this number. On the other hand, the Muslim community seeks to highlight its importance by suggesting much higher numbers. Nevertheless, detecting significant Islamic calendar effects on meat consumption clearly indicates that the number of Muslims is high enough to have a considerable effect in a North-American country with more than 300 million inhabitants. Therefore, we suggest that the most commonly estimated numbers of less than 3 million U.S. Muslims, denoting less than 1% of the total population size, are questionable. Certainly, we cannot suggest any number for the actual U.S. Muslims population. However, we strongly suggest the previous numbers to be inspected and estimated again, regardless of their origin.

With regard to the seasonal adjustment of time series data from non-Muslim nations and seasonal adjustment software such as ARIMA X-12 and TRAMO/SEATS, this study strongly supports suggestions that Islamic calendar effects should be taken into account rather than have their possible impact ignored. It is most likely that especially economic time series data from European countries with significant Muslim population (e.g. France, Germany and the UK) are also impacted by Islamic festivities. Unfortunately, these effects are not considered by scholars so far although such impact may give an interesting and valuable new insight into Muslim demand patterns.

This study has the shortcoming that meat was the only everyday good analyzed. Hopefully, other scholars will so investigate others and continue this debate. Knowing that this study may provoke rejection by some scholars, the author confidently points out that the aim of all studies is to motivate further scientific debate and research. With this innovative study, the aim is to fuel a fruitful scientific debate and further research.

Therefore, the author looks forward to making his data available to interested scholars worldwide.

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Tables

Table 1: Religious Meaning of Islamic Months

Islamic Month	*Religious Meaning*
Muharram	• First month of the Islamic calendar • Fighting is forbidden during this month • Optional fasting • Shia Muslims mourn due to the Martyrdom of Imam Hussein in the Battle of Karbala (Day of Ashura)
Ramadan	• Month of spiritual reflection and worship • All Muslims are obliged to fast during this month
Shawwal	• Eid Al-Fitr marks the end of Ramadan and the first day of Shawwal • All Muslims celebrate the end of fasting • Shia Muslims mourn due to the Martyrdom of Imam Baqir
Dhu al-Hijjah	• The pilgrimage to Mecca (Hajj) takes place in this month • Shia Muslims mourn due to the Martyrdom of Imam Hussein

Source: Author's descriptions

Table 2: Variable Acronyms

$Log(y_t)$ represents the log form of the variable to be deseasonalized

α_0 is the intercept of our function and thus the base quarter for adjustment calculations

D_i=1, if y belongs to the ith Gregorian calendar month and D_i=0, otherwise

n_{ji} equals the number of days of the jth Islamic month falling in the ith Gregorian month

n_{ji+1} equals the number of days of the jth Islamic month falling in the $(i+1)$th calendar month

$n_j = n_{ji} + n_{ji+1}$

ε_i represents the error variable

δ_p are the auto regressive process parameters

η_q are the moving average process parameters

Source: Riazuddin and Khan (2005)

Table 3: Unit-Root Test Results for U.S. Meat Consumption from 1989Q1-2010Q4

		Intercept			Intercept & Trend		
		ADF*	DF-GLS*	KPSS**	ADF*	DF-GLS*	KPSS**
Level	Test Statistics	-1.1907	-0.5920	0.6965	-2.3264	-2.5137	0.2178
	Critical Value	-2.8967	-1.9447	0.4630	-3.4648	-3.0844	0.1460
First Difference	Test Statistics	-4.8134	-1.1463	0.2028	-5.4176	-2.8989	0.0977
	Critical Value	-2.8967	-1.9449	0.4630	-3.4669	-3.0972	0.1460

*Note: Critical values at 5% level, * H_0: Variable is non-stationary, ** H_0: Variable is stationary*

Table 4: HEGY-Test for Seasonal Unit Roots

	Test Statistic	***5% Critical Value***
Z(t) - Fr 0	-0.444	-2.880
Z(t) - Fr 1/2	-3.357	-1.950
Z(t) - L.Ann.	-3.604	-1.900
Z(t) – Annual	-2.948	-1.680
Joint Annual	12.419	3.080
All SEAS. Fr	14.318	2.740
All freq.	10.851	3.370

Note: H_0: Variable is non-stationary

Table 5: Seasonal ARIMA-Model Estimation Results

Dummy Variable	*Coefficient*	*P-Value*
Muharram	-0.393168*	0.0758
Ramadan	-0.211321	0.3774
Shawwal	0.485938**	0.0314
Dhu al-Hijjah	0.064360	0.7924
1st Quarter	-1.046947***	0.0000
2nd Quarter	1.555247***	0.0000
3rd Quarter	1.366906***	0.0000
4th Quarter	1.185973***	0.0000

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

Table 6: Breusch-Godfrey Serial Correlation LM Test

H_0: No Serial Correlation

F-statistic	1.110727	Prob. F(10,45)	0.3753
Obs*R-squared	15.43016	Prob. Chi-Square(10)	0.1171

Note: Test is conducted with a residual lag-length of 10

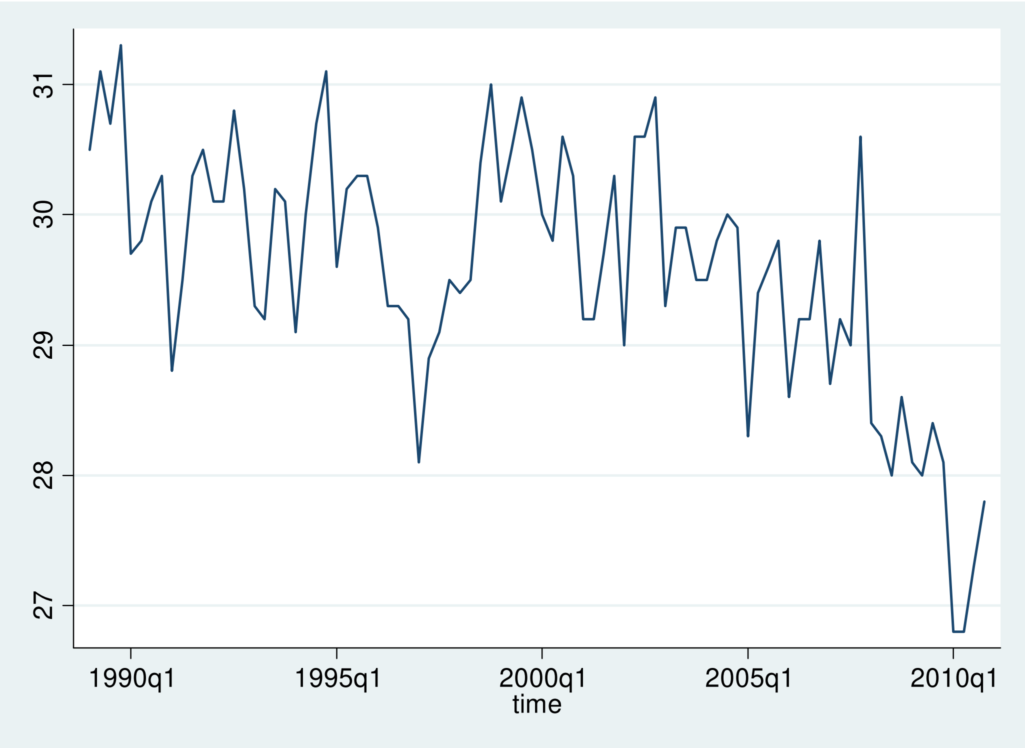
Table 7: Breusch-Pagan-Godfrey Heteroskedasticity Test

H_0: Constant Error Variance

F-statistic	0.591253	Prob. F(7,70)	0.7609
Obs*R-squared	4.354325	Prob. Chi-Square(7)	0.7382
Scaled explained SS	1.768593	Prob. Chi-Square(7)	0.9715

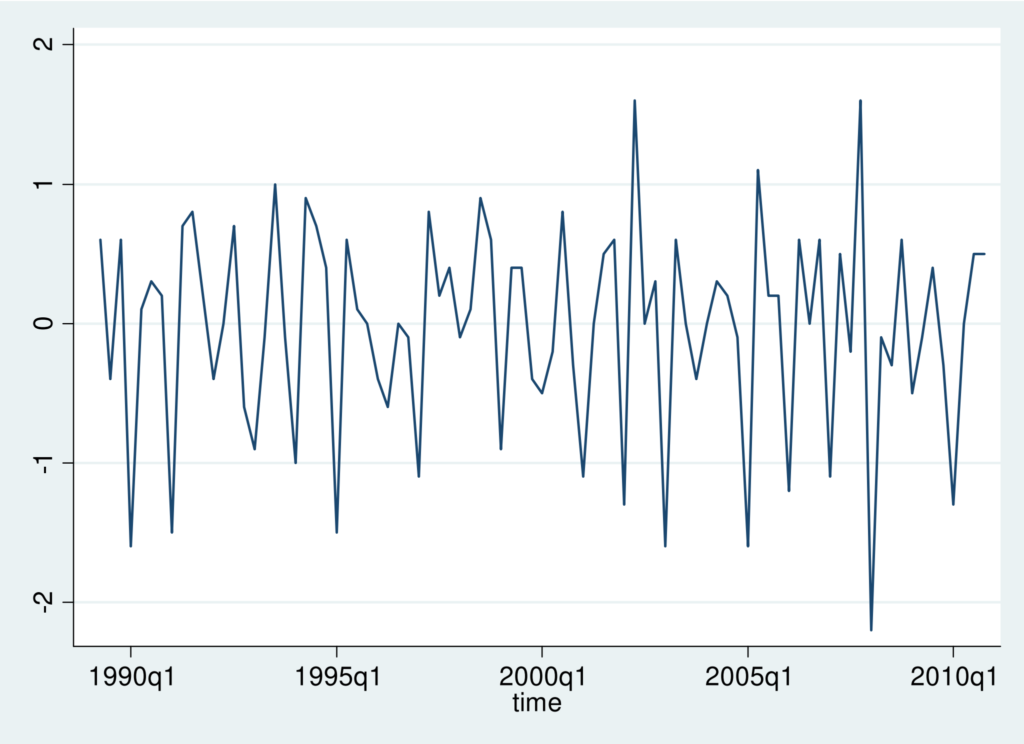
Figures

Figure 1: Per Capita Meat Consumption in the U.S., measured in pounds



Source: USDA Economic Research Service, http://www.ers.usda.gov

Figure 2: First-Difference of Per Capita Meat Consumption in the U.S.



Source: USDA Economic Research Service, http://www.ers.usda.gov and author's calculation