Effect of Fasting on Traffic Accidents

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Ahmet Gulek*

Abstract

On May 21st, 2018, Inger Stojberg, Denmark's immigration Minister, claimed that Muslims' fasting during the month of Ramadan poses a danger to society, especially in the case of Muslim hospital personnel and bus drivers. The latter claim rested on the premise that fasting increases the likelihood of traffic accidents. Since this premise matters to 1.6 billion Muslims in the world and to the people who live in close proximity to these people, I find it important to test this claim with data. This paper provides causal evidence (for the first time I believe) that fasting during the Ramadan month increases the likelihood of Road Traffic Accidents (RTAs). My identification strategy exploits both the exogenous variation of the Ramadan month period due to the differences between the Lunar and Gregorian calendars, and the variation in the timing of sunset. Using a rich dataset with a long time span of 18 years, I can identify the effects of Ramadan independently of seasonal effects. I show that Ramadan decreases RTAs on average, but this result arises from the effect of Ramadan on the unobserved traffic density. By restricting the sample to working days and focusing on the effect of Ramadan on the time period 15:00-18:00 when Ramadan can have only a minor effect on traffic density (workers who leave work constitute the major portion of traffic density at that time period), I show that Ramadan increases RTAs up to 13.0%. Ramadans effect is stronger in cities where the incumbent religious party AKP has higher votes, or alcohol related accidents constitute a lesser percentage of total RTAs. Both properties imply higher conservatism where more people are expected to be fasting during Ramadan. This provides further evidence that the increase in RTAs during Ramadan is caused by fasting.

*Department of Economics, Koc University, Istanbul, Turkey. e-mail: agulek13@ku.edu.tr

1 Introduction

On May 21st, 2018, Inger Stojberg, Denmarks Immigration Minister, claimed that Muslims' fasting during the Ramadan month poses a danger to the society, especially via Muslim hospital personnel and bus drivers. The latter claim rested on the premise that fasting increases the likelihood of traffic accidents. Since this premise matters to 1.6 billion Muslims in the world and to the people who live in close proximity to these people, I find it important to test this claim with data. The primary contribution of this paper is to provide causal evidence for the first time that fasting significantly increases the likelihood of Road Traffic Accidents (RTAs).

My empirical setting is Turkey where I study RTAs that resulted in injury and/or death. It is commonplace among Turks, who are predominantly Muslim, to fast from dawn to sunset for the entire month. Fasting is one of the Five Pillars of Islam, and with reasonable medical exceptions, it is obligatory for believers after adolescence. The dataset for this study covers all the traffic accidents that resulted in injuries and/or deaths during the period 2000-2017. This long timespan allows me to identify the effect of Ramadan on RTAs purged of seasonality by exploiting the fact that the month of Ramadan moves earlier in the Gregorian calendar by about eleven days every year.

The main findings of this paper can be summarized as follows: RTAs fall significantly during the month of Ramadan by 15 accidents per day. This fall is primarily driven by Ramadan's effect on the unobserved traffic density. Fatigue induced by fasting decreases agents' likelihood of going out, which decreases the unobserved traffic density and consequently the number of RTAs. This effect is minimal on working days because of agents' obligations of going to work. Restricting the sample to working days reduces but does not eliminate the bias because cultural effects during the Ramadan month (such as not consuming alcohol or going out less at night) still decrease the unobserved traffic density. Only by looking at the effect of Ramadan on the period 15:00-18:00 during working days when Ramadan has little or no effect on traffic density[1] can I show that Ramadan increases RTAs up to 13.0%. Ramadans effect is stronger in cities where the incumbent religious party AKP has higher votes, or alcohol related accidents constitute a lesser percentage of total RTAs. Both properties imply higher conservatism where more people are expected to be fasting during Ramadan. This provides further evidence that the increase in RTAs during Ramadan is caused by fasting.

[1]Workers who leave work constitute the major portion of traffic density at that time period. Their behavior is not affected by the Ramadan month as the official working hours are not changed in Turkey during the Ramadan month

Ramadan observance and its effects are likely to go unnoticed in societies where Muslims are a small minority. However, lack of awareness can be dangerous. There were 1.6 billion Muslims in the world as of 2010 according to the Pew Research Center, and roughly 93 percent of surveyed Muslim adults indicated that they fast during Ramadan.[2] As every religious practice, Ramadan has its own intended and unintended effects. Educated responses to these effects with support from data would be beneficial to everyone.

The rest of this paper is organized as follows. Section reviews the literature. Section 3 provides some background on Ramadan and discuss the mechanisms via which RTAs can be affected. Section 4 presents the data and summary statistics. Section 5 provides the empirical results and discussion. Section 6 concludes.

2 Literature Review

Traffic accidents has been a leading cause of death in various countries. Numerous public policy measures have been put forward to decrease the number of and the fatalities from traffic accidents. Examples include but are not limited to additional vehicle safety regulations, changing the minimum legal drinking age, beer taxes, maximum legal blood alcohol content, zero-tolerance laws, graduated driver license program regulations in US. These policies gave rise to an enormous literature analyzing their effects. Peltzman (1975) shows that mandated improvements in physical vehicle safety increases driving intensity (which nullifies the policys effect on highway deaths), whereas Lindgren and Stuart (1980) does not find a similar effect for Sweden. Seatbelt laws are shown to decrease traffic fatalities (Cohen and Einav, 2003), especially for the youth (Carpenter and Stehr, 2008). Dee et al. (2005) show that graduated driver licensing regulations reduced traffic fatalities among 15-17 year olds by at least 5.6%.

Drunk driving is an important part of traffic accidents. Levitt and Porter (2001) quantify the risks posed by drinking drivers by using a hidden richness inherent in two car crashes) and find that legally drunk drivers are 13 times more likely to cause an accident. Several laws have been passed in US to reduce the negative externality of driving under influence (DUI). The 0.08 Blood alcohol concentration (BAC) limit in US has been studied thoroughly and found to be reducing the number of traffic fatalities (Dee, 2001; Eisenberg, 2003). Similar research suggests that zero-tolerance laws which lower the legal blood alcohol level of persons under 21 to 0.02 or

[2] Pew Research Center's Forum on Religion & Public Life, *The Future of the Global Muslim Population*, 2011, and *The World's Muslims: Unity and Diversity*, 2012.)

less reduce fatal crash rates (Eisenberg, 2003), and heavy episodic drinking for underage males (Carpenter, 2004). Social host laws for minors that impose liability on adults who host parties are shown to reduce the drunk-driving fatality rate among 18-20 year olds by 9% (Dills, 2010).

The minimum legal drinking age (MLDA) is one of the most studied alcohol control policies in United States [3]. A common finding is that an increase of MLDA to 21 decreases traffic fatalities of 18-19 year-olds (Dee, 1999; Dee and Evans, 2001). However, Miron and Tetelbaum (2009) argue that the effect of MLDA laws is in fact much lower. In an interesting setup, Lovenheim and Slemrod (2010) show that in counties within 25 miles of a lower-MLDA jurisdiction, a legal restriction on drinking actually increases fatal accident involvement of the youth as they drive to the lower MLDA jurisdiction area to drink.

Another line of literature tries to establish the determinants of alcohol related traffic accidents.[4] Ruhm (1996) finds that higher beer taxes are associated with reductions in crash deaths, but this result is challenged by others.[5] Young and Bielinska-Kwapisz (2006) use beer taxes as instrumental variables to show that traffic fatalities are negatively related to prices. Availability of alcohol is also shown to be a determinant of RTAs. Cotti and Walker (2010) show that there is a strong link between the presence of a casino in a country and the number of alcohol related fatal traffic accidents. In contrast, Green et al. (2014) reveal that liberalization of bar closing times in England (which resulted in an extension of bar hours) actually decreased traffic accidents.

The effect of Ramadan on RTAs have been analyzed by other papers, but their results suffer greatly from methodological and data restrictions. Khammash and Al-Shouha (2006) look at the patients treated due to RTAs in October and November of 2004, and document that during the Ramadan month (October 15-November 13) they treated significantly fewer patients. In contrast, Bener et al. (1992) conduct a retrospective study of all road traffic accidents and injuries at a hospital between January 1st and December 31st, 1990, and find that the number of persons who were injured by traffic accidents was slightly higher during the Ramadan month. In support of this finding, Tahir et al. (2013) analyze the trends in RTCs managed by an emergency service, Rescue 1122, in 2011 in Punjab, Pakistan and reveal that the service responded on average to more traffic accidents during Ramadan (August 2011) than the other months in the sample (January-August 2011). The most comprehensive analysis that I could find was that of

[3]Interested reader can refer to Wagenaar and Toomey (2002) for the review of the literature from 1960 to 2000

[4]Interested reader can look at Chaloupka et al. (2002) for a review

[5]Mast et al. (1999) argue that this relationship is not robust across data periods. Dee (1999) shows that beer taxes have insignificant effects on teen drinking

Mehmood et al. (2015), in which the authors analyze all road traffic injury victims presenting to emergency departments in Karachi between September 2006 and September 2011 and find that frequency of RTAs did not change significantly during Ramadan. My results indicate that these conclusions are driven by the seasonality embedded in the data generating process of RTAs. Moreover, Ramadan affects the unobserved traffic density, an omitted variable that none of these papers account for. Therefore their results do not allow for causal inference.

Lastly, this paper can be taken as a new addition to the economics of religion in the sense that it identifies the causal effects of a religious practice.[6] Important and related contributions include Campante and Yanagizawa-Drott (2015) who document that longer Ramadan fasting has a negative effect on output growth, Demiroglu et al. (2017) who show that small business loans originated in the month of Ramadan are more likely to default, and Romem and Shurtz (2016) who use the exogenous variation in traffic volume associated with the Sabbath to measure the externality of driving.

3 Background

Ramadan is the ninth month of the Islamic lunar calendar during which Muslims fast by abstaining from food, drinks, tobacco and sexual activity from dawn to sunset for 29 or 30 days, depending on the length of the lunar month. Pre-pubertal children, pregnant women, women during menstruation or post-childbirth confinement and lactation, travelers on long journeys, and people with physical or mental illnesses are exempt from Ramadan fasting. The daily routine of Ramadan involves a pre-dawn breakfast (suhoor), and a meal at sunset (iftar), and a supererogatory late night prayer which is often performed with the congregation (taraweeh).

According to a survey conducted by the Pew Research Center in 2012, 97% of Turkish citizens identify themselves as Muslims and 87% of the Muslims say that they fast during Ramadan. The Religious Life Survey conducted in 2014 by the Turkish Statistical Institute (TUIK) on behalf of the Presidency of Religious Affairs finds a similar 82% of the 37,624 households interviewed performed fasting.

Medical studies provide evidence that Ramadan fasting is associated with moderate increases in symptoms such as headache, sleep deprivation, dehydration, stress-related irritability, and physical exhaustion, but no serious, life-threatening health problems.[7] Recognizing the adverse physiological effects of fasting, governments in Muslim-majority countries officially reduce work

[6] Interested reader can look at Iyer (2016) for a review of this literature

[7] see the references in **?**

hours by one to three hours during Ramadan and adjust to earlier hours in the day.[8] Work hours are not officially adjusted in a few Muslim-majority countries, Turkey being one.

Because of the differences between the Lunar and Gregorian calendars, Ramadan moves earlier by about eleven days in the Gregorian calendar every year, rotating over the seasons in cycles of roughly 33 years. Due to the monthly seasonality in RTAs, a long dataset like the one used in this paper is crucial for identification. Otherwise, coefficient estimates of Ramadan treatment would capture the month fixed effects and therefore would not be reliable.

Fasting requires abstinence from food and beverages from sunrise to sunset. The variation of the dates of Ramadan also results in variation in the duration of abstinence, which can affect the RTAs. Figure 1 shows the timing of sunset and sunrise in Istanbul, the most populated city in Turkey for the year 2018. As seen in figure 1, sunrise can occur before 6:00 in summer and as late as after 8:am in November. Similarly, sunset occurs before 18:00 in winter and after 20:00 in summer. Hence, the duration of abstinence can change up to 4-5 hours during the year. Moreover, as it is common among Turks to dine together at iftar (sunset) during the Ramadan month, changes in the timing of sunset will change the effect of Ramadan on the unobserved traffic density at different hours. Whereas 30-60 minutes before the sunset we would expect the traffic density to be high due to more people going to restaurants, we would expect a sudden drop in traffic density around the sunset because most people would be dining instead of driving.

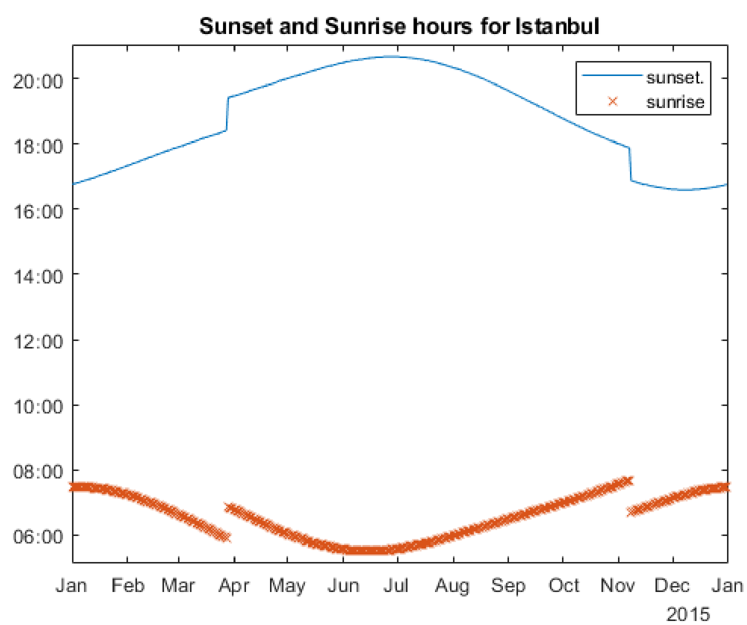

Figure 1: Timing of Sunset and Sunrise in Istanbul

[8]Dinar Standard, *Productivity in Ramadan*, 2011

4 Empirical Analysis

4.1 Data

The data for this study are provided by the Turkish Traffic Education and Research Department. It consists of two datasets. The first one is a panel that has detailed records of each traffic accident that resulted in injuries and/or deaths at province level for the period 2000-2017 (number of cars involved, number of injuries and deaths, the timing of the accident in hours and minutes etc). In total, it consists of 6575 daily observations in Turkey. During my time span, there were 1,792,345 accidents that resulted in 3,026,676 injuries and 51,334 deaths. With the 18 years of data I have, Ramadan treatment fully interacts with all the months from June to December, it interacts with May on three observations and with January on four observations. The second dataset provides information related to drivers involved in these accidents, which can be matched via unique accident ids. This allows me to partially separate alcohol related accidents and the rest.[9]

I supplement the data by obtaining from the website of the Presidency of Religious Affairs (PRA) an official record of Ramadan days in the Gregorian calendar because the dates in my dataset are in the Gregorian convention.[10] I also collected the timing of sunset and sunrise in Istanbul in 2015 from the website timeanddate.com. Table 1 provides the summary statistics for the RTAs in my dataset.

On average, there are 287 RTAs in Ramadan days and 271 RTAs in non-Ramadan days. Notice that the standard deviations are high so that it cannot be concluded that RTAs in Ramadan are significantly higher than the RTAs in non-Ramadan days. As a result of these RTAs, on average 486 people were injured and 9 people died in Ramadan days, compared to 458 injuries and 8 deaths in non-Ramadan days. As the standard deviations are higher, I cannot conclude that they are statistically different. There is more than 50% drop in alcohol related accidents during Ramadan as people consume much less alcohol during the Ramadan month. Time series graphs of these variables and more detailed summary statistics are given in the appendix.

[9] In many cases, injured drivers are rushed to the hospitals, where they do get tested for alcohol. However, as these tests are done at a later time, they do not enter my data. Consequently, I can observe only a small percentage of DUI cases

[10] to understand the degree by which the effects of Ramadan treatment depend on temperature, I obtain historical city-level daily temperatures from the Turkish State Meteorological Service, but the analysis is not over yet

Table 1: Summary Statistics

	All Accidents		Ramadan Accidents		Non-Ramadan Accidents	
No of days	6575		536		6039	
(Per day)	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Accidents	272.6	114.7	287.07	125.91	271.32	113.58
Injuries	460.33	198.9	485.84	221.92	458.07	196.58
Deaths	7.81	4.61	8.64	4.51	7.73	4.61
Alcohol involved	7.08	5.02	3.85	3.43	7.36	5.04
Drunk driver	3.73	3.88	1.66	2.1	3.91	3.95
No alcohol involved	265.52	111.4	283.23	123.5	263.95	110.14

4.2 Empirical Problems

Denmark's immigration Minister's claim rests on the premise that fasting increases the likelihood of traffic accidents. This claim can be modeled in the following way.

$$
\begin{aligned}
y_{i,t} &= \beta_0 + \beta_1 Attention_{i,t} + \beta_2 TD_t + \gamma' W_t + \zeta_t \\
Attention_{i,t} &= \alpha_0 + \alpha_1 Nutrition_{i,t} + \alpha_2 BAC_{i,t} + \delta' Z_t + v_{i,t} \\
Nutrition_{i,t} &= \theta_0 + \theta_1 Fasting_{i,t} + \nu_{i,t} \\
Fasting_{i,t} &= \Theta_0 + \Theta_1 Ramadan_t + a_{i,t}
\end{aligned}
\tag{1}
$$

where $y_{i,t}$ is a dummy that equals to 1 if individual i has an accident at time t, $Attention_{i,t}$ is the attention of individual i at time t, $BAC_{i,t}$ is the blood alcoho concentration of individual i at time t, TD_t is the traffic density at time t, W is matrix of variables such as the day of the week, month of the year, weather and road conditions etc, and ζ_t is the error term. The claim implicitly assumes that $Attention_{i,t}$ is a function of nutrition level such as the amount of hydration and blood glucose, which is affected by fasting during the month of Ramadan. The chain of causality follows: Individual i is more likely to fast during the month of Ramadan. If individual i fasts, her nutrition level decreases, which decreases her attention, which increases her likelihood of getting into an accident. This is the effect of fasting on the likelihood of RTAs. Structural estimation of these channels is not possible because (1) I do not observe $y_{i,t}$ (I only observe the total number of accidents), and (2) I observe only a small subset of RHS variables. If the exogenous variation due to the differences in the Gregorian and Lunar Calendars can eliminate the correlation of Ramadan treatment and the rest of the unobserved variables and error terms, then the following reduced form equation would provide a consistent estimate of the effect of fasting on traffic accidents.

$$RTA_t = \phi_0 + \phi_1 Ramadan_t + \gamma W_t + \eta_t \tag{2}$$

where W_t are the observable variables that can be correlated with *Ramadan* treatment either due to data generating process (such as Religious Holidays), or due to finite data (day of the week, month, year etc). Equation 2 is applicable for causal inference only if $Ramadan_t$ treatment is uncorrelated with error term η_t, which is unlikely in this case. In particular, Ramadan changes people's driving habits, which affects the traffic density and consequently the frequency of traffic accidents.

$$\begin{aligned} TD_t &= \alpha_0 + \alpha_1 \sum_{i=1}^{n} go\_out_{i,t} + \epsilon_t \\ go\_out_{i,t} &= \beta_0 + \beta_1 fatigue_{i,t} + \eta_{i,t} \\ fatigue_{i,t} &= \theta_0 + \theta_1 fasting_{i,t} + \nu_{i,t} \end{aligned} \tag{3}$$

Fasting causes fatigue from dehydration and malnutrition endured by not eating and drinking from dawn to sunset. When people are tired, they may choose to rest at home, which decreases their probability of going out. When fewer people go out, traffic density decreases. Because traffic density is expected to be (positively) correlated with the number of accidents, equation 2 suffers from omitted variable bias.

Fatigue is only one way by which Ramadan can affect the traffic density. People who fast will not have lunch, hence whereas people may go out to have lunch during the non-Ramadan months, they will not do so during Ramadan, which will decrease the traffic density around lunchtime. Moreover, alcohol sales drop substantially during Ramadan, which may decrease the number of drivers under influence and therefore decrease RTAs.[11] People also do not go out as much at night during Ramadan. This can also decrease RTAs especially at night time. Additionally, Turkish people have iftar at restaurants during the Ramadan month, which increases the traffic density in the 30-60 minutes before the sunset. Because I cannot observe the traffic density the estimated coefficient of ϕ_1 of equation (2) would be biased. The true effect of Ramadan can only be determined by analyzing the time periods during which Ramadan is not likely to affect traffic density and when fasting's effect on RTAs is visible (i.e. when abstinence from food and drinks creates hunger and dehydration, potentially after lunchtime).

[11] The data about the BAC of drivers has limitations, hence I delay the analysis until the end of this paper

4.3 Average Treatment Effect of Ramadan on RTAs

I start by examining the average treatment effect of Ramadan on all RTAs in the dataset. This is problematic in certain ways. Ramadan treatment affects alcohol related accidents differently (a thorough analysis is done later in the paper). However, Ramadan's effect on RTAs is not well studies before. In other words, there are no empirical facts that I can assume as given. Jumping ahead to the main specification at the end of this paper may create concerns regarding the validity of my results such as data manipulation. Instead, I prefer starting from the most general case and work my way through more detailed models, explaining at each step why more detailed analysis is needed. Equation 4 shows my baseline specification.

$$RTA_t = \beta_0 + \beta_1 R_t + \theta RH_t + \gamma WeekDay_t + \Theta Month_t + \Gamma Year_t + \epsilon_t \tag{4}$$

where RTA_t is the number of road traffic accidents at time t, R_t is a dummy that equals to one if day t falls on a Ramadan month, RH_t are variables that capture the Eid and Ramadan holidays $weekday_t$, $month_t$, $year_t$ are week of the day dummies (e.g. Monday, Tuesday,...), month and year fixed effects. I have to control for Religious holidays because the dates of religious holidays are determined according to Lunar Calendar, which creates a correlation between the Ramadan treatment and religious holidays. For instance, Ramadan holiday starts the day after the month of Ramadan ends. Because the number of accidents increases on vacations, omitting religious holidays result would cause bias in the estimates.

I estimate equation 4 by OLS. Table 2 provides the OLS results based on different specifications.

Simple OLS in column 1 with no religious holiday controls, day of the week, month or year fixed effects result in a positive and significant coefficient for Ramadan treatment. The very low R^2 shows that Ramadan does not explain much of the variation in traffic accidents, which is expected. The statistical significance in the first column does not provide valuable information as it is a spurious regression with a nonstationary dependent variable. In column 2, I control for religious holidays. Coefficient estimate slightly increases but this increase is not statistically significant. In column 3, I control for year fixed effects, which increases the R^2 from 0.005 to 0.7508. The coefficient of Ramadan increases slightly. In column 4, I include month fixed effects, which changes the sign of the Ramadan treatment from 18.17 to -14.90. It also improves R^2 from 0.7508 to 0.903. In column 5, I include the day of the week fixed effects, which slightly increases the R^2.

Notice that the introduction of month fixed effects changes the sign of the coefficient. This

Table 2: Average Treatment Effect of Ramadan on RTAs

	(1)	(2)	(3)	(4)	(5)
Ramadan	15.76***	16.7***	18.17***	-14.90***	-15.02***
	(5.63)	(5.63)	(2.33)	(2.14)	(2.13)
N	6575	6575	6575	6575	6575
R^2	0.001	0.005	0.7508	0.903	0.909
No of parameters estimated	2	4	21	32	38
Religious Holidays	No	Yes	Yes	Yes	Yes
Year F.E.	No	No	Yes	Yes	Yes
Month F.E.	No	No	No	Yes	Yes
Day of the Week F.E.	No	No	No	No	Yes

Notes: Robust standard errors in parenthesis

explains why there are opposing results in the literature. There is monthly seasonality in the data. Even with 18 years of observation, the Ramadan treatment cannot take a full circle around the year and hence is correlated with the months. The monthly seasonality is also stronger than the effect of Ramadan and hence if disregarded, the sign of the Ramadan variable changes. **The true average treatment effect of Ramadan is negative, not positive**. On average, there are 15 fewer accidents in Ramadan than in non-Ramadan days, having controlled for monthly and yearly seasonality.

Going back to the discussion in the previous section, the negative effect of Ramadan on the number of RTAs is not the causal effect of fasting, it is a weighted average of the effect of Ramadan on traffic density, alcohol consumption and the effect of fasting on attention. The result only implies that the effect of Ramadan on traffic density exists and is negative.[12]

4.4 Heterogenous Treatment Effects of Ramadan

There is more than one explanation for why we observe a decrease in RTAs during Ramadan. First, alcoholic beverage sales drop substantially during the Ramadan month. This is because alcohol consumption is prohibited in Islam. Whereas many Muslims do consume alcohol in normal times in Turkey, increased religious atmosphere of Ramadan nevertheless lowers alcohol sales substantially. Fewer sales are likely to result in less DUI, which may cause a decrease

[12] I assume that fasting cannot increase attention to make this conclusion

in RTAs. Testing this second possibility would be straightforward if one had data about the BAC of the drivers in RTAs. In many cases, injured drivers are rushed to the hospitals, where they do get tested for alcohol. However, as these tests are done at a later time, they do not enter the Turkish data. What percentage of the alcohol related accidents cannot be captured by the Turkish data is not known. Consequently, I can observe only an unknown percentage of DUI cases. Random mismeasurement in the independent variable causes attenuation bias, hence I cannot cleanly test this channel with the Turkish data.[13] Second, people prefer to go out less during the Ramadan month, potentially because of increased fatigue due to fasting or other cultural aspects related to driving habits. This mechanism can be tested by looking at the differences in the treatment effect during weekdays and weekends. Because people need to go out during the weekdays in order to go to work, Ramadan would affect RTAs less via this channel. However, during the weekends when people can choose between staying at home and going out, we should see this effect more clearly. To put it more formally, equation 5 shows my new specification.

$$\begin{aligned} y_t = \beta_0 + \beta_1 \quad R_t + \beta_2 \quad (R_t \quad fri_t) + \beta_3 \quad (Ramadan \quad sat_t) + \\ \beta_4 \quad (R_t \quad sun_t) + \gamma \quad W_t + \epsilon_t \end{aligned} \tag{5}$$

where y_t is the number of RTAs in specification 1, and the log of RTAs in specification 2, and W are the control variables. I omit the treatment interactions with Mondays, Tuesdays, Wednesdays, Thursdays dummies.[14] Table 3 shows the OLS results.

The reason why I included Friday in the regression is to see whether there were unexpected dynamics at the end of the weekdays. From the regression results, one cannot reject the null that Ramadan affects RTAs on Fridays equally as in other weekdays. On weekdays, the coefficient estimate of Ramadan is -5.81, hence on average there are about 6 fewer accidents (or about 4%) on Ramadan days, and this change is statistically significant. On Saturdays, this negative effect increases to 22 accidents per day (or about 11%), and on Sundays it increases to 53 accidents (or 16%). Ramadan treatment is nine times more effective on Sundays compared to weekdays in absolute terms, and 4 times stronger in percentage terms. This provides strong evidence for the "stay home" hypothesis. During the Ramadan month, data seem to suggest that agents choose

[13] In section ????? I separate the alcohol related and unrelated RTAs and analyze Ramadan's effect on both variables separately, but since that anlysis is noisy I decided to separate it from the main arguments of the paper

[14] In other specifications I allowed the Ramadan variable to interact with all the days of the week, but on weekdays I did not find a statistically significant difference

Table 3: The Ramadan Effect on weekdays and weekends

Specification	(1)	(2)
Dependent Variable	RTA	logRTA
Ramadan	-5.81**	-0.041***
	(2.55)	(0.0083)
Ramadan_fri	-0.60	-0.0099
	(6.02)	(0.019)
Ramadan_sat	-16.50**	-0.070***
	(6.48)	(0.020)
Ramadan_sun	-47.31***	-0.192***
	(5.47)	(0.018)
Observations	6575	6575
R^2	0.9108	0.9253
Religious Holiday Control	yes	yes
Year F.E.	yes	yes
Month F.E.	yes	yes
Day of the Week F.E.	yes	yes
Test for Ramadan+Ramadan_fri=0 (p-value)	0.2432	0.003
Test for Ramadan+Ramadan_sat=0 (p-value)	0.0002	0
Test for Ramadan+Ramadan_sun=0 (p-value)	0	0

Notes: Robust standard errors in parenthesis to stay at home instead of going out during weekends, arguably due to increased fatigue, hence the number of RTAs decline substantially. In other words, the negative effect of Ramadan found in table 4 is driven mostly by the Saturday and Sunday effects.

Table 5 shows that people's obligations of going to work on weekdays limit the effect of Ramadan on the traffic density. Regardless of whether agents fast or not, they have to go to work on weekdays. To show further proof of this channel, I compare the effect of Ramadan on official work days and official non-working days (weekends together with religious and national holidays). Table 4 shows the results.

Table 4: The Ramadan Effect on vacations and working days

Specification	1	2
Dependent Variable	RTA	logRTA
Ramadan	-9.17***	-0.05***
	(2.19)	(0.0072)
Ramadan_vacation	-22.12***	-0.097***
	(5.13)	(0.017)
vacation	16.41	0.060
	(1.00)	(0.0035)
Observations	6575	6575
R^2	0.9038	0.9190
Month F.E.	yes	yes
Year F.E.	yes	yes

Notes: Robust standard errors in parenthesis

Similar to the analysis of weekdays and weekends, the effect of Ramadan on RTAs iis negative on working days, and this effect is more than tripled on non-working days. Because I am controlling for vacations in general, I do not separately include day of the week or religious holiday fixed effects. The main argument is that if fasting has an effect on RTAs, we would expect it to be constant for all days. The fact that there are huge differences in the effect of Ramadan on RTAs shows that Ramadan has a significant effect on the unobserved traffic density. When people can choose to stay at home during Ramadan, they tend to do so. As I am after the causal effect of fasting on traffic accidents, I need to limit the bias arising from the effect of Ramadan on traffic density. Table 4 shows that Ramadan decreases traffic density more on non-working days. Hence, in the rest of the paper, I will restrict the sample to working days only.

4.5 The True Treatment Effect of Fasting

Even with sample restricted to working days, Ramadan will still change people's driving habits. For instance, all the unemployed and the people who are not in the labor force do not have obligations of going to work on working days, hence their driving habits are still affected by fasting. Moreover, even people who go to work will change their driving habits to a certain degree on working days. They will not go out to lunch as those who fast will not have one, which will decrease the traffic density during noon. Furthermore, there are certain traditions during the Ramadan month that can actually increase traffic density on certain hours. It is common among Turkish people to have iftar together, either at each other's houses or at restaurants. Assume that during Ramadan people are more likely to dine outside. This would cause a high traffic density before the sunset while people are going to restaurants. Traffic density would be low for 1-2 hours after sunset while people dine, and it would increase afterward while people are returning to their houses. The negative effect of Ramadan on RTAs on working days shows that the overall effect of Ramadan on traffic density is negative. However, there is intra-day variation in the effect of Ramadan on traffic density, which can be exploited to find the true causal effect of fasting. Assume two agents, the first agent fasts and the second agent does not. In the morning hours, there should not be much difference between the two agents as they are equally well nourished (sunrise is not far before the usual breakfast times). However, at noon Agent 2 has lunch and Agent 1 does not due to abstinence. Then, Agent 1 becomes less nourished and more dehydrated then the Agent 1 (I assume away occasional water inputs for simplicity, which could cause additional difference between Agent 1 and Agent 2). If hunger and dehydration affect the likelihood of accidents, I should observe it starting from after lunch hours (after 14:00). The effect should increase as time passes due to the increase in the hunger and dehydration levels. Whereas the effect of fasting on RTAs should increase as time passes, the effect of fasting on traffic density can be negligible around 16:00-18:00 as working people who constitute the majority of the society and possibly of the drivers will leave work around those times. In other words, even if Ramadan has a certain effect on the traffic density that I cannot think of, it should be fairly negligible around 16:00-18:00 as the majority of the drivers at this time are workers who leave work, and their behavior is not affected by the Ramadan month as the official working hours are not changed in Turkey during the Ramadan month. If fasting causes an increase in the likelihood of accidents around that time, it can be considered as the true effect of fasting on RTAs.

More formally, I estimate the following equation:

$$RTA_{h1-h2,t} = \beta_0 + \beta_1 \quad Ramadan_t + \gamma \quad W_t + \epsilon_t \tag{6}$$

where $RTA_{h1-h2,t}$ is the number of RTAs between hours h1 and h2 at day t, W is the month and year fixed effects. This way, I can see the intra-day variation in the effect of Ramadan. For each hour interval of the day (e.g. 00:00-00:59) I estimate this model using OLS.

Table 5: The effect of Ramadan on RTAs on different hours of the day

00:00-00:59	01:00-01:59	02:00-02:59	03:00-03:59	04:00-04:59	05:00-05:59	06:00-06:59	07:00-07:59
-0.594***	-0.908***	-1.279***	-0.941***	-0.887***	-0.602***	-0.688***	-1.894***
(0.173)	(0.142)	(0.106)	(0.100)	(0.0933)	(0.0955)	(0.127)	(0.198)

08:00-08:59	09:00-09:59	10:00-10:59	11:00-11:59	12:00-12:59	13:00-13:59	14:00-14:59	15:00-15:59
-2.773***	-1.659***	-1.745***	-1.395***	-1.200***	-0.318	1.388***	2.247***
(0.231)	(0.219)	(0.233)	(0.229)	(0.264)	(0.277)	(0.294)	(0.314)

16:00-16:59	17:00-17:59	18:00-18:59	19:00-19:59	20:00-20:59	21:00-21:59	22:00-22:59	23:00-23:59
3.047***	1.360***	1.933***	0.697*	-1.528***	-0.789***	0.183	-0.258
(0.312)	(0.315)	(0.323)	(0.316)	(0.256)	(0.215)	(0.208)	(0.218)

Note: Sample restricted to working days, Robust standard errors in parenthesis

Table 5 shows the effect of Ramadan on RTAs on different one-hour periods of the day (Graphical illustration can be seen on figure 2).[15] Notice that between midnight and 13:00, Ramadan has a negative and significant effect on RTAs. As explained earlier, people drink less alcohol and go out less during the Ramadan month, which decreases the RTAs. I had expected to find the effect of fasting on RTAs after the lunchtime (that is when people start getting hungrier and more dehydrated compared to non-Ramadan days), and this is what the data show. Between 14:00-14:59, Ramadan increases RTAs by 1.4 accidents, and this effect is statistically significant at 0.1%. Between 15:00-15:59, this effect increases to 2.25 accidents, and

[15] the straight line is the coefficient estimate of the Ramadan's effect, and the dashed lines are the 95% confidence intervals of the effect.

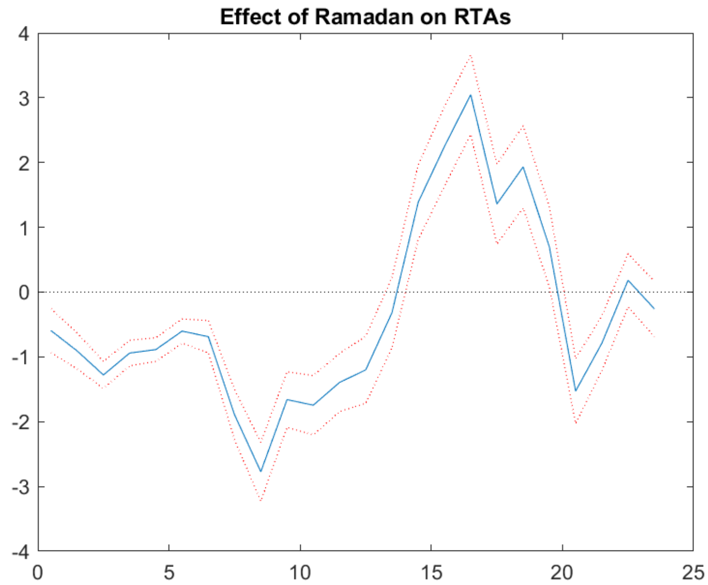

Figure 2: Hourly variation in the effect of Ramadan

between 16:00-16:59, it increases to 3 accidents. The positive and significant effect continues until 20:00, after which I again observe a negative and significant effect. This is because many people are dining instead of driving after sunset, which decreases the traffic density and hence decreases the RTAs.

It is not a coincidence that the sign of the effect of Ramadan changes between 19:00-19:59 to 20:00-20:59. In most of my sample, the sunset occurs around 19:30, which explains the decrease in RTAs after 20:00. This also causes an upward bias in the effect of Ramadan on 19:00-19:59 interval as more people might be in traffic to go to restaurants. Nonetheless, the positive and highly significant effect of Ramadan on RTAs between 14:00-18:00 cannot be explained by any change in traffic density, which provides strong evidence that fasting increases the likelihood of accidents.

The intra-day variation of the effect of fasting on the likelihood of attention has allowed me to identify the average effect of fasting on RTAs. My findings suggest that fasting decreases agents' attention levels, which increases their likelihood of causing accidents. It is important to note that both fasting's effect on RTA and Ramadan's effect on traffic density changes by month. As days get longer, the period of abstinence increases. Summer months are also warmer, which causes more dehydration, and therefore can further decrease agents' attention levels. Hence, the intensity of the effect of Ramadan might depend on the month. On the other hand, the variation in the timing of sunset across months can create bias in certain estimates of table 5.

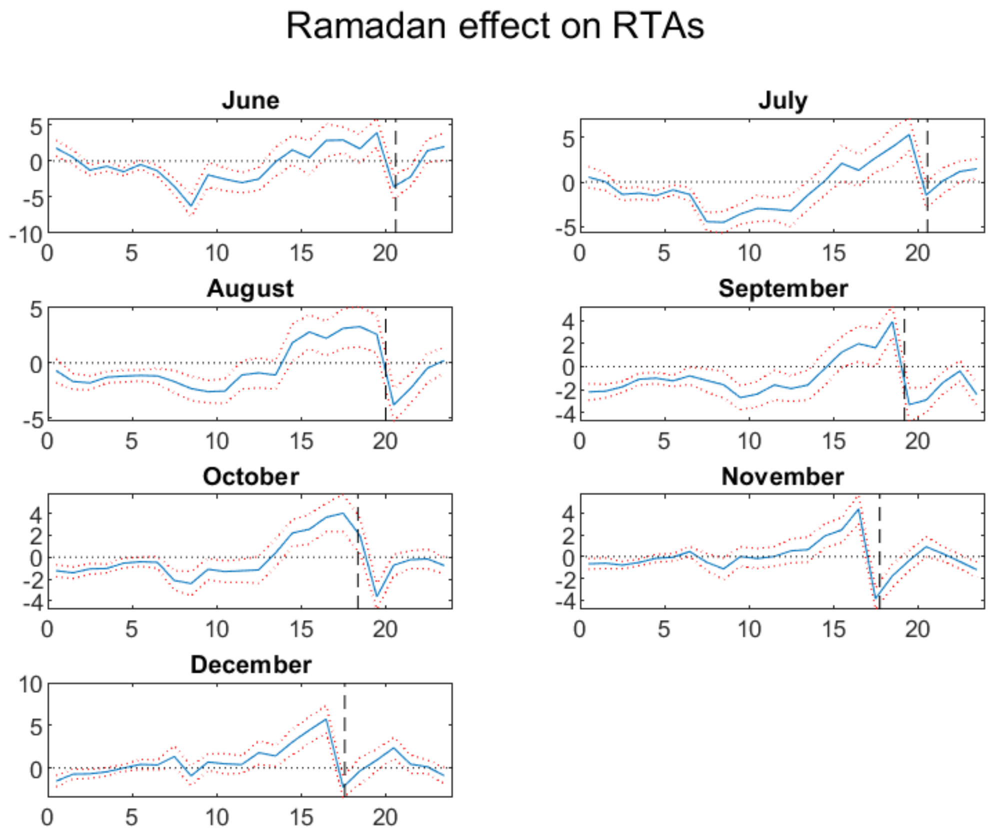

Figure 3: Hourly variation in the effect of Ramadan on RTAs for different months

For instance, I showed that the average effect of fasting on RTAs on 18:00-18:59 and 19:00-19:59 were positive and significant. However, in December sunset takes place around 16:30, hence the traffic density and therefore the number of RTAs should be lower around that time. This can cause bias in the estimates. Hence, in order to find the true effect of fasting on RTAs, I must look at near work-end hours that are not close to the sunset period. I do it by analyzing the effect of Ramadan on each hour interval of the day for each month in my sample. Formally, I improve the equation 6 by allowing the Ramadan treatment to interact with month dummies. The results are shown on table 6 and on figure 3. The effects during May and January are omitted due to data limitations.[16]

In Figure 3, the dashed vertical line is the timing of the sunset on the 15th day of the month in Istanbul in 2015, the straight line is the coefficient estimate of the Ramadan's effect, and the dashed lines are the 95% confidence intervals of the effect. The figure provides concrete evidence for how Ramadan, fasting in particular, affects the RTAs. First of all, notice that in all months

[16] Ramadan treatment occurs only thrice in May and four times in January in my whole sample

Table 6: Effect of Ramadan on different hour-month periods

	Jun	Jul	Aug	Sep	Oct	Nov	Dec
13:00-13:59	-0.105	-1.049	-1.100	-1.609*	0.393	0.637	1.420*
	(1.049)	(0.812)	(0.642)	(0.675)	(0.654)	(0.586)	(0.623)
14:00-14:59	1.546	0.121	1.829*	-0.157	2.213***	1.889***	3.048***
	(1.018)	(0.821)	(0.855)	(0.764)	(0.622)	(0.565)	(0.761)
15:00-15:59	0.475	2.084*	2.800***	1.260	2.559***	2.443***	4.446***
	(1.207)	(1.010)	(0.783)	(0.685)	(0.692)	(0.581)	(0.793)
16:00-16:59	2.860*	1.312	2.226**	2.005*	3.655***	4.356***	5.728***
	(1.164)	(0.907)	(0.796)	(0.795)	(0.663)	(0.676)	(0.817)
17:00-17:59	2.906**	2.698***	3.122***	1.639	4.026***	-3.852***	-2.245***
	(0.921)	(0.798)	(0.914)	(0.849)	(0.870)	(0.503)	(0.621)
18:00-18:59	1.716	3.921***	3.279***	3.926***	1.979*	-1.773***	-0.342
	(1.009)	(1.079)	(0.934)	(0.682)	(0.829)	(0.537)	(0.798)
19:00-19:59	3.934***	5.299***	2.581**	-3.326***	-3.616***	-0.359	0.933
	(1.020)	(0.933)	(0.865)	(0.743)	(0.593)	(0.479)	(0.642)
20:00-20:59	-3.554***	-1.466*	-3.807***	-2.925***	-0.727	0.902	2.359***
	(0.856)	(0.721)	(0.752)	(0.557)	(0.499)	(0.474)	(0.628)
21:00-21:59	-2.181**	0.123	-2.306***	-1.404**	-0.225	0.257	0.447
	(0.666)	(0.746)	(0.667)	(0.501)	(0.416)	(0.342)	(0.550)
22:00-22:59	1.438	1.172*	-0.468	-0.380	-0.159	-0.455	0.139
	(0.827)	(0.587)	(0.681)	(0.460)	(0.455)	(0.332)	(0.397)
23:00-23:59	1.992*	1.470*	0.216	-2.442***	-0.768	-1.209***	-0.908
	(0.966)	(0.573)	(0.587)	(0.501)	(0.395)	(0.352)	(0.492)

Effects on May and January are not reported because of data limitations (in summer months in particular), there is a statistically significant decline in the number of RTAs at night time. This is not the effect of fasting, but rather the cultural effect of Ramadan on RTAs. During Ramadan, alcohol sales drop substantially (alcohol is prohibited in Islam), people go out less at night, and even if they do, they do not consume alcohol as much. We see this effect as a decrease in RTAs at night time. The reason why this effect is more visible in the summer months than in November or December is that due to the weather conditions, people do not go out at night as much during winter than in summer. Summer is the vacation time for schools including higher education, hence it is more convenient to go out even in working days. In normal times, this creates an increase in RTAs. When Ramadan occurs during the summer months, it decreases substantially the going out motive of people, which decreases the traffic density, the number of drivers under influence, and consequently the number of RTAs. Ramadan has a similar effect on winter months, but people do not go out as much during winter months in normal times as well, hence Ramadan has a relatively small effect. Second, realize that the negative and significant effect of Ramadan in early hours of the day becomes positive in all months around 15:00. As previously explained, this is when we would expect the effect of hunger and dehydration to start affecting attention levels during Ramadan. The effect of Ramadan changes sign abruptly near the sunset because of the dining habits. During iftar, roads are mostly empty as culturally people dine together at iftar. This results in a negative and significant effect on RTAs. In other words, figure 4 shows evidence for the intuition I have provided in the previous sections as it provides the cleanest picture which allows me to detect the effect of Ramadan on traffic density and the effect of fasting on RTAs separately.

The positive effect of Ramadan just 30-60 minutes before the sunset can be misleading as more people might be in traffic to reach their destinations for the iftar, or people might be speeding to reach iftar in time, both of which would increase RTAs. However, we see a positive and significant effect for 4-5 hours leading to the sunset, which cannot solely be explained by the effect of Ramadan on traffic density. This positive and significant effect between 15:00-18:59 especially in summer months when sunset is after 20:00 is a strong evidence for the effect of fasting on traffic accidents.

Restricting the analysis to the period 15:00-18:59 where fasting shows its effect independently of sunset effect on summer months, I can show the economic significance of the effect of fasting on RTAs. For the months of June, July, August, and September, for each day Ramadan increases RTAs by 8.0, 10.0, 11.4, and 8.8 accidents in that order during the period 15:00-18:59. Considering the mean number of RTAs on these months at that time period, the effect of Ramadan constitutes to a 10%, 11.9%, 13.0%, and 10.1% increase respectively for the months of June, July, August, and September. These are huge effects considering that I am not including accidents that result in only financial costs. Each accident in my sample resulted in injuries and or deaths. Because Ramadan month lasts for 30 days on average. if Ramadan takes place during August only, in total it would increase RTAs by 300 accidents that resulted in injuries and or deaths on average.

4.6 City-wise Differences in the Effect of Ramadan

There are 81 cities in Turkey located in 7 regions. There is considerable heterogeneity in the cities in terms of purchasing power, population, living standards etc. So far I have ignored these differences and considered Turkey as a whole. In this section, I will exploit these differences to see how the treatment effect of Ramadan varies by cities. The main reason for this analysis is that if the increase in RTAs during Ramadan occurs because of fasting as argued in this paper, then in more conservative cities where more people fast I should be able to detect higher effects of Ramadan. Unfortunately, there is no publicly available dataset that I know of that includes the percentage of people who fast at each city. Even if there were, the data could be biased as even people who do not fast during Ramadan may claim that they do due to social pressure. Instead, I will rely on a proxy: the percentage of votes the incumbent conservative party AKP received in 2011 general elections.

AKP votes can be a proxy conservatism in a city because AKP is a highly conservative party who uses religion as the main cornerstone in its rhetoric. They have a higher percentage of votes in the rural areas of Turkey, which are known to be more conservative from the western cities such as Izmir or Mugla (both cities were won by CHP, the leftist secular party on Turkey). A nice feature of AKP votes from the econometrician's point of view is that AKP votes vary a lot between cities, from 16.2% votes in Tunceli to 69.6% votes in Konya and Kahramanmaras. This can allow the AKP votes to capture the differences in conservatism in different cities of Turkey.

First, to show that the panel results are comparable with the previous results, I estimate the following equation:

$$RTA_{i,t} = \beta_1 \quad Ramadan_t + \gamma \quad S_i + \theta \quad W_t + \epsilon_{i,t} \tag{7}$$

where $RTA_{i,t}$ is the number of RTAs in city i at time t (time t can be day t of a specific hour at day t), S_i are the state fixed effects, W_t are the month and year fixed effects. In this section, I always cluster by state to estimate the standard errors. the Figure 4 shows the intra-day

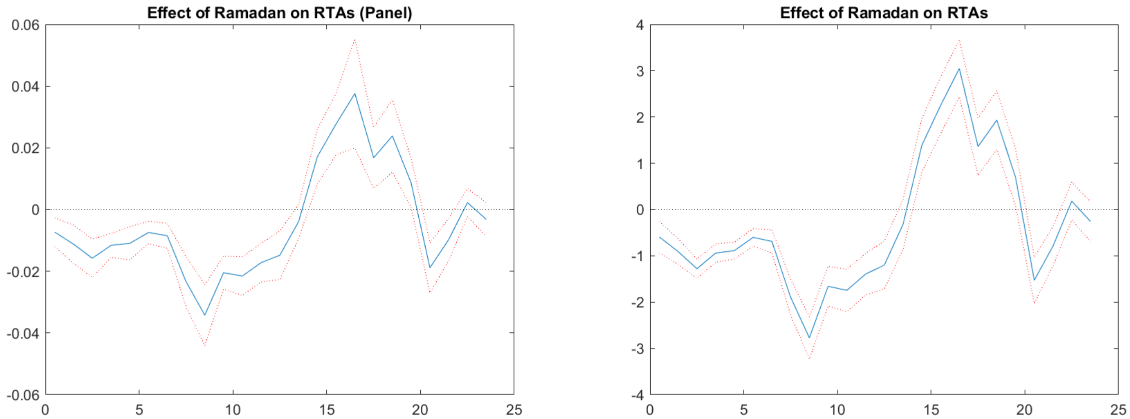

Figure 4: Effect of Ramadan on RTAs (Panel Estimates and Pooled Estimates)

variation of the effect of Ramadan for RTAs for both Panel and previously shows Turkey data. Notice that the graphs are almost identical, which validates that the results in previous and current section are comparable.

Next, I allow the Ramadan treatment to interact with the AKP votes in 2011.[17] If AKP votes in a city is correlated with the percentage of people who fast during Ramadan, and if the positive effect of Ramadan during the afternoon hours is the treatment effect of fasting, then we would expect to see an increased effect of Ramadan in cities where AKP has higher votes. Formally, I estimate the following equation:

$$RTA_{i,t,h1-h2} = \beta_0 + \beta_1 \quad R_t + \beta_2 \quad R_t \quad AKPvote_i + \gamma \quad S_i + \theta \quad W_t + \epsilon_{i,t} \qquad (8)$$

where $RTA_{i,t,h1-h2}$ is the number of RTAs in state i, day t, and hour period h1-h2, S_i is the state fixed effect, and W_t is month and year fixed effects. Similar to the previous section, I estimate this model with OLS for each hour interval during the day. In this specification, there are two coefficients of interest: β_1 which captures the effect of Ramadan on a hypothetical city where no one has voted for AKP in 2011, and β_2 which captures how much the treatment effect of Ramadan changes by the percentage of AKP votes. Hence, in each graph, I plot the β_1 on the left-hand side and β_2 on the right-hand side.

Figure 5 reveal a striking image. Looking at the left panel, we see that in a hypothetical city where AKP got no votes, the Ramadan does not have any positive effect on the RTAs. In fact, zero is inside the 95% confidence interval in almost all hours except the night time. That has

[17] Tables 18, 19, and 20 in the appendix shows the percentage of AKP votes in each city in Turkey

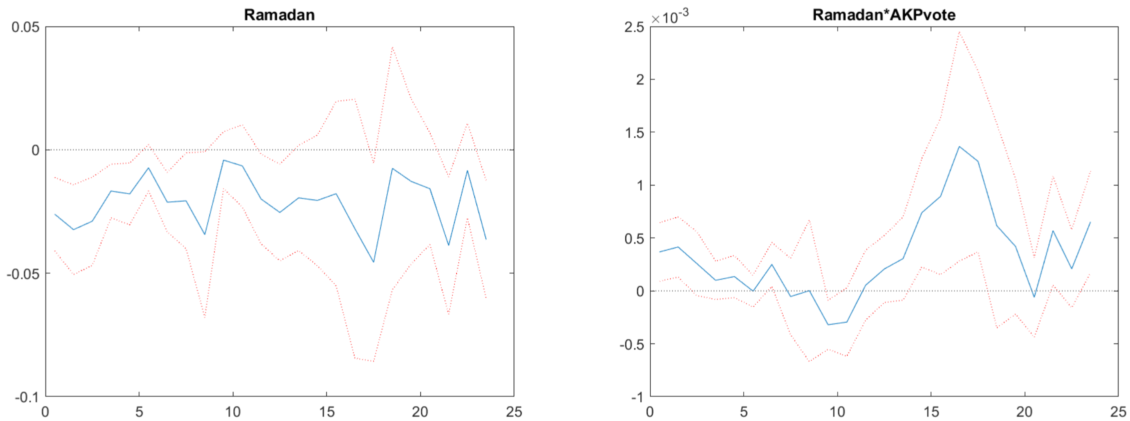

Figure 5: Variation in the Effect of Ramadan depending on the AKP votes

to do with the behavior patterns of Turkish people. Even the people who are not very religious and who do not fast prefer to go out less at night during the Ramadan month. The month of abstinence, even if it does not cause certain people to fast, has a general abstinence effect in the culture. This results in a decrease in RTAs. The right panels show that as the AKP votes increase in a city, the treatment intensity of Ramadan increases. If AKP votes is a good proxy for the level of conservatism in a city, then this correlation can be interpreted as a causal relationship.

Overall, the analysis in this section shows that the effect of Ramadan on RTAs is not homogenous, it depends on the level of conservatism in a city as expected. As the increase in RTAs arises from people who fast, if a bigger percentage of people in a city fast, then we would expect to see a higher treatment effect of Ramadan, which is justified by the data.

4.7 The effect of Ramadan on RTAs (Un)related to alcohol Consumption

As previously mentioned, the Turkish dataset partially allows for the tracking of alcohol related accidents. If the police checks for the BAC count at the accident scene, then the results are provided in the dataset. However, if the drivers are rushed to the hospital, then the dataset does not include the BAC count taken at the hospitals. There is no way that I know of to infer what percentage of alcohol related accidents are captured by the dataset using the dataset itself. Therefore, the exact numbers in this section should be taken with a grain of salt. The reason why I study this link the last is that the main findings of this paper do not rely on the identification of alcohol related accidents. This section only serves to enrich the results already established in this paper.

The capability of observing alcohol related and unrelated accidents separately allows me to (1) document the differences in the Ramadan's effect on alcohol related and unrelated accidents, and (2) obtain a second proxy for the conservatism in a given city. Assume two cities A and B. Assume that city A is more conservative than city B. Then, I would expect more alcohol to be consumed in city B than city A. Consequently, a higher percentage of RTAs should be related to alcohol in city B than city A. I can use the percentage of alcohol related accidents to all accidents for each city as a proxy for the conservatism level of that city. If the positive treatment effect of Ramadan in the afternoon hours is weaker in cities with a high percentage of alcohol related RTAs, then this can be used as further proof that the positive effect of Ramadan is driven by fasting.

The problem with alcohol related RTAs in Turkish Data does not threaten the internal validity of the regression analyses under one weak assumption:

Assumption 1 *The percentage of unobserved alcohol related accidents is the same during Ramadan and non-Ramadan months*

To understand why this assumption is needed, let RTAs to be driven simply by two different means for Ramadan and nonRamadan months. Let the mean of the data generating process during Ramadan be 10, and 20 for the remaining days. This means that alcohol related accidents decrease by 10 units, or by 50% during Ramadan. Further assume that x% of the accidents is actually captured by data, for simplicity let x=50. Then, we would observe in the data a data generating process with a mean of 5 in Ramadan days and 10 in other days. Hence, we would conclude that Ramadan decreases alcohol related RTAs by 5 units, or by 50%. The unit inference is wrong by a factor of x, but the percentage inference is correct so long as x does not vary between Ramadan and non-Ramadan days. This requires that the same percentage of drivers in RTAs are rushed to the hospital during Ramadan and nonRamadan day.

Using the Turkish dataset, I categorize accidents that involve at least one driver who had nonzero BAC as an alcohol related accident and BAC above 0.50 (the legal limit in Turkey) as a drunk driving related accident. Then, I estimate the main specification by restricting the sample to working days only, this time by using RTAs, RTAs that include at least one driver with positive BAC (RTA_alc), RTAs that include at least one drunk driver (RTA_drunk), and RTAs that don't include drivers with positive BAC (RTA_noalc). The results are given on the first three columns of table **??**. With sample restricted to official working days, Ramadan decreases RTAs by 8.6 accidents, alcohol related accidents by 3.26 accidents and RTAs unrelated to alcohol by 5.35 accidents on average. These effects are statistically significant at 5%. Notice that the statistical significance of the negative effect of Ramadan on RTAs drop if alcohol related accidents are not counted. This is in line with the argument that people consume less alcohol during Ramadan and hence have relatively fewer RTAs during the Ramadan month. This effect was also visible in the summary statistics in table 1. The relatively low estimate of the effect of Ramadan on alcohol related accidents does not imply that alcohol related accidents are affected less by Ramadan as the number of alcohol related accidents is low in general. Table 1 shows that on average there are 7.08 alcohol related accidents and 265.52 non-alcohol related accidents in Turkey. This implies that Ramadan decreases alcohol related accidents by almost half, whereas non-alcohol related accidents drop by around 4% as seen in column 6 (log specification for alcohol related accidents cannot be made due to the zero entries in alcohol related accidents vector).

Table 7: Effect of Ramadan with different specifications

Specification	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	RTA	RTA_alc	RTA_drunk	RTA_noalc	logRTA	logRTA_noalc
treatment	-8.602***	-3.257***	-2.038***	-5.345*	-0.0522***	-0.0412***
	(2.196)	(0.124)	(0.0979)	(2.176)	(0.00725)	(0.00731)
Month F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
N	4499	4499	4499	4499	4499	4499

Distinguishing the alcohol related and unrelated accidents enable me to show that (1) alcohol related accidents drop around half during Ramadan, whereas not alcohol related accidents drop only by 4% on average. Hence, as claimed in the previous sections, one major component of the drop in total RTAs is the drop in alcohol related accidents during the Ramadan. Still, during the day on average Ramadan causes a significant drop in RTAs unrelated to alcohol, which is driven by the unobserved traffic density. Following the methods used in the previous section, I estimate the effect of Ramadan on RTAs related and unrelated to alcohol for every hour interval of the day to see the intraday variation of the effects. In other words, I estimate equation 6 for alcohol related and unrelated accidents separately, which are shown on figure 6. The graph on the left shows that there is no positive effect of Ramadan on alcohol related accidents. Mostly, there are negative and significant effects which are mostly located at night

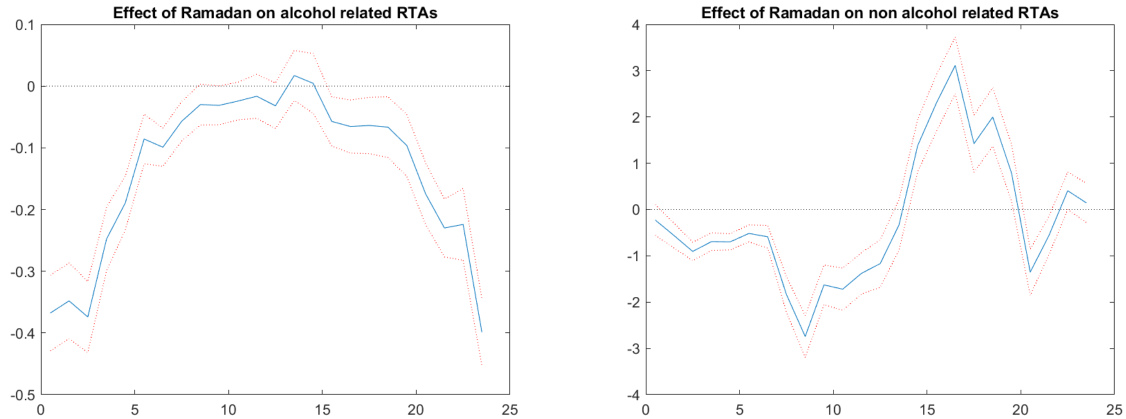

Figure 6: Effect of Ramadan on alcohol related and unrelated RTAs

hours. This is intuitive as alcohol related RTAs occur mostly at night time. As people do not go out to drink during the Ramadan month, the alcohol related accidents drop substantially. The graph on the right shows the effect of Ramadan on RTAs unrelated to alcohol. It highly resembles 2. Even with RTAs unrelated to alcohol we see a decline in RTAs at nighttime. This is because of two reasons. First, I do not observe all of the alcohol related accidents. Hence, some part of the drop in alcohol related accidents will be captured in the right graph. Notice that assumption 1 does not eliminate this bias because I am working in absolute terms, not in percentages. Hence the uncaptured drop in alcohol related accidents is likely to be a major part of the drop at night time in alcohol unrelated accidents. Second, people also do not go out at night during Ramadan, which decreases the traffic density and hence the number of RTAs. Consequently, even if all alcohol related accidents were purged from the right graph, the drop at night time can be observed.

A log specification can allow for interpretation in terms of percentages, but it is problematic for most of the regression specifications because of the zero entries. In my dataset, there are one-hour intervals on certain days when there were no RTAs recorded in Turkey, especially at night time. However, in the afternoon hours this is not a problem (as can be seen in tables 13 and 17), which allows for log specification. Also, the effect of fasting on RTAs is most visible in the afternoon hours. Hence, I estimate equation 6 for both RTA and RTA_noalc for the hour intervals between 14:00-17:00. Table 8 provides the results. Notice that for each hour interval, purging out the alcohol related accidents increases the treatment effect of fasting. The effect arises to 18.2% in the hour interval of 16:00-17:00.

Table 8: Log Specification for afternoon hours for RTA and RTA_noalc

Specification	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	RTA_14-15	RTA_noalc_14-15	RTA_15-16	RTA_noalc_15-16	RTA_16-17	RTA_noalc_16-17
treatment	0.0870***	0.0877***	0.130***	0.133***	0.178***	0.182***
	(0.0175)	(0.0175)	(0.0163)	(0.0163)	(0.0161)	(0.0162)
Month F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
N	4499	4499	4499	4499	4499	4499

The reason why I did not include hours after 17:00 is because in winter months iftar occurs around 17:00, and as shown before the number of RTAs drop significantly around iftar because the majority of people are dining instead of driving. This problem can be avoided by looking at the Ramadan's effect separately for each month, using a variation of the equation 6 by allowing the Ramadan treatment to interact with month dummies. Table 9 summarizes the results. Coefficients in each row stand for the estimated effect of Ramadan for that month and that hour interval. Figures 7 and 8 show the confidence interval for the effect of Ramadan for separate months on RTAs and RTAs unrelated to alcohol. The vertical dashed line is the timing of sunset on the 15th day of that month in 2015 in Istanbul. In June and July, no significant effect can be detected. There are a few reasons for this phenomenon. First, once the vacations are dropped out of the sample, there are only 46 Ramadan observations in the month of June, whereas in other months there are around 56-58 observations, more than 20% more. This is because Ramadan occurred in 2018 and will occur in 2019, on June. Lack of observations is one potential explanation. In terms of statistical significance, figure 3 provides a more complete picture. Figures 7 and 8 are useful to see the percentage increase in RTAs that occur due to fasting. The estimates near sunset can be misleading due to people's driving habits around iftar. If people are rushing to get home, this will cause an increase in RTAs unrelated with fasting. However, positive and significant effects occur long before the sunset in most months. As explained before, the positive increase can happen due to two reasons: lack of nutrition (fasting), and increased traffic density. Whereas traffic density can increase 1-2 hours before iftar, it is unlikely to have an increasing effect on traffic density around 14:00-iftar. Hence, the positive and significant effect observed in the months of August, September, and October in afternoon hours, and especially at 17:00-18:00 hour interval (effect in July is significant at 10%) provides evidence for the effect of fasting. This effect can raise to 30% in October. In August

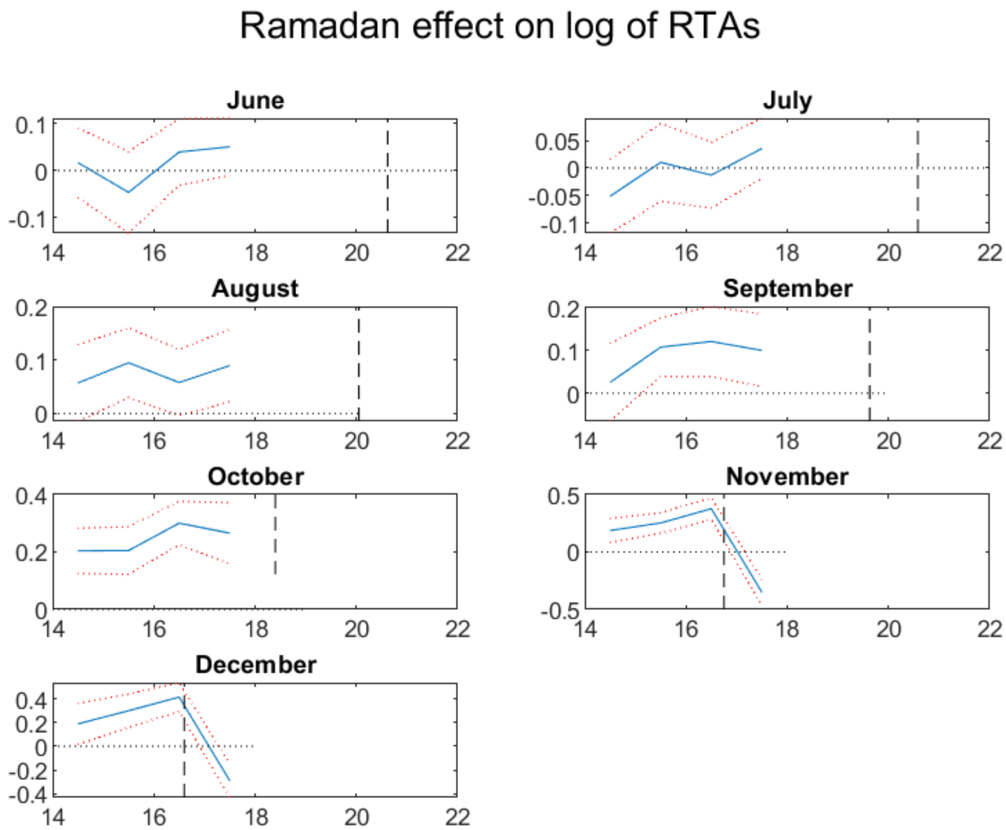

Figure 7: Hourly variation in the effect of Ramadan on log of RTAs for different months

and September effect is around 10%.

As explained at the beginning of this section, the percentage of alcohol related accidents in a city can be used as a proxy to capture the overall conservatism of that city. I accept the fact that this proxy is noisy. Alcohol sales and alcohol related accidents are related, but definitely not one-to-one. Even if no major problem arises from that channel, the power of predicting the likelihood of fasting from alcohol consumption is low. Whereas highly religious people in Turkey do not consume alcohol and fast regularly (true positive), there are people who consume alcohol and fast during Ramadan (false negative), and who do not consume alcohol and do not fast during Ramadan (false positive). Furthermore, assumption 1 which was essential for the previous results is not sufficient, it must hold not for Turkey as a whole but for each city separately. More formally:

Assumption 2 *The percentage of unobserved alcohol related accidents does not vary across cities or across Ramadan and non-Ramadan days.*

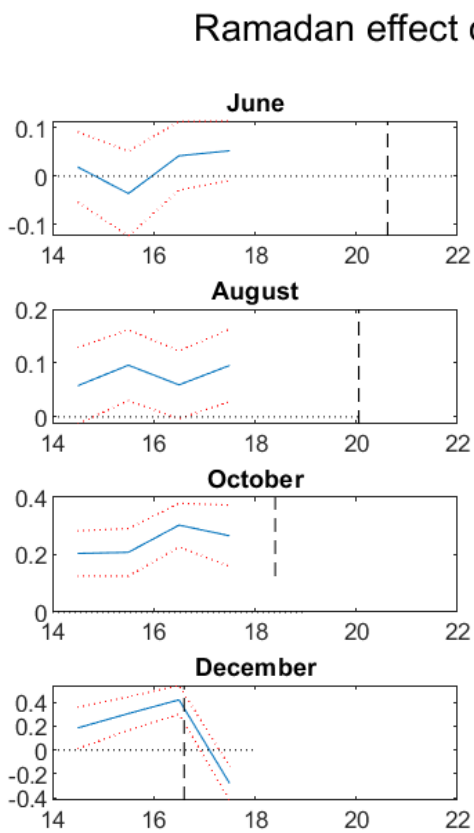

Figure 8: Hourly variation in the effect of Ramadan on log of RTAs unrelated to alcohol for different months

Table 9: Log Specification for afternoon hours for RTA and RTA_noalc for different months

	All RTAs				Alcohol Unrelated			
	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00
June	0.017	-0.046	0.039	0.050	0.019	-0.036	0.042	0.052
	(0.038)	(0.044)	(0.036)	(0.031)	(0.037)	(0.045)	(0.036)	(0.031)
July	-0.052	0.010	-0.013	0.036	-0.052	0.013	-0.012	0.039
	(0.034)	(0.036)	(0.031)	(0.028)	(0.034)	(0.036)	(0.031)	(0.028)
August	0.057	0.095	0.058	0.090	0.058	0.096	0.060	0.096
	(0.036)	(0.033)	(0.032)	(0.034)	(0.036)	(0.034)	(0.032)	(0.034)
September	0.025	0.107	0.120	0.100	0.029	0.108	0.128	0.106
	(0.046)	(0.035)	(0.042)	(0.043)	(0.046)	(0.035)	(0.042)	(0.043)
October	0.204	0.205	0.300	0.266	0.205	0.208	0.303	0.266
	(0.040)	(0.042)	(0.039)	(0.0549	(0.040)	(0.042)	(0.039)	(0.055)
November	0.187	0.253	0.377	-0.351	0.185	0.256	0.384	-0.349
	(0.053)	(0.045)	(0.048)	(0.057)	(0.054)	(0.045)	(0.048)	(0.057)
December	0.189	0.300	0.415	-0.291	0.186	0.306	0.422	-0.280
	(0.088)	(0.072)	(0.062)	(0.072)	(0.089)	(0.071)	(0.061)	(0.072)

Standard errors in paranthesis

Assumption 2 has two components. First, it fixes the percentage of unobserved alcohol related accidents in each city. If this part holds, then the prior analyses can be done for each city separately and percentage-wise inference would be valid for each city separately. The second part of assumption 2 has to do with the correct ranking of cities, i.e. the power of the proxy variable. For illustration purposes, let city A and B have 20 accidents per day on average. City A has 10 alcohol related RTAs and 10 unrelated ones, and city B has 4 alcohol related RTAs and 16 unrelated ones. Also, of the 10 alcohol related accidents in city A, let only 10% be captured, and of the 4 accidents in city B, let 50% be captured. This would be a violation of the second part of assumption 2. Looking at the data, we would see that city A has 1 alcohol related accident out of 20 and city B has 2 alcohol related accidents out of 20, which would lead us to conclude that city A is more conservative than city B, which is wrong.

Under assumption 1 and 2, I allow the Ramadan treatment to interact with alc_state, i.e. the percentage of alcohol related RTAs in a given state. The claim is that if a state has a higher percentage of alcohol related RTAs, then people in that city are more likely to be drinking alcohol, which means that on average they are less religious, and hence I expect them to fast less. This should result in the treatment effect of Ramadan to be higher in cities where the

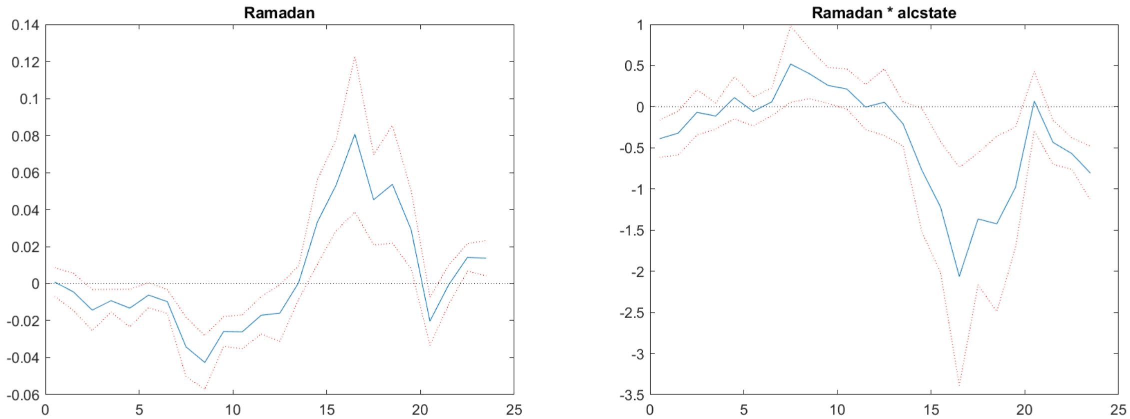

Figure 9: Variation in the Effect of Ramadan depending on the percentage of alcohol related RTAs

percentage of alcohol related accidents is lower. Formally, I estimate the following equation.

$$RTA_{i,t,h1-h2} = \beta_0 + \beta_1 \quad R_t + \beta_2 \quad R_t \quad alc\_state_i + \gamma \quad S_i + \theta \quad W_t + \epsilon_{i,t} \tag{9}$$

where $RTA_{i,t,h1-h2}$ is the number of RTAs in state i, day t, and hour period h1-h2, S_i is the state fixed effect, and W_t is month and year fixed effects. Similar to the previous section, I estimate this model with OLS for each hour interval during the day. I also use four different measures of RTAs, which are total RTAs, alcohol unrelated RTAs (RTA_noalc), log of 1+RTAs, and log of 1+RTA_noalc. In this specification, there are two coefficients of interest: β_1 and β_2. Hence, in each graph, I plot the β_1 on the left-hand side and β_1 on the right-hand side.

The figures 9, 10 provide evidence that the intuition was correct. First of all, the left-hand side of the figures shows the estimated Ramadan effect for a state that has zero percentage of alcohol related accidents. In such a hypothetical city we would expect people to be highly religious, and hence it is not surprising that we see a positive effect in the afternoon hours. The more interesting part of these figures is the right-hand side graph which shows the estimated coefficient of the interaction variable. Notice that the estimated coefficients for the interaction variable are negative and significant, meaning that if the percentage of alcohol related accidents is higher at a given state, the average effect of Ramadan is smaller. There definitely is a correlation between the percentage of alcohol related RTAs in a given city and the effect of Ramadan. For the reasons explained in the previous paragraph, I claim that this is not merely a correlation but a causal relationship. Alcohol related accidents is a proxy for the level of religious sentiments in a city, which affects the treatment intensity.

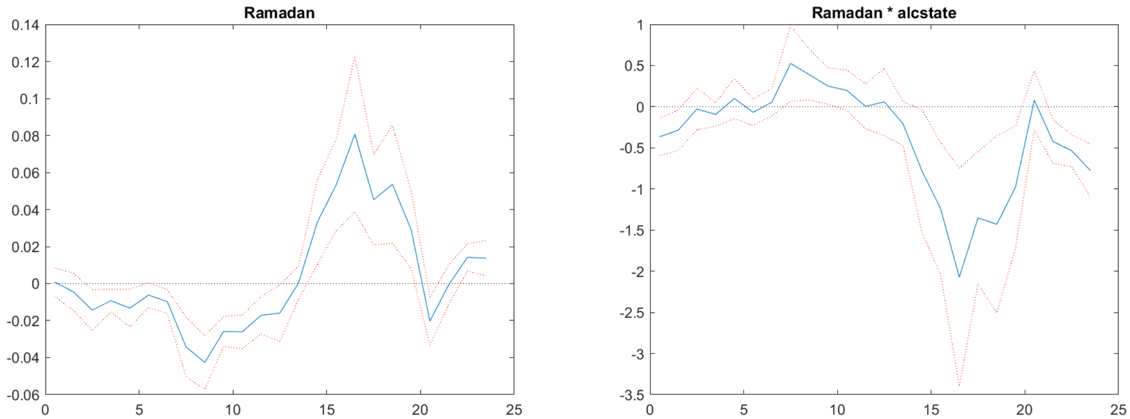

Figure 10: Variation in the Effect of Ramadan depending on the percentage of alcohol related RTAs (RTA_noalc specification)

4.8 Effect of Ramadan on Traffic Intensity

During the paper, I have always stated that traffic density is an unobserved variable which causes bias in the reduced form regressions. This led me to look at the effect of Ramadan on hours when Ramadan is unlikely to have a significant impact on traffic density. Whereas traffic density data in Turkey is mostly not available, it is not nonexistent. In particular, traffic density on major roads in Istanbul has been kept since 2012 (I looked for similar data in other major cities in Turkey, but I could not find data that have a significant span). In this section, I first analyze the effect of Ramadan on the traffic density in Istanbul during the day, and then I use the traffic density information as an additional control variable in equation 6 to see whether the results regarding the effect of Ramadan stays robust. It should be noted that the traffic index in Istanbul is not an ideal proxy for traffic density. Traffic index is a variable between 0 and 100. 0 means that there are almost no vehicles, 100 means all roads are jammed. In both scenarios, we would expect fewer RTAs. A better variable would count the number of cars passing on a road per minute, which would give more information regarding the speed and number of vehicles on that road.

Similar to the previous sections, I drop observations belonging to weekends and official vacations. Formally, I estimate the following equation for the first part:

$$TI_t = \beta_0 + \beta_1 \quad Ramadan_t + \gamma \quad W_t + \epsilon_t \tag{10}$$

where TI_t is the traffic index at time t in Istanbul, $Ramadan_t$ is the treatment, and W_t

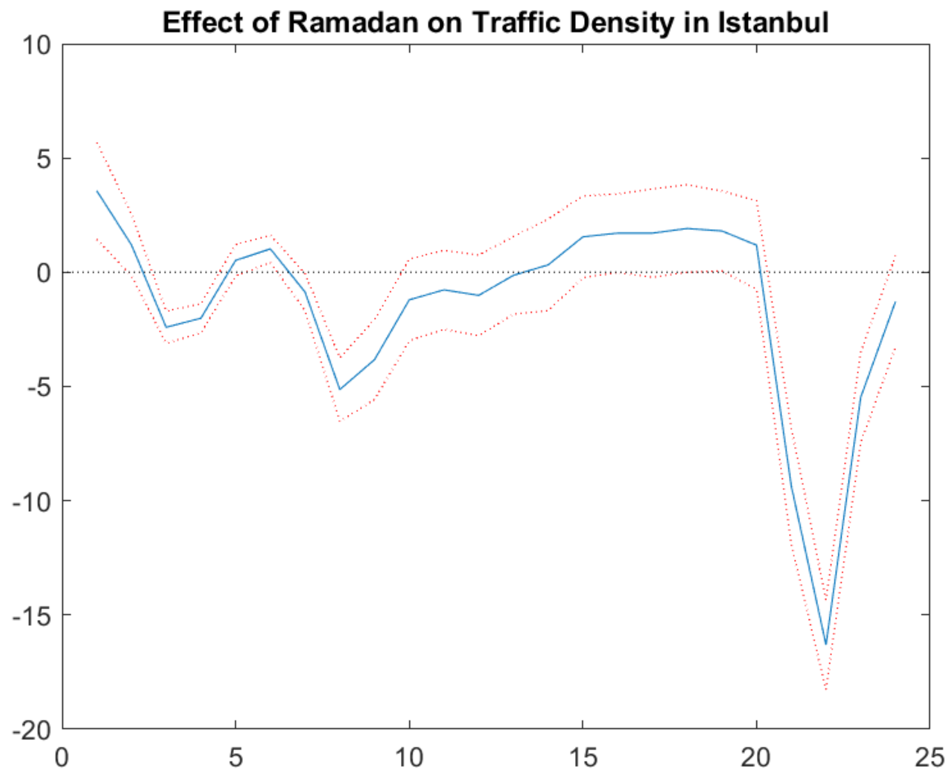

Figure 11: The Daily Variation in the Effect of Ramadan on Traffic Density

consists of month and year fixed effects. I estimate this equation with OLS. Figure 11 shows the daily variation in the mean and the confidence interval of β_1 (Ramadan's effect). Interestingly, there is a positive and significant effect at midnight, which is probably due to people leaving iftar and going back home. The traffic index data in Istanbul is available since 2012, hence Ramadan occurs mostly in months of July and June when the sun sets after 20:00 o'clock. Iftar is a long meal, hence many people leave iftar after 23:00-24:00. In Istanbul, it turns out to be causing a slight increase in traffic intensity for an hour. There are also negative effects around 3-4 am and 8-10 am intervals. Then, there seems to be a positive effect which is significant at 10 % but not 5% in the afternoon hours. However, this is increase is constant in the afternoon hours and is also very small, hence it cannot explain the increasing effect of the Ramadan on RTAs in the afternoon hours (Recall that Ramadan's positive effect on RTAs in the afternoon hours is increasing, not constant). The economically significant drop occurs around sunset, which is caused by the majority of people to be dining at the same time. This explains the decrease in the effect of Ramadan on RTAs around sunset in figure 3.

To show that my conclusion regarding the effect of Ramadan on RTAs remain robust to partially controlling for traffic density, in my panel dataset I first drop observations that do not belong to Istanbul or outside of the span of the traffic density data, and then estimate equation 6. I then add Traffic Index as a control variable and reestimate the equation. I do these two steps using all RTAs and RTAs purged from alcohol related accidents separately. Figure 12 shows the results.

The top left graph shows the estimated effect of Ramadan on RTAs in Istanbul with shortened data. Whereas the mean effect is similar to what I had shown using Turkish data for the afternoon hours, the standard errors are high due to the lack of data and hence no significant effect can be detected. The top right graph shows the estimated effect of Ramadan on RTAs when traffic density information is used as an additional control. Notice that almost nothing changes, which shows either (1) the data at hand is not a good proxy for the traffic density, and/or (2) traffic density does not explain the increase in the RTAs in the afternoon hours. Whereas I have argued for the second option throughout the paper, the first explanation is also a valid point as traffic density information does not change the estimated effect at night time as well. This can be due to several reasons. First, in Istanbul we do not see a significant decrease in RTAs at night time during Ramadan unlike the rest of Turkey. We also do not observe a decline in traffic density at night time in Istanbul. Hence, there is nothing for the traffic density information to explain in Istanbul to begin with. The slight increase in traffic density in the afternoon hours and the sharp decline around sunset could potentially explain part of the effect of Ramadan on RTAs, but it does not seem to be the case. To see it more clearly, I plotted the mean effects in the top two graphs on each other without the confidence intervals, which is shown as the 5th graph at the bottom. The dashed line is the effect with traffic index controlled for. Notice that the lines overlap each other almost perfectly except at 0-2am in the morning. The 3rd and 4th graphs show the effect of Ramadan on RTAs unrelated to alcohol. Because they are mostly the same as the first two graphs they do not need much explanation.

Overall, this section serves to show that having used all the resources available in Turkish data (to the best of my knowledge), the results regarding the effect of fasting on RTAs remain robust.

5 Conclusion

This paper provides causal evidence (for the first time I believe) that fasting during the Ramadan month increases the likelihood of Road Traffic Accidents (RTAs). My identification strategy

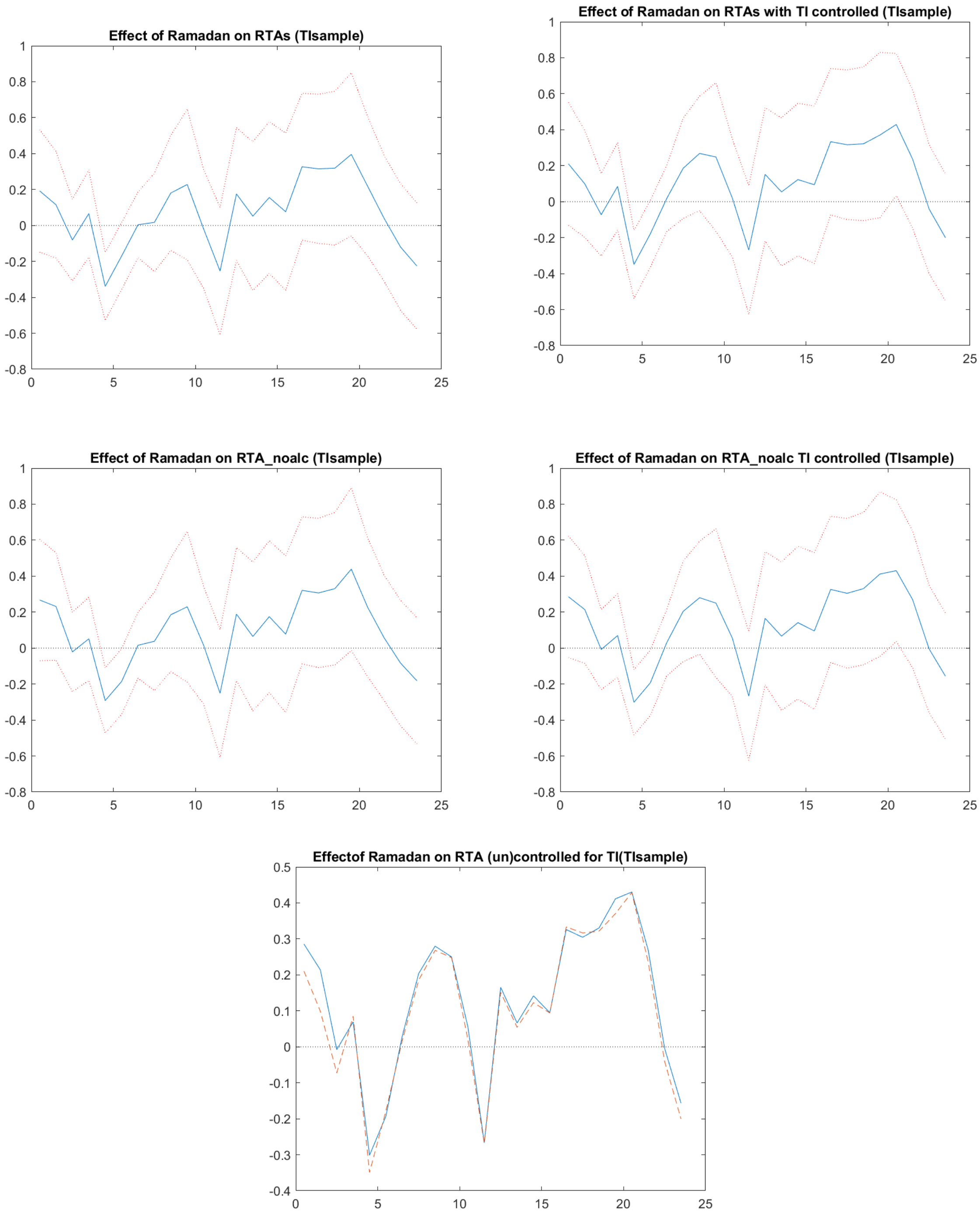

Figure 12: Variation in the Effect of Ramadan with and without traffic index control

exploits both the exogenous variation of the Ramadan month period due to the differences between the Lunar and Gregorian calendars and the variation in the timing of sunset. Using a rich dataset with a long time span of 18 years, I can identify the effects of Ramadan independently of seasonal effects. I show that Ramadan decreases RTAs on average, but this result arises from the effect of Ramadan on the unobserved traffic density. By restricting the sample to working days and focusing on the effect of Ramadan on the time period 15:00-18:59 when Ramadan can have only a minor effect on traffic density (majority of whom are workers who leave work, and whose behavior is not affected by the Ramadan month as the official working hours are not changed in Turkey during the Ramadan month), I show that Ramadan increases RTAs up to 13.0%. The effect is both economically and statistically significant.

The negative effect of Ramadan on the remaining time periods is due to its effect on traffic density as people's driving habits change significantly during the Ramadan month. People go to restaurants more during the Ramadan month for iftar, which increases the traffic density and consequently RTAs before the sunset. People also consume less alcohol and go out less frequently at night, which creates a significant drop in RTAs at night time. By focusing on the work-end hours on working days that are distant from the sunset, I show that fasting increases the likelihood of RTAs independent of the channel through traffic density. I further show that in cities where I expect more people to be fasting due to higher conservatism levels (high AKP votes or low percentage of alcohol related accidents) the effect of Ramadan is stronger, which provides more evidence that the increase in RTAs is due to the fasting behavior of agents. Hence, I provide robust empirical evidence that fasting increases the likelihood of accidents.

My findings underscore the importance of considering religious practices as determinants of RTAs, injuries, and deaths related to trauma. They also point out to important policy work because Ramadan affects a significant fraction of the world population (1.6 billion Muslims) directly and those who live nearby indirectly. Academic research examining the effects of Ramadan in various frameworks is scarce and I believe this is a fruitful research area for many disciplines.

Lastly, my findings suggest a direct link between fasting and the likelihood of accidents, which can be used as evidence for the claim of Denmark's Prime Minister. A bus driver who fasts during Ramadan can be more likely to cause an accident, but so might be a bus driver who is following a regime program to lose weight. Whether the society should distinguish between the fasting practices of a Muslim and the weight-loss efforts of an average person is out of the scope of this paper. I show that fasting increases the likelihood of accidents. How societies can benefit from this information must be discussed and analyzed thoroughly.

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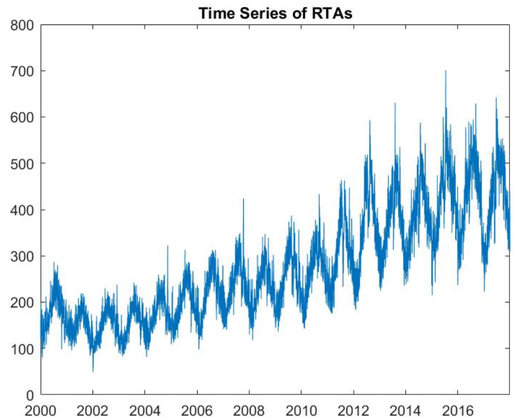
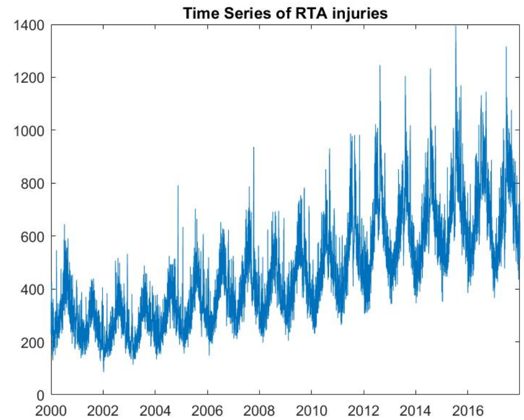
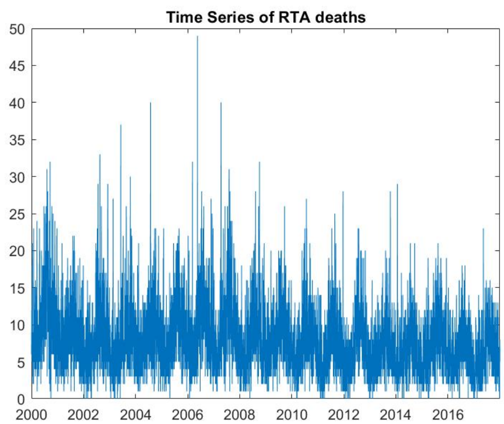


(a) Number of RTAs



(b) Number of injuries



(c) Number of deaths

Figure 13: Time Series Graphs of RTAs, injuries and deaths

A Data

Figure 13 shows how the number of RTAs, injuries and deaths change over time. Data show monthly seasonality for the number of RTAs, injuries, and deaths; and a trend in the number of RTAs and injuries. The number of deaths doesn't have a trend. This may be due to several reasons, better road conditions, better car safety etc. The monthly seasonality of the data shows the importance of using a large dataset to examine the RTAs. With data of relatively short span, month fixed effects cannot be eliminated, which eliminates the potential for causal inference. Table 10 shows the regression results of the number of RTAs, injuries, and deaths on the month dummies.

Table 10: Regression results for month fixed effects

	(1) noofaccidents	(2) noofinjuries	(3) noofdeaths
jan	-41.06***	-61.36***	-0.937***
	(4.889)	(8.015)	(0.241)
feb	-39.30***	-64.76***	-1.203***
	(5.181)	(8.276)	(0.233)
mar	-18.63***	-44.04***	-1.013***
	(5.340)	(8.467)	(0.236)
apr	12.17*	4.032	-0.350
	(5.968)	(9.465)	(0.240)
may	37.24***	50.63***	0.450
	(5.967)	(9.734)	(0.245)
jun	64.06***	114.6***	2.035***
	(6.220)	(10.48)	(0.262)
jul	87.09***	185.6***	3.550***
	(6.414)	(11.13)	(0.280)
aug	90.51***	192.5***	3.925***
	(6.368)	(10.81)	(0.282)
sep	78.64***	147.8***	2.409***
	(6.445)	(10.97)	(0.270)
oct	50.55***	81.12***	1.710***
	(5.976)	(9.819)	(0.261)
nov	25.84***	39.97***	1.048***
	(5.835)	(9.357)	(0.251)
_cons	243.3***	405.9***	6.826***
	(3.721)	(5.891)	(0.178)
N	6575	6575	6575

Standard errors in parentheses

* $p < 0{:}05$, ** $p < 0{:}01$, *** $p < 0{:}001$

Table 11: Regression results for day of the week fixed effects

	(1) noofaccidents	(2) noofinjuries	(3) noofdeaths
tue	-9.471	-20.48*	-0.250
	(5.222)	(8.675)	(0.201)
wed	-9.537	-22.29*	-0.201
	(5.258)	(8.735)	(0.200)
thu	-8.716	-17.57*	-0.0650
	(5.246)	(8.754)	(0.204)
fri	9.837	15.69	0.210
	(5.431)	(9.010)	(0.212)
sat	15.37**	53.07***	1.502***
	(5.391)	(9.270)	(0.218)
sun	0.315	60.93***	1.309***
	(5.362)	(9.583)	(0.220)
_cons	272.9***	450.4***	7.449***
	(3.801)	(6.322)	(0.147)
N	6575	6575	6575

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Summary Statistics for RTAs with full data

	RTAs				RTAs if R=0				RTAs if R=1			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
00:00-00:59	7.46	4.52	0	29	7.47	4.42	0	27	7.29	5.54	0	29
01:00-01:59	5.92	3.81	0	33	5.98	3.77	0	33	5.23	4.11	0	21
02:00-02:59	4.44	3.09	0	28	4.52	3.10	0	28	3.54	2.83	0	16
03:00-03:59	3.55	2.63	0	26	3.62	2.64	0	26	2.82	2.33	0	12
04:00-04:59	3.08	2.35	0	19	3.13	2.36	0	19	2.50	2.08	0	12
05:00-05:59	3.11	2.35	0	17	3.12	2.34	0	15	2.95	2.38	0	17
06:00-06:59	4.25	2.82	0	20	4.25	2.81	0	20	4.32	2.96	0	20
07:00-07:59	8.46	4.69	0	31	8.51	4.74	0	31	7.92	4.07	0	23
08:00-08:59	12.59	7.08	0	45	12.67	7.19	0	45	11.69	5.51	1	28
09:00-09:59	10.84	5.64	0	36	10.87	5.67	0	36	10.40	5.19	0	35
10:00-10:59	11.78	5.81	0	38	11.82	5.83	0	38	11.32	5.59	1	36
11:00-11:59	13.67	6.49	0	43	13.70	6.52	0	43	13.45	6.13	2	39
12:00-12:59	15.43	7.78	1	49	15.44	7.83	1	49	15.37	7.14	3	43
13:00-13:59	16.13	7.96	1	53	16.06	8.00	1	53	16.89	7.53	3	45
14:00-14:59	16.95	8.38	2	51	16.73	8.32	2	51	19.43	8.66	2	50
15:00-15:59	17.85	8.82	1	57	17.52	8.71	1	57	21.52	9.20	4	53
16:00-16:59	18.35	9.27	0	61	17.96	9.16	0	52	22.75	9.45	3	61
17:00-17:59	18.64	9.34	1	55	18.38	9.10	1	53	21.56	11.34	1	55
18:00-18:59	18.06	9.42	0	59	17.77	9.09	0	57	21.32	12.03	1	59
19:00-19:59	16.64	8.98	0	54	16.46	8.64	0	51	18.65	11.98	1	54
20:00-20:59	13.36	7.31	0	49	13.39	7.31	0	49	13.05	7.22	1	41
21:00-21:59	11.55	6.33	0	45	11.55	6.29	0	45	11.60	6.87	0	32
22:00-22:59	10.30	5.73	0	36	10.24	5.63	0	36	10.99	6.76	0	33
23:00-23:59	10.19	5.61	0	38	10.16	5.47	0	37	10.53	7.04	0	38

Table 13: Summary Statistics for RTAs with restricted data

	RTAs				RTAs if R0				RTAs if R1			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
00:00-00:59	6.59	3.94	0	26	6.56	3.80	0	26	6.88	5.31	0	24
01:00-01:59	5.06	3.04	0	22	5.08	2.98	0	22	4.87	3.66	0	19
02:00-02:59	3.71	2.49	0	19	3.76	2.49	0	19	3.11	2.36	0	11
03:00-03:59	2.97	2.13	0	15	3.00	2.13	0	15	2.56	2.15	0	10
04:00-04:59	2.59	1.95	0	13	2.63	1.96	0	13	2.21	1.82	0	9
05:00-05:59	2.74	2.04	0	13	2.74	2.04	0	13	2.68	2.04	0	10
06:00-06:59	4.12	2.66	0	17	4.12	2.65	0	17	4.16	2.68	0	17
07:00-07:59	9.18	4.81	0	31	9.26	4.87	0	31	8.29	3.86	1	23
08:00-08:59	14.18	7.26	0	45	14.29	7.41	0	45	12.83	5.03	1	28
09:00-09:59	11.61	5.76	0	36	11.64	5.80	0	36	11.27	5.21	0	35
10:00-10:59	12.27	5.88	0	38	12.29	5.91	0	38	12.03	5.52	1	32
11:00-11:59	13.96	6.49	1	43	13.94	6.54	1	43	14.23	6.00	2	30
12:00-12:59	15.67	7.94	1	48	15.65	8.01	1	48	15.96	7.17	3	43
13:00-13:59	15.80	7.83	1	47	15.70	7.85	1	47	16.93	7.48	3	45
14:00-14:59	16.62	8.21	2	51	16.36	8.13	2	51	19.56	8.63	2	49
15:00-15:59	17.77	8.78	1	57	17.42	8.67	1	57	21.75	9.04	5	53
16:00-16:59	18.33	9.32	1	56	17.91	9.23	1	52	23.07	9.05	7	56
17:00-17:59	18.46	9.24	1	55	18.17	9.00	1	52	21.80	11.05	2	55
18:00-18:59	17.73	9.24	0	59	17.38	8.90	0	57	21.67	11.78	2	59
19:00-19:59	16.12	8.70	0	54	15.87	8.29	0	47	18.99	12.13	1	54
20:00-20:59	12.80	6.94	0	49	12.77	6.92	0	49	13.13	7.17	1	41
21:00-21:59	10.88	5.91	0	44	10.83	5.82	0	44	11.50	6.85	0	32
22:00-22:59	9.60	5.30	0	33	9.49	5.15	0	32	10.80	6.66	0	33
23:00-23:59	9.40	5.05	0	38	9.33	4.85	0	32	10.27	6.87	0	38

Table 14: Summary Statistics for alcohol related RTAs with full data

	RTA_alc				RTA_alc if R=0				RTA_alc if R=1			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
00:00-00:59	0.61	0.85	0	6	0.65	0.87	0	6	0.25	0.54	0	4
01:00-01:59	0.65	0.90	0	7	0.68	0.91	0	7	0.24	0.52	0	3
02:00-02:59	0.57	0.84	0	9	0.60	0.85	0	9	0.24	0.51	0	3
03:00-03:59	0.45	0.74	0	6	0.47	0.75	0	6	0.19	0.45	0	3
04:00-04:59	0.34	0.64	0	6	0.36	0.65	0	6	0.16	0.43	0	3
05:00-05:59	0.22	0.51	0	5	0.23	0.52	0	5	0.13	0.39	0	2
06:00-06:59	0.16	0.42	0	3	0.17	0.42	0	3	0.09	0.34	0	3
07:00-07:59	0.13	0.38	0	3	0.14	0.39	0	3	0.09	0.29	0	2
08:00-08:59	0.12	0.36	0	3	0.12	0.36	0	3	0.10	0.30	0	2
09:00-09:59	0.09	0.31	0	3	0.09	0.32	0	3	0.06	0.26	0	2
10:00-10:59	0.08	0.30	0	2	0.08	0.30	0	2	0.07	0.27	0	2
11:00-11:59	0.10	0.33	0	3	0.10	0.33	0	3	0.08	0.31	0	3
12:00-12:59	0.12	0.36	0	3	0.12	0.36	0	3	0.12	0.38	0	2
13:00-13:59	0.12	0.35	0	3	0.12	0.35	0	3	0.12	0.36	0	3
14:00-14:59	0.14	0.40	0	5	0.14	0.40	0	3	0.16	0.44	0	5
15:00-15:59	0.18	0.44	0	4	0.18	0.44	0	4	0.17	0.43	0	2
16:00-16:59	0.22	0.49	0	4	0.22	0.49	0	4	0.16	0.40	0	3
17:00-17:59	0.26	0.54	0	6	0.26	0.55	0	6	0.18	0.44	0	3
18:00-18:59	0.31	0.60	0	6	0.31	0.60	0	6	0.22	0.48	0	2
19:00-19:59	0.35	0.64	0	5	0.36	0.65	0	5	0.22	0.50	0	3
20:00-20:59	0.37	0.65	0	5	0.38	0.66	0	5	0.17	0.44	0	3
21:00-21:59	0.41	0.70	0	5	0.43	0.71	0	5	0.18	0.49	0	4
22:00-22:59	0.47	0.71	0	5	0.50	0.72	0	5	0.23	0.50	0	3
23:00-23:59	0.61	0.84	0	8	0.64	0.86	0	8	0.22	0.45	0	2

Table 15: Summary Statistics for alcohol related RTAs with restricted data

	RTA_alc				RTA_alc if R0				RTA_alc if R1			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
00:00-00:59	0.54	0.78	0	5	0.57	0.79	0	5	0.23	0.53	0	4
01:00-01:59	0.55	0.79	0	5	0.58	0.80	0	5	0.24	0.51	0	3
02:00-02:59	0.47	0.74	0	5	0.50	0.75	0	5	0.19	0.46	0	3
03:00-03:59	0.37	0.64	0	5	0.39	0.66	0	5	0.18	0.43	0	2
04:00-04:59	0.26	0.54	0	4	0.28	0.55	0	4	0.11	0.36	0	2
05:00-05:59	0.17	0.43	0	3	0.18	0.44	0	3	0.12	0.36	0	2
06:00-06:59	0.13	0.38	0	3	0.14	0.38	0	3	0.06	0.25	0	2
07:00-07:59	0.11	0.34	0	3	0.11	0.34	0	3	0.07	0.28	0	2
08:00-08:59	0.12	0.35	0	3	0.12	0.36	0	3	0.10	0.30	0	1
09:00-09:59	0.09	0.31	0	3	0.09	0.32	0	3	0.07	0.28	0	2
10:00-10:59	0.08	0.29	0	2	0.08	0.29	0	2	0.07	0.27	0	2
11:00-11:59	0.10	0.33	0	3	0.10	0.34	0	3	0.09	0.33	0	3
12:00-12:59	0.12	0.35	0	3	0.12	0.36	0	3	0.10	0.33	0	2
13:00-13:59	0.11	0.34	0	3	0.11	0.34	0	3	0.13	0.38	0	3
14:00-14:59	0.13	0.39	0	5	0.13	0.38	0	3	0.15	0.46	0	5
15:00-15:59	0.16	0.42	0	4	0.16	0.42	0	4	0.12	0.36	0	2
16:00-16:59	0.19	0.46	0	4	0.20	0.46	0	4	0.14	0.39	0	3
17:00-17:59	0.21	0.48	0	4	0.22	0.48	0	4	0.16	0.42	0	3
18:00-18:59	0.25	0.52	0	3	0.25	0.52	0	3	0.20	0.46	0	2
19:00-19:59	0.29	0.56	0	5	0.29	0.57	0	5	0.21	0.47	0	3
20:00-20:59	0.31	0.58	0	4	0.32	0.59	0	4	0.17	0.44	0	3
21:00-21:59	0.34	0.62	0	5	0.36	0.63	0	5	0.14	0.39	0	2
22:00-22:59	0.43	0.67	0	4	0.45	0.68	0	4	0.23	0.51	0	3
23:00-23:59	0.53	0.76	0	6	0.56	0.78	0	6	0.21	0.43	0	2

Table 16: Summary Statistics for alcohol unrelated RTAs with full data

	RTA_noalc				RTA_noalc if R=0				RTA_noalc if R=1			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
00:00-00:59	6.84	4.27	0	27	6.82	4.15	0	26	7.04	5.36	0	27
01:00-01:59	5.27	3.48	0	27	5.30	3.43	0	27	4.99	3.98	0	21
02:00-02:59	3.86	2.78	0	24	3.91	2.78	0	24	3.30	2.65	0	15
03:00-03:59	3.10	2.35	0	23	3.14	2.36	0	23	2.63	2.21	0	12
04:00-04:59	2.74	2.11	0	14	2.78	2.12	0	14	2.35	1.93	0	10
05:00-05:59	2.88	2.19	0	15	2.89	2.19	0	14	2.81	2.27	0	15
06:00-06:59	4.09	2.73	0	20	4.08	2.71	0	18	4.23	2.91	0	20
07:00-07:59	8.33	4.63	0	31	8.37	4.68	0	31	7.83	4.03	0	22
08:00-08:59	12.47	7.02	0	45	12.55	7.14	0	45	11.59	5.45	1	28
09:00-09:59	10.75	5.58	0	35	10.78	5.61	0	35	10.34	5.17	0	35
10:00-10:59	11.69	5.76	0	37	11.73	5.77	0	37	11.25	5.55	1	36
11:00-11:59	13.57	6.43	0	43	13.59	6.46	0	43	13.36	6.08	1	39
12:00-12:59	15.31	7.69	1	48	15.32	7.75	1	48	15.25	7.08	3	43
13:00-13:59	16.01	7.88	1	53	15.94	7.92	1	53	16.77	7.47	3	45
14:00-14:59	16.81	8.28	2	51	16.59	8.22	2	51	19.27	8.52	2	50
15:00-15:59	17.67	8.72	1	56	17.34	8.61	1	56	21.35	9.09	4	53
16:00-16:59	18.13	9.15	0	59	17.74	9.03	0	52	22.59	9.36	3	59
17:00-17:59	18.38	9.20	1	55	18.12	8.96	1	53	21.38	11.21	1	55
18:00-18:59	17.76	9.27	0	59	17.46	8.94	0	57	21.10	11.92	0	59
19:00-19:59	16.29	8.80	0	52	16.10	8.45	0	50	18.43	11.79	1	52
20:00-20:59	13.00	7.14	0	49	13.01	7.14	0	49	12.88	7.13	1	41
21:00-21:59	11.14	6.16	0	43	11.12	6.11	0	43	11.42	6.75	0	32
22:00-22:59	9.83	5.54	0	35	9.75	5.43	0	35	10.76	6.65	0	33
23:00-23:59	9.58	5.38	0	38	9.52	5.22	0	35	10.31	6.92	0	38

Table 17: Summary Statistics for alcohol unrelated RTAs with restricted data

	RTA_noalc				RTA_noalc if R0				RTA_noalc if R1			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
00:00-00:59	6.04	3.73	0	26	5.99	3.58	0	26	6.65	5.12	0	24
01:00-01:59	4.51	2.82	0	22	4.50	2.75	0	22	4.63	3.50	0	18
02:00-02:59	3.24	2.26	0	16	3.26	2.26	0	16	2.93	2.26	0	11
03:00-03:59	2.60	1.94	0	13	2.62	1.93	0	13	2.38	2.05	0	10
04:00-04:59	2.33	1.80	0	12	2.35	1.81	0	12	2.10	1.73	0	8
05:00-05:59	2.57	1.94	0	13	2.57	1.94	0	13	2.55	1.96	0	9
06:00-06:59	3.99	2.58	0	17	3.98	2.58	0	16	4.10	2.63	0	17
07:00-07:59	9.07	4.75	0	31	9.14	4.81	0	31	8.22	3.82	1	22
08:00-08:59	14.06	7.20	0	45	14.18	7.35	0	45	12.74	4.99	1	28
09:00-09:59	11.52	5.70	0	35	11.55	5.74	0	35	11.21	5.18	0	35
10:00-10:59	12.19	5.83	0	37	12.21	5.86	0	37	11.96	5.48	1	32
11:00-11:59	13.86	6.43	1	43	13.84	6.47	1	43	14.14	5.95	2	30
12:00-12:59	15.56	7.86	1	48	15.53	7.92	1	48	15.87	7.12	3	43
13:00-13:59	15.69	7.76	1	47	15.60	7.78	1	47	16.79	7.41	3	45
14:00-14:59	16.49	8.12	2	51	16.23	8.04	2	51	19.41	8.48	2	48
15:00-15:59	17.61	8.69	1	55	17.26	8.57	1	55	21.62	8.96	5	53
16:00-16:59	18.14	9.22	1	56	17.71	9.12	1	52	22.93	8.98	7	56
17:00-17:59	18.25	9.12	1	55	17.95	8.88	1	51	21.64	10.94	2	55
18:00-18:59	17.48	9.13	0	59	17.12	8.78	0	57	21.47	11.67	2	59
19:00-19:59	15.84	8.56	0	52	15.58	8.14	0	45	18.78	11.96	1	52
20:00-20:59	12.49	6.82	0	49	12.45	6.79	0	49	12.96	7.08	1	41
21:00-21:59	10.55	5.79	0	43	10.47	5.69	0	43	11.36	6.75	0	32
22:00-22:59	9.16	5.14	0	33	9.04	4.98	0	32	10.57	6.54	0	33
23:00-23:59	8.87	4.88	0	38	8.76	4.66	0	32	10.06	6.78	0	38

Table 18: 2011 votes in Turkey part 1

Name	State no	AKP	CHP	MHP
Adana	1	37.4	30.8	20.4
Adiyaman	2	67.4	16.6	4.6
Afyon	3	60.4	16.5	18.6
Agri	4	47.5	2.2	2.2
Amasya	5	52.3	27.8	15
Ankara	6	49.2	31.4	14.6
Antalya	7	39.4	33.3	20.9
Artvin	8	46.8	35.1	13.7
Aydin	9	35.5	38.1	18.2
Balikesir	10	46.5	33.8	13.9
Bilecik	11	42.5	25.4	27.3
Bingol	12	67.1	3.1	1.3
Bitlis	13	50.6	1.7	3.2
Bolu	14	58.5	20.1	16.1
Burdur	15	49	25.4	18.7
Bursa	16	52.9	25	14.4
anakkale	17	41.5	39.5	14.6
ankiri	18	65.7	6	23
orum	19	61.2	24.1	10.8
Denizli	20	46.6	31.2	17
Diyarbakir	21	32.9	2.2	0.8
Edirne	22	30.4	51.7	13.3
Elazig	23	67.4	13.2	14.5
Erzincan	24	57.4	30.2	9.4
Erzurum	25	69.2	4.8	13.3
Eskiehir	26	44.1	35.5	14.6
Gaziantep	27	61.8	19.4	9.5

Table 19: 2011 votes in Turkey part 2

Name	State no	AKP	CHP	MHP
Giresun	28	59.4	23.7	11.9
Gumuhane	29	65	7.8	21.6
Hakkari	30	16.4	0.9	1
Hatay	31	44.6	38.4	12.7
Isparta	32	53	21.8	19
Mersin	33	32.2	31.6	23
stanbul	34	49.5	31.3	9.4
zmir	35	36.9	43.8	11.2
Kars	36	42.6	16.6	17.3
Kastamonu	37	55.6	14.8	23.1
Kayseri	38	64.9	12.1	18
Kirklareli	39	27.7	52.7	16.7
Kirsehir	40	50.8	22.5	21.9
Kocaeli	41	52.7	24.6	11.9
Konya	42	69.6	10.2	13.2
Kutahya	43	64.6	12.4	15.8
Malatya	44	68.5	19.7	8.1
Manisa	45	46.9	28.8	16.9
Kahramanmaras	46	69.6	11.5	13
Mardin	47	32	3.7	0.6
Mugla	48	32.9	45.8	16.3
Mu	49	42.9	4.1	4.1
Nevehir	50	60.4	16.6	18
Nigde	51	54.2	21.5	19.1
Ordu	52	60.2	22.6	11.7
Rize	53	69.1	17.1	7.6
Sakarya	54	61.6	16.2	15

Table 20: 2011 votes in Turkey part 3

Name	State no	AKP	CHP	MHP
Samsun	55	61.9	21.7	11.3
Siirt	56	48.1	2.8	1.1
Sinop	57	54.9	31.1	8.3
Sivas	58	63.3	15.3	9.9
Tekirdag	59	36	44.5	13.5
Tokat	60	56	23.4	15.8
Trabzon	61	59.1	18.2	15.3
Tunceli	62	16.2	56.2	2.2
Sanliurfa	63	64.8	3	3
Usak	64	49.8	29.8	16.4
Van	65	40.2	3.7	3
Yozgat	66	66.6	10.9	18.3
Zonguldak	67	47.2	37.5	6.3
Aksaray	68	66.1	11.7	18
Bayburt	69	63.5	3.7	24.2
Karaman	70	57.4	18.9	18.2
Kirikkale	71	62.1	15.1	18.8
Batman	72	36.9	6.5	0.6
Sirnak	73	20.6	2.5	1.2
Bartin	74	48.5	28.8	15.9
Ardahan	75	40.2	29.8	10
Igdir	76	28.2	1.7	34.1
Yalova	77	46.8	32.4	10.6
Karabuk	78	57.9	19	15.6
Kilis	79	59.5	15.2	21
Osmaniye	80	43.1	11.5	41.3
Duzce	81	65.9	12.4	16.2