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Exploring traffic safety culture and drunk driving: An examination of the community and DUI related fatal crashes in the U.S. (1993–2015)

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A R T I C L E I N F O

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A B S T R A C T

This project explores the relationship between structural level factors associated with community traffic safety culture toward alcohol and alcohol related fatal crashes in the United States from 1993 to 2015. Multilevel growth curve models were estimated to explore these relationships within longitudinal data. As hypothesized, increases in factors associated with anti-alcohol community norms, values, attitudes, and beliefs were related to decreases in alcohol related crashes at the county level. Conversely, measures associated with pro-alcohol factors were related to increased alcohol related crashes. These findings are consistent with traffic safety culture, social norms theory, and the Positive Community Framework (PCF).

1. Introduction

Despite considerable efforts to reduce driving under the influence (DUI) in the United States, about twenty percent of drivers continue to do so (Drew, 2010) which results in thousands of fatal automobile crashes every year (NHTSA, 2016a). In recent years scholars have purported that culture, norms, and attitudes are important factors to consider when analyzing traffic safety (Ward & Özkan, 2014). While the U.S. has a very established "car culture" (Atchley, Shi, & Yamamoto, 2014), it also has a strong culture toward alcohol which varies over time and place (Williams, 2006). As such, this project aims to assess the relationships between structural factors related to community alcohol norms and DUI fatal crashes in the United States from 1993 to 2015.

Traffic safety culture is an influential factor related to risky driving behaviors such as drinking and driving (Ward, Linkenbach, Keller, & Otto, 2010). This concept is also "growing rapidly as a new paradigm to improve traffic safety" (Ward & Özkan, 2014, p. 292). The perspective acknowledges that as social beings, driver decisions are influenced by values, beliefs, expectations, and attitudes that are all shaped by social factors that are external to the driver and shared by a culture or community (Ward et al., 2010). As such the traffic safety culture influences driver decisions to engage in risky behaviors such as speeding, seatbelt use, drinking and driving and so forth. The American norms toward speeding is a good example of traffic safety culture in that despite being illegal, and a risk factor for crashing, a plethora of drivers engage in it. In fact, research has shown that many deliberately engage in this risky behavior because they are influenced by the perceived social norms regarding speeding and have a positive belief about the outcome (Forward, 2010). Others have also noted that the intention to speed is predicted by moral norms and the social acceptance of speeding (Conner et al., 2007).

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Importantly, evidence suggests that traffic safety culture is not the same across all areas and groups. While there are many environmental factors that contribute to crash risk in rural areas (e.g. access to emergency medical care, roadway types, and other hazards), rural drivers also engage in more risk-taking behaviors because of the rural traffic safety culture (Ward, 2007). For example, seatbelt use, speeding, and alcohol are more predominant in rural areas compared to urban areas, and some of these differences are attributed to diversity in the perceived risk of these propensities between urban and rural drivers (Rakauskas, Ward, & Gerberich, 2009). Demographic differences in traffic safety culture are also prevalent. One example of a demographic factor is age (Ward et al., 2010). Young drivers are vastly overrepresented among fatal crashes in the United States compared to other age groups (Compton & Ellison-Potter, 2008). While some of this is likely related to a lack of driving experience and driving skills, some researchers have argued that a teenage subculture exists that may also contribute through encouraging the risky behaviors. In fact, teenage drivers have the highest rates of speed related crashes, following too closely, and poor seatbelt use (Compton & Ellison-Potter, 2008). The traffic safety culture literature is suggestive of differences across time as well. For example, there has been a significant change in social norms related to alcohol use and drunk driving since the anti-DUI movement began in the 1980s (Williams, 2006). Research also suggests that a culture of distracted driving has developed in the United States (Li, Gkritza, & Albrecht, 2014).

Since the development of the traffic safety culture perspective, no research to date has examined the relationship between traffic safety culture related to alcohol and DUI related crashes. However, research from a variety of areas is suggestive of the importance of these factors. For example, alcohol use is lower in communities that are less tolerant of alcohol (Bryden, Roberts, Petticrew, & McKee, 2013). Additionally, moral beliefs about alcohol and drunk driving are associated with abstinence from drunk driving (Greenberg, Morral, & Jain, 2005; Lanza-Kaduce, 1988; Piquero & Paternoster, 1998). Religion may also play a role in developing cultural beliefs about alcohol within the community since large concentrations of evangelical protestants are related to dry counties (counties that forbid the sale of alcohol) (Frendreis & Tatalovich, 2010). However, increases in the Catholic population are associated with less control over alcohol sales (Frendreis & Tatalovich, 2010). Communities composed largely of residents of lower socioeconomic status also view alcohol differently than others. For example, inner city groups view alcohol use much differently than the broader social movement advanced by MADD (Herd, 2011). Specifically, while the broader movement associates blame alcoholism on the individual, inner city groups blame environmental factors such as poverty (Herd, 2011). Moreover, residents of the most deprived neighborhoods are more likely to binge drink than those in the least deprived neighborhoods (Fone, Farewell, White, Lyons, & Dunstan, 2013).

In sum, while the prior literature on drunk driving has largely focused on the driver/crash and state level units of analysis, it has largely overlooked not only the community as a unit of analysis, but also community traffic safety culture factors such as norms, attitudes, values, and beliefs that may be related to drunk driving crashes. The examination of traffic safety culture is especially important when examining alcohol related crashes because drinking alcohol is generally a social activity that is likely to be influenced by the social surroundings of the drinker. As such, to fill this void in the literature, this project hypothesizes as follows:

H1. Increases in structural factors related to anti-alcohol community norms, values, beliefs, and attitudes are related to decreases in alcohol related fatal crashes in the United States.

H2. Increases in structural factors related to pro-alcohol community norms, values, beliefs, and attitudes are related to increases in alcohol related fatal crashes in the United States.

2. Method

To test these hypotheses, this project aggregated and merged data from several sources to the county level. First, this study utilized data from the Fatality Analysis Reporting System (FARS) to measure fatal crashes in the U.S. (National Highway Traffic Safety Administration (NHTSA), 2016b). These data are compiled and maintained by the National Highway Traffic Safety Administration (NHTSA, 2016b), and reflect crashes which occur on public roadways that result in at least one fatality of a motorist or non-motorist within 30 days of a crash (NHTSA, 2016b).

The cross-sectional cumulative data from the General Social Survey (GSS) was also used for several measures (Smith, Marsden, & Michael Hout, 2015). To produce county level aggregates of the individual level data, the sensitive geographic identification code files were obtained under special contract with NORC (see National Opinion Research Center (NORC), 2017). Therefore, some of the data used in this analysis are derived from Sensitive Data Files of the GSS, obtained under special contractual arrangements designed to protect the anonymity of respondents. These data are not available from the authors. Persons interested in obtaining GSS Sensitive Data Files should contact the GSS at GSS@NORC.org. These two files were merged using the county FIPS codes to allow the subsequent aggregation to the county level.

Data from the Association of Religion Data Archives were used to measure religion at the county level (Association of Statisticians of American Religious Bodies, 1990, 2000; Grammich et al., 2010). These data provide information on the number of members of each religious denomination and were collected every ten years at the county level. Data collected in 1990, 2000, and 2010 were utilized. Since these data are only collected every ten years the values from those surveys were imputed using a linear interpolation at that point in time. The formula for these interpolations is as follows:

$$T_{ct} = t_1 + (t_2 - t_1)/10_{(1-9)}$$

Data from the Economic Research Service was obtained to measure rurality (Butler & Beale, 1990). These data, known as "Beale codes" measure the rurality or urbanism of a county on a continuum rather than a simple dichotomous measure of rural vs. urban making it superior to other methods. While this was originally developed in 1974, it has been updated every ten years (1993, 2003, and 2013). Due to the infrequent construction of these data, the linear interpolation formula above was also utilized to estimate values for years between updates. Data from the National Institute on Alcohol Abuse and Alcoholism was obtained to measure per-capita alcohol consumption (LaVallee, Kim, & Yi, 2014), and Federal Highway Administration (2015) data was procured to estimate total vehicle miles traveled.

The National Center for Education Statistics (2016) institutional characteristics files for 1993–2015 was also used to measure the presence of a university. Aggregate county level data from the U.S. Census was also utilized to control for socio-demographic differences among counties. Additionally, data from the National Alcohol Beverage Control Association (2014) was used to create dichotomous measures of dry counties, which are counties that outlaw the sale of alcohol.

2.1. Measures

Table 1 presents descriptive statistics for all measures utilized for this project. The dependent variable is a continuous measure of the total frequency of DUI fatal crashes in each county. The independent variables used to measure norms, values, attitudes, and beliefs are presented in Table 2 and includes the percent of the population in each county that adheres to an anti-alcohol or pro-alcohol religion, the presence of a large university campus, prohibition of alcohol sales, and bar/tavern use.

Similar to others (e.g. Rookey, 2012), this project utilized the percentage of the community that identifies as affiliated with an anti-alcohol religious group to measure anti-alcohol community values and beliefs. These anti-alcohol religions include the Latter-Day Saints, Seventh Day Adventists, and the Southern Baptist Convention (Rookey, 2012). The percent of the population that identify as Catholic is also measured to represent pro-alcohol religion (see Gusfield, 1996). While

Table 1
Descriptive statistics (n = 2326).

	Mean	Standard deviation	Min	Max
DUI fatal crashes	17.22	26.48	0	285
Total population	648,496	965,053	1963	9,938,312
% Population anti-alcohol religion	0.08	0.11	0	0.76
% Population catholic	0.21	0.15	0	0.71
Large football university	3.74	3.80	0	10.75
Strength of religion component	0.87	0.45	0	2.57
% Go to bars/taverns monthly +	0.27	0.24	0	1
% never go to bars/taverns	0.47	0.26	0	1
Non-DUI fatal crashes	36.63	52.48	0	630
Repeat DUI offender crashes	2.38	4.55	0	94
Beale code (urban - rural)	1.83	1.76	0	9
Socio-economic status component	48,642	12,682	20,247	104,133
% Caucasian	0.75	0.17	0.16	0.99
% Population 18 and under	0.24	0.03	0.13	0.34
% Population 18–24	0.07	0.02	0.04	0.31
% Population 25–34	0.14	0.03	0.13	0.34
% Population 65 plus	0.08	0.06	0	0.39
Male/female ratio	96.91	5.71	85.48	202.4
Total vehicle miles traveled	104,577	78,216	3307	329,534
Total per-capita alcohol consumption	2.22	0.29	1.37	3.99
Moist county	0.18	0.39	0	1
Dry county	0.01	0.11	0	1

Table 2
Measures of community traffic safety culture.

Normative behavior	% Go bars/taverns monthly % Never go TO bars/taverns Presence of a large university
Values and beliefs	Anti-alcohol religious Affiliation Catholic religious Affiliation Presence of a large university
Local attitudes	Dry counties Moist counties Presence of a large university

Catholics may not drink more alcohol than other religions, there has historically been significant symbolic conflict over attitudes, beliefs, and values toward alcohol between Catholics and Protestants which has influenced alcohol policy regarding prohibition and drunk driving (see Gusfield, 1996). A composite measure was also created for strength of religion, which could influence the anti-alcohol religions ability to dissuade alcohol consumption. It is composed of measures for those that attend church weekly (.919), attend church yearly (−.804), and indicate they have a strong religious affiliation (.850). This measure was weighted by the eigenvalues in parentheses above, and the Cronbach's alpha statistics (.843) from the reliability analysis indicate the measures scale well together.

There is a plethora of research indicating high levels of alcohol consumption and binge drinking among college students (see Borsari & Carey, 2001; Hingson, Zha, & Weitzman, 2009), and that drinking is a considerably normative behavior (Presley, Meilman, & Leichliter, 2002) among this party subculture (Hagan, 1991). Alcohol consumption is also greater at four-year institutions with athletics programs and/or considerable Greek life (Presley et al., 2002). The pro-drinking attitudes related to this subculture of partying are also not limited to students (Ahern, Galea, Hubbard, Midanik, & Syme, 2008). Universities are also accompanied by other factors that support drinking such as liquors stores and bars (Kuo et al., 2003) and events such as football games (Oster-Aaland & Neighbors, 2007). Since many university events such as tailgating at football games include not only students but also members of the community, the pro-drinking norms of the university are spread into the community as well (see Neighbors, Oster-Aaland, Bergstrom, & Lewis, 2006; Oster-Aaland & Neighbors, 2007). Therefore, consistent with prior studies (Rookey, 2012), this project included as a dichotomous variable to measure the presence of a university offering at least a bachelor's degree and financial aid to student athletes in the football program. This measure was also weighted by the logarithmic student population to account for the size of the school (see Rookey, 2012). Counties without a university serve as the reference category.

County alcohol sales legislation was used to measure local attitudes toward alcohol. It was operationalized with binary variables representing wet, dry, and moist counties. This is important because this legislation should reflect the anti-alcohol sentiment of the public in each community. Wet counties were operationalized as those that do not forbid the sale of alcohol, and dry counties are those that do forbid alcohol sales. Moist counties are those that do not completely fit into either category. For example, moist counties may have no county legislation that forbids the sale of alcohol which make them appear wet, but there is a town or city within this county that does forbid it. Thus, these counties are labeled as moist counties, for they are not completely wet or dry. Wet counties serve as the reference category among these predictors.

Four measures for the frequency of bar/tavern use measures normative behavior in each community regarding bar and tavern use. These measures are important because more than half of DUI trips originate at bars, taverns, and restaurants (see Moulton, Peterson, Haddix, & Drew 2010). As such, this project measures the percent of respondents in each county that never go to bars or taverns, and the percent of those that go to taverns once a month or more.

Because rural drivers have greater crash risks and are more likely to engage in risk-taking behaviors (Rakauskas et al., 2009; Ward, 2007), this project utilizes "Beale Codes" to control for an ordinal continuum from rural to urban (Butler & Beale, 1990). Additionally, because not all DUI crashes are caused by the intoxicated driver (Stringer, 2016), this project also controls for other factors within each county that may cause crashes by including a measure of the frequency of non-DUI related crashes in each county (Morrison, Ponicki, Gruenewald, Wiebe, & Smith, 2016). The frequency of crashes involving a driver with a prior DUI conviction also controls for DUI recidivism since recidivists have a greater risk of involvement in fatal crashes than other drivers (Fell, 2014). Additionally, recidivists are more likely to engage in global criminality (Gould & Gould, 1992) thus making them part of the criminal subculture. Recidivists are also more likely to have negative views of the law and moral values that are supportive of DUI (DeMichele, Lowe, & Payne, 2014). Both measures of recidivist DUI crashes and non-DUI crashes were logarithmically transformed prior to analysis.

The socio-demographic composition of the community was also controlled. Because young people have an increased propensity to drink and drive (Drew, 2010) and are increasingly involved in DUI related crashes (Compton & Ellison-Potter, 2008; Peck, Gebers, Voas, & Romano, 2008), four continuous measures represent the percent of the population under 18, 18–24, 25–34, and 65 and over. Also, because men are more likely to drive after drinking (Zador, Krawchuk, & Voas, 2000), the ratio of men to women was measured as the number of men per 100 women. Since alcohol use and abuse varies across racial and ethnic groups (Holmila, Mustonen, Österberg, & Raitasalo, 2009), one variable controlled for the percent of the population that is Caucasian.

Because alcohol problems are prevalent in deprived neighborhoods (Fone et al., 2013) and among the working class (Hemmingsson, Lundberg, Diderichsen, & Allebeck, 1998) a composite measure was utilized to control for the socio-economic status of each county. This measure was comprised of the median income (.907), percent of the population below the poverty level (−.713), and the percent with a bachelor's degree or more (.800). These measures were weighted by the eigenvalues in parenthesis above, and the reliability analysis indicates these measures scale well together. The estimated total vehicle miles traveled, and total per-capita alcohol consumption were also controlled (Tippetts, Voas, Fell, & Nichols, 2005; Voas, Tippetts, & Fell, 2000). The estimated total vehicle miles traveled was normalized with a logarithmic transformation prior to analysis.

2.2. Data analysis

This project utilizes multilevel modeling as recommended for examining traffic safety culture (Ward et al., 2010; Özkan & Lajunen, 2011). Due to the longitudinal nature of these data, a multilevel growth curve model was used to examine change over time. As such, the repeated county observations (n = 2326) comprised level 1 of the analysis. These repeated observations are then nested within each county (n = 446) at level 2. Since state level factors may also influence these relationships, each county was also nested within its state (n = 50) at level 3. As such, level 1 represents change over time and levels 2 and 3 represent the nested structure of divergence across place (counties and states, respectively). This strategy allows for the data to be modeled as they naturally exist as observations over time nested within counties and states, which is important for an unbiased estimation of standard errors that accounts for within county and state clustering (Raudenbush & Bryk, 2002). Finally, this method also allows the model to take advantage of one of the best advantages of multilevel modeling: the ability to estimate random effects models that account for the interaction of covariates with unmeasured factors at higher levels (Snijders & Bosker, 2012).

Because the dependent variable has a significant positive skew, an over dispersed Poisson generalized hierarchical model was used to assess the frequency of fatal DUI related crashes. This accounts for the positive skew in the data and prevents the overestimation of zero values, like the negative binomial model (Raudenbush & Bryk, 2002) which is argued to be superior to when analyzing count data (DeMichele et al., 2014). Furthermore, the Poisson analysis utilized varying exposure rather than constant exposure. This is important because not all U.S. counties have similar opportunity for DUI crashes due to differential population sizes. For example, the county with the lowest population size in the sample (n = 1963) is not likely to have a similar frequency of fatal DUI crashes as another county with 100,000 residents. Thus, the population 16 years or more was used to estimate the automobile driving population within each county to account for varying exposure. This approach leads to considerable changes to the left side of the equation, however apart from the parameters added to account for the overdispered varying exposure Poisson distribution, it this calculation is very similar to the creation of a rate of DUI fatal crashes to the population 15 years old or more. The formula for the unconditional cubic polynomial overdispersed varying exposure Poisson model used is presented below:

$$(Y_{tij}|\lambda_{tij} \sim P(\sigma^2 m_{tij}, \lambda_{tij}) = \pi_{oij} + (\pi_{1ij}X) + (\pi_{1ij}X^2) + (\pi_{1ij}X^3) + e_{tij}$$

$$\pi_{0ij} = B_{00j} + r_{0ij}$$

$$B_{00j} = \gamma_{000} + u_{00j}$$

where Y_{ij} is the number of DUI fatal crashes occurring in time t, county i, and state j, m_{ij} is exposure (the logarithmic population 15+), λ_{ij} is the event rate per time period, and σ^2 is the overdispersion of level 1 variance parameter.

There are several ways of presenting the findings from count models such as these (DeMichele et al., 2014). The model coefficients are perhaps the least intuitive since they are indicative of a change in log units of the dependent variable. To aid in the interpretability of the findings, the exponentiated coefficients (event rate ratios) are presented with standard errors in parentheses. One option for interpreting the event rate ratios is to rely upon the factor change in the dependent variable per change in the independent variable; however, since this is not very intuitive this project adopts the approach of interpreting the rate ratios as percent change in the dependent variable (see DeMichele et al., 2014).

The models presented are mixed effects models. Thus, random effects that are statistically significant were allowed to vary, while those that do not significantly vary were fixed in the final models (Raudenbush & Bryk, 2002). The year is fixed in all models to prevent violations of the assumption of independence. Polynomial models also assessed variables for non-linearity with DUI fatal crashes (Allison, 1999; Raudenbush & Bryk, 2002). Cubic non-linearity was discovered for the measure of time, thus indicating multiple changes in DUI fatal crashes over time. This cubic polynomial is illustrated in the equation above.

The intra-class correlation coefficient (ICC) was calculated from the variance components for each level (Raudenbush & Bryk, 2002). These calculations indicate that sixty, twenty-three, and seventeen percent (ICC of .60, .23, and .17) of the variance in DUI related fatal crashes is explainable at levels 1, 2, and 3 of these data, respectively. Additionally, the reliability estimates (.827) indicate that approximately eighty-three percent of the variance in DUI related fatal crashes is explainable with these data and approximately seventeen percent is related to random sampling error and is therefore unexplainable. The proportion of variance explained by each model at each level was estimated through the calculation of a pseudo r-squared by comparing change in the variance components between the unrestricted and restricted models (see Raudenbush & Bryk, 2002). Variance inflation factors were utilized to assess multicollinearity, and none was found among the parameters.

All predictors have been centered around the grand mean since group mean centering was not required (Enders & Tofighi, 2007; Raudenbush & Bryk, 2002) and to properly interpret the coefficients for the contextual effects. Contextual effects models were also assessed for all independent variables (See Raudenbush & Bryk, 2002). These are created by using aggregates of the level 1 data at level 2. These models vary somewhat from the traditional contextual effect model because level 1 is not the individual but is the repeated observation of each county. As such, the contextual effect at level 2 is place (counties) while the level 1 coefficients represent change over time.

3. Results

Table 3 presents the findings from the over dispersed Poisson hierarchical generalized models predicting DUI fatal crashes for the entire sample of counties and states in the U.S. from 1993 through 2015. The percent of the variance explained at each

Table 3
Mixed effects 3 level over dispersed poisson growth curve models predicting DUI fatal crashes with GSS sample (1993–2015).

	Model 1	Model 2	Model 3	Model 4
Observations Over Time Level 1 (N = 2326)				
% Population anti-alcohol religion	0.169*** (.430)	0.501** (.257)	0.924 (.384)	0.912 (.384)
% Population catholic	2.980*** (.247)	1.505* (.178)	1.511* (.178)	1.456* (.179)
Large football university	1.014*** (.006)	1.015** (.005)	1.015** (.005)	1.001 (.006)
% Go to bars/taverns monthly +	1.060 (.041)	1.067 (.040)	1.069 (.040)	1.070 (.040)
% Never go to bars/taverns	1.065 (.038)	1.065 (.037)	1.070 (.037)	1.084 (.037)
Strength of religion component	1.006 (.021)	1.005 (.021)	1.042 (.027)	1.040 (.027)
Non-DUI fatal crashes	–	1.589*** (.024)	1.589*** (.024)	1.552*** (.024)
Repeat DUI offender crashes	–	1.187*** (.014)	1.187*** (.014)	1.181*** (.014)
Beale code (urban - rural)	–	0.949*** (.013)	0.949*** (.013)	0.951*** (.013)
Socio-economic status	–	0.999 (.001)	0.999 (.001)	0.999 (.001)
% Caucasian	–	0.686* (.150)	0.686* (.150)	0.655** (.151)
% Population 18 and under	–	1.847* (.728)	1.473* (.728)	1.592* (.735)
% Population 18–24	–	0.201 (.051)	0.191 (.051)	0.045** (.119)
% Population 25–34	–	0.641 (.939)	0.634 (.939)	0.748 (.949)
% Population 65 plus	–	0.258** (.481)	0.262** (.481)	0.392 (.490)
Male/female ratio	–	0.998 (.003)	0.998 (.003)	0.998 (.003)
Total vehicle miles traveled	–	1.172*** (.042)	1.172*** (.042)	1.181*** (.042)
Total per-capita alcohol consumption	–	1.562*** (.080)	1.562*** (.080)	1.560*** (.084)
Anti-alcohol religion * strength of religion	–	–	0.603* (.240)	0.615* (.239)
Year	0.919*** (.038)	0.721*** (.057)	0.721*** (.057)	0.721*** (.060)
Year^2	1.007*** (.002)	1.021*** (.003)	1.021*** (.003)	1.021*** (.003)
Year^3	0.999*** (.000)	0.999*** (.000)	0.999*** (.000)	0.999*** (.000)
County Level 2 (N = 446)				
Moist county	0.860 (.164)	1.019 (.087)	1.019 (.087)	1.031 (.082)
Dry county	0.764 (.453)	1.021 (.285)	1.021 (.285)	1.159 (.283)
Large football university	–	–	–	1.032*** (.009)
Mean% never go to bars/taverns	–	–	–	0.592* (.237)
State Level 3 (N = 50)				
L1 R-squared	0.21	0.22	0.23	0.23
L2 R-squared	0.14	0.88	0.88	0.88
L3 R-squared	0.01	0.76	0.76	0.76

* $p < .05$.
** $p < .01$.
*** $p < .001$

level varies across model and the final model accounts for approximately twenty-three percent of the variance at level 1 (over time), eighty-eight percent of the variance across counties, and seventy-six percent of the variance across states. Thus, these models appear to explain more of the variance in DUI fatal crashes across place than over time.

The percent of the population that identifies as adhering to an anti-alcohol religion is a significant predictor of DUI fatal crashes both before and after controlling for other factors in models 1 and 2. Interestingly, there is also a significant interaction between anti-alcohol religion and the average strength of religious affiliation in each county over time. This interaction is illustrated in Fig. 1 below to aid in interpretation. Because the religious strength component was continuous, Fig. 1 was created by using values from the 25th and 75th percentile of the component to formulate the z axis and display the interaction effects. Values along the x axis are also negative at the x/y intersection due to mean centering. While the coefficient for the main effects of percent anti-alcohol religion and strength of religion are not significantly different from zero ($p > .05$), the interaction of these measures is a significant predictor of DUI fatal crashes. Thus, anti-alcohol religion is not significantly related to DUI fatal crashes when strength of religion is low. However, with every increase in religious strength the decline in DUI fatal crashes predicted by each increase in anti-alcohol religion (about 9%) increases by about thirty-eight percent. Thus, as is illustrated in Fig. 1, the decline in DUI fatal crashes predicted by increases in anti-alcohol religion is much greater for the 75th percentile of religious strength than the 25th percentile which has a slight upward trend (although insignificant).

Furthermore, increases in the percent of the population that adheres to the Catholic religion is related to a significant increase (about 45–50%) in DUI fatal crashes in all models in Table 3. The findings for the presence of a large university indicate the measure was a significant predictor of DUI fatal crashes across place but not time. The measures of bar/tavern use were not significant predictors of DUI fatal crashes over time at level 1. However, increases in the percent of the population that never goes to bars/taverns was related to approximately a forty-one percent decrease in DUI fatal crashes at level 2 (across counties). Finally, no significant difference was found between dry, wet, and moist counties.

A supplemental analysis was conducted which substituted fatal DUI crashes involving a driver with a prior DUI arrest for total fatal DUI crashes. This model provided some noteworthy results. Specifically, bar-use was not significantly related to recidivist crashes over time or place as it was for total fatal DUI crashes. Furthermore, there was no significant moderation

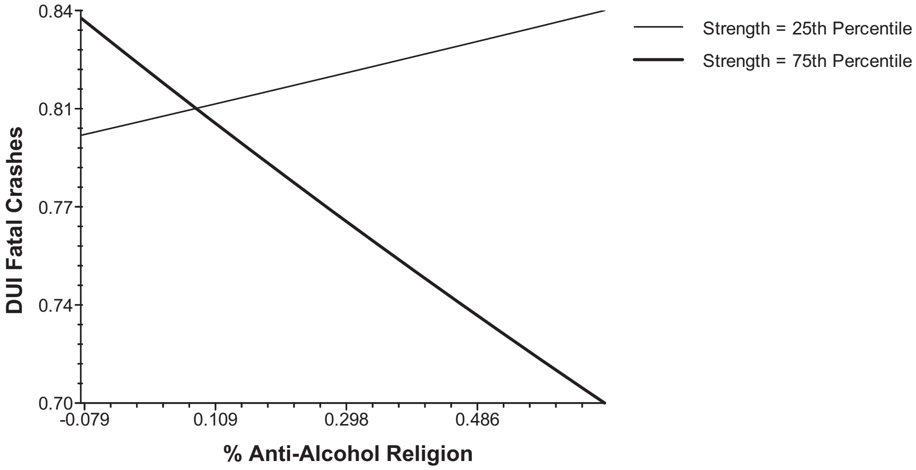

Fig. 1. Interaction of percent anti-alcohol religion and religious strength.

of anti-alcohol religion by strength of religion, and the main effects of these measure were also insignificant. The dry and moist counties remained insignificant predictors and the percent Catholic is also not a significant predictor of recidivist DUI crashes. However, the measure of large universities with football programs was significantly related to recidivist DUI crashes over time (Event Rate Ratio = .958***) and place (Event Rate Ratio = 1.058***) similar to the previous results.

4. Discussion

This project makes an important addition to the developing literature on traffic safety culture by examining structural factors related to alcohol norms, attitudes, beliefs, and values within the community and fatal alcohol related crashes in the U.S. from 1993 to 2015. The findings are consistent with prior literature and theory on the relationship between traffic safety culture (Ward et al., 2010; Ward & Özkan, 2014), social norms theory (Perkins, 2003) and automobile crashes (Perkins, Linkenbach, Lewis, & Neighbors, 2010). As hypothesized, factors associated with anti-alcohol sentiments were associated with decreased DUI related fatal crashes, and pro-alcohol culture within a community was related to increased fatal DUI crashes.

While the prior literature has examined the relationship between community norms and alcohol use, this is the first project to examine the potential for these factors to impact alcohol related crashes. Social norms influence alcohol consumption and alcohol related harm (Wood, Read, Palfai, & Stevenson, 2001). As theorists and researchers have previously noted, groups and communities with strong anti-drinking norms have low drinking rates and those with permissive alcohol norms have higher drinking rates (Akers, 1992; Bryden et al., 2013). Thus, since alcohol consumption is related to, and a necessary element of, DUI crashes the relationship of structural level factors associated with alcohol community norms and DUI fatal crashes is logical.

The measures of anti-alcohol and pro-alcohol religious adherents were central measures of alcohol values and beliefs within the community. This is consistent with informal social control as members of a religion with proscriptive norms (abstinence) consuming less alcohol than members of religions with more permissive norms toward alcohol (Krohn, Akers, Radosevich, & Lanza-Kaduce, 1982). However, the moderation of the anti-alcohol religious adherents measure by the average strength of religion in Table 3 also makes sense because social learning may mediate the influence of structural level factors (Akers, 2009) such as traffic safety culture. In fact, some have found that the alcohol norm qualities of peers are more influential on alcohol use than religion (Krohn et al., 1982). Thus, the ability of anti-alcohol religion to influence community norms, traffic safety culture, and alcohol related harm is dependent on the strength of the religion in the community.

The findings for the presence of a university campus are consistent with the idea that pro-alcohol social norms associated with the presence of large university and its student population. While permissive university norms toward drunkenness have not been assessed in relation to crashes, they have been related to increases in binge drinking (Ahern et al., 2008; Jones-Webb & Karriker-Jaffe, 2013) which is frequent among large university student populations and the surrounding community. Young people are at an increased risk of being involved with DUI crashes to begin with (Peck et al., 2008; Zador et al., 2000), and college is a time of freedom and decreased informal social control for students. For many traditional students, it is their first time living away from their parents and other agents of social control. However, since the university remains important after controlling for age, it's effects cannot be attributed to young people altogether. As such, it is likely that the pro-alcohol university culture and norms found at universities (Presley et al., 2002) and surrounding communities (Ahern et al., 2008) that gives rise to increases in alcohol consumption and alcohol related harms such as DUI fatal crashes in the community. In fact, Rookey (2012) indicates the DUI enforcement is also less in U.S. counties with large universities with football programs because the community is more tolerant of alcohol use.

The insignificant findings for alcohol sales prohibition is consistent with some of the prior literature (Kelleher, Pope, Kirby, & Rickert, 1996), though others have found that county level prohibition of alcohol sales reduces crashes (Eger, 2006). Some find that the distance to legal alcohol is more important than presence in a dry county and there is a negative relationship between distance and crashes (Gary, Aultman-Hall, McCourt, & Stamatiadis, 2003; Giacopassi & Winn, 1995; Jewell & Brown, 1995). As such, the lack of alcohol availability in dry counties forces drivers to travel further to wet counties where they can procure alcohol and then return home, often under the influence (Gary et al., 2003). Interestingly, since the religious composition of a county is the strongest predictor of a dry county (Frendreis & Tatalovich, 2010), the effect of a counties dry status may have been mediated by controlling for anti-alcohol and pro-alcohol religion.

Thus, these findings suggest that the lack of alcohol availability in dry counties may not reduce DUI crashes, but the anti-alcohol traffic safety culture. While a dry county is indicative of anti-alcohol sentiments which curtail DUI crashes, there are still those that engage in DUI behavior in dry counties, and Webster, Pimentel, and Clark (2008) found that DUI offenders in dry counties are more likely to be chronic repeat offenders with alcohol and drug abuse problems. DUI offenders within the dry community would likely make up a small deviant section of the community that does not abide by the anti-drunk driving culture of the majority of the community.

Bars and Taverns are also places within communities with limited informal social control and the traffic safety culture related to alcohol and DUI may be different within groups that frequent them. There is also now a substantial literature which links these alcohol outlets to fatal crashes (Morrison et al., 2016; Ponicki, Gruenewald, & Remer, 2013). Therefore, since about 20% of DUI trips originate at bars and taverns (Moulton et al., 2010) it is predictable that areas where people never go to bars/and taverns are related to decreased DUI crashes. While this data was not able to determine why collectives did not ever go to bars/taverns it may be due to the stigmatization of such venues within the community culture, especially since the relationship remained after controlling for other factors such as dry counties etc.

While it may appear the community factors related to alcohol norms, attitudes, beliefs, and values might be indirectly related to DUI crashes by influencing alcohol consumption, the relationship between these factors remained significant after controlling for per-capita alcohol use. This replication suggests that the structural factors associated with alcohol norms may have a direct effect on DUI crashes. A direct effect of these factors is consistent with the idea that moral values and the definition of the drunk driving social problem may vary across place (Goode & Ben-Yehuda, 2010). Additionally, because these structural factors reflect the moral values and internal controls of the population, which are important protective factors against DUI (Greenberg et al., 2005; Lanza-Kaduce, 1988; Piquero & Paternoster, 1998), they may be able to influence DUI behavior and as a result fatal DUI related crashes.

Finally, the findings support policies such as the Positive Community Framework (PCF) which can reduce risky driving (Otto, Ward, Swinford, & Linkenbach, 2014) and drunk driving (Perkins et al., 2010). Thus, campaigns aimed at transforming cultural norms and attitudes to increase moral attachment to the law should supplement enforcement efforts to reduce alcohol related crashes (Edwards, Freeman, Soole, & Watson, 2014). Such efforts can not only reduce the intention of a driver to engage in risky driving behavior but can also increase the likelihood that bystanders will intervene to prevent the behavior from occurring (Otto et al., 2014).

This analysis was limited in several respects worth noting. The use of secondary data presents some issues with measurement of the concepts of traffic safety culture. While these structural factors are hypothesized to be related to alcohol norms, values, attitudes, and beliefs, in some instances they are not direct measures thereof. Additionally, these analyses were limited in their ability to control for alcohol availability, so future research may wish to explore alternative measures of controlling for alcohol availability. Measures of per-capita alcohol consumption and vehicle miles traveled were also only available at the state level over time, so they do not control for differences within states. Finally, while the religious measures were based on prior research about alcohol among these groups, others may wish to explore other religious groups such as atheists, Muslims, or other denominations of the protestant religion in the future.

5. Conclusion

In conclusion, this project supports the traffic safety culture framework, and indicates that community norms, values, beliefs, and attitudes toward alcohol are related to fatal DUI related crashes across U.S. counties. However, the measures utilized here suggest that while these factors influence change across time in some instances, they are most influential across place. Thus, while there has been change in social norms regarding alcohol and DUI over time (Williams, 2006), there is also considerable variation across place which should be explored further. Finally, this project supports the idea of traffic safety culture and contributes to a better understanding of this phenomenon in relation to drunk driving and traffic fatalities in the United States.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.trf.2018.05.014.

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