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Policing the Drinking Community: An Assessment of the Criminal Justice Response to Drunk Driving and Alcohol Related Crashes (1985 -2014)

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POLICING THE DRINKING COMMUNITY: AN ASSESSMENT OF THE CRIMINAL JUSTICE RESPONSE TO DRUNK DRIVING AND ALCOHOL RELATED CRASHES (1985 -2014)

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ABSTRACT

POLICING THE DRINKING COMMUNITY: AN ASSESSMENT OF THE CRIMINAL JUSTICE RESPONSE TO DRUNK DRIVING AND ALCOHOL RELATED CRASHES (1985 -2014)

Richard James Stringer
Old Dominion University, 2018
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The objective of this study was to analyze the relationships among arrests, informal alcohol related social norms, and alcohol related fatal crashes in the U.S. from 1985-2014. Despite inexorable efforts to eliminate drunk driving, approximately twenty percent of the population drives after drinking (Drew, 2010). Although law enforcement arrests play a key part in policies to deter drunk driving, enforcement of DUI laws varies widely across the country (Erickson et al., 2015). However, no project has explored the relationship between structural factors related to community norms, enforcement, and automobile crashes. Thus, this project adds to the literature and understanding of drunk driving by providing a longitudinal evaluation of drunk driving policy that can inform future policy and community-based interventions. This study hypothesizes that community norms toward alcohol will affect DUI enforcement as well as the occurrence of alcohol related crashes and that this relationship will vary over time. The objective was accomplished by aggregating and merging several large longitudinal secondary data sets to the county level and state level. Because of differences in aggregate level factors and policies (O'Neill & Kyrychenko, 2006), multilevel modeling was used to allow for the contemporaneous assessment of state and county factors as well as model these data over time (Raudenbush, 2004). The findings provide mixed support for the contention that DUI arrests reduce the frequency of alcohol related fatal crashes within counties. However, some support is found for the hypothesis that structural factors associated with community alcohol norms are related to DUI enforcement and alcohol related crashes, although the directionality is not always as it was originally hypothesized. These results, coupled with the extant research on drunk driving as well as other theoretical issues, suggest that policies aimed at deterring drunk driving may be less effective at preventing drunk driving. The importance of the impact of structural factors related to community norms is also discussed with an emphasis on further exploration of these factors in future research.

This dissertation is dedicated to my family, friends, and all those whose lives have been adversely impacted by alcohol and drunk driving.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Driving under the influence (DUI) is a social problem in the United States which results in thousands of fatal automobile crashes every year. Although DUI related fatalities have been significantly reduced over the past few decades (Williams, 2006), DUI crashes still contribute to over 10,000 deaths annually (NHTSA, 2014). However, not all communities suffer to the same extent, for some are plagued by greater numbers of DUI fatalities than others have few or none. Over the years, substantial criminal justice resources have focused on deterring drunk driving behavior, however all of these polices rely on significant DUI arrests (Ross, 1992, Mastrofski and Ritti, 1992). In fact, more persons are arrested for DUI than for any other offense in the U.S. (UCR, 2014), although enforcement varies widely across the country (Erickson et al., 2015). Despite persistent efforts to eliminate DUI, twenty percent of the U.S. population drives after consuming alcohol every year (Drew, 2010). As such, research suggests that punitive policies alone may not be effective and the aforementioned dissimilarities in DUI arrests and crashes may be attributed to differences in social norms across communities.

The DUI social problem is argued to be a product of an interaction between two social problems, alcohol abuse and traffic safety (Ross, 1994). The American culture is one of alcohol and automobiles. In fact, over fifty percent of Americans aged 12 and over indicated that they consumed alcohol in 2013 (SAMSHA, 2014). Additionally, except for the very large metropolitan areas such as New York City, the American culture demands that citizens either own or have access to automotive transportation (Jacobs, 1989). Thus, given the American reliance on automobile transportation and the propensity to consume alcohol, it comes as no surprise that the two interact.

Traffic accidents are generally considered an unfortunate, but unavoidable, price to pay for the enormous benefits of road transportation (Haight, 1985). In fact, while 33,561 people lost their lives in automobile crashes in 2012, only 10,322 of these crashes involved alcohol (NHTSA, 2014). Thus, the rarely mentioned non-alcohol related crashes account for over sixty percent of fatal crashes in the United States, and as Jacobs (1989) points out, even if we could eliminate all the drunk drivers, the traffic safety issue would still be a problem and lives would still be lost every year. However, there is a much greater stigmatization associated with alcohol related crashes than others. Although some might consider a non-alcohol related crash to be "an accident", crashes that involve alcohol are seen as much larger social problems that are preventable and therefore not an accident (Laurence, Snortum, & Zimring, 1988; Lerner, 2011).

The stigmatization of alcohol related crashes compared to non-alcohol related crashes can be traced back to a symbolic stigmatization of alcohol. Like many social problems (Spector & Kitsuse, 1987), alcohol use has enjoyed a symbolic meaning for quite some time (Gusfield, 1986). Alcohol has a symbolic relationship with status politics and cultural conflict that goes back to the 19th century pre-prohibition era and the temperance movement (Gusfield, 1986). Temperance legislation was targeted at immigrants (many of whom were Catholic) whose values conflicted with the American Protestant ethic, and was a symbolic means to illustrate the power of the Protestant morality as well as identify those that held traditional Protestant values from those who did not (Gusfield, 1963). Since characteristics such as self-control, productivity, hard work, and discipline are indicative of the Protestant ethic, abstinence became symbolic of the ambitious successful person (Gusfield 1963; Gusfield 1981; Weber & Parsons 1998). The passage of prohibition represented a cultural "victory of protestant over catholic, rural over urban, tradition over modernity, and the middle class over both the lower and upper strata" (Gusfield, 1963, p. 7).

Although alcohol related crashes had been occurring since the invention of the automobile (Jacobs, 1989; Lerner, 2011), it was not until the 1980's that the social movement against DUI began (Gusfield, 1984). Prior to the 1980's crashes involving alcohol were treated as unconnected individual accidents, rather than a result of a larger social problem. Interestingly, it was not a change in the frequency of DUI and DUI related crashes in the 1980's compared to prior decades that caused this movement. Rather the public became aware of it as a social problem. In fact, theorists argue that social problems are not defined by their objective harm to society, but rather the degree of concern over the issue felt by society (Blumer, 1970; Spector & Kitsuse, 1987). Thus, collective definitions and public perceptions of DUI are more important than fatal alcohol related crashes in the United States in framing the DUI problem. In other words, it is not an issue of how harmful drunk driving is but how harmful society thinks it is.

Since social problems such as DUI are socially defined, it logically follows that different segments of society may have different definitions of problems such as DUI (Becker, 1966). Thus, those that have anti-alcohol believes are likely to see it as an alcohol problem, while environmentalists might consider it a result of too many vehicles, and others may attribute it to poorly maintained roads, unsafe vehicles, poor seatbelt use, or public transportation. However, since some segments of society wield more social and political power than others, they will have greater influence over the overall definition of DUI and policy, although it may not reflect the desires of everyone (Quinney, 1970). In fact, Wellford (1975) argues that "crime is a form of behavior defined by the powerful to control the powerless" (p. 335).

The development of the DUI social problem can be traced back to a single moral crusader named Candy Lightner. In 1980, a young girl was struck and tragically killed by a man who was driving under the influence of alcohol. This led her mother, Candy Lightner, to start the group Mothers Against Drunk Driving (MADD.) which became the driving force behind much of the reform and public concern over drunk drivers (Reinarman, 1988). Lightner acted as a moral entrepreneur to call the media, the public, and the politicians attention to this issue, and what had happened to her daughter (Reinarman, 1988). As public support and MADD grew substantially, the government was pressured to do something about DUI, and politicians could not politically afford to oppose the movement. This political pressure from both MADD and voters lead to tougher legislation for DUI such as increased fines, jail time, license suspensions and so forth. Enforcement was increased as well. In fact, convictions for driving under the influence doubled between 1981 and 1985 (Reinarman, 1988).

While MADD had a great deal of influence on this movement (Reinarman, 1988), cultural conflict and moral values toward alcohol are also important just as they were to prohibition. In fact, the DUI movement has been referred to by some as a new temperance movement (Gusfield, 1984). However, morality is relative, in that what is considered evil in one time, situation, or area may be considered acceptable in others (Goode & Ben-Yehuda, 2010). Over time American society has shifted its views on alcohol impaired driving. As alcohol related fatalities has received more attention, the DUI issue has further developed into a moral issue, and some see it as morally wrong to drive after drinking. Thus, the DUI problem may have contributed to a new anti-alcohol movement, for those with the same moral and cultural values that were able to pass the only constitutional amendment in history to ban the use of a substance (alcohol) are likely to play a part in, and favor, DUI control as well.

The formal definition of driving under the influence, which is governed by state law, has undergone significant changes throughout history. Specifically, over time the per-se limit has been changed from .15 BAC to .10 BAC, and then from .10 BAC to .08 BAC. Most recently, the National Transportation Safety Board proposed that the per-se level be lowered again from .08 to .05 which is about 2-3 drinks in one hour (NTSB, 2013). The per se limit is the blood alcohol concentration (BAC), or the amount of alcohol present in a driver's blood that creates a presumption that the driver is impaired. Interestingly, these changes do not exhibit a grassroots objective type of lawmaking, in that all of society agrees in them (Goode & Ben-Yehuda, 2010). Instead, these changes resulted from coercion by the federal government, who threatened to withdraw federal highway funding from states unless they lowered their per-se BAC limits to .08 (Tippetts, Voas, Fell, & Nichols, 2005).

The aforementioned exemplifies a lack of consensus lawmaking and suggests that DUI legislation may be developed by certain segments of society that are in power and then forced on the rest of society. Thus, illustrating the political phenomenon in which definitions of crime and morality are developed in society (Schur, 1980). Interestingly, the founder of MADD, Candy Lightner, did not agree with these policy changes as they would be "diluting law enforcement efforts against truly dangerous drivers" (Lerner, 2011, p. 128). This is not to say the drunk driving is not a problem and that DUI policy lacks legitimacy. However, it does present some interesting questions about the social definition of drunk driving, policies to reduce DUI related crashes, and variation in the morality and public sentiments about this issue.

While substantial criminal justice resources are aimed at deterring alcohol impaired driving, little criminological research has assessed the effect it has on reducing alcohol related crashes. This may be explained by the rarity of criminologists and traffic safety scholar's consideration of one another's research (DeMichele, Lowe, & Payne, 2014). Thus, this study adds to the limited criminological research on the effectiveness of the deterrence based polices aimed at reducing alcohol related fatalities by assessing the relationship between DUI arrests and DUI related fatal crashes in the United States.

This study also aims to bridge the literature and data from both the criminological and traffic safety fields to fill a significant gap in the literature – the role of the community. Research in a variety of areas is suggestive of the importance of the community in understanding both enforcement of the law and alcohol related crashes. Just as formal definitions of drinking and driving have varied, this project investigates the changes informal definitions of deviance and the tolerance of drinking and driving within communities that may affect drinking and driving, and the enforcement of the DUI code within the community. While there is a plethora of DUI arrests and crashes in the country, the most problematic areas for fatal crashes may also have the least enforcement due to community norms regarding alcohol and DUI. Thus, the goals of this project are a) to determine the impact that increases in DUI arrests have on fatal crashes and b) assess the role that structural factors associated with community alcohol norms have on alcohol related fatal crashes and DUI enforcement within counties.

CHAPTER II

LITERATURE REVIEW

This chapter begins with a review of the literature on the effect of alcohol on automobile crashes. However, since driving under the influence of alcohol is not the only factor related to crashes, other structural and subcultural factors which contribute to crashes are also discussed. As previously noted, several different methods have been implemented to reduce alcohol related crashes. Therefore, the research on the effectiveness of policies aimed at deterring the public from drinking and driving as well as preventing recidivism is also reviewed. Finally, research on community differences in alcohol use, alcohol polices, and DUI enforcement is presented to advocate for the importance of examining community differences in alcohol related crashes, DUI enforcement, and the relationship between these two factors.

The Effect of Alcohol on Crashes

There is a plethora of evidence which shows that alcohol is related to increased crash risk and increases in the severity of injuries incurred in automobile crashes. Research also helps us to understand the mechanisms through which alcohol is related to crashes. The extant research illustrates a causal chain which suggests that alcohol impairs driver performance, which then leads to increased driver responsibility for causing a crash, thus leading to an increased crash risk among impaired drivers. Additionally, research also indicates that the severity of injuries is greater in alcohol involved crashes which increases the likelihood of fatalities because of a crash. This section will summarize the extant research from the traffic safety literature involving these factors.

First, the experimental research examining the impact of alcohol on driver performance is reviewed. Second, studies which compare driver responsibility to other factors that cause crashes between impaired and non-impaired drivers is examined. Third, field research which assesses crash risk by comparing impaired and non-impaired drivers who crash to those that do not. Finally, other studies that assess the severity of injuries that result from alcohol related and non-alcohol related crashes. These factors combined with the high frequency of drunk driving in the U.S. results in the high number of alcohol related crashes and fatalities each year.

Driver Performance

While alcohol does not directly cause crashes, it works indirectly to negatively influence a driver's performance. There is significant experimental and laboratory evidence that shows that alcohol impairs driving related skills such as vision, reaction time, and divided attention (see e.g. Moskowitz & Fiorentino, 2000; Moskowitz, Zador, Smiley, Fiorentino, & Burns, 2000). These experimental studies are generally conducted in a controlled simulator environment where drivers can ingest alcohol and observers can note changes in their ability to maneuver the simulated vehicle and respond to stimuli. While the extent of impairment to a driver generally increases with BAC level, no threshold where driver impairment begins has been established (Ogden and Moskowitz, 2004).

The prior literature has mixed results when assessing low blood alcohol levels effects on driver performance. Some suggest that this relationship varies based on baseline driving skills, specifically alcohol impairs those with poor driving skills more than those with better skills (Harrison & Fillmore, 2005). However, other research suggests that the complexity of the task the driver is being asked to perform may be more important. Specifically, Martin and Colleagues (2013) found that the complexity of the driving task is the most important predictor of the effect of alcohol and that variables such as skill level, alcohol tolerance, age, and gender have limited effects. Furthermore, research has concluded that low BAC impairs a driver's ability to perform complex divided attention tasks, while other driving related factors such as steering, visual perception, and reaction time are not significantly affected (Martin et al., 2013; Ogden & Moskowitz, 2004; Yung-Ching & Shing-Mei, 2007). For example, Verster and Colleagues (2009) used a divided attention steering simulator (DASS) which measures the operator's ability to stay in their lane while responding to a secondary visual task of responding to different digits that appeared in the peripheral area of the screen, and found significant impairment at a BAC of .02.

Responsibility Analysis

While the effect of alcohol on driver impairment is important, driver impairment does not automatically translate into crashes. Crashes are complex sequences of events with multiple causal agents that come together to make the accident possible (Gusfield, 1985). Generally, these factors are driver, vehicle, and environmental factors such as road, weather, and other vehicle or object related crash factors (Haddon, 1972). Many other factors have been shown to impact the decision to drink and drive, as well as the relationship between BAC and automobile crashes, such as risk taking, distractions, etc. (af Wåhlberg, 2012; Elander, West, & French, 1993; Elvik, Vaa, Erke, & Sorensen, 2009; Grime, 1987; Harrison & Fillmore, 2005, 2011; Mann et al., 2010; Mayhew, Donelson, Beirness, & Simpson, 1986; Ogden & Moskowitz, 2004; Peck et al., 2008; Porter, 2011; Rakauskas et al., 2008; Williams & Shabanova, 2003). Since there are many factors that lead to crashes, the focus on one driver-based characteristic (alcohol) is a drastic oversimplification of the problem (Zylman, 1968). Therefore, because crashes do not occur within the controlled laboratory vacuum, it is important to analyze the alcohol and crash relationship in the natural environment.

A different type of research assesses the driver's responsibly for causing a crash. While impaired drivers are often seen as responsible for causing a crash, in many cases the drinking driver is not responsible for the crash. Thus, the cause is some other factor such as the other vehicles, pedestrians, objects, bicyclists, vehicle mechanical issues, or other environmental factors. Responsibility is assessed by comparing differences in responsibility for causing a crash between alcohol-impaired drivers and non-impaired drivers. There are a few studies in the extant literature that examine the relationship between blood alcohol content and the driver's responsibility for causing the accident (Borkenstein, Crowther, & Shumate, 1974; Hurst, Harte, & Frith, 1994; Mounce & Pendleton, 1992; Terhune & Fell, 1981). The results of these studies have been mixed and somewhat controversial.

The now classic Grand Rapids study was the first direct case controlled test of the relationship between alcohol impairment and automobile crash risk. The study found that drivers with blood alcohol contents above .04 had a significantly higher relative probability of responsibility for an accident compared to drivers who had not consumed alcohol (Borkenstein et al., 1974). This study also identified several other crucial factors that affect crash risks, specifically, age, driving experience, and drinking experience (Borkenstein et al., 1974). Interestingly, Borkenstein and Colleagues (1974) also found that drivers involved in single vehicle crashes at night with a blood alcohol level between .01 and .04 had a lower relative risk of causing a crash than drivers with no alcohol in their system (Borkenstein et al., 1974). This drop in relative risk of a crash became known as the "Grand Rapids Dip" (Corfitsen, 2003; Zylman, 1968).

The dip in relative risk in automobile crashes for low blood alcohol levels has produced significant controversy. Hurst and Colleagues (1994) hypothesized that increased tolerance for alcohol due to differences in the frequency of consumption may account for some of dip in risk of a crash. Conversely, Zylman (1972b) argued that since “the dip” was due to large variance in relative risk over time of day. He argued that daytime drinkers and drivers are generally more experienced at both drinking and driving, thus they can indulge in a drink or two and still drive better than others. Other research has argued that since the dip in risk only existed at night, it may be a result of an increased number of tired drivers on the road at night that suppresses the effect of the risk for drivers with low blood alcohol levels (Corfitsen, 2003). In another study, Mounce and Pendleton (1992) found that while responsibility for causing an accident increased with blood alcohol level, the differences in responsibility between sober drivers and those that had been drinking was small. As such, they argue that research should try to identify other factors that may influence the relationship between low BAC and crash risk.

One such factor that has received a lot of attention is age which has also been linked to alcohol use. It has been argued that age is an even more important predictor of the risk of being in an automobile accident than alcohol (Zylman, 1972a). Furthermore, it is argued that alcohol and driving interact with young drivers differently because they are “at the early stages of both their driving career and drinking career” (Zylman, 1972a, p. 34). The result is that even small amounts of alcohol can be highly detrimental to the ability to drive safely. There is a great deal of other research that documents the important interaction of age and blood alcohol as well (Hedlund, 1994; Hingson et al., 2002; Mayhew et al. 1986; Romano et al., 2014; Voas et al., 2012; Zador et al., 2000; Zylman, 1968, 1972).

Alcohol, Drugs, and Crash Risk

There is now overwhelming evidence that indicates that drunk drivers have a significantly increased risk of being involved in an automobile crash. Crash risk is assessed by comparing drivers who crash to drivers who do not. These studies compare the risk of crashing between impaired drivers to non-impaired drivers. Several field studies have been conducted by merging data from the Fatal Accident Reporting System (FARS) and the National Highway Survey (NHS) to assess the relationship between relative risk of being involved in a fatal crash and blood alcohol level (Romano, Torres-Saavedra, Voas, & Lacey, 2014; Voas, Torres, Romano, & Lacey, 2012; Zador, 1991; Zador, Krawchuk, & Voas, 2000). Generally, these studies have found that there is a significant positive relationship between blood alcohol level and relative risk of a crash level, however, the relative risk does not increase significantly at low blood alcohol levels (Blomberg, Peck, Moskowitz, Burns, & Fiorentino, 2005; Peck, Gebers, Voas, & Romano, 2008; Romano et al., 2014; Voas et al., 2012; Zador, 1991; Zador et al., 2000). Some have assessed the relationship between age, blood alcohol content, and crash risk and found there to be significant differences in the relationship between blood alcohol content and risk of a crash by age, and in some cases, illustrate the "Dip" in risk at low blood alcohol levels for some ages and gender (Voas et al., 2012; Zador, 1991; Zador et al., 2000). However, Blomberg et al. (2005) found that the "Dip" in relative risk disappeared when adjusting for systematic sampling errors and small biases related to hit and run crashes and other factors.

Other studies have found that legal and illegal drugs significantly interact with blood alcohol levels to increase crash risk (Dubois, Mullen, Weaver, & Bedard, 2015; Romano et al., 2014; Romano & Voas, 2011). Although the study of the relationship between the influences of illicit drugs and crashes has not been given the same attention in the past as alcohol, some recent studies have shown that it does have some effect on crash risk by itself although the risk is not found to be as great as alcohol (Movig et al., 2004; Romano et al., 2014; Romano & Voas, 2011). Scholars have argued that this may be a result of drugged driving being overshadowed by the focus on alcohol impairment as well as the lack of technology and training to identify and test drivers for illicit drugs compared to alcohol (Romano et al., 2014; Romano & Voas, 2011).

Recent research has shown that cannabis and alcohol combined show an increased crash risk (Dubois et al., 2015). While stimulants and cannabis account for many of the drugs involved in crashes, stimulants and other drugs contributed to crashes more than cannabis regardless of BAC level (Romano et al., 2014; Romano & Voas, 2011). Interestingly, Compton and Berning (2015) found the crash risk to be greater for those that tested positive for cannabis than other illegal drugs; however, after controlling for age, BAC, ethnicity, and gender the relationship between drugs and crash risk was no longer statistically significant. As such, Compton and Berning (2015) argue that because these other factors (age, ethnicity, BAC, and gender) are so highly correlated with drug use they account for the increase in crash risk found with drug use.

While the aforementioned studies provide a significant addition to the literature and bridge the gap between controlled experiments and the real world they are not without their limitations. One such substantial limitation is the sampling frame of the National Highway Survey which limits its data collection to drivers and accidents that occur on Friday and Saturday nights between 10pm and 3am. This hinders the ability to make broad generalizations about automobile crashes because only 27 percent of fatal accidents occur during this time (NHTSA, 2011). Furthermore, this limitation has the possibility of introducing sampling bias because many single vehicle accidents that occur at night involve alcohol (Subramanian, 2003). It is also noted that many of these studies have not fully assessed the responsibility of the alcohol impaired driver in causing the accident and whether the crash was caused by some other systematically spurious effect of either vehicle or environment. While some have attempted to mitigate this problem by only analyzing single vehicle accidents, they continue to do so under the assumption that the driver was responsible for the accident and without accounting for potential environmental factors (Romano & Voas, 2011; Zador, 1991). In fact, one study noted “drivers involved in single vehicle crashes were assumed to be responsible for their crashes” (Williams & Shabanova, 2003, p. 528).

Alcohol and Injuries

While the previously mentioned studies have examined the relationship between intoxication and the risk of automobile crashes, the relationship between intoxication and the severity of human injuries incurred because of these crashes is less developed and perhaps more controversial. The most noteworthy research on this subject is that of Phillips and Brewer (2011) which found that drivers with blood alcohol levels as low as .01 are significantly more likely to produce more severe accident injuries. This is important because while other studies have shown increased injuries at higher levels of intoxication, this study shows an increase even at very low levels of alcohol consumption. Other research finds that intoxicated drivers have been shown to have significantly higher odds of fatal injuries than sober drivers, and alcohol has been shown to pose the largest risk of driver injury among all the psychoactive substances (Hels et al., 2013; Ristic et al., 2013; Shyhalla, 2014). Furthermore, drivers above the legal limit (.08) who are at fault are more likely to suffer from a severe injury or death than those involved in crashes caused by sober drivers (Traynor, 2005; Shyhalla, 2014).

Despite these findings, others contend that alcohol can protect against injury in automobile crashes. Research indicates that drivers with higher blood alcohol concentrations may lead to less severe injuries than those who are less intoxicated (Mann et al., 2011; Waller et al., 1986, 2003). However, when controlling for other factors such as seatbelt use, vehicle damage, speed, driver age, and vehicle weight alcohol is shown to exacerbate injury severity in most cases (Waller et al., 1986). Additionally, while alcohol tolerance was hypothesized to mediate this relationship, tolerance was not found to significantly affect the potentiation effect of alcohol (Waller et al. 2003). Other research has shown that there is no meaningful relationship between alcohol and drug use and severity of accidents among drivers in the Netherlands although selection bias and sample size may be an issue here (Smink et al., 2005). Overall, the findings suggest that the effect that alcohol has on the severity of injuries varies somewhat from study to study, but the most rigorous studies find it leads to increased injuries in most cases.

Since automobile crashes are complex interactions of events and predispositions that cause the crash, prior research has also identified factors that may mediate and aggravate the relationship between injury severity and intoxication. One particularly interesting factor is the risk-taking propensities of a driver (Shyhalla, 2014). Because driving under the influence involves risk taking behavior, it seems logical that drivers who engage in this behavior may engage in other risky driving behavior. In fact, research finds that those who drive after consuming alcohol are also more likely to speed, operate the striking vehicle, and be improperly seat belted which increases injuries (Li et al., 1997; Hijar, 1998; Phillips and Brewer, 2011). Additionally, Li and Colleagues (1997) indicates that it is not the biological effect of alcohol that increases injuries but rather the effects of risk taking correlates such as speeding or failing to wear a seatbelt.

Other Factors Related to Crashes

While alcohol increases the risk of crashing at the driver level, research consistently suggests that alcohol levels are not the only principal factors in understanding crash risk. In this section, we move beyond the effects of alcohol on crashes at the driver and crash level into the literature on broader environmental and structural level factors that influence crashes. These include structural factors, traffic safety culture, and the laws and activities of the criminal justice system designed to deter drunk driving.

Structural Factors and Crashes

Research has found that several structural factors influence automobile crashes in the country. For example, the economy (Evans & Graham, 1988; Wagenaar, 1984), traffic laws (Abdel-Aty, Dilmore, & Dhindsa, 2006; Ossiander & Cummings, 2002), and vehicle safety regulations (Lund & Ferguson, 1995; Robertson, 1996) have been found to be related to reductions in the occurrence of fatal crashes. In fact, socioeconomic and demographic factors account for more than half the variance in fatal crashes between states (O'Neill & Kyrychenko, 2006). Thus, it is important to control for the variance in these structural level factors over time and place.

Likewise, varying structural factors impact alcohol related crashes as well. Since alcohol use and the operation of a motor vehicle are necessary elements for alcohol related crashes, aggregate fluctuations in these factors can also influence alcohol related fatalities. In fact, per capita alcohol consumption, the total vehicle miles traveled, urbanization, and other socioeconomic factors further impact the number of DUI crashes (Fell, Tippetts, & Voas, 2009; O'Neill & Kyrychenko, 2006; Voas, Tippetts, & Fell, 2000). That said, structural factors, such as alcohol taxes are also effective at reducing DUI fatalities (Lavoie et al., 2017), and some have found seatbelt laws and excise taxes to be more effective at reducing DUI fatalities than deterrence based polices (Evans, Neville, & Graham, 1991). Socioeconomic differences may also be related to alcohol use and abuse as well as alcohol related crashes (Borkenstein et al., 1974; Fone et al., 2013; Zylman, 1968). There have also been aggregate level changes in risk taking behavior over time. For example, while assessing changes in alcohol related fatalities, Voas et al. (2012) noted that the relative risk of being involved in a fatal crash doubled for sober drivers from 1996 to 2007 which is thought to be related to other risk-taking behavior "such as texting or cell phone use" (p. 348).

Traffic Safety Culture

In recent years, the traffic safety literature has expanded to include research into traffic safety culture as a factor that shapes the risk of risky driving behaviors including drinking and driving (Ward, Linkenbach, Keller, & Otto, 2010). This 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). This traffic safety culture influences driver decisions to engage in risky behaviors such as speeding, seatbelt use, drinking and driving and so forth. Thus, it is important to not only focus on drivers, but also others such as law enforcement, policy makers, and the rest of the community, that may encourage or discourage risky behaviors that lead to crashes.

American cultural attitudes toward speeding is a good example of traffic safety culture in that despite being illegal and a risk factor for crashing many 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). Conner and Colleagues (2007) noted that the intention to speed is predicted by moral norms and the social acceptance of speeding.

Importantly, there is evidence that traffic safety culture is not the same across all areas and groups of people. Research points to substantial variation across region and demographic factors in traffic safety culture. Fatal crash risk is much greater in rural areas than on urban roadways. While there are many environmental factors that contribute to these risks such as access to emergency medical care and roadway types and 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. Some of these differences are attributed to a perceived difference in risks between urban and rural drivers (Rakauskas, Ward, & Gerberich, 2009). Additionally, while those in rural areas have more structural causes of fatal crashes and engage in more risk-taking behavior, those in large urban areas have increased opportunities for alternative transportation systems such as walking, trains, subways, buses, taxis’ s, Uber, etc. Therefore, the urban community culture may not require the daily operation of a motor vehicle daily. In fact, New York city has one of the lowest fatal crash rates in the country.

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. Specifically, there have been significant increases in cultural norms toward seatbelt use over time which has the potential to affect both alcohol and non-alcohol related fatal crashes.

Efforts to Reduce Alcohol Related Crashes

Another body of research that helps us understand drunk driving is that which explores the effects of various policies aimed at deterring this behavior. In this section of the paper, literature on lowering the legal limit and a host of general and specific deterrent policies is reviewed. While findings regarding the effectiveness of these policies are mixed, they are suggestive of changes in these relationships over time and place.

As previously noted, the per-se BAC limit has been lowered over time, and some empirical research has been conducted to assess the effectiveness of lowering the legal per se limit to .08. While most have found that lowering the limit is related to lower alcohol related crashes (Bernat, Dunsmuir, & Wagenaar, 2004; Foss, Stewart, & Reinfurt, 2001; Hingson, Heeren, & Winter, 1996; Johnson & Fell, 1995; Shults, Elder, Sleet, Nichols, Alao, Carande-Kulis, Zaza, Sosin, & Thompson, 2001), others have reported no significant changes, effectiveness only for short periods of time, or that the effect is related to other factors such as the media, enforcement, and general deterrence (Albalate, 2008; Bartl & Esberger, 2000; Foss et al., 2001; Mann et al., 2001; Rogers, 1995; Voas, Tippetts, & Fell, 2000). Furthermore, no significant variation in the effect of lowering the legal limit has been shown across states (Bernat, Dunsmuir, & Wagenaar, 2004).

Research on the effect of lowering the BAC level to .08 has shown mixed results sometimes even in the same state. For example, Apsler and colleagues (1999) found that the change to a .08 level in North Carolina did have a significant effect; however, Foss, Stewart, and Reinfurt (2001) found the effect of the change to be non-significant. Likewise, Rogers and Colleagues (1995) found no significant change in fatalities following the change to .08 in California, however, Research and Evaluation Associates (1991) found there to be a 12%

reduction in fatalities. These findings may be a result of diverse measures, covariates, or statistical methods (Mann et al., 2001). The issue of covariates when assessing the effect of DUI legislation is of importance because fatal traffic accidents, fatal alcohol related accidents, and alcohol use was already declining when this legislation was enacted which could result in misinterpretation of results without control for this preexisting trend (Aspler et al., 1999).

While Apsler and Colleagues (1999) controlled for other factors such as pre-existing downward trends, the presence of other laws, sobriety checkpoints, other enforcement changes, or a general societal trend for reduced alcohol use, some other studies did not. For example, Johnson and Fell (1995) found significant reductions in fatalities after the passage of the .08 legislation, however, expressly state that "the current analysis does not account for other potentially important factors, e.g. other legislation that could influence the impact of .08 BAC legislation" (p. 2). Thus, the mixed results between studies result from differences in important control variables which may jeopardize the validity of the findings with spurious effects. Apsler and Colleagues (1999) hypothesize that .08 BAC laws may have some deterrent effect, but this effect is dependent on combining it with other components such as enforcement, administrative license revocations, and others.

Johnson and Fell (1995) found that lowering the BAC level to .08 to be significant in 4 of 5 states examined, the exception was Maine. Furthermore, Apsler and Colleagues (1999) found that 5 of 11 states studied showed lower rates of alcohol related fatal accidents, four other states were already showing a downward trend in alcohol related fatalities due to other factors, and the remaining two states showed a reduction only after administrative license revocation laws were enacted. It is worth noting that all the states that showed reductions in alcohol related fatalities already had administrative license revocation laws in effect, and that two other states showed no effect from the lowered BAC levels until the administrative license revocation law was passed (Apsler et al., 1999). As such, the effect of the lower BAC laws is not as strong as others may purport, and may be dependent on other factors.

Additionally, some have argued that there is evidence that lowering the per se limit yet again to .05 would effectively prevent crashes (Fell & Voas, 2006; Wagenaar, Maldonado-Molina, Ma, Tobler, & Komro, 2007). Wagenaar and Colleagues (2007) estimates that approximately 360 lives are saved every year from the change to .08, and an additional 538 could be saved by lowering the limit to .05. While there is a significant amount of laboratory evidence that shows that drivers show some impairment at this lower level (Harrison & Fillmore, 2005; Moskowitz & Fiorentino, 2000; Martin et al., 2013; Moskowitz et al, 2000), there is little actual crash analysis of low BAC and crash responsibility (Phillips, Sousa, & Moshfegh, 2014). However, one study shows that although low BAC is related to increased crash responsibility, low BAC drivers are only involved in a small fraction of crashes, and are responsible in far less (Stringer, 2016).

Although alcohol related crashes have declined significantly over the past few decades (Williams, 2006), the effects of deterrence based policies, such as increased in enforcement and punishment, have shown mixed but largely ineffective results. These mixed results may be indicative of varying relationships across time and place, that are not captured in all studies. The effects of state DUI interventions also may have been overstated (Eisenberg, 2003), with alcohol consumption declining steadily since 1982 this may have led to decreases in DUI crashes alone (Lakins, LaVallee, Williams, & Yi, 2008). An aggregate change in alcohol consumption is likely a result of some other aggregate social, economic, or demographic change in society. Furthermore, it is argued that the reduction in alcohol related fatalities is not due to any one law, but a combination of several efforts combined, and sobriety checkpoints and media attention have an effect as well (Voas et al., 2000). Thus, the research suggests that many varying formal and informal factors should be explored.

The extant research has evaluated several of the previous policies aimed at deterring drunk driving. For example, Freeman (2007) found that changing the per se BAC limit to .08 had no effect on traffic fatalities, while administrative license suspensions and mandatory seatbelt laws did effect fatalities at the state level. Piquero and Paternoster (1998) found that strong deterrent effects can be found in the perceived certainty of punishment directed at individual DUI offenders. Conversely, Wagenaar and Colleagues (2007) found that mandatory fines may have some impact on alcohol impaired crashes in some instances, but mandatory jail time had negligible effect. However, interventions such as lower BAC levels for young and inexperienced drivers and intervention programs for alcohol servers aimed at youth have been successful in reducing crashes (Shults, et al., 2001). Further underage drinking laws reduce alcohol related fatal crashes (Fell, et al., 2008). Increased DUI news coverage is also related to fewer DUI’s within the community (Voas, Holder, & Gruenewald, 1997), and this may be indicative of increased perceptions of enforcement. Furthermore, the use of sobriety checkpoints has shown to reduce impaired driving and crashes in some instances (Elder et al., 2002; Fell, Lacey, & Voas, 2004), especially in small communities (Lacey, et al., 2006). However, the effect on alcohol related crashes is mainly limited to the 2-mile radius around the checkpoint (Nunn & Newby, 2011).

While aggregate increases in arrests are associated with decreased crashes in some cases, the results are mixed (Cameron, 2013; Dula, Dwyer, & LeVerne, 2007; Fell, Tippetts, & Voas, 2009; Fell et al., 2014; Yao, Johnson, & Tippetts, 2015). Sanem and Colleagues (2015) found that a combination of enforcement efforts (e.g. sobriety checkpoints, saturation patrols, and open container enforcement) may lead to a decrease in impaired driving. While per capita arrest rates are associated with a decline in impaired driving crashes, the effect of traffic stops is rendered insignificant by controlling for the prevalence of impaired drivers (Fell et al., 2014). Additionally, the significant effect of per capita arrests on fatal crashes is stronger in urban areas compared to rural areas (Yao et al., 2015). Thus, the effect of these policies varies with structural community factors.

Some studies have shown that the effects and the threat of criminal justice intervention vary from person to person based on their own moral values regarding driving after drinking. For example, the perceived risk of punishment and arrest is not related to subsequent DUI, but moral tolerance, prior drinking and driving and prior legal interventions are related to recidivism (Lanza-Kaduce, 1988). Opinions that drinking and driving is immoral and that sobriety checks are good also serve as a protective factor against DUI, while the perceived risk of crash or punishment does not have any effect (Greenberg et al., 2005). This suggests that internal controls are more important controls against DUI than external control (Greenberg et al., 2005). Along with moral values some other traits of repeat offenders have been identified that include volatility, antisocial friends, teenage deviance, and negative views of the law (DeMichele, Lowe, & Payne, 2014).

Research on recidivism is particularly important when examining DUI crashes because DUI recidivists have a higher risk of fatal crash involvement than other drivers (Fell, 2014). Furthermore, recidivist drunk drivers are not heavily influenced by the vicarious experience of others through general deterrence (Freeman & Watson, 2006). The research on reducing recidivism through specific deterrence has shown mixed results. For example, some have found that measures such as ignition interlocks are effective at reducing recidivism while installed (Coben & Larkin, 1999), and that mandatory license revocation and increased fines lead to reductions in recidivism (Yu, 1994). Additionally, severity and swiftness of punishment significantly affect a probationer's survival time, however community context does not appear to exert any influence (Lee & Teske, 2015). Conversely, first time offenders are argued to be at a substantial risk of recidivism regardless of sanctions imposed (Ahlin et al., 2011), and there is no difference between jail versus no jail offenders (Martin, Annan, & Forst, 1993). Finally, deterrence based policies are least effective for the main target (High BAC drivers) of these policies (Houston & Richardson, 2004), and those with underlying problems, such as alcoholism (Goodfellow & Kilgore, 2014), which may also contribute to recidivism. Therefore, while recidivism is not a central issue for this project, recidivism levels may impact crashes, and efforts to reduce drinking and driving may have different effects for this subpopulation.

Some research has also evaluated the effects of non-punitive informal and rehabilitative measures. Developed under the drug court model, some localities have developed DUI courts as a non-punitive means of reducing recidivism. However, research indicates that those assigned to DUI courts show no significant reduction in recidivism when compared to those who are tried and convicted (Bouffard & Richardson, 2007; Bouffard, Richardson, & Franklin, 2010). However, some rehabilitative programs such as the Turning Point Treatment Program has shown to successfully reduction recidivism (Pratt, Holsinger, & Latessa, 2000). Additionally, Taxman and Piquero (1998) found that rehabilitation is more effective for recidivists than punishment, and less formal approaches are most effective for first time offenders. Furthermore, informal approaches to DUI such as community shaming have been shown to reduce recidivism (Grasmick, Bursik, & Arneklev, 1993), though this is likely to vary across communities.

Community Context

While the extant research has explored a plethora of factors related to alcohol related crashes, there is one factor that has been largely overlooked – community context. Research from a variety of areas is suggestive of the importance of the community context in alcohol related crashes. Therefore, this section will illustrate how diversity in policy, public opinion, alcohol use, moral values, and law enforcement of alcohol and DUI issues vary across communities in a manner that is suggestive of the importance of the structural factors related to community alcohol norms.

Alcohol and DUI Policy

Changes in alcohol and DUI policy over time and across communities may result from the opinions of a small group of powerful people rather than a consensus within society. Thus, both informal and formal criminal justice responses to DUI may vary across time and place. While the consensus model assumes that everyone agrees that a behavior should be criminalized, the conflict model diverges from this assumption and acknowledges that each segment of society has its own values and norms (Quinney, 1970). Furthermore because of conflict between segments of society and an uneven distribution of power, some groups may organize and develop interest groups which can influence public policy (Quinney, 1970). Thus, public policies can reflect the interests of a small group rather than society as a whole. The symbolic politics and conflict regarding alcohol and drunk driving are illustrated in the context of the prohibition (Gusfield, 1986) and the drunk driving movement (Gusfield, 1981, 1996; Reinarman, 1988).

In fact, although nationwide alcohol prohibition was repealed some time ago, the regulation of the sale of alcohol is very different across the country. In fact, approximately ten percent of counties in the U.S. prohibit the sale of alcohol (dry counties) (Frendreis &

Tatalovich, 2010). While one can purchase a bottle of liquor at the corner gas station in some areas, in other counties the sale of alcohol in completely banned. The diversity in county level alcohol policies suggests different community norms and/or interests in alcohol control across counties. While the variation in the sale of alcohol suggests that variations in opinion throughout the county can influence policy, one final example illustrates how some policies are enacted that may conflict with public opinion. For example, research suggests that the states did not lower the BAC limit voluntarily because they all agreed in the change, but were coerced into doing so by the federal government with the threat of rescinding a state's federal highway funds (Tippetts, Voas, Fell, & Nichols, 2005). Thus, this coercion illustrates that state DUI laws may not result from a consensus of the public within that state, but rather the influence of other factors which may be representing the interests of a small segment of society with the power to influence the legislation.

Public Opinion

Generally, it is important to understand public opinion because it plays a key role in alcohol policy development (Latimer, Harwood, Newcomb, & Wagenaar, 2003). However, in some circumstances, as previously discussed, alcohol policies may also be developed without public support. In fact, research by Holmila and colleagues (2009) indicates that community public opinion is divided on alcohol control policies that are influenced by national legislation, economic forces, and state regulators.

Within communities there are several factors that drive public opinion about alcohol policies. Drinking propensities are also a strong predictor of opinions about alcohol control policies (Wagenaar, Harwood, Toomey, Denk, & Zander, 2000). Specifically, infrequent and non-drinkers are significantly more likely to favor policies that limit the use and availability of alcohol, and heavier drinkers are least likely to support them (Holmila, Mustonen, Österberg, & Raitasalo, 2009; Wagenaar et al., 2000). Research also shows that alcohol use is lower in communities that are less tolerant of alcohol (Bryden, Roberts, Petticrew, & McKee, 2013). Thus, one could argue that dry counties or those with the most limitations on the ability to procure alcohol may also be largely composed of non-drinkers.

Alcohol abuse is generally associated with the lower classes (Gusfeld, 1996). Therefore, communities composed of a large percent of residents of lower socioeconomic status may exhibit more alcohol related problems. For example, the economic status of a neighborhood impacts binge drinking, in that those in the most deprived neighborhoods are more likely to binge drink than those in the least deprived neighborhoods (Fone, Farewell, White, Lyons, & Dunstan, 2013). Others found that those employed in blue collar occupations are more likely to suffer from alcoholism than those in higher white collar non-manual job employment (Hemmingsson, Lundberg, Diderichsen, & Allebeck, 1998). Thus, the socio-demographic composition of a community is an important predictor of alcohol use and alcohol abuse within that community. Interestingly, inner city groups also 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).

Religion is the strongest predictor of alcohol prohibition within a county. Although large concentrations of evangelical Protestants are associated with dry status, increased Catholic populations lead to the acceptance of alcohol (Frendreis & Tatalovich, 2010). Interestingly, the former is associated with anti-alcohol related social norms, while the latter is generally more accepting of alcohol consumption. Thus, the religious composition of a county may be correlated with alcohol-related norms in the community.

Several other factors are also related to opinions about alcohol control policies. While religious composition is the strongest predictor of a dry country, other demographic variables such as income, education, and urbanization also play a role (Frendreis & Tatalovich, 2010). Additionally, females, parents, and those that identify as conservative are more likely to favor alcohol control policies than males, those without children, and liberals (Wagenaar et al., 2000). Although, age, education, race, and income are important predictors of public opinion toward alcohol control policies, they vary in direction across different policies (Wagenaar et al., 2000). Thus, if there are aggregate level differences in public opinion about alcohol control, then it is likely to affect informal community norms toward alcohol and/or alcohol policy.

Research also shows that individual moral beliefs about alcohol and DUI are associated with abstinence from drunk driving (Greenberg, Morral, & Jain, 2005; Lanza-Kaduce, 1988; Piquero & Paternoster, 1998). For example, the perceived risk of punishment and arrest is not related to subsequent DUI, but moral tolerance, prior drinking and driving and prior legal interventions are related to recidivism (Lanza-Kaduce, 1988). Opinions that drinking and driving is immoral and that sobriety checks are good also serves as a protective factor against DUI, while the perceived risk of crash or punishment does not have any effect (Greenberg et al., 2005). This suggests that internal controls are more important controls against DUI than external control (Greenberg et al., 2005). Additionally, increased DUI news coverage has been related to less drinking and driving within the community (Voas, Holder, & Gruenewald, 1997), and coverage of fatal crashes may be contribute to the belief that drinking and driving is morally wrong. Since these moral values and internal controls are likely learned through the process of socialization and social learning, they may vary with structural factors and community norms (Akers, 1992; 2011).

The diversity in morality, values, and community norms related to alcohol may influence the behavior of citizens within counties. In areas with high anti-alcohol sentiments there will likely be greater support for tough formal legislation toward DUI. However, when anti-alcohol sentiments are lower, there is greater potential for public opinion within a community to conflict with the formal definitions of DUI. When there is consensus between the formal and informal norms of a community, informal means of social control may aid in reductions of DUI. However, when public opinion is more tolerant than the law, informal social control will be very low, and informal norms may even encourage alcohol consumption and DUI behavior. Finally, conflict can result in lower perceptions of legitimacy of the DUI code which decreases the probability that members of community will follow the law (Platt, 1977; Tyler, 1990)

Differential Enforcement

Local counties do not have the legislative power to change or override state laws. However, they do have the power to choose to prioritize the enforcement of certain laws over others. Regardless of state policies and federal politics, police officers generally have broad discretion in their enforcement duties. Additionally, police departments and police officers are not insulated from the norms of the community, and their behavior can be influenced by the community as well. Since public opinion plays a significant role in alcohol policy (Latimer, Harwood, Newcomb, & Wagenaar, 2003), officials may be reluctant to strictly enforce unpopular legislation. Therefore, while states may be coerced into passing more stringent DUI laws, this does not necessarily mean the laws will be enforced equally across all counties within the state.

In fact, research suggests that enforcement of DUI laws varies widely across the country (Erickson, et. al., 2015). Research also finds that informal norms and the tolerance of alcohol use and drunk driving vary between communities, and these factors are related to DUI enforcement within the community (Mastrofski, Ritti, & Hoffmaster, 1987; Rookey, 2012). In fact, Kinkade and Leone (1992) found that the passage of laws that increased the punishment for DUI in California led to decreases in arrests, which may indicate that administrators and police officers did not agree with this law and chose not to enforce it. Theorists also argue that police officers are affected more by their working environment, the informal norms of the community, and day to day activities than by formal rules and regulations (Feeley, 1973; Lipsky, 2010).

Normative climates toward alcohol use can account for some of the variation in DUI enforcement between counties (Rookey, 2012), and DUI arrests may be less in communities, such as a college town community, that are more tolerant of alcohol compared to others who are less tolerant of alcohol use (Mastrofski, Ritti, & Hoffmaster, 1987). Mastrofski and colleagues (1987) found that though the incidence of DUI was greatest in a small college town, the climate was far more tolerant of alcohol related problems than other communities and officers were significantly less likely to arrest intoxicated drivers. Although there was conflict between townspeople and students over dealing with noise, drunkenness, and disorderly parties, officers were more likely to utilize discretion even though the chief believed in strict DUI enforcement (although he also acknowledged the need for discretion) since students were "repeatedly called the community's bread and butter" (Mastrofski et al., 1987, p. 395).

The community can also influence the priority of DUI enforcement among police leadership, which can then impact DUI arrests: however, research suggests this varies with several other factors (Mastrofski & Ritti, 1992, 1996; Mastrofski et al., 1987). The local community can influence the demand for DUI enforcement within that community. Because resources are limited, the impact of increased demand for DUI enforcement on the priorities of the police administration will vary with the extent of the demand for calls for service, which generally determine the everyday work of police departments (Goldstein, Goldstein, & Hill, 1990). While the priority of DUI enforcement among police leadership can impact DUI arrests, this relationship varies with several factors such as the command and control capacity of police administrators and informal social control by the local police culture (Mastrofski & Ritti, 1992; Mastrofski et al., 1987). The police administration can encourage or dissuade the DUI enforcement through its command and control capacity of by shaping officer discretion, influencing socialization, and through rewards and punishment (Mastrofski & Ritti, 1992).

The local police culture can also influence police decision-making, and in some cases, can influence enforcement despite administrative directives (Mastrofski et al., 1987). Moreover, as Feeley (1973) argues, the informal norms within the department are often more influential than the formal rules and polices of the administration. Finally, when the command and control capacity of the administration is particularly weak, the local police culture has an even greater influence on DUI enforcement, which is particularly influential in watchman style departments (Mastrofski & Ritti, 1992).

Police behavior can also vary according to the policing style of the department within the community. Wilson's (1978) theory of the *Varieties of Police Behavior* argues that police departments vary in orientation (legalistic, service, and watchman styles) based on the characteristics of the population and the local political culture. The legalistic agency is characterized by frequent police-citizen interventions that rely on formal definitions of crime to determine when to intervene (less discretion) but also formal responses to crime (increased arrests and citations). Service style departments often have frequent interventions; however, they are informal and rely on citizen complaints to decide when they should respond. Watchman style departments have infrequent responses and the most discretion to determine whether and how to respond to a given situation. Thus, officers in a legalistic department are more likely to make arrests and may be less influenced by informal community norms related to alcohol than officers in other styles of departments.

Additionally, police decisions vary per the level of social deviance and crime within a community (Klinger, 1997). Specifically, in communities with elevated levels of violent crime, there is predicted to be less enforcement of lesser offenses such as the traffic code. Thus, in communities with high violent crime rates, police may not spend their time with traffic and order maintenance issues, thus there will be less arrests for these types of crimes although they are still being committed. Thus, it follows that there will be a significant amount of subjectivity in the enforcement of drunk driving laws. In fact, the region of the country is found to impact DUI enforcement. Specifically, dry southern regions that exhibit the least alcohol consumption are also associated with more DUI enforcement than wet and moderate regions in the rest of the country (Erickson et al., 2015). This may account for some of the differences in DUI policing between rural vs. urban communities as well (Crank, 1990; Riksheim & Chermak, 1993).

In conclusion, the extant literature has provided an abundance of knowledge on alcohol impaired driving in the United States. From the profusion of studies on alcohols effect on crash risk, injuries, responsibility, and driver performance to the evaluation of the various policies aimed at preventing these propensities the breadth is great. However, one area has been largely neglected in the prior literature- the examination of community factors. While the literature often focuses on assessing the individual driver, offender, or victim, or the effect of policies on large aggregate state level crashes or arrests, few studies consider the community which lies in the middle. Accordingly, because literature from both the traffic safety and criminological literature is suggestive of the importance of the community, this inquiry examines this largely overlooked area of study.

Theory

Deterrence theory is utilized as a theoretical framework to guide this project. Deterrence theory is of importance here because mostly policies is developed with the goal of deterring actors from drunk driving. Deterrence theory dates to the classical school of criminology and the ideas of Cesare Beccaria and Jeremy Bentham. The theory posits that threat of punishment will prevent individuals from committing criminal acts. The theory has three main parts, the certainty of the punishment, the swiftness or celerity of the punishment, and the severity of the punishment (Beccaria, 2009 [1764]). The certainty of punishment refers to the odds that one will be caught and punished. If there is less likelihood of being caught, then there is less deterrent effect. The punishment should also be swift so that the association between the crime and the punishment will be stronger (Beccaria, 2009 [1764]). The severity of the punishment refers to proportion of punishment relative to the harm done by committing the crime. If the punishment it is too severe, then it will be unjust and not deter people from committing crimes, and if it is not severe enough it will not deter crime. Finally, this theory assumes a rational choice by the actor of whether to engage in criminal behavior or not after weighing the risks and benefits, and deciding whether the benefit outweighs the risk (Clarke & Cornish, 1985).

Deterrence theory also differentiates between specific and general deterrence (Zimring & Hawkins, 1973). Specific deterrence refers to the goal of preventing those who have been caught and punished from committing the same act again in the future. General deterrence is aimed at society as whole and the aims to set an example for those who have not yet committed a crime, or at least been caught, by punishing others (Zimring & Hawkins, 1973). Thus, it creates the fear that they will be punished the same way should they be caught.

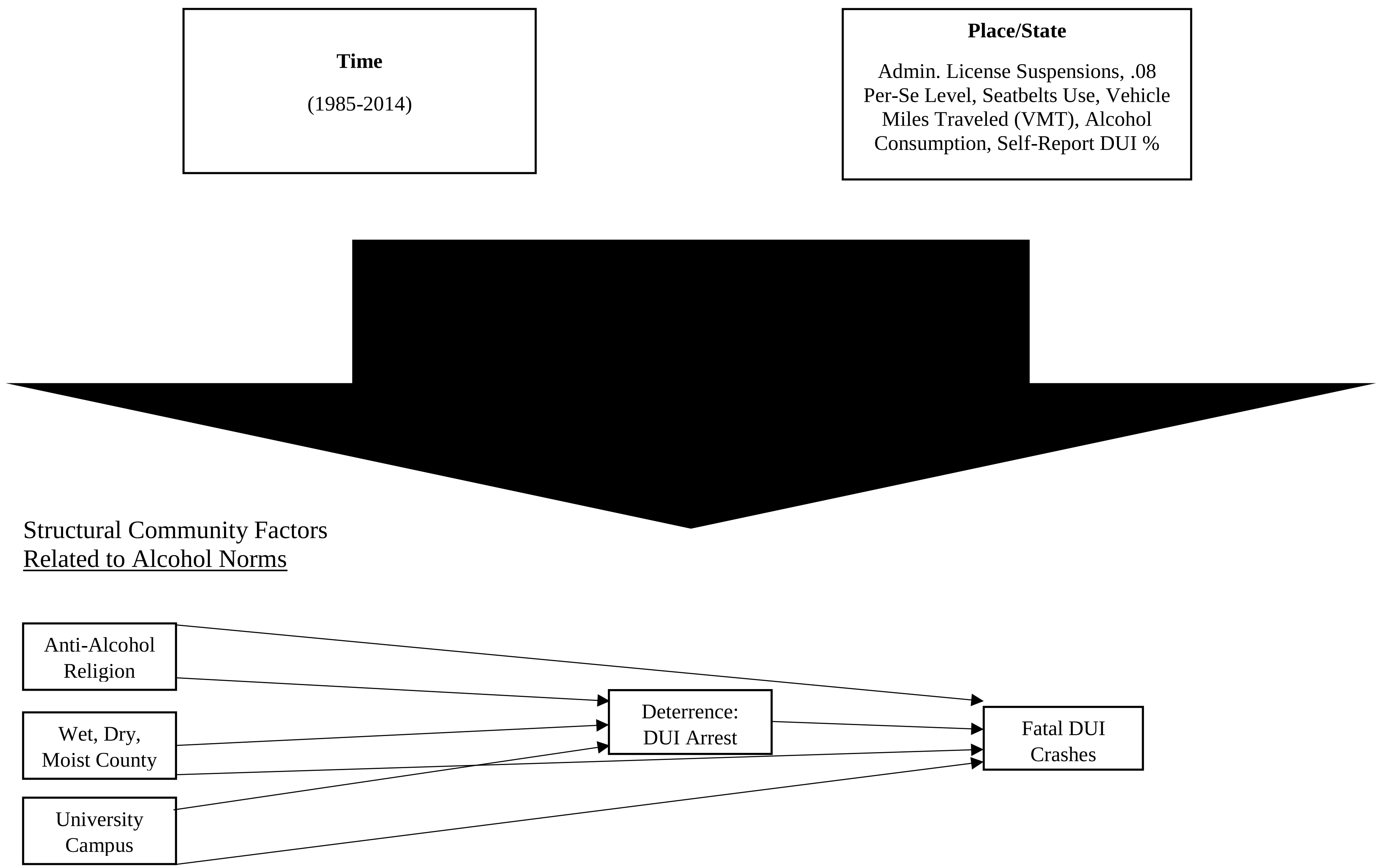
The process of arrest and adjudication is argued to be punishment in and of itself (Feeley, 1979). This is especially true in the case of DUI offenses, for those arrested for DUI are generally taken to jail for a night upon their arrest, and not allowed to be bonded out until their initial time is up. Additionally, many states have adopted administrative driver's license suspensions that take place when an offender is arrested. While DUI offenders may generally receive brief jail sentences, community service, education programs, and license suspensions as forms of formal punishment, they rarely receive harsh prison terms except in the case of repeat offenders and fatalities.

Furthermore, some have argued that deterrence can be expanded beyond formal sanctions into deterrence from informal sanctions when others find out about their arrest and conviction (Paternoster, Saltzman, Waldo, & Chiricos, 1985; Zimring & Hawkins, 1973). Thus, an offender may be informally sanctioned for his or her arrest outside of the formal system of punishment. This is important because some research has found that things such as the loss of a job, friendships, shame, embarrassment, and other factors are more influential than the fear of arrest (Anderson, Chiricos, & Waldo, 1977; MacKenzie & De Li, 2002; Petee, Milner, & Welch, 1994; Thomas & Bishop, 1984). The extant literature is also suggestive of the effectiveness of informal community sanctions such as shaming (see e.g. Grasmick, Bursik, and Arneklev, 1993; Taxman and Piquero, 1998). Thus, the community and one's peer and other social groups may play an important part in deterring drunk driving. The implementation of informal sanctions for an act of crime or deviance may depend on informal definitions of deviance and social norms within one's social group or community. For example, one's friends at the bar or tavern may be significantly less likely to shame or ostracize an individual for a DUI arrest than one's employer. Furthermore, some communities may be more tolerant of alcohol use than others, and therefore informal sanctions may vary.

Hypotheses

1. Because prior research indicates that community norms toward alcohol influence law enforcement decision-making and DUI enforcement, it is hypothesized that increases in structural factors related to anti-alcohol norms will lead to increases in DUI enforcement and increases in pro-alcohol factors will result in decreases in DUI arrests within a community.
2. Because community norms influence alcohol consumption and driving propensities, it is hypothesized that increases in structural factors related to anti-alcohol community norms are related to a decrease in fatal DUI crash rate within a county.
3. Deterrence theory posits that increased certainty of punishment for a crime will reduce the occurrence of that crime. Therefore, because increases in DUI arrests result in an increased in certainty of punishment, it is hypothesized that increases in DUI arrests are related to decreases in the fatal DUI crash rate.
4. Hypotheses 1 – 3 suggest a direct effect of DUI arrests on alcohol related crashes as well as community factors related to alcohol norms on DUI arrests and alcohol related crashes. Because community factors, DUI arrests, and alcohol related crashes all vary across time and place, it is hypothesized that the aforementioned relationships will also vary across time and place.

Figure 1. Heuristic Model of Hypotheses 1-4



CHAPTER III

METHODS

Analytic Plan

The primary objective of this study was to analyze the relationship between arrests, structural factors related to alcohol, and alcohol related fatal crashes in the U.S. from 1985-2014. The main social issue of the drunk driving problem is the deaths that result from the crashes. As such, data from the Fatality Analysis Reporting System (FARS) was utilized to measure the occurrence of alcohol related crashes across counties. Additionally, several other large longitudinal data sets were aggregated to the county, or state level to perform these analyses. Next, multilevel growth-curve analysis was employed to assess these relationships over time. This allowed for the examination of differences in the occurrence of fatal crashes as well as enforcement between and within counties while also contemporaneously controlling for time as well as other county and state factors. These analyses assess the effectiveness of the arrest rates in deterring DUI behavior that leads to fatal crashes, as well as the importance of structural community factors related to alcohol norms.

Data Sources

This project merged data from several sources to assess multiple facets of the DUI problem and response at the county and state level. The effect of the criminal justice response was assessed through county level enforcement, as well as other legislative and policy measures at the state level. The sampling frame is all 3,143 counties within the 50 states and the District of Columbia between 1985 and 2014. This results in a total of 89,149 counties and 1,470 states cases over the period. Unfortunately, the states of Florida and Illinois had to be excluded from the sample due to systematic non-reporting of UCR data within the sampling frame that could not be resolved through imputation.

Enforcement was assessed through arrest data from the Uniform Crime Reports (UCR). The Uniform Crime Reports (UCR) provides data on arrests and offenses known within the United States. These data contain information on arrests for both Part I (murder, rape, robbery, aggravated assault, burglary, larceny, auto theft, and arson), and Part II offenses (e.g. forgery, fraud, vice offenses, and drug and alcohol crimes). These data were used to measure DUI arrests as well as violent crimes known to police across U.S. counties. Since the unit of analysis is the county, the County-Level Detailed Arrest and Offense Data files for 1994 through 2014 were downloaded directly from ICPSR (United States Department of Justice. Office of Justice Programs. Federal Bureau of Investigation, 2014).

However, the UCR county level files prior to 1994 were not utilized because there is a break in the county level data series that results from changes in the way the county level files are constructed that changed in 1994. The changes in the county level data series resulted from changes in the imputation procedures for non-reporting across counties and originating agencies within counties. Specifically, prior to 1994, any originating agency that reported twelve months of data was included as is, those that reported less than six months of data were excluded, and those that reported six to eleven months were increased and weighted by 12/months reported (United States Department of Justice. Office of Justice Programs. Federal Bureau of Investigation, 2014). However, beginning in 1994 to increase the quality of data, a new procedure was implemented to provide more accurate estimates. Specifically, originating agencies reporting twelve months were kept as is, while agencies reporting three to eleven months were increased by a weight of 12/months reported, and agencies reporting zero to two months were set as missing and imputed. Thus, the county files for the two periods are developed by utilizing two different methods and should not be compared to one another.

To facilitate this longitudinal analysis from 1985-2014 the 1985-1993 data were developed by utilizing the Arrests by Age, Sex, and Race file (United States Department of Justice. Federal Bureau of Investigation. Uniform Crime Reporting Program Data [United States]: Arrests by Age, Sex, and Race, 1993). Because these data are aggregates by age, sex, and race, they were first summed to provide estimates for each reporting agency. Subsequently, procedures were implemented in order create county level estimates of drunk driving arrests and Part I violent offenses known to the police in each county and year that would mirror the procedures utilized for the post 1993 county files. Specifically, agencies that reported twelve months of data were kept as is, those that reported between three and eleven months were increased by a weight of 12/months reported, and those reporting zero to two months were imputed. The formula for the calculations for the weight of the agencies reporting three to eleven months was:

$$F_{at} = a + \left(\frac{a}{m}\right) * (12 - m)$$

with F_{at} = Frequency of arrests per agency and year, a = to arrests reported, m = months reported.

Multiple imputation was utilized to estimate the total arrests for the agencies reporting zero to two months out of the year. Like the post 1993 data files, these imputations utilized agencies reporting all twelve months of data, and the predictors used were the same including the calculated arrest rates, state, and geographic stratum. All agencies were then aggregated to the county level and merged with the post 1993 county level UCR files.

This study also utilizes data from the Fatality Analysis Reporting System (FARS) to develop measures of alcohol and non-alcohol related fatal crashes (NHTSA, 2013). These data are compiled and maintained by the National Highway Traffic Safety Administration (NHTSA). These data reflect accidents 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, 2013). Information is provided on the crash, vehicles, persons, weather, as well as many others. Crash and person/driver level data were aggregated to the county level as frequencies of alcohol and non-alcohol related crashes within each county per year. These data will not be weighted, as they are population data and do not come from a sample.

Data from the National Association of Religion were used to measure religion at the county level (Churches and Church Membership in the United States, 1980; 1990; 2000; 2010). These data were collected every ten years at the state and county level and data back to 1890. It provides information on the number of members of each religious denomination within each state and county. County level data collected in 1980, 1990, 2000, and 2010 will be utilized. Since these data are only collected every ten years the values from those surveys will be imputed using a linear interpolation at that point in time. This assumes that there is a linear trend in religious affiliation between time one and time two. The formula for these and the other interpolations was:

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

The National Center for Education Statistics institutional characteristics files for 1985-2014 were used. The National Center for Education Statistics (NCES) is the main federal entity for collecting data related to education (National Center for Education Statistics, 2016). These data measure for the presence of large universities in counties. Also, major athletic programs such as football are also included in these data, as well as the number of enrolled students with will be used to construct weights for university size.

Behavioral Risk Factor Surveillance System data was also included. These data are longitudinal and were collected dating back to 1984. These data are collected and maintained by the Center for Disease Control (CDC), and were downloaded directly from their website. They include the prevalence of various behaviors within the United States. While these are individual level data, they contain a state level indicator which will allow for aggregation to the state level. They represent the percent of the population that indicates that they have consumed alcohol in the past year and driving under the influence in the past year. To account for sampling variation across years and get a good representative sample across years, data were aggregated in five-year samples to the state level.

Moreover, data from the Federal Highway Administration Highway Statistics Series measured and controlled for the total vehicle miles traveled within a state. These data are submitted to the Department of Transportation annually by the states and have been made available in the form of tables and charts since 1945. These data contain statistical information on motor fuel, motor vehicle registrations, driver licenses, highway user taxation, highway mileage, travel, and highway finance (Federal Highway Administration, 2015).

A measure of rural versus urban counties was included as a control variable using "Beale Codes" from the Economic Research Service (Butler & Beale, 1990). 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 a superior measure to other methods. This is accomplished by distinguishing metropolitan counties by the population size of their metro area, and nonmetropolitan counties by degree of urbanization and adjacency to a metro area. There are nine total categories that are divided into three metropolitan and six non-metropolitan categories, and each county is assigned to one of the nine codes. While this was originally developed in 1974, it has been updated every ten years (1983, 1993, 2003, and 2013). Due to the infrequent construction of these data, the linear interpolation at each missing point in time was utilized to fill missing years between updates like the religion data.

Census data was utilized to control for socio-demographic differences among counties. Aggregate county level data was downloaded from ICPSR. These data reflect county demographics from the decennial census collections. ICPSR has extensive tabulations for the period of study 1980-2010 (e.g. population size by gender ratio, age distribution, racial composition, education level, employment ratios, and median income). Again, since the census is only collected every ten years, the linear interpolation was imputed into missing data years.

Data from the National Institute for Health's (NIH) Alcohol Policy Information System (APIS) was used to construct state policy measures. The APIS data contains detailed information on a variety of alcohol-related legislation and other policies at both State and Federal levels (National Instiute on Alcohol Abuse and Alcoholism [NIAAA], 2015). Thus, these data will be utilized to measure state legislation such as per-se BAC limit changes and administrative license suspensions. These data will also be supplemented with data from the Governor's Highway Safety Association, Mothers against Drunk Driving (MADD), and the Insurance Institute for Highway Safety. Data from the National Alcohol Beverage Control Association (2014) was used to create dichotomous measures of dry, wet, and moist counties. Finally, per capita alcohol consumption was obtained from the National Institute on Alcohol Abuse and Alcoholism (LaVallee, Kim, and Yi, 2014).

Measures

Several county and state level measures were utilized for this project. Information on specific measures and descriptive statistics is presented in Table 1. County level measures include the measures fatal alcohol related and non-alcohol related crashes, crashes involving repeat DUI offenders, DUI arrests, the presence of a large university campus, the percent of the population that belong to an anti-alcohol religion, and wet, moist, and dry counties.

County level control variables include the violent crime rate, urban vs. rural, median income, age distribution, sex ratio, the percent of the population with a bachelor's degree or more, and the percent of the population that is Hispanic, African-American, Caucasian, or other races within each county. State level measures were utilized to represent the effect that state level policies have on alcohol related accidents including .08 per-se BAC law and administrative license suspensions, open container laws, allowing DUI checkpoints, and allowing counties to be dry (Home rule). State level self-report measures also control for the percent of the population that has consumed alcohol in the past year, the percent that has driven drunk in the past year, and the percent of the population that frequently wears their seatbelt while driving.

County Level Measures

Measures of crashes within a county each year were utilized. Alcohol related fatal crash rates served as both a dependent and independent variable. Additionally, the total rate of all of motor vehicle crashes was be utilized to control for other potential factors in the community that may cause crashes in general. The rate of alcohol related crashes that involve a driver with a prior DUI conviction was also included. These are calculated by dividing the number of fatal crashes by the county population. In addition, the crash rate for crashes that involve a driver

Table 1. Descriptive Statistics

Name	Mean	Standard Deviation	Min	Max	Data Source	Data Years Available
County Level Factors (n=89,149)						
Total Alcohol Related Crashes	3.85	9.27	0	445	FARS	1985-2014
Total Fatal Crashes	10.99	25.36	0	1,171	FARS	1985-2014
Repeat Offender Crashes	0.66	1.92	0	172	FARS	1985-2014
DUI Arrests	2705	2705.01	0	115,415	UCR	1985-2014
Violent Crime Arrests	418.54	1382.32	0	64,718	UCR	1985-2014
Population	84,524	274,103	52	9,938,311	Census	1980, 1990, 2000, 2010
Median Income	33923.54	8130.82	15363	81,846	Census	1980, 1990, 2000, 2010
% African-American	8.77	14.69	0	86.50	Census	1980, 1990, 2000, 2010
% Hispanic	6.31	12.36	0	98	Census	1980, 1990, 2000, 2010
% Caucasian	84.73	16.7	1.9	100	Census	1980, 1990, 2000, 2010
% Population Age <18	24.97	3.49	0	46.59	Census	1980, 1990, 2000, 2010
% Population Age 18-24	7.22	3.28	0	57.94	Census	1980, 1990, 2000, 2010
% Population 25-34	12.97	2.57	0	32.97	Census	1980, 1990, 2000, 2010
% Population 35-44	13.69	2.04	0	25.86	Census	1980, 1990, 2000, 2010
% Population 45-54	12.95	2.33	2.14	50.00	Census	1980, 1990, 2000, 2010
% Population 55-64	10.81	2.51	0	29.93	Census	1980, 1990, 2000, 2010
% Population 65+	10.61	6.7	0	51.30	Census	1980, 1990, 2000, 2010
% Bachelor's Degree or More	16.64	8.25	0	80	Census	1980, 1990, 2000, 2010
% Below the Poverty Level	13.1	6.87	0	63	Census	1980, 1990, 2000, 2010
Mean Income	39,154	11152.39	13,825	126,448	Census	1980, 1990, 2000, 2010
Male/Female Ratio	101.24	11.87	0	383	Census	1980, 1990, 2000, 2010
Beale Code (Urban - Rural)	5.82	2.553	1	10	ERS	1983, 1993, 2003, 2013
Wet County	0.84	0.42	0	1	NABCA	1985-2014
Moist County	0.13	0.33	0	1	NABCA	1985-2014
Dry County	0.03	0.18	0	1	NABCA	1985-2014
College Campus	0.67	2.76	0	1	NCES	1985-2014
% Latter Day Saint Adherents	2	8.83	0	100	NAR	1980, 1990, 2000, 2010
% Seventh Day Adventists	0.27	0.56	0	17.52	NAR	1980, 1990, 2000, 2010
% Southern Baptist Convention	12.84	15.56	0	100	NAR	1980, 1990, 2000, 2010
% Catholic	12.89	14.55	0	100	NAR	1980, 1990, 2000, 2010
State Level Factors (n=1,470)						
.08 Per-Se Law	0.50	0.50	0	1	APIS	1985-2014
Administrative License Suspension	0.71	0.45	0	1	APIS	1985-2014
Open Container Law	0.65	0.48	0	1	APIS	1985-2014
State Does not Allow DUI Checkpoints	0.235	0.42	0	1	APIS	1985-2014
HomeRule (State Allows Dry Counties)	0.31	0.46	0	1	NABCA	1985-2014
% Drinking and Driving in Past Year	0.04	0.02	0	0.14	BRFSS	1985-2014
% Alcohol Use in Past Year	0.50	0.13	0.3	0.68	BRFSS	1985-2014
% Seatbelt Use	0.67	0.19	0.25	0.98	BRFSS	1985-2014
Per Capita Alcohol Consumption (Gallons)	2.39	0.57	1.2	5.05	NIH	1985-2014
Vehicle Miles Traveled (Millions)	51295	53760.52	3223	329534	FHWA	1985-2014

with a prior DUI conviction will be included. These will be calculated as the rate per 100,000 of the population.

$$CR = \left(\frac{C}{P}\right) * 100{,}000$$

Where CR= crash rate, C = crashes reported, and P = population.

The total DUI arrests within each county were included as a measure of DUI enforcement based on deterrence theory's proposition that increased certainty of punishment will decrease crime. Certainty of punishment is the probability that one will be caught and punished for a crime (Akers & Sellers, 2000). Thus, while this may not capture certainty in the way the theorists intended, logically increases in police arrests for DUI will produce a statistically increased probability of punishment. Some have argued that the total number of arrests is a better measure certainty of punishment than other measures because criminals are more likely to be aware of arrest frequencies than complex ratios (Decker & Kohfeld, 1985; Sampson & Cohen, 1988).

While others have utilized various theoretically derived measures for certainty of punishment there is some controversy over what the best measure is. A meta-analysis by Pratt and Cullen (2005) indicates that certainty of punishment has been tested by using measures of policing effects such as police force size, the arrest ratio (arrests/known offenses) also known as the clearance rate, police per capita, and police expenditures; however, the arrest ratio is found to have the strongest effect size in relation to crime. Logically, the arrest ratio appears to be a better measure because increases in measures such as the number of sworn officers or police expenditures does not necessarily translate into increased probability of arrest for one single crime such as DUI. In fact, Klinger (1997) argues that in communities with high violent crime rates there will be less enforcement of traffic laws such as DUI. Therefore, officers that are busy with serious violent crimes such as murders, rapes, robberies, among others do not have time to enforce lesser offenses such as DUI offenses. It may even result in a reciprocal relationship because these areas need more officers to control violent crime while the DUI code goes unenforced.

Although some have tested the effect of the arrest ratio on crime rate (Sampson & Cohen, 1988; Tittle & Rowe, 1974), the use of the arrest ratio has also lead to mixed results over the years. Specifically, some find that increases in the arrest ratio lead to decreases in the crime rate (Logan, 1975; Wilson & Boland, 1978; 1981). However, others have found no significant relationship between arrest ratio and crime rates (Greenberg, Kessler, & Logan, 1979).

There have been several explanations put forth for these mixed results over the years. For example, Tittle and Rowe (1974) concluded that certainty must reach a critical level to be effective at reducing crime. Others find that distinct levels of certainty of punishment are required for different crimes (Bailey, 1976). Conversely, some argue that the use of the arrest ratio introduces an artefactual statistical relationship where none is present originally (Jacob & Rich, 1980), and the utilization of this measure can create tautological results when assessing trends in crime and arrest rates (Chilton, 1982).

The direction of the relationship is also a source of debate. Some have implemented lag structures to show arrests do not affect crime, but that increases in arrests are preceded by increases in crime (Decker & Kohfeld, 1985). Thus, increases in arrests may be caused by increases in crime, and the causal ordering may be the other way around. Contrarily, others have tested for this reciprocal relationship and found no effect of crime on arrests, but an effect of arrests on crime (Chamlin, 1988; Chamlin, Grasmick, Bursik, & Cochran, 1992). Some attribute contrary results to time lag structures that may be too long to uncover the effect of the deterrent measures (Chamlin, Grasmick, Bursik, & Cochran, 1992). Nevertheless, time ordering and a lag structure is important, and will be implemented for these analyses.

There is also some controversy about whether the frequency of arrests should be utilized instead of the arrest ratio. Wilson and Boland (1982) argue that criminals are affected by increases in the arrest ratio as the probability of arrest, and this creates an appropriate test of deterrence theory. However, Decker and Kohfeld (1985) argue that criminals will not be knowledgeable about complex ratios and probabilities of arrest and are more likely to know about the number of arrests taking place in their neighborhoods and in the media. Thus, the number of arrests is more likely to affect their perceptions of the certainty of arrest (Decker and Kohfeld, 1985). This is especially true of DUI arrests because although the public only has an ambiguous knowledge about the probability of arrest for serious index crimes, police interventions for other offenses such as public drunkenness and driving violations are much more visible and lead to increased perceptions of apprehension (Sampson & Cohen, 1988).

Finally, the dark figure of crime is a significant issue for DUI offenses. Index crimes such as murders, robberies, larcenies are more likely to be reported to the police than are DUI offenses. Therefore, they are conducive to the development of a rate of arrests out of offenses known. However, DUI offenses known to the police and DUI arrests are likely one in the same because they generally come to the attention of the police through their own observations, rather than reports from citizens, which is then followed by an arrest (Snortum, Riva, Berger, & Mangione, 1990). Therefore, considering the aforementioned, the yearly number of DUI arrests was measured herein instead of the other measures for several reasons. Total DUI arrests were logarithmically transformed using the following due to the positive skew in the count data as well as the presence of zero values for some counties.

$$\mathrm{Y} = \log(x + 1)$$

It is important to control for the violent crime rate within the community because the enforcement of traffic violations such as DUI may depend on the level of social deviance within a community (Klinger, 1997). Specifically, communities with higher violent crime are argued to have less enforcement of traffic offenses (e.g. Drunk Driving). Because law enforcement efforts are focused on the more serious crimes, offenses seen as less serious may be overlooked due to limited resources. Therefore, the total rate of violent offenses known to police was utilized to control for violent crime within each county. This rate was be calculated using the standard calculation of offenses known per 100,000 of the population to represent the crime rate in each county as follows:

$$CR = \left(\frac{C}{P}\right) * 100{,}000$$

Where CR = violent crime, C = offenses known to police, and P = population size.

To test whether the formal factors addressed above vary with structural characteristics associated with alcohol norms, several indicators of community norms for alcohol were included. First, a measure of the percentage of the community that identifies as affiliated with a religious group that has been identified by prior research as being anti-alcohol. These include the Latter-Day Saints, Seventh Day Adventists, Nazarenes, and the Southern Baptist Convention (Gusfield, 1996; Nelson, Naimi, Brewer, Bolen, & Wells, 2004; Room & Mäkelä, 2000). While no prior study has included a measure of pro-alcohol religions, this study also included a measure of the percent of the population that identify as Catholic since this is argued to be a pro-alcohol religion by Gusfield (1996).

County alcohol sale legislation was operationalized as wet, dry, and moist counties with a dichotomous variable for each. This is important because since counties theoretically are enacting this legislation voluntarily, this should be an excellent measure of public sentiment within the county. Wet counties will be 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 lie in either category and are more complex. These counties might have no county legislation that forbids the sale of alcohol which make them appear wet; however, 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. Dichotomous variables were created for each of these types of alcohol legislation with wet counties serving as the reference category.

The presence of a college campus was included as a dichotomous variable in accordance with prior literature (Mastrofski et al., 1987; Rookey, 2012). Additionally, only schools that offer a bachelor's degree or more and offer financial aid to student athletes in the football program will be included, others will be placed in the reference category. The prior coding is consistent with Rookey (2012) and the belief that these schools are most representative of pro-alcohol social norms. This measure was also weighted by the student population to account for the size of the school.

Rural drivers are argued to engage in more risk-taking behaviors as a result of the rural traffic safety culture (Ward, 2007). For example, a lack of seatbelt use, speeding, and alcohol use prior to driving are more predominant in rural areas compared to urban areas. Some of these differences are attributed to a perceived difference in risks between urban and rural drivers (Rakauskas, Ward, & Gerberich, 2009). Additionally, fatal crash risk is much greater in rural areas than on urban roadways. There are also many environmental factors that contribute to increased risks of fatal crashes in rural areas such as access to emergency medical care, roadway types, and other hazards. Therefore, rural versus urban counties will be controlled for by utilizing “Beale Codes” from the Economic Research Service which represent each county along a continuum from rural to urban (Butler & Beale, 1990).

Additionally, several measures control for the demographic composition of the community were included at the county level. Since attitudes about alcohol control policies as well as the propensity to drive after drinking varies across gender (Wagenaar et al., 2000), the ratio of men to women in the county was controlled. Youthful age (18-29) has been shown to be related to traffic safety culture (Ward & Özkan, 2014), opinions about DUI policy (Wagenaar et al., 2000), drinking and driving (Drew, 2010), as well as alcohol related crashes (Compton & Ellison-Potter, 2008; Peck et al., 2008; Zador et al., 2000). Therefore, the age composition of the county population was controlled with eight dichotomous variables that represent the percent of the population that is below 18, 18-24, 25-34, 35-44, 45-54, 55-64, and 65 or older. Finally, racial and ethnicity diversity have been related to opinions about alcohol policies, although it varies across different policies (Holmila et al., 2009; Wagenaar et al., 2000). Thus, four variables controlled for the percent of the population that is Caucasian, African-American, Hispanic, and other race or ethnicity since community norms toward alcohol may vary with the racial composition of the community. Other races served as the reference category.

Control measures were also implemented for economic conditions within the community. Because binge drinking is more common in the most deprived neighborhoods compared to the least deprived (Fone et al., 2013), a measure of the percent below the poverty level was included. Additionally, since alcohol use is generally associated with the working class (Gusfield, 1996), and alcoholism is more prevalent among this class (Hemmingsson et al., 1998), the median income within a county was also measured initially. The median income was utilized rather than the mean since income is generally skewed with outliers. However, this was later removed due to collinearity with poverty and education as well as statistical insignificance. Additionally, due to the association between level of education and increased punitive attitudes toward alcohol (Holmila et al., 2009; Wagenaar et al., 2000), the percent of the population with a bachelor's degree or more was also measured.

State Level Measures

Since alcohol consumption and vehicle travel are necessary elements to driving under the influence (Jacobs, 1989), measures of the frequency of these independent behaviors will be included as control variables. The total vehicle miles traveled within each state each year was operationalized as a continuous measure to control for the variance in motor vehicle travel across time and place since this has been found to impact crashes (Voas et al., 2000). Due to the positive skew in this variable, it was logarithmically transformed to achieve normality. Per capita alcohol consumption was constructed as the per capita gallons of ethanol (pure alcohol) consumed in each state every year.

Self-report data from the BRFSS (Behavioral Risk Factor Surveillance System) was also used to measure the percent of the population that has self-reported driving after consuming alcohol, consuming alcohol, and binge drinking in the past year are all included as continuous measures. Additionally, the percent of the population that always or nearly always wears their seatbelt when driving or riding in a motor vehicle is included to control for aggregate injury severities. Because each of the above questions was not asked in every state and year from 1985-2014, multiple imputation was used to impute values into missing cells for states and years prior to analysis. Multiple imputation is one of the most preferred methods for dealing with randomly missing data as it allows for a statistical prediction of the missing values based on valid cases and data (Allison, 2001; Raudenbush & Bryk, 2002). Along with the valid cases for the self-report data, the other variables in the state file were also used to predict the missing values, and the imputation models were constrained to return a value within the range of the original data. The analysis returned five separate imputation estimate files, all of which were utilized in the analysis and the results were averaged across all five (see Raudenbush & Bryk, 2002).

Several other state policies that vary over time and state are also controlled. Since the per-se BAC limit has varied across the period of study and it is argued to impact crashes a dichotomous measure represents the BAC level for each state over time (.10 or .08) (Wagenaar, Maldonado-Molina, Ma, Tobler, & Komro, 2007). Also, a dichotomous variable controls where and when administrative license suspensions laws for DUI offenders are implemented because the implementation of these laws has been found to impact alcohol related crashes (see Voas et al., 2000; Wagenaar & Maldonado-Molina, 2007). Additionally, because open container laws and DUI checkpoints may impact drinking and driving, dichotomous measures were also implemented for this legislation.

Data Analysis

Because of the potential impact of state level aggregate and policy factors, multilevel analysis was performed using HLM 7 (Raudenbush, et al., 2011). As such, county and state level data were analyzed contemporaneously through nested hierarchical growth curve models that allow for the examination of these data over time. Additionally, since the dependent variable has a significant positive skew, as many count variables do, analysis will be conducted by utilizing the Poisson analysis feature. This option also allows for the control of over dispersion in the dependent variable like that of the negative binomial model (Raudenbush & Bryk, 2002), which is argued to be superior than the standard linear model when analyzing DUI arrests (see DeMichele, Lowe, and Payne, 2014). Specifically, while the variance at level 1 is generally expressed as:

$$w_{ij} = n_{ij}\lambda_{ij}$$

The overdispersion option adds a variance component to account for a larger variance than asssumed within these data (Raudenbush & Bryk, 2002). Thus, the variance at level 1 would be expresed as:

$$\sigma^2 w_{ij}$$

Furthermore, the Poisson analysis is conducted with varying exposure rather than constant exposure. This is important because not all U.S. counties have similar frequencies of DUI crashes because they have different population sizes. For example, odds are the county with the lowest population size in the sample (n=52) is not going to have a simlar frequency of crashes as another with 100,000 or more residents. Thus, varying exposure is controlled by population 16 years or more within the community in order to estimate the automobile driving population within that county. Due to the positive skew in this factor, it was logarithmically transformed prior to entry. In its simplest form, this over dispersed varying exposure multilevel Poisson model is expressed as:

$$E(Y_{ij}|\lambda_{ij}) \sim P\left(\sigma^2 m_{ij}, \lambda_{ij}\right) = \pi_{0ij} + e_{tij}$$

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

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

While Tables 2 and 4 present growth curve models, Tables 3 and 5 present nested models. While the growth model is preferable for these longitudinal data, it is not without its limitations, and cannot introduce time-varying covariates (TVCs) at levels higher than level 1. Therefore, the nested approach was utilized for these models to circumvent the limitations of the growth model and allow the examination of time-varying covariates at the state level. These models nest each county and year within each state and year. Specifically, level 2 is changed from the county level illustrated in Tables 2 and 4 to a time-varying state level in Tables 3 and 5. The differences in the composition of the two files are illustrated below:

Table 2. Differences in Growth vs. Nested Files

	Growth Files	Nested Files
Level 3	States N=49	States N=49
Level 2	Counties (N=2,986)	Repeated State Observations 1985-2014 (N= 1,470) (N=49 States * 35 Years)
Level 1	Repeated County Observations 1985-2014 (N=89,149) (92,986 Counties * 35 Years)	Repeated County Observations 1985-2014 (N=89,149) (N=2,986 Counties * 35 Years)

As such, level 1 is constructed of repeated county observations from 1985-2014 (N = 89,419). However, rather than nesting these level 1 observations within each of the 2,986 counties examined, they are nested within the time varying state factors at level 2 (n= 1,470). Thus, level 2 is comprised of the repeated observations of each of the 48 states and D.C. that are examined from 1985-2014. Level 3 is constructed of the 48 states and D.C. (N = 49). For example, 1985 Los Angeles (level 1) was nested within 1985 California (level 2), which was then nested within the state of California (level 3).

The change from a growth curve to a nested model will lead to a minor change in the interpretation of these data. The growth models presented above predicted a change in DUI fatal crash rate growth. Specifically, this method modeled the growth of DUI crash/arrest rates over time, and then used the variables entered to predict changes in that growth. However, the nested approach does not model the change in the dependent variable over time and try to predict changes in growth. Therefore, the nested model is interpreted as predicting the DUI fatal crash/arrest rate for each county in the following year (because of the time lag) with the independent variables without predicting a change in growth over time.

The models presented are mixed effects models. Thus, random effects that are statistically significant will be allowed to vary in both types of analysis, while others that do not significantly vary were fixed in the final models (Raudenbush & Bryk, 2002). The random effects model is illustrated below with the addition of random effects r_{1ij} & u_{10j}:

$$E(Y_{ij}|\lambda_{ij}) \sim P(\sigma^2 m_{ij}, \lambda_{ij}) = \pi_{0ij} + (\pi_{1ij} X) + e_{tij}$$

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

$$\pi_{1ij} = B_{10j} + r_{1ij}$$

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

$$B_{10j} = \gamma_{100} + u_{10j}$$

Additionally, all predictors have been centered around the grand mean since there is no reason to believe that group mean centering is appropriate for these data (see Enders & Tofighi, 2007). These models also present multiplicative interactions at the same and across levels of analysis. While same level interaction is calculated the same as in fixed effects regression models as $(X_1 * X_2)$, cross level interactions are created by adding a higher-level predictor to explain the variation in an effect at a lower level.

Compliance with the assumptions of multilevel modeling (linearity, normality, homoscedasticity, and independence) will be assessed and corrected prior to analysis. Multicollinearity was assessed at level 1 through variance inflation factors and no collinearity appears to be present. Collinearity at other levels, and across levels was assessed through the examination of variance-covariance matrices as well the examination of standard error changes between models, and none has been identified. Additionally, robust standard errors were utilized as a diagnostic for violations of the assumptions of homoscedasticity (Liang & Zeger, 1986; Maas & Hox, 2004; Raudenbush, et al., 2011).

Polynomial models were estimated for several variables to test for non-linearity among the predictors. Non-linearity was discovered for both the measures of year and DUI arrests within these data. First, a quadratic model was estimated and non-linearity was discovered among these predictors. However, because non-linearity may extend beyond one single curve in the relationship (Allison, 1999; Raudenbush & Bryk, 2002), a cubic model was subsequently tested, followed by a quartic model as well. While the cubic model was found to fit these data, the quartic model did not fit. Thus, findings from the cubic models are presented. These models were identified by entering squared and cubed transformations of these variables as illustrated below.

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

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

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

Lag Structure

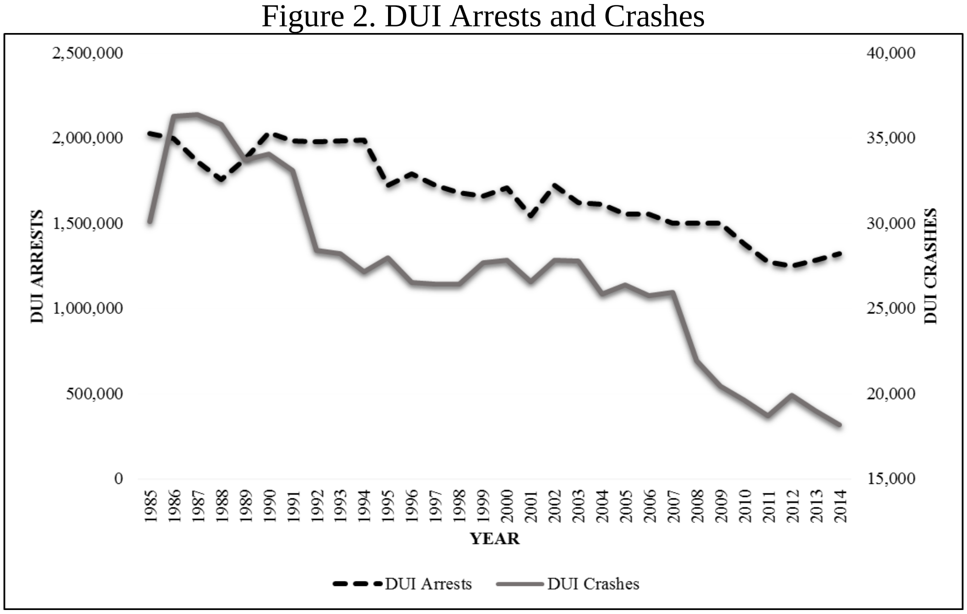
A one-year lag time was implemented to control for temporal ordering in the causal model. This strategy is designed to circumvent the shortcomings of the non-recursive multilevel modeling which does not assess directionality of the relationship. The contemporaneous analysis of relationships in the non-recursive model does not control for temporal ordering of the casual relationship; thus, the direction of the relationship is uncertain. This is particularly problematic when assessing the effect that arrests have on crashes because the relationship may be reciprocal in that crashes may affect arrest rates as well. However, to circumvent this issue and control for temporal ordering and allow for causal inferences to be drawn from these data, a one-year lag time between independent and dependent variables was utilized for the analyses presented herein. The next chapter presents findings from these analyses.

CHAPTER IV

FINDINGS

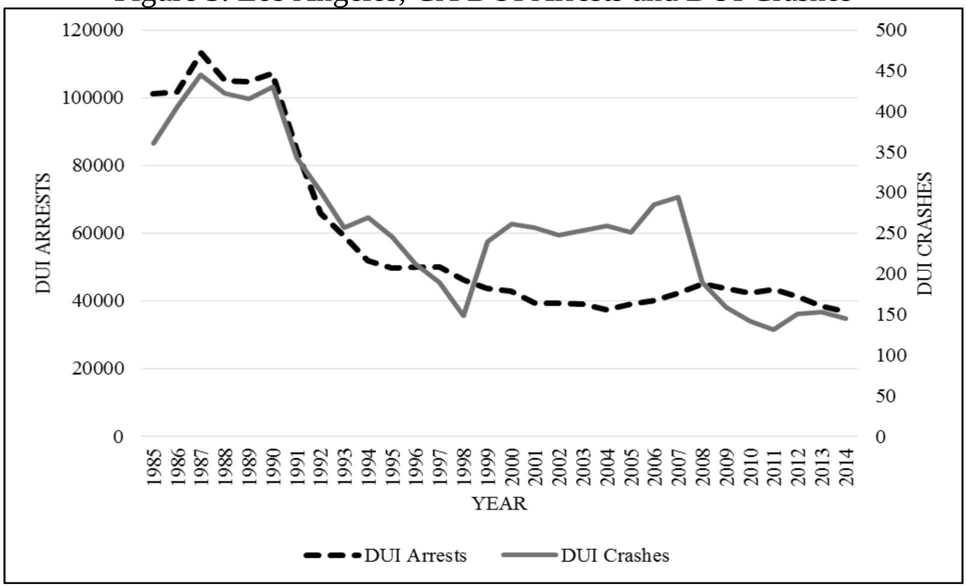
The following chapter presents the findings from the statistical models which test the aforementioned hypotheses. The first section presents growth curve and nested models that utilize DUI arrests as the dependent variable. The second section presents similar models that utilize DUI fatal crashes as the dependent variable. Figures 2-4 illustrate that the relationships between DUI arrests and DUI related fatal crashes varies across both time and place (see Hypothesis 4). Figure 2 illustrates the bivariate relationship between DUI arrests and DUI crashes per 100,000 of the population in the United States from 1985-2014. These data indicate that both DUI arrests and crashes have generally declined during the period of study.

Figure 2. DUI Arrests and Crashes



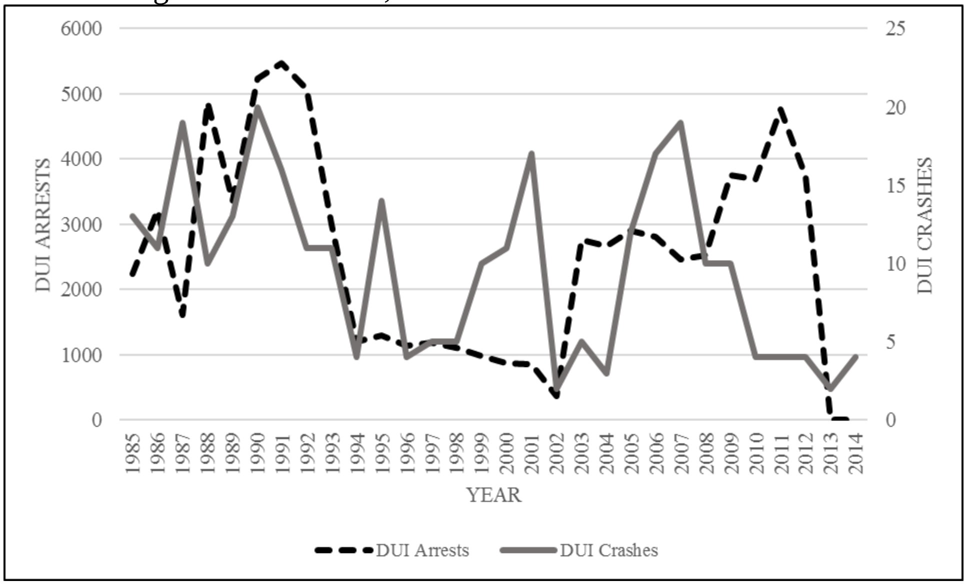
Figures 3 and 4 illustrate DUI arrests and DUI crashes in Los Angeles, CA and New York, NY from 1985-2014. These two areas represent the highest (Los Angeles) and the lowest (New York) frequencies of DUI crashes and DUI arrests in the country. These figures illustrate that the differences in the relationship between DUI crashes and arrests varies across different place. Los Angeles shows a high point of both arrests and crashes in the 1980's and early 1990's followed by a decline in both, and then a rise in crashes during the 1999 though 2007 period.

Figure 3. Los Angeles, CA DUI Arrests and DUI Crashes



Conversely, the New York figure shows a much more eratic up/down trend which is likely attibuted to the lower frequency and range of both DUI crashes and DUI arrests in New York. These data illustrate a high point in DUI arrests in the early 1990's followed by a decline in DUI arrests that lasts until 2002 when arrests begin to rise again.

Figure 4. New York, NY DUI Arrests and DUI Crashes



DUI Arrest Rate Predictions

Table 3 presents the findings from the mixed effects Poisson growth curve analysis which predicts growth in DUI arrests with a one-year time lag. Level 1 is constructed of the observations of the 2,986 counties over a 30-year period from 1985-2014. Level 2 is made up of the 2,986 counties in which the level 1 observations over time are nested. Both level 1 and 2 are nested within level 3 (n= 49), which is made up of all U.S. states and the District of Columbia, except for Florida and Illinois.

The reliability estimate from the unrestricted model shows that about seventy-two percent of the variance in DUI arrests is explainable from these data, and approximately twenty-eight percent of the variance is due to sampling bias. The intra-class correlation coefficient for level one, two, and three is calculated and offered below. This statistic provides the percent of the variance in the dependent variable that is explainable at each level. The calculation for the level two ICC is provided below.

$$\widehat{P} = \frac{\tau}{\tau + \sigma^2 + \pi}$$

Levels one and three are calculated by substituting their respective variance component in the numerator. The calculations indicate an ICC of .87 at level 1. Therefore, almost all the variance (87%) in DUI arrests is explainable at level 1. Additionally, eight and five percent (level 2 ICC = .08, level 3 ICC = .05) of the variance in DUI arrest rate is explainable at levels 2 and 3, respectively.

There are several ways of presenting the findings from count models such as these (Demichele, Lowe, and Payne, 2014). The coefficients from the models are perhaps the least intuitive since they are indicative of a change in log units of the dependent variable, like the log-odds in logistic regression. To aid in the interpretability of the findings the event rate ratios are presented with standard errors in parentheses. The event rate ratios are simply the exponentiated coefficients from the model, again similar to the conversion of log-odds ratios to odds-ratios in logistic regression. One way of interpreting the event rate ratios is by the factor change in the dependent variable per change in the independent variable (Demichele, Lowe, and Payne, 2014). For example, a rate ratio of 1.20 would be interpreted as an increase in the dependent variable by a factor of 1.20 per increase in the independent variable. Since this is not very intuitive, and redundant, this project adopts the approach of interpreting the rate ratios as percent change in the dependent variable. Thus, the above rate ratio would be interpreted as a 20 percent increase in the dependent variable (see Demichele, Lowe, and Payne, 2014).

Additionally, r-squared estimates are presented for each model and level of analysis in Table 3. Overall, the final models account for approximately eighty-five, thirty-four, and fifty percent of the variance in DUI arrest rate change across time, counties, and states, respectively. Model 2 illustrates that the independent variables account for only about one percent of the

Table 3. Mixed Effects Growth Curve Models Predicting DUI Arrest Rate with 1 Year Lag

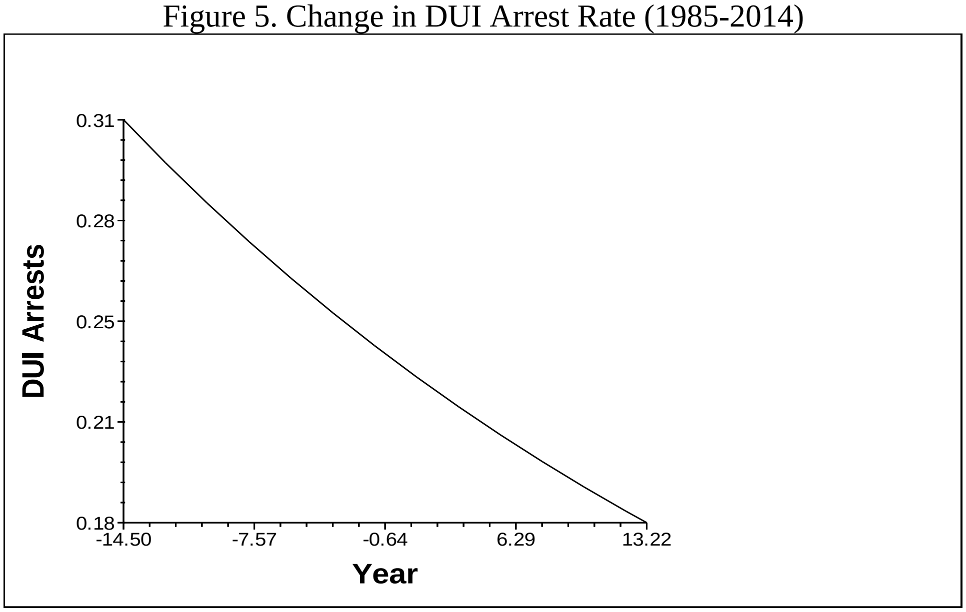
	Model 1 Year	Model 2 Independent Variables	Model 3 L1	Model 4 L1 and L2
County Level (N = 89,149)				
Year	0.943*** (.013)	0.943*** (.013)	1.016 (.013)	1.017 (.013)
$Year^2$	1.001* (.000)	1.001** (.000)	0.998*** (.000)	0.998*** (.000)
% Latter Day Saints Adherents	-	1.011 (.003)	1.023 (.016)	1.021 (.016)
% Seventh Day Adventists	-	1.753*** (.057)	1.118* (.046)	1.116* (.046)
% Seventh Day $Adventists^2$	-	0.898*** (.016)	-	-
% Seventh Day $Adventists^3$	-	1.004*** (.001)	-	-
% Southern Baptist Adherents	-	0.981*** (.004)	0.996 (.003)	0.996 (.003)
% Southern Baptist $Adherents^2$	-	1.001*** (.000)	-	-
% Catholic Adherents	-	1.003* (.001)	1.003 (.002)	1.003 (.002)
Football University	-	1.019*** (.003)	1.029*** (.005)	1.029*** (.005)
Beale Code (Urban - Rural)	-	-	0.924*** (.013)	0.925*** (.013)
DUI Fatal Crashes	-	-	1.017** (.006)	1.017** (.006)
Repeat Offender Crashes	-	-	0.981 (.013)	0.981 (.013)
Violent Crime Offenses Known	-	-	1.101*** (.011)	1.101*** (.011)
% Below the Poverty Level	-	-	0.994 (.009)	0.995 (.009)
% Bachelors Degree or More	-	-	1.040*** (.004)	1.040*** (.004)
% African-American	-	-	1.028** (.011)	1.028** (.011)
% Hispanic	-	-	1.017** (.007)	1.017** (.007)
% Caucasian	-	-	0.993 (.008)	0.994 (.008)
% Population Age <18	-	-	1.035*** (.006)	1.036*** (.006)
% Population 25-34	-	-	1.060*** (.007)	1.060*** (.007)
% Population 35-44	-	-	1.013*** (.009)	1.013*** (.009)
% Population 45-54	-	-	1.008 (.010)	1.008 (.010)
% Population 55-64	-	-	0.964** (.011)	0.964** (.011)
% Population 65+	-	-	1.033*** (.002)	1.033*** (.002)
Male/Female Ratio	-	-	0.989*** (.003)	0.990*** (.003)
Level 2 (N=2,986)				
Dry County	-	-	-	0.744*** (.087)
Moist County	-	-	-	0.973 (.064)
Level 3 (N=49)				
L1 R-Squared	0.65	0.66	0.85	0.85
L2 R-Squared	0	0	0.34	0.34
L3 R-Squared	0	0	0.49	0.50

*p<.05, **p<.01, ***p<.001

variance in DUI arrest growth at level 1. The change in r-squared between model 2 and 3 indicates that the addition of the control variables explains an additional nineteen percent of the variance in DUI arrest. Additionally, models 3 and 4 allow the slopes to vary randomly across counties and states. According to the r-squared statistic for model 3, these random effects explain approximately thirty-four and forty-nine percent of the variance in DUI arrest rate at the county and state levels, respectively. The addition of measures of dry and moist counties in model 4 only explains an additional one percent of the variance in DUI arrest rate at level 3.

Model 1 indicates that change in DUI arrest rate has declined throughout the period of study. Specifically, DUI arrest rate has declined by approximately six percent per year. While the quadratic non-linear model was fit, the coefficient was very small. As such, while the slope was not completely linear, the effect of the non-linearity is very small as illustrated below in Figure 5. The trend of DUI arrests over time is important for the growth model, because all future models and variables introduced predict change in DUI arrest growth.

Figure 5. Change in DUI Arrest Rate (1985-2014)



Many of the independent variables proved to be significant predictors of change in DUI arrest rate. While the percent of the population that identifies as a Seventh Day Adventist was positive and statistically significant in all models, initially it presented as a cubic non-linear polynomial relationship. However, the non-linearity was explained away by the addition of the control variables in model 3. This results in a linear positive increase in DUI arrest rate of about twelve percent per increase in the percent of the population that identifies as a Seventh Day Adventist. While the Southern Baptist population presented a significant quadratic relationship with DUI arrest rate initially, after controlling for other factors it was insignificant.

Similarly, Catholic population was significant in model 2, but after controlling for other factors it was not a significant predictor of change in DUI arrest rate. The percent of the population that adheres to the church of the Latter-Day-Saints was insignificant in all models in Table 3. Though the arrest rate in moist counties was not significantly different from wet counties, dry counties are predicted to have a decrease in DUI arrest rate of about twenty-six percent compared to wet counties. Counties with a large university with a football team are predicted to have an increase in DUI arrest rate of about two-three percent per increase in the student population.

Many of the control variables also produce noteworthy results. Beale code indicates a seven percent decrease in DUI arrest rate per unit increase in rurality. Each increase in DUI fatal crashes results in a two percent increase in DUI crash rate growth. However, DUI fatal crashes involving a repeat offender were insignificant predictors of DUI crash rate growth. Each percent increase in violent crime predicts an increase in DUI arrest rate growth of about ten percent. Although the poverty level was not significant, each percent increase in the population with a bachelor’s degree or more results in a four percent increase in DUI arrest rate. Each percent increase in the African-American and Hispanic population is associated with an increase in DUI arrest rate. Each unit increase in the ratio of males to females also resulted in a ten percent increase in DUI arrest rate.

Increases in all the age population categories, except for those aged 45-54, was significantly related to DUI arrest rate. Additionally, all the significant categories were positively related to DUI arrest rate except for those aged 55-64. Each percent increase in the population aged 55-64 resulted in a four percent decrease in DUI arrest rate growth. Among those age ranges related to increases in the DUI arrest rate there was also some variability. Specifically, each percent increase in the population between 25-34 leads to six percent increase in DUI arrest rate. While increases in the population under 18 indicates a four percent increase in arrest rate, increases in the population over 65 years old predicts an increase in DUI arrest rate of only three percent. The lowest positive relationship is for increases in the population between 45 and 44, which is only a one percent increase in DUI arrest rate growth for each percent increase in the population in that age range.

Table 4 presents results from the nested models which introduce state level factors to predict DUI arrests. These models present a similar reliability estimate (.962) which indicates that ninety-six percent of the variance in DUI arrests is explainable by these data. The intra-class correlation coefficient indicates that ninety-nine percent of the variance in DUI arrests is explainable at county level (level 1), and only one percent of the variance is explainable at the state level.

Like Table 3, the independent variables explain approximately two percent of the variance in DUI arrests. However, the control variables explain an additional fifty-two percent of the variance in DUI arrests. Overall the models explain sixty-seven percent of the variance in

DUI arrests at level 1. The final models explain thirty-eight percent of the variance at level 2 and sixty-three percent of the variance at level 3.

Interestingly, models 3 and 6 explain more of the variance at level 3, while models 2, 4, and 5 explain more of the variance at level two. It is important to remember what these levels represent to understand the meaning of the changes in variance explained across these levels. Specifically, level two represents changes in states over time, while level three represents differences between states. The independent variables in model 2 have more random effects at level two than at level three which leads to the explanation of a greater variance in the dependent variable at level three. In other words, the relationships between the independent variables varies with state change over time, rather than between states. As such, without controlling for other factors, more variance is explained between states over time at level 2 (39%) than the differences between states at level 3 (06%).

However, after introducing control variables at level 1, more of the variance in differences across states is explained (62%). Conversely, after level 2 covariates are introduced, models 4 and 5 explain more of the variance at level 2 (31% of states over time), than between states (10%). Model 6 is where it all comes together, and one must remember that ninety-nine percent of the variance in the DUI arrests is explainable at level 1, and the state factors are not especially vital to the explanation of the variance in DUI arrests. However, the interaction of these factors with county factors is important, after these interactions are modeled the greatest amount of variance at level two (states over time = 38%) and level three (between states = 63%) is explained.

Table 4. Mixed Effects Nested Poisson Models Predicting DUI Arrest Rate with 1 Year Lag

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Year Only	Independent Variables	L1	L1 and L2	L1 and L2 Parsimonious	Cross-Level Interactions
Level 1 - County Factors (N = 89,419)						
Year	0.911*** (.006)	0.889*** (.008)	0.984*** (.002)	0.982*** (.003)	0.983*** (.003)	0.980*** (.003)
Year²	1.002*** (.000)	1.003*** (.000)	-	-	-	-
% Latter Day Saints Adherents	-	0.987*** (.002)	1.058* (.024)	1.051* (.023)	1.053* (.023)	1.049* (.023)
% Seventh Day Adventists	-	1.062*** (.011)	1.003 (.010)	1.002 (.010)	1.002 (.010)	0.999 (.010)
% Southern Baptist Adherents	-	0.991*** (.001)	1.003 (.007)	1.006 (.006)	1.006 (.006)	1.006 (.006)
% Catholic Adherents	-	1.008*** (.001)	1.005 (.003)	1.005 (.003)	1.005 (.003)	1.005 (.003)
Football University	-	1.147*** (.010)	1.017*** (.005)	1.018*** (.005)	1.018*** (.005)	1.016*** (.005)
Dry County	-	0.895* (.046)	0.856* (.070)	0.863* (.070)	0.863* (.070)	0.871* (.070)
Moist County	-	0.935 (.039)	0.957 (.074)	0.911 (.074)	0.902 (.074)	0.914 (.068)
Beale Code (Urban - Rural)	-	-	0.898*** (.009)	0.896*** (.009)	0.896*** (.009)	0.899*** (.008)
BAC .08 Interaction	-	-	-	-	-	1.019* (.009)
DUI Fatal Crashes	-	-	1.028*** (.005)	1.029*** (.004)	1.030*** (.004)	1.028*** (.003)
BAC .08 Interaction	-	-	-	-	-	0.998*** (.001)
Vehicle Miles Interaction	-	-	-	-	-	0.992*** (.002)
Total Alcohol Interaction	-	-	-	-	-	0.993*** (.001)
Repeat Offender Crashes	-	-	1.007*** (.002)	1.007*** (.002)	1.007*** (.002)	1.008*** (.002)
Violent Crime Offenses Known	-	-	1.397*** (.007)	1.396*** (.007)	1.396*** (.007)	1.423*** (.007)
BAC .08 Interaction	-	-	-	-	-	1.152*** (.012)
% Self-Report DUI Interaction	-	-	-	-	-	0.452** (.252)
% Below the Poverty Level	-	-	0.987*** (.004)	0.987*** (.004)	0.987*** (.004)	0.986*** (.003)
% Bachelors Degree or More	-	-	1.014*** (.001)	1.014*** (.001)	1.014*** (.001)	1.013*** (.001)
% African-American	-	-	0.986* (.006)	0.982** (.006)	0.982** (.006)	0.983** (.006)
% Hispanic	-	-	1.007 (.005)	1.007 (.005)	1.007 (.005)	1.007 (.005)
% Caucasian	-	-	0.990 (.006)	0.988* (.006)	0.988* (.006)	0.990 (.005)
% Population <18	-	-	1.013*** (.003)	1.008* (.004)	1.008* (.004)	1.008* (.004)
% Population 25-34	-	-	1.034*** (.004)	1.031*** (.005)	1.031*** (.005)	1.029*** (.005)
% Population 35-44	-	-	0.951*** (.007)	0.952*** (.007)	0.952*** (.007)	0.950*** (.007)
% Population 45-54	-	-	1.002 (.008)	0.998 (.008)	0.998 (.008)	0.999 (.008)
% Population 55-64	-	-	1.008 (.009)	1.006 (.009)	1.006 (.009)	1.009 (.009)
% Population 65+	-	-	0.998 (.002)	0.993** (.003)	0.993** (.003)	0.993** (.003)
Male/Female Ratio	-	-	0.992*** (.002)	0.992*** (.002)	0.992*** (.002)	0.993** (.002)
Level 2 - State Factors (N = 1,470)						
BAC .08 Law	-	-	-	1.060 (.031)	-	0.852*** (.040)
Administrative License Suspension	-	-	-	0.887** (.044)	0.902* (.043)	0.901* (.045)
Open Container Law	-	-	-	1.103** (.038)	1.132*** (.036)	1.108** (.038)
HomeRule (States Allow Dry Counties)	-	-	-	1.106 (.180)	-	-
State Allows DUI Checkpoints	-	-	-	1.097 (.202)	-	-
% Self Report DUI in Past Year	-	-	-	1.166 (.710)	1.461 (.593)	9.037** (.757)
% Always Use Seatbelt	-	-	-	0.936 (.075)	-	-
Per Capita Alcohol Gallons Consumed	-	-	-	1.151* (.070)	1.163* (.070)	1.223** (.071)
Vehicle Miles Traveled (Millions)	-	-	-	1.022 (.137)	1.015 (.136)	1.104 (.141)
Level 3 - States (N=49)						
L1 R-Squared	0.13	0.15	0.67	0.67	0.67	0.67
L2 R-Squared	-	0.39	0.20	0.31	0.31	0.38
L3 R-Squared	-	0.06	0.62	0.10	0.10	0.63

*p<.05, **p<.01, ***p<.001

The introduction of state level factors introduces several noteworthy findings. Some of the state level policy factors are significantly related to DUI arrest rate. The implementation of administrative license suspensions predicts an eleven percent decrease in DUI arrest rate. Additionally, states with open container laws are related to a ten percent increase in DUI arrest rate. The development of the .08 per-se BAC law, allowing dry counties, and DUI checkpoints do not have any significant impact on DUI arrest rate.

The introduction of additional control measures also provides some interesting insight into varying DUI arrest rates. The per-capita gallons of alcohol consumed in each state is a significant predictor of DUI arrest rate in all models and leads to a two percent increase in DUI arrest rate for each unit increase in per capita gallons of alcohol consumed. The total vehicle miles traveled and the percent of the population that always wear their seatbelt do not have any significant impact on DUI arrest rate. Interestingly, self-report DUI does not have any direct impact on DUI arrest rate until model 6 which introduces cross level interactions. Once the interaction of self-report DUI with Beale code, DUI crashes, and violent crime are controlled, the main effects of each percent increase in self-report DUI are significantly related to a nine times increase in DUI arrest rate ratio.

Several of the state level factors were found to significantly interact with county level factors in model 6. The .08 BAC legislation, self-report DUI, alcohol consumption, and vehicle miles traveled interacted with county level factors. While each unit increase in Beale code predicts a decrease in DUI arrest rate of ten percent prior to the .08 BAC legislation, after this law was implemented each unit increase only leads to an eight percent decrease in DUI arrest rate. Additionally, .08 BAC laws, vehicle miles traveled, and total alcohol consumption interact with DUI fatal crashes to predict DUI arrest rate. Each unit increase in DUI fatal crashes leads to about a three percent increase in DUI arrest rate when there is no .08 legislation, vehicle miles traveled, and alcohol consumption are zero. However, when after the .08 BAC law was implemented there was a slight decrease (0.2%) in the predicted increase in DUI arrest rate. Furthermore, each percent increase in total vehicle miles traveled within a state predicts a small decrease (0.8%) in the predicted increase in DUI arrest rate per increase in DUI fatal crashes. Moreover, each increase in per-capita alcohol consumption leads another decrease (0.7%) in the predicted increase posed by an increase in DUI fatal crashes.

The final cross level interactions are the interactions of the .08 BAC law and self-report DUI with Part I violent crime offenses known to police. Each percent increase in violent crime offenses known results in a forty-two percent increase in DUI arrest rate prior to the .08 BAC legislation when self-report DUI is zero. However, after the .08 BAC legislation was implemented each percent increase in violent crime leads to a fifty-eight percent increase in DUI arrest rate. Additionally, each unit percent increase in self-reported DUI results in a fifty-five percent decrease in the predicted forty-two percent increase in DUI arrests predicted by increases in violent crime. Thus, as self-reported DUI mean increases the effects of violent crime on DUI arrests decreases.

Many of the independent variables remained insignificant predictors of DUI arrest rate like the results in Table 3. However, the measure for the presence of a university with a football team remains statistically significant in these models after controlling for other state level factors, thus further contributing to the convergent validity of this finding. Specifically, each percent increase in the student population at a university with a football team predicts a two percent increase in DUI arrest rate. Dry counties continue to exhibit a significant negative arrest rate compared to wet counties and moist counties do not significantly vary compared to wet counties. Specifically, dry counties are predicted to have a decreased arrest rate of about thirteen percent in the final models. Finally, none of the independent variables were found to interact with state level factors.

Some of the independent variables show diverse findings in the nested models compared to the growth curve models. The percent of the population that identifies as a latter-day saint is a significant predictor of DUI arrest rate. Each percent increase in the latter-day saint population leads to five percent increase in DUI arrest rate. This finding is divergent from the results from Table 3, which indicated that the latter-day saint population was not a statistically significant predictor of DUI arrest rate. Additionally, in the growth curve models presented in Table 3 the Seventh Day Adventist population was a significant predictor of DUI arrest rate growth. However, in the nested models presented in Table 4, it fails to achieve statistical significance.

Some notable differences and similarities can be found in the results for the control variables when comparing the prior growth curve models to the nested models. Specifically, while the number of repeat DUI offender crashes was not significant in the growth curve models, each increase in repeat offender crashes does lead to a small (0.8%) significant increase in DUI crash rate. Additionally, poverty rate was not a significant predictor of DUI arrest rate growth, however, it does predict a significant one percent decrease in DUI arrest rate per increase in the percent below the poverty level.

The racial composition of the community appears less important in the nested models compared to the growth curve analysis, however the impact of the ratio of males to females remains similar. Specifically, the nested models predict that each increase in the African-American population leads to a decrease in DUI arrest rate of about two percent. However, the growth curve predicted a significant positive relationship for both African-American and Hispanic population. Caucasian population is insignificant in both types of analysis. The results for sex ratio remains consistent with a one percent decrease in DUI arrest rate per increase the ratio of male to female population.

Many of the results for the age distribution of the population remain significant, although some nuances can be formulated across the models. First, each percent increase in the population under 18 leads to a small increase (0.8%) in DUI arrest rate. Interestingly, the population between 18-24 is not significant until state level controls are implemented. Once state level factors are controlled, each increase in the percent of the population between 18-24 leads to a ten percent decrease in DUI arrest rate. This is particularly interesting since the growth curve models predicted a three percent increase in DUI arrest rate growth per increase in population 18-24. A similar anomaly can be found with the coefficient for the age range of 35-44 and those 65 and over which was positive in Table 3, but now predicts a five percent decrease and three percent increase in DUI arrest rate per increase in its population, respectively. While the population 55-64 was a significant negative predictor in the growth models, it is statistically insignificant in the nested models. All the other age categories remain unchanged from the growth curve analysis.

In sum, it was hypothesized that increases in structural factors associated with anti-alcohol norms would be related to increases in DUI enforcement within a community, and vice versa (H1). The results provide little support for this hypothesis, and the null hypothesis can only be partially rejected based on these findings. Specifically, the anti-alcohol religious population was not significantly related to DUI arrests in many cases; however, when the religious population was related to DUI arrests the direction was as hypothesized. Furthermore, although the presence of a university and dry counties were significantly related to DUI arrests, the direction of the relationship was not as hypothesized.

DUI Fatal Crash Predictions

Table 5 presents the findings from the mixed effects Poisson growth curve analysis which predicts fatal DUI crashes with a one-year time lag. The event rate ratios are presented with standard errors in parentheses. Level 1 is constructed of the observations of the 2,986 counties over a 30-year period from 1985-2014. Level 2 is made up of the 2,986 counties in which the level 1 observations over time are nested. Both level 1 and 2 are nested within level 3 (n= 49), which is made up of all U.S. states and the District of Columbia, except for Florida and Illinois.

Although it drops in the later models, the initial reliability estimates indicate that about 94 percent of the variance in DUI fatal crashes is explainable from these data, and approximately 6 percent of the variance is due to sampling bias. The intra-class correlation coefficient for level one, two, and three is calculated and provided below. The calculations indicate an ICC of .54 at level 1, .27 at level 2, and .19 at level 3. Therefore, 54, 27, and 19 percent of the variance in fatal DUI crashes is explainable at levels 1, 2, and 3, respectively.

Additionally, r-squared estimates are presented for each model and level of analysis in Table 5. Overall, the final models account for approximately fourteen, fifty-eight, and sixty-nine percent of the variance in fatal DUI crashes across time, counties, and states, respectively. Model 1 introduces the control for the year and indicates that change over time accounts for approximately ten percent of the variance in fatal crashes. Model 2 illustrates that DUI arrests account for two percent of the variance in DUI related crashes over time, while they account for ten and fifteen percent of the variance in crashes across counties and states. Model 3 indicates all the independent variables account for four, seventeen, and fifteen percent of the variance in DUI fatal crashes across time, counties, and states, respectively. Models 4 and 5 indicate that the control variables do not explain any of the variance over time. However, they also indicate that these factors explain an additional forty-one percent of the variance in crashes across counties, and an additional fifty-eight percent of the variance across states.

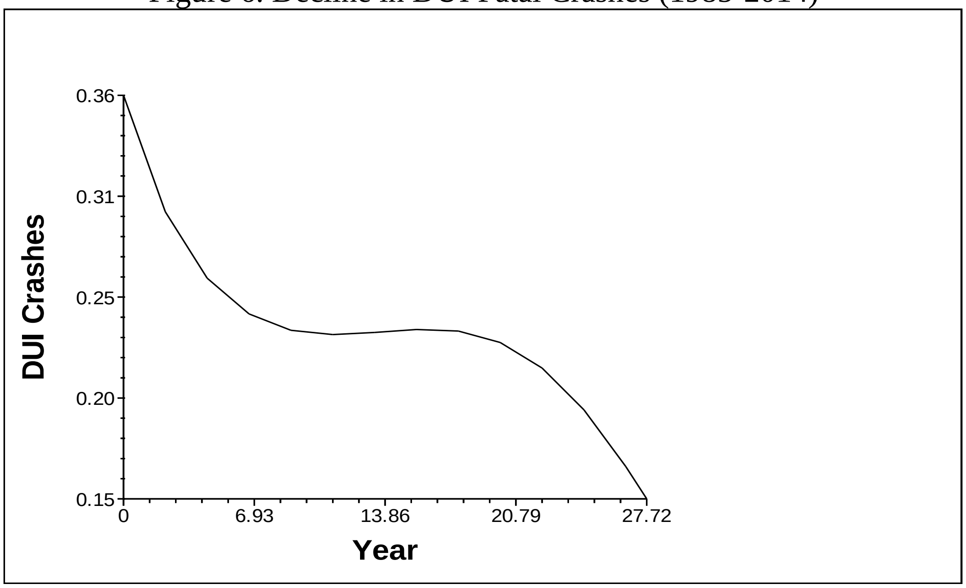
Table 5. Mixed Effects Growth Curve Models Predicting DUI Fatal Crashes with 1 Year Lag

	Model 1	Model 2	Model 3	Model 4	Model 5
	Year	Arrests and Year	L1 All Independent Variables	All L1	L1 and L2
County Level Factors (N = 89,149)					
DUI Arrests	-	0.968 (.033)	0.961 (.033)	1.101*** (.025)	1.098*** (.024)
DUI Arrests^2	-	1.029** (.010)	1.031** (.010)	0.992 (.004)	0.992 (.004)
DUI Arrests^3	-	0.996** (.001)	0.996** (.001)	1.001*** (.000)	1.001** (.001)
DUI Arrests^4	-	1.001** (.001)	1.001** (.000)	-	-
Year	0.906*** (.002)	0.909*** (.002)	0.909*** (.002)	0.898*** (.003)	0.898*** (.003)
Year^2	1.008*** (.001)	1.008*** (.001)	1.007*** (.001)	1.007*** (.001)	1.007*** (.001)
Year^3	0.999*** (.001)	0.999*** (.001)	0.999*** (.001)	0.998*** (.001)	0.998*** (.001)
% Latter Day Saints Adherents	-	-	0.998 (.003)	0.997 (.002)	0.997 (.002)
% Seventh Day Adventists	-	-	1.013 (.012)	1.029** (.011)	1.029** (.011)
% Southern Baptist Adherents	-	-	1.006 (.005)	1.005 (.004)	1.005 (.004)
% Catholic Adherents	-	-	1.005* (.002)	1.002* (.001)	1.002* (.001)
Football University	-	-	1.006*** (.001)	0.993 (.005)	0.993 (.001)
Beale Code (Urban - Rural)	-	-	-	0.976*** (.005)	0.977*** (.005)
Total Fatal Crashes	-	-	-	1.015*** (.000)	1.015*** (.001)
Repeat Offender Crashes	-	-	-	1.002 (.001)	1.001 (.001)
Violent Crime Offenses Known	-	-	-	1.087*** (.012)	1.086*** (.012)
% Below the Poverty Level	-	-	-	0.999 (.001)	0.999 (.001)
% Bachelors Degree or More	-	-	-	1.007*** (.001)	1.007*** (.001)
% African-American	-	-	-	0.993*** (.001)	0.993*** (.001)
% Hispanic	-	-	-	0.999 (.001)	0.999 (.001)
% Caucasian	-	-	-	0.988*** (.001)	0.988*** (.001)
% Population Age <18	-	-	-	0.997 (.003)	0.997 (.003)
% Population 25-34	-	-	-	1.024*** (.003)	1.024*** (.003)
% Population 35-44	-	-	-	1.013*** (.004)	1.013*** (.004)
% Population 45-54	-	-	-	1.009* (.004)	1.009* (.004)
% Population 55-64	-	-	-	0.981 (.005)	0.981 (.005)
% Population 65+	-	-	-	0.995*** (.001)	0.995*** (.001)
Male/Female Ratio	-	-	-	0.997*** (.001)	0.997*** (.001)
DUI Arrests * Football University	-	-	-	1.002** (.001)	1.002** (.001)
DUI Arrests * Beale Code (Urban v. Rural)	-	-	-	0.998* (.001)	0.998** (.001)
DUI Arrests * P1 Violent Offenses	-	-	-	0.988*** (.002)	0.988*** (.002)
DUI Arrests * Total Fatal Crashes	-	-	-	0.999*** (.000)	0.999*** (.000)
Level 2 Factors (N=2,986)					
Dry County	-	-	-	-	0.748*** (.065)
Moist County	-	-	-	-	1.011 (.053)
Level 3 Factors (N=49)					
L1 R-Squared	0.10	0.12	0.14	0.14	0.14
L2 R-Squared	-	0.10	0.17	0.58	0.58
L3 R-Squared	-	0.15	0.15	0.69	0.69
Reliability Estimate Level 1	0.949	0.945	0.914	0.902	0.902
Reliability Estimate Level 2	0.939	0.928	0.614	0.513	0.510

*p<.05, **p<.01, ***p<.001

Figure 6 illustrates a decline in DUI fatal crashes in the United States over time from 1985-2014. Like Figure 2, a downward trend is presented over time, with the most decline residing at the beginning and end of the period and no change during the middle of the time period.

Figure 6. Decline in DUI Fatal Crashes (1985-2014)

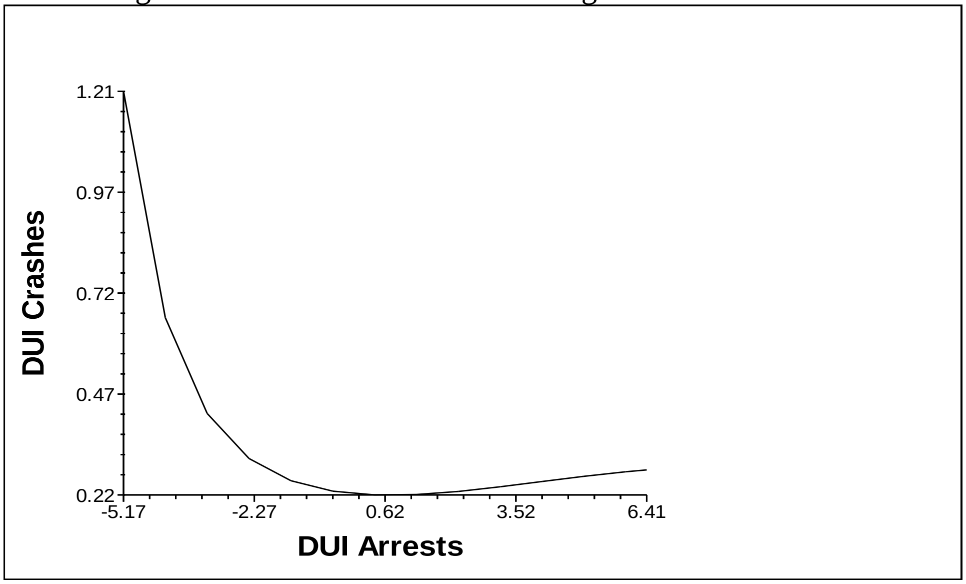


Results from Table 5 indicate a significant non-linear relationship between DUI arrests and growth in DUI crashes. While models 2 and 3 show a quartic non-linear relationship, after controlling for other factors and controlling for multiplicative interaction a cubic relationship is fit in subsequent models. The direction of the relationship between DUI arrests and crashes changes from negative to positive as more control variables are introduced in model 4. Additionally, the religious and university student population are also significant predictors of changes in DUI crash growth.

Figure 7 illustrates the relationship between DUI arrests and crashes from Model 2. This model initially predicts that every percent increase in DUI arrests leads to a decline in DUI crashes of about three percent (3.2%). However, as DUI arrests within a county become more frequent, this decrease in crash growth does not remain the same. Specifically, one percentage increase in DUI arrests is predicted to lead to an increase in DUI crash rate growth of about three percent (2.9%), which leads to only a slight decrease in the slope (0.4%) at the approximate mean (50%) of DUI arrests within the sample. This is followed by a slight increase in DUI fatal crashes (.01%) per each percent increase in DUI arrests on the right side of the distribution.

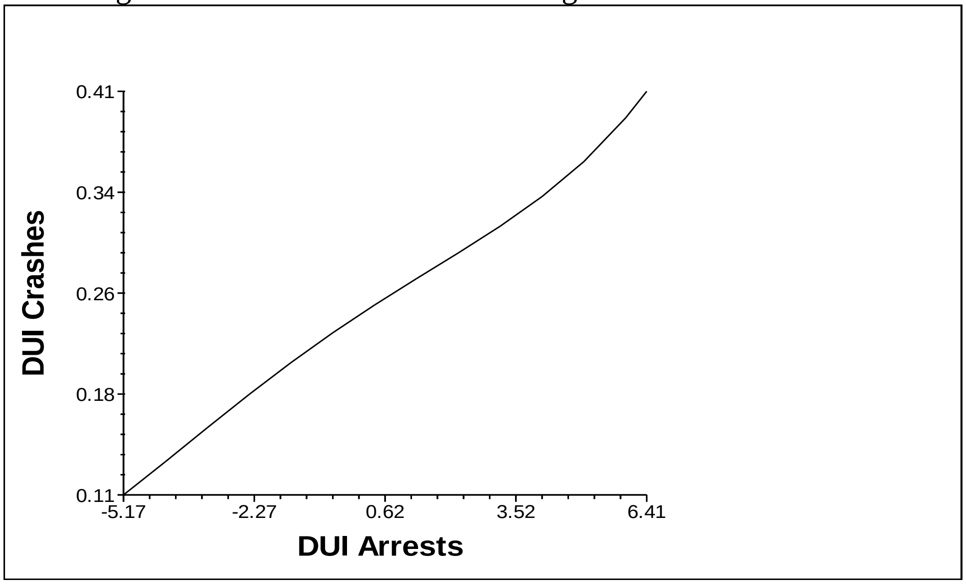
Model 3 introduces other independent variables for religions and large football university campuses within a county. The impact of DUI arrests on crash growth does not significantly change in this model. The percent Catholic Adherents and the large football university students are the only statistically significant predictors of growth in DUI crash rate. Specifically, a one percent increase in the Catholic population is predicted to have an increase (0.5%) in DUI fatal crash growth. Additionally, a one percent increase in students at a large university campus within the county is predicted to increase (0.5%) DUI fatal crash growth as well. Although these estimates may appear small and indicative of negligible effect for a one percent change, they would be much more considerable with higher percentage increases such as 10 percent or more.

Figure 7. DUI Arrest Predicted Change in DUI Crash Rate



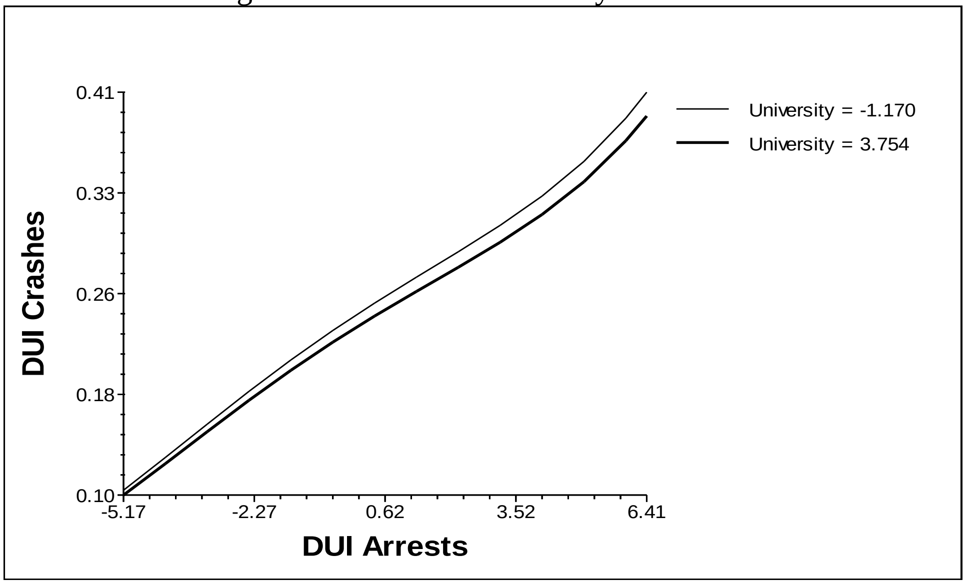
Model 4 introduces control variables as well as several multiplicative interaction predictors of DUI crash growth. This leads to several changes in the relationship between DUI arrests, religious and university population, and DUI crash growth. DUI arrests are found to interact with the football university population, rural vs. urban, Part I violent offenses known, and total fatal crashes within a county. Figure 8 illustrates the main effects of DUI arrests on DUI crashes from these interaction models. The main effects are interpreted as the effect of DUI arrests when the football university population, rural vs. urban, Part I violent offenses known, and total fatal crashes within a county is zero. This indicates a ten percent increase in DUI crash growth per one percent increase in DUI arrests for rural counties with no large university, violent crime, or fatal crashes. This positive slope declines slightly to about a nine percent increase in crash growth in counties with DUI arrests greater than the overall mean.

Figure 8. DUI Arrest Predicted Change in DUI Crash Growth



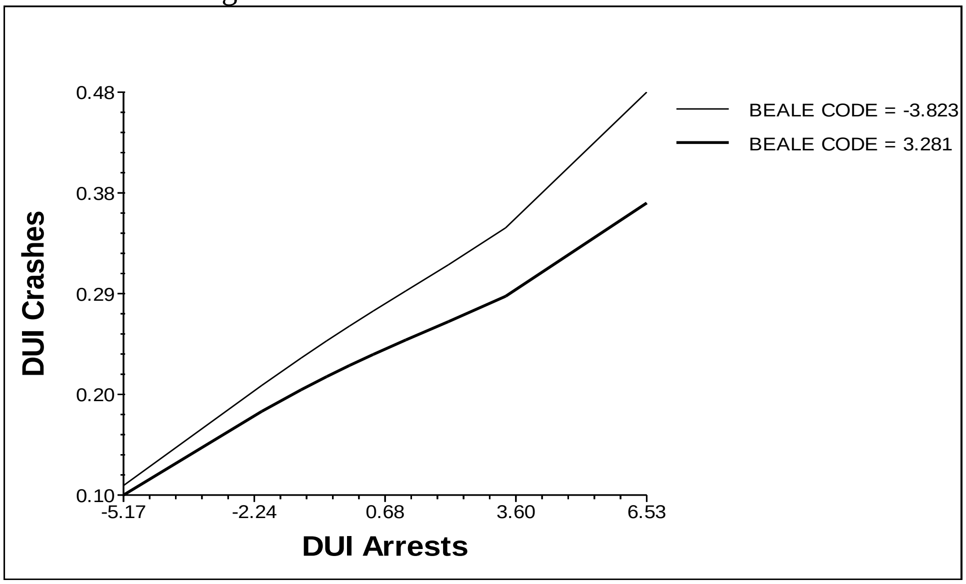
DUI arrests are found to interact with the number of students at a large university campus with a football team. This indicates that every percent increase in university student population within a county leads to an increase (0.2%) in fatal DUI crash growth. Therefore, the relationship between DUI arrests and growth in DUI crashes is significantly different for counties with a large university campus with a football program compared to those without one. This interaction is illustrated in Figure 9. To illustrate this figure, two categories were created from the university student population. This was accomplished by averaging the lower quartile (25^{th} percentile of the distribution) and the upper quartile (75^{th} percentile of the distribution). This procedure was also utilized to present interactions in the other figures with continuous variables as well. Because the measures were mean centered prior to analysis, all values within the distribution below the mean have negative values. Therefore, the value representing the average of the lower quartile in these figures is negative (e.g. University = -1.170 in Figure 9 below).

Figure 9. Arrest and University Interaction



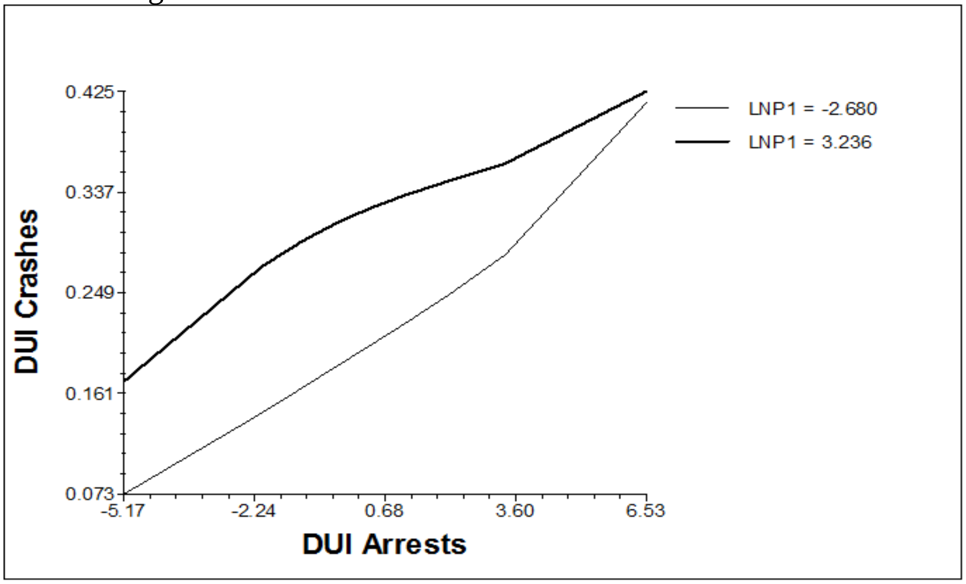
DUI arrests significantly interact with the Beale code of a county. The Beale code distinguishes urban counties from rural counties using a code (ranging from 1-9) with the most urban counties coded as one, and the most rural coded as nine. The results indicate that every unit increase in Beale code results in about a two percent decrease in crash growth when DUI arrests are zero. However, each unit increase in Beale code reduces the increase in crash growth predicted by DUI arrests (0.2%). This interaction is illustrated in Figure 10 below.

Figure 10. Arrest and Beale Code Interaction



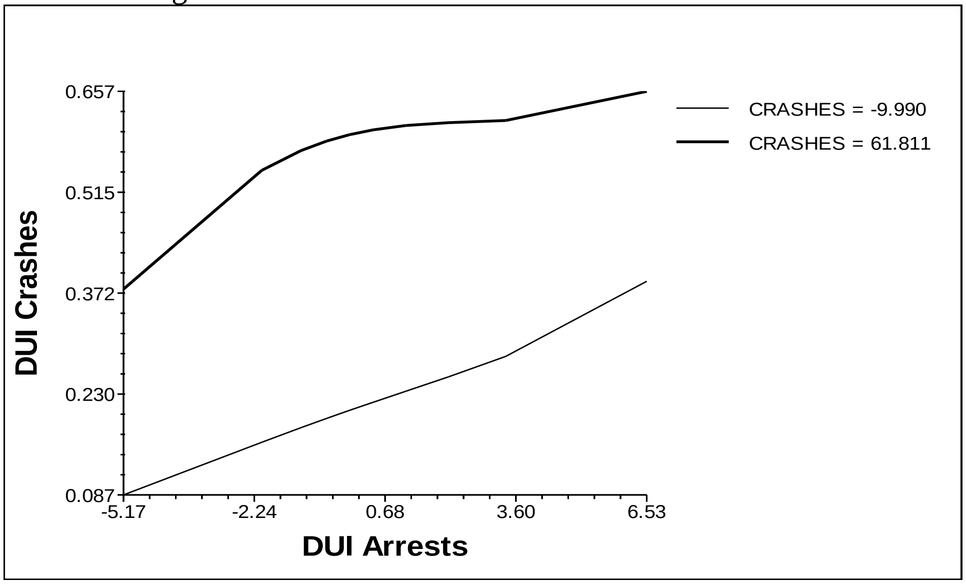
DUI arrests present a statistically significant interaction with the total Part I violent offenses known to the police within a county. Per Table 5, each percent increase in violent offenses known leads to approximately a nine percent increase in DUI fatal crash growth when DUI arrests are zero within the county. However, each percent increase in violent offenses decreases the predicted increase in crash growth predicted by each percent increase in DUI arrests by about one percent as illustrated in Figure 11.

Figure 11. Arrest and Part I Violent Offenses Interaction



The total number of all fatal crashes that occur within a county each year also interacts with the relationship between DUI arrests and DUI fatal crashes. Specifically, every unit increase in the frequency of all fatal crashes in a county is predicted to decrease the positive effect of DUI arrests on DUI fatal crashes (0.1%). Additionally, when there are no DUI arrests within a county each unit increase in the frequency of all fatal crashes predicts an increase in DUI fatal crash growth of about two percent. These interactions are illustrated by the averaged upper and lower quartiles of total crashes in Figure 12 below.

Figure 12. Arrest and Total Fatal Crashes Interaction



Models 4 and 5 illustrate that several of the other independent variables remain statistically significant predictors of fatal DUI crash growth while controlling for other factors. Specifically, the percent of the Catholic population predicts an increase in DUI crash growth (0.2%). Additionally, after controlling for other factors, the percent of the population that identifies as Seventh Day Adventist becomes a significant predictor of fatal DUI crash growth. It indicates predicts that for every one percent increase in Seventh Day Adventist population there is an increase in DUI crash growth of approximately three percent. The interaction of the university and DUI arrests has rendered the direct effect of the university presence statistically insignificant. The other religious population compositions have no significant impact on DUI crash growth in these models. While moist counties appear to have no impact on DUI crashes, dry counties have a 25 percent decrease in DUI crashes compared to wet counties.

Several of the control variables entered in models 4 and 5 were also significant predictors of changes in DUI fatal crash growth. Each increase in the percent of the population that holds a bachelor's degree or more leads to an increase in DUI fatal crash growth (0.7%). Additionally, race and ethnic composition are important predictors of fatal DUI crash growth. Specifically, each percent increase in the African American and Caucasian population is predictive of a decrease in fatal DUI crash growth of about one percent. The ratio of men to women also indicates that each unit increase in the proportion of women to men is related to a decrease in DUI crashes (0.3%). Measures of the Hispanic population, poverty level, and repeat offender crashes were not statistically significant predictors of fatal DUI crash growth.

The age distribution of each county was important. All age groups were statistically significant predictors of fatal DUI crash growth except for the percent of the population under 18 and the percent between 55 and 64. While all ages between 18 and 55 were associated with an increase in DUI crash growth, the percent of the population above 55 was associated with a decrease in fatal DUI crash growth. The increase in DUI crash growth is greatest for the younger aged populations and declines with each increase in age group. For example, one percent increase in the population between 18 and 24 is predictive of the greatest increase in fatal DUI crash growth of almost three percent. However, increases in the age groups of 25-34, 35-44, and 45-54 lead to an increase in DUI crash growth of about 2 percent, one percent, and less than one percent (0.9%), respectively. While the percent of the population between 55-64 is not a significant predictor of DUI crashes, a one percent increase in the population 65 or above is indicative of a decline (0.5%) in DUI crash growth.

Table 6 introduces state level factors to predict changes in DUI crashes over time. The reliability estimates indicate that about 81 and 99 percent of the variance in DUI fatal crash growth is explainable from these data at levels 1 and 2, respectively. The intra-class correlation coefficient indicates that 92% of the variance in fatal DUI crash growth is explainable at level 1 (counties observations over time). While two percent is explainable at level 2 (state observations over time), six percent is explainable at level 3 (48 states and D.C.). These changes compared to the models in Table 4 can be attributed to the use of only one county level in this table and the elevated level of variance that is explainable at the county level. Per the r-squared statistics, the final models account for approximately eighty, thirty-five, and fifty-six percent of the variance in DUI fatal crashes.

The results for the relationship between DUI arrests and DUI crashes is comparable to the relationship illustrated in Table 5 and contributes to the convergent validity of the relationship. Specifically, the relationship between the two is non-linear and positive. Additionally, while early models show an initial decline in DUI crashes with increases in DUI arrests, after controlling for other factors this relationship is reduced to a lower order polynomial with a positive coefficient and relationship when all interactions are zero. While many of the interactions such as total crashes, Part I violent offenses, Beale Code, and football university were replicated from Table 3, these models also illustrate an interaction between DUI arrests and the percent of the population that identifies as Southern Baptist. Specifically, when there are no Southern Baptist adherents within a county, each percent increase in DUI arrests leads to an increase in DUI fatal crashes of about thirty percent. However, every percent increase in Southern Baptist population leads to a small decrease in DUI crashes (0.2%).

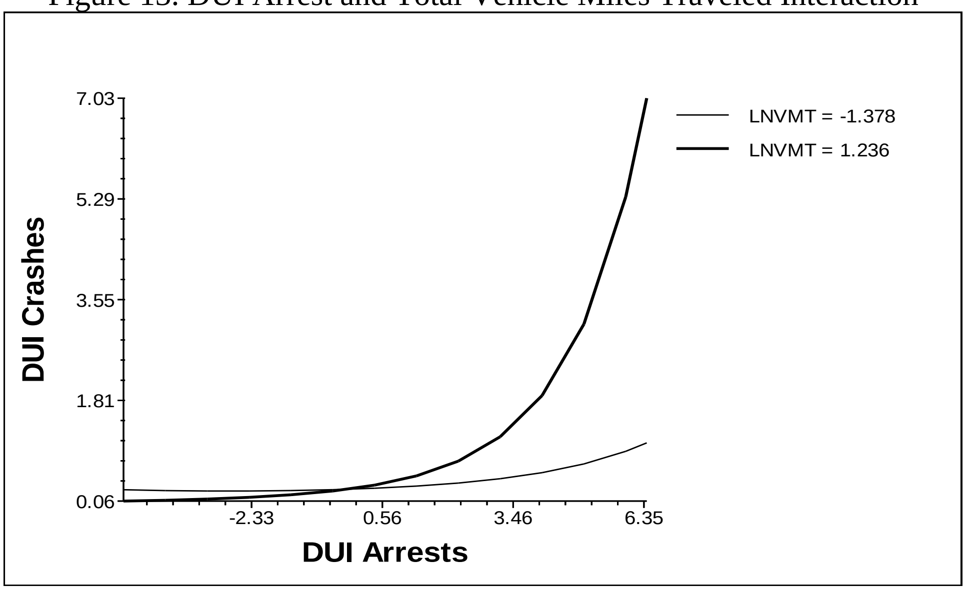
Table 6. Mixed Effects Nested Multilevel Poisson Models Predicting DUI Fatal Crashes with 1 Year Lag

	Model 1 Year Only	Model 2 Arrests and Year	Model 3 L1 Independent Variables	Model 4 ALL L1	Model 5 L1 and All L2	Model 6 L1 and L2 Parsimonious	Model 7 Cross-Level Interactions
Level 1 - County Factors (N = 89,419)							
DUI Arrests	-	0.950 (.079)	1.289*** (.073)	1.307*** (.041)	1.312*** (.041)	1.308*** (.035)	1.293*** (.035)
DUI Arrests²	-	1.096*** (.008)	1.011*** (.007)	1.018*** (.003)	1.018*** (.003)	1.018*** (.002)	1.017*** (.002)
DUI Arrests³	-	0.995*** (.001)	-	-	-	-	-
Open Container Law	-	-	-	-	-	-	1.033*** (.006)
Vehicle Miles Traveled (Millions)	-	-	-	-	-	-	1.113*** (.009)
Year	0.908*** (.006)	0.957*** (.009)	0.955*** (.007)	0.930*** (.006)	0.979*** (.006)	0.941*** (.006)	0.941*** (.006)
Year²	1.007*** (.001)	1.008*** (.001)	1.007*** (.001)	1.005*** (.001)	1.005*** (.001)	1.005*** (.001)	1.005*** (.001)
Year³	0.999*** (.000)	0.999*** (.000)	0.999*** (.000)	0.999*** (.000)	0.999*** (.000)	0.999*** (.000)	0.999*** (.000)
Dry County	-	-	0.735*** (.026)	0.827*** (.022)	0.827*** (.022)	0.825*** (.022)	0.825*** (.022)
Moist County	-	-	0.968* (.015)	1.009 (.013)	1.009 (.013)	1.003 (.013)	1.003 (.013)
% Latter Day Saints Adherents	-	-	0.998* (.001)	1.028* (.010)	0.996** (.001)	0.997*** (.001)	0.997*** (.001)
% Seventh Day Adventists	-	-	1.070*** (.004)	1.049 (.029)	1.004 (.004)	1.005 (.004)	1.004 (.005)
% Southern Baptist Adherents	-	-	1.010*** (.001)	1.023** (.007)	1.026*** (.007)	1.026*** (.007)	1.022** (.007)
% Catholic Adherents	-	-	1.003*** (.000)	1.005* (.002)	1.005* (.002)	1.005* (.002)	1.005** (.002)
Football University	-	-	0.961*** (.006)	1.026*** (.004)	1.027*** (.004)	1.027*** (.004)	1.027*** (.004)
Beale Code (Urban - Rural)	-	-	-	1.037*** (.009)	1.037*** (.009)	1.037*** (.009)	1.028*** (.009)
Total Fatal Crashes	-	-	-	1.027*** (.001)	1.027*** (.001)	1.027*** (.001)	1.027*** (.001)
Repeat Offender Crashes	-	-	-	1.059*** (.007)	1.059*** (.007)	1.059*** (.007)	1.059*** (.007)
Violent Crime Offenses Known	-	-	-	1.306*** (.016)	1.313*** (.016)	1.312*** (.016)	1.283*** (.016)
% Below the Poverty Level	-	-	-	1.008*** (.001)	1.008*** (.001)	1.008*** (.001)	1.008*** (.001)
% Bachelors Degree or More	-	-	-	0.995*** (.001)	0.995*** (.001)	0.995*** (.001)	0.995*** (.001)
% African-American	-	-	-	0.991* (.001)	0.999* (.001)	0.999* (.001)	0.999* (.001)
% Hispanic	-	-	-	0.994*** (.001)	0.995*** (.001)	0.995*** (.001)	0.995*** (.001)
% Caucasian	-	-	-	0.990*** (.001)	0.990*** (.001)	0.990*** (.001)	0.990*** (.001)
Male/Female Ratio	-	-	-	0.997*** (.001)	0.997*** (.001)	0.997*** (.001)	0.997*** (.001)
% Population Age <18	-	-	-	1.011*** (.002)	1.016*** (.001)	1.016*** (.001)	1.016*** (.001)
% Population 18-24	-	-		1.007*** (.002)	1.008*** (.002)	0.990*** (.001)	0.990*** (.001)
% Population 25-34	-	-	-	1.027*** (.002)	1.036*** (.002)	1.036*** (.002)	1.036*** (.002)
% Population 35-44	-	-	-	1.005 (.003)	0.995 (.003)	0.995 (.003)	0.995 (.003)
% Population 45-54	-	-	-	1.011** (.004)	1.006 (.004)	1.006 (.004)	1.006 (.004)
% Population 55-64	-	-	-	1.039*** (.004)	1.039*** (.004)	1.039*** (.004)	1.039*** (.004)
% Population 65+	-	-	-	0.983*** (.002)	0.979*** (.001)	0.979*** (.001)	0.979*** (.001)
DUI Arrests * Football University	-	-	1.011*** (.000)	0.998*** (.001)	0.998*** (.001)	0.998*** (.001)	0.998*** (.001)
DUI Arrests * Southern Baptist Adherents	-	-	0.997*** (.000)	0.998*** (.000)	0.998*** (.000)	0.998*** (.000)	0.999*** (.000)
DUI Arrests * Beale Code (Urban - Rural)	-	-	-	0.981*** (.001)	0.981*** (.001)	0.981*** (.001)	0.983*** (.001)
DUI Arrests * P1 Violent Offenses	-	-	-	0.963*** (.002)	0.962*** (.002)	0.962*** (.002)	0.966*** (.002)
DUI Arrests * Total Fatal Crashes	-	-	-	0.998*** (.000)	0.997*** (.000)	0.997*** (.000)	0.998*** (.000)
Level 2 - State Factors (N = 1,470)							
BAC .08 Law	-	-	-	-	0.989 (.021)	-	-
Administrative License Suspension	-	-	-	-	0.986 (.022)	-	-
Open Container Law	-	-	-	-	1.030 (.020)	-	0.993 (.022)
HomeRule (States Allow Dry Counties)	-	-	-	-	1.125 (.073)	-	-
State Allows DUI Checkpoints	-	-	-	-	0.864 (.079)	-	-
% Self Report DUI in Past Year	-	-	-	-	1.642 (.378)	1.544 (.368)	1.619 (.395)
% Seatbelt Use	-	-	-	-	1.024 (.048)	-	1.059 (.049)
Per Capita Alcohol Gallons Consumed	-	-	-	-	1.155*** (.034)	1.167*** (.034)	1.169** (.056)
Vehicle Miles Traveled (Millions)	-	-	-	-	1.046 (.033)	1.043 (.033)	1.031 (.043)
Level 3 - States (N=49)							
L1 R-Squared	-	0.69	0.70	0.80	0.80	0.80	0.80
L2 R-Squared	-	0.00	0.00	0.33	0.45	0.34	0.35
L3 R-Squared	-	0.58	0.58	0.49	0.49	0.50	0.56
Reliability Estimate 1	0.813	0.863	0.792	0.695	0.698	0.699	0.685
Reliability Estimate 2	0.994	0.972	0.971	0.715	0.725	0.719	0.680

*p<.05, **p<.01, ***p<.001

The replication of the DUI arrest and DUI crash relationship is particularly interesting given the consistency of the relationship after controlling for other additional factors known to affect this relationship such as alcohol consumption, total vehicle miles traveled, and self-report drunk driving. In fact, these factors do not appear to mediate the relationship between DUI arrests and DUI crash rate. However, the open container law and the total vehicle miles traveled do show significant cross-level interaction with DUI arrests in model 7 which illustrates moderation of the DUI arrest and DUI fatal crash rate relationship. Specifically, the positive effect of DUI arrests on DUI fatal crash rate is increased in states with an open container law by about three percent. Additionally, the effect of arrests is increased by eleven percent for every million miles driven within a state. This interaction is illustrated below in Figure 13.

Figure 13. DUI Arrest and Total Vehicle Miles Traveled Interaction



Several other state level factors were introduced in model 5, however, per capita alcohol consumption was the only statistically significant predictor of DUI fatal crash rate. Every increase in per capita gallons of alcohol consumed predicts an increase in DUI crash rate of approximately 16-17 percent. To achieve model parsimony, several of the insignificant factors were removed from level 2 in model 6. Total vehicle miles traveled, per capita alcohol consumption, and self-report DUI were kept in model 6. Though per-capita alcohol consumption was the only statistically significant predictor of DUI crash rate, self-report DUI and total vehicle miles traveled were retained as important control variables in the prediction of DUI fatal crash rate.

Although many of the relationships between many of the other independent variables remains similar between the models in Table 4 and Table 5, there are some differences between the growth curve and nested models. First, dry counties remain a significant predictor of DUI crashes and indicate a decrease in DUI fatal crash rate of about seventeen percent compared to wet counties. The difference between moist and wet counties is still insignificant. The presence of students of a large university with a football team also stays an important predictor of DUI crash rate. Specifically, while it continues to interact with DUI arrests to predict DUI crash rate, it also has a significant direct effect on DUI fatal crash rate in the nested models. In fact, when DUI arrests are zero within a county, each increase in the student population of one of these universities is associated with an increase in DUI fatal crash rate of about three percent.

While the percent of the population that identified as a Latter-Day Saint adherent was insignificant in Table 5, in Table 6 each percent increase in the Latter-day Saint population within a county leads to a small (0.3%) statistically significant decrease in fatal DUI crash rate. The Southern Baptist population, which was statistically insignificant in Table 4, now shows a significant positive increase of about two percent in DUI fatal crash rate when DUI arrests are zero within a county. Like the growth curve models, each increase in the catholic population leads to a small (0.5%) significant increase in DUI crash rate.

In sum, it was hypothesized that increases in structural factors associated with anti-alcohol sentiments within a community would lead to decreases in alcohol related crashes (H2). This hypothesis is only partially supported by these findings. The significant negative relationship presented between dry counties and DUI crashes supports this hypothesis. However, in some instances increases in the anti-alcohol religious population is related to an increase in DUI crashes rather than the hypothesized decrease. Finally, Hypothesis three posited that increases in DUI arrests would be related to decreases in DUI related crashes at the county level. Although, a negative relationship was found between these two phenomena in Figure 7, this relationship is reversed after controlling for other factors in subsequent models as illustrated in Figure 8. As such, this hypothesis is only partially supported by these data and the analysis.

CHAPTER V

DISCUSSION

This project analyzed the relationship between structural factors associated with community alcohol norms, DUI arrests and DUI related fatal automobile crashes in the United States between 1985 and 2014. Although informal norms within a community may influence DUI enforcement and drunk driving within a community it was hypothesized that increased DUI enforcement within a community would lead to decreases in DUI crashes. Thus, the relationship between DUI arrests and DUI crashes was also examined. The findings offer many noteworthy contributions to the current literature, theory, and public policy on drunk driving.

Structural Level Factors Associated with Alcohol Norms and DUI Fatal 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 are known to 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 (see e.g. 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.

Anti-alcohol religious adherents were related to DUI crashes within communities. The increased crash rate predicted by a large Catholic population is consistent with Catholic pro-alcohol norms (see Gusfeld, 1981), and the negative effect of Latter-Day Saints population indicative of anti-alcohol social norms. While no prior empirical research has examined the relationship between religious norms and DUI crashes, some have examined similar related issues. For example, Krohn and colleagues (1982) found that members of a religion with proscriptive norms (abstinence) consumed alcohol less than members of other religions with more permissive norms toward alcohol. Furthermore, Rookey (2012) found anti-alcohol religious populations in a community was related to increases in DUI arrests. Therefore, the religious structural norms may be influencing alcohol use and DUI related crashes within communities as well. Some of the results were not as expected, however.

The results for two of the populations of anti-alcohol religious groups were interesting and not as expected. Specifically, Seventh-day Adventists and Southern Baptists were associated with increases in DUI crashes. This reflects a conflict with the anti-alcohol norms of these religions and the community population. This may arise from an inability of these anti-alcohol religions to influence the behavior of the population because of a lack of social power to influence definitions of deviance (see Quinney, 1970), or from social disorganization (Shaw & McKay, 1942), however many of the factors related to social disorganization within a community have been controlled here. Interestingly, Akers (2009) argues that learning will mediate the influence of structural level factors, and some have found that the alcohol norm qualities of peers are stronger predictors of alcohol use than religion (Krohn et al., 1982). Thus, pro alcohol norms learned elsewhere in the community may be more important than the anti-alcohol norms of these religions.

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 may be conductive to increased DUI related crashes. While permissive norms toward drunkenness have not been assessed in relation to crashes, they have been related to increases in binge drinking (Ahern, et al., 2008; Caetano & Clark, 1999; Jones-Webb & Karriker-Jaffe, 2013) which is frequent among large university student populations. Young people are at an increased risk of being involved with DUI crashes to begin with (Peck, et al., 2008; Zador, Krawchuk, & Voas, 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. One plausible explanation is that it is the pro-alcohol university culture and norms, especially in the universities examined here that have large football teams, that gives rise to increases in alcohol consumption which leads to increased DUI crashes.

Although some prior studies have found that county level prohibition of alcohol sales reduces crashes (Eger, 2006), others have found no relationship (Kelleher, Pope, Kirby, & Rickert, 1996), or that it depends on other factors (Gary et. al., 2003). For example, 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 et. al., 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). While a dry county is indicative of anti-alcohol sentiments which curtail DUI crashes, there are still those that engage in DUI behavior even 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-alcohol sentiment of much of the community. Thus, the frequency of DUI is much lower, which is consistent with the decrease in DUI crashes found here.

Interestingly, in many instances the relationship between structural factors related to alcohol norms remained significant after controlling for alcohol use, which 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 (Becker, 1966; 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 (Lanza-Kaduce, 1988; Greenberg et al, 2005; Piquero and Paternoster, 1998), they may be able to influence DUI behavior and as a result fatal DUI related crashes.

Structural Level Factors Associated with Alcohol Norms and DUI Arrests

Structural community factors related to alcohol norms are also related to DUI enforcement; however, these findings diverge from the extant literature in several ways. First, the positive relationship between large universities with a football program and DUI arrests diverges from the limited prior exploration of this topic. For example, Mastrofski and Colleagues (1987) found that though the incidence of DUI was greatest in a small college town, the climate was far more tolerant of alcohol related problems than other communities and officers were significantly less likely to arrest intoxicated drivers. Additionally, while Rookey (2012) initially found the presence of a large university to be a positive predictor of DUI arrests, the coefficient was reversed after controlling for the young adult population. Here the relationship remains positive despite this control measure.

Methodologically, the diverse results may be a result of the control for spatial autocorrelation in the prior study or the longitudinal methodology implemented herein. Substantively, one must consider that the mere presence of a large university may not have a great deal of influence on the social norms of the larger community outside of the university. While this may be true in a small college town, it is less likely to matter when a university located inside a larger metropolitan area. Furthermore, smaller police departments (which you are more likely to find in small college towns) may be more likely to arrest drunk drivers compared to larger departments because while small departments pursue DUI offenders to prove their professional worth, larger departments often find themselves preoccupied with other issues (Mastrofski et al., 1987).

This project showed limited support for the contention that increases in anti-alcohol religion would lead to increases in the frequency of DUI enforcement. Despite research which suggests that the percent of the population that adheres to an anti-alcohol religion is an important predictor of increased DUI enforcement (Rookey, 2012), after controlling for other factors only two of these percentages of religion in the population were found to be significant. Along with being cross-sectional, the prior study also controlled for spatial autocorrelation, which may have also played a role in varied findings. However, the development of the measures of anti-alcohol religion may have been influential. Specifically, while Rookey (2012) found a composite measure of all the anti-alcohol religions measured herein to be a significant predictor of DUI arrests, this project analyzed these measures of religion separately.

The Rookey (2012) study did not provide any details about the construction of the composite measure of anti-alcohol religion, which combined all the anti-alcohol religious groups assessed here which would have allowed for a more in-depth discussion about the diversity of the findings (Rookey, 2012). Since no use of principle components or the creation of a weighted measure is discussed, the measure from the prior study is assumed to be the result of adding the population percentages together. While this project attempted to develop a composite measure of anti-alcohol religion, the factor analysis indicated these 4 anti-alcohol religious groups did not scale well together using these longitudinal data. The failure of the principal components analysis to identify these factors as a composite measure of anti-alcohol religion may result from the diversity of spatial locations of these religious groups. For example, while Southern Baptists are assumed to be primarily located in southern counties, Latter-Day Saint adherents are more likely to be located within counties in the Midwest. Therefore, it is unlikely that a correlation will be found between the percentage of these groups at the county level. Given this situation, it may seem logical to add the anti-alcohol religious measures together to increase degrees of freedom within the statistical models. However, this method does not allow the researcher to distinguish between the relationships of different religions and DUI arrests, a distinction which appears important given the findings of this project.

While it was hypothesized that dry counties would predict an increase in DUI enforcement due to the assumption that there would be significant anti-alcohol sentiment in a voluntarily dry county, these analysis present findings to the contrary. This is consistent with the initial findings of Powers & Wilson (2004), who found that dry counties are predictive of less DUI arrests in Arkansas. However, after controls were implemented by Powers & Wilson (2004) for the number of police officers in each county the relationship between dry counties and DUI arrests was insignificant. Thus, the findings for DUI arrest rate may suffer from omitted variable bias due to the failure to control for the number of officers in each county.

The decrease in DUI arrests in dry counties may also be explained by reductions in the frequency of drunk driving within a dry county compared to a wet county. As such, while police enforcement of the DUI code may be stricter in dry counties, a lower frequency of DUI drivers will lead to decreased opportunity to arrest DUI offenders (Mastrofski et al., 1987), which will lower arrest rates. In fact, the association of anti-alcohol norms with much higher ratios of DUI arrest rates to self-reported DUI (Linsky, Colby Jr, & Straus, 1986), suggests that that the frequency of DUI drivers plays a key role in this relationship. However, the lack of difference in DUI arrest rates when a county goes from being dry to wet (Scalen, 2011), suggests the lack of alcohol availability in dry counties is not the only factor that determines DUI enforcement and that community norms (which would remain similar both before and after the county converted to wet) may influence opportunities to arrest DUI offenders and police decision-making.

Overall the unexpected findings for the influence of community factors have several potential explanations. While police decision-making is influenced by informal norms (Feeley, 1973) and the working environment of the officers (Lipsky, 1980), they may also vary with the policing style of the department (Wilson, 1978). Since this project assessed arrests which are formal police interventions the results may be biased toward legalistic police departments which are more likely to rely on the formal definition of criminal law and formal interventions such as arrests when dealing with citizens (Wilson, 1978). Furthermore, because these styles of departments are least likely to be affected by community norms, it appears that community norms do not have that much influence on police behavior. While legalistic departments are most likely to reject service orientations and believe that DUI offenders should be punished, service oriented departments (which are more likely to be influenced by the informal norms of the community) will also view arrests as just one option (reserved for the most severe cases) among others (such as having them call a friend to pick them up) for intervention in a DUI situation (Mastrofski, Ritti, & Snipes, 1994). Watchman style departments are also influenced greatly by the political culture and community, but are less likely to intervene at all (Wilson, 1968). Therefore, the Watchman style departments that are most likely to be influenced by the community are also the least likely to make DUI arrests, which may influence the findings here. Additionally, because most DUI situations are police initiated rather than a result of a call for service, little is known about the number of police DUI encounters that result in an informal resolution or those with no intervention at all (Mastrofski, Ritti, & Snipes, 1994). That said, clearly, the arrest data utilized here are biased toward the legalistic intervention because they exclusively measure the formal intervention. While these factors are important others argue that rarely does a department fit neatly into one category or another, and re-iterates Wilson's (1968) suggestion that the political culture within communities may be more important than organizational factors (see Chappell et al., 2006)

While the community can influence the priority of DUI enforcement among police leadership, which can impact DUI arrests, this varies with several other factors (Mastrofski & Ritti, 1992, 1996; Mastrofski et al., 1987). As such, community norms toward or against DUI enforcement are not deterministic, an understanding which may further clarify the findings here. Additionally, the presence of interest groups such as MADD in a community may be able to influence political leaders and police leadership to increase the prioritization and rigor of DUI enforcement (Reinarman, 1988), which may not reflect community norms toward alcohol and DUI.

First, while the community can influence demand for DUI enforcement, finite police resources may not allow for increased DUI enforcement if the demand for calls for service, which generally determine the everyday work of police departments (Goldstein et al., 1990), are monopolizing police resources. This project attempted to control for other demands on police time by controlling for violent crime in the community. Based on Klinger's (1997) theory that enforcement of traffic offenses would be less in areas with greater levels of social deviance (crime), communities with greater violent crime would prioritize enforcement of these crimes over traffic enforcement, and time spent responding to violent crime would also diminish the opportunity for DUI enforcement as well. However, the findings indicate that violent crime is positively associated with DUI arrests. Others have also found that police departments with the highest DUI arrests also had higher rates of offending for other crimes compared to others (Mastrofski & Ritti, 1996). However, differences in policing styles could explain these results as high rates of arrests for many offenses are common in legalistic departments (Wilson & Boland; Wilson, 1978). Furthermore, while DUI was rarely treated as a serious offense prior to the 1980's (Gusfield, 1981; Reinarman, 1988), by 1985 police officers may have associated DUI with a serious offense. Thus, Klinger's (1997) theory may not be applicable to arrest decisions related to DUI during this period.

Furthermore, even if police leadership does consider DUI enforcement a high priority, the ability of police leadership to influence enforcement depends on the command and control capacity of police administrators and informal social control by the local police culture (Mastrofski & Ritti, 1992; Mastrofski et al., 1987). The police administration can encourage or dissuade the DUI enforcement though its command and control capacity of by shaping officer discretion, influencing socialization, and through rewards and punishment (Mastrofski & Ritti, 1992). The local police culture can also influence police decision-making, and in some cases, can influence enforcement despite administrative directives (Mastrofski et al., 1987). Moreover, as Feeley (1973) argues, the informal norms within the department are often more influential than the formal rules and polices of the administration. Finally, when the command and control capacity of the administration is particularly weak, the local police culture has an even greater influence on DUI enforcement, which is particularly influential in watchman style departments (Mastrofski & Ritti, 1992).

Additionally, the causal link between the community demand for enforcement and DUI enforcement can also be influenced by officers known as “rate busters” (Mastrofski et al., 1994, p. 138). These officers arrest a disproportionately high number of DUI offenders which bring the DUI arrest rates to much higher levels than they would be otherwise (Mastrofski & Ritti, 1992; Mastrofski et al., 1994). One might say that these officers represent deviants within their departments because they do so despite administrative and informal norms from their peers against it (Mastrofski et al., 1994). These officers are alienated from the department and are motivated by overtime pay for DUI court appearances as well as a desire to defy the department establishment and work-group norms (Mastrofski et al., 1994). Since these officers operate in contradiction to the community and department norms and have a significant impact on DUI arrests, they may contribute to some of the unexpected results such as the increased arrests predicted in counties with a university.

Since the working environment of the officer can influence decision making (Lipsky, 1980), there are some other potential correlations between DUI and violent crime worth noting. Because police officers make more vehicle stops in areas with greater violent crime (Petrocelli, Piquero, and Smith, 2003), this may lead to increases in the discovery of drunk drivers within high crime areas. Additionally, DUI offenders are not a homogenous group and many repeat offenders are likely to show signs of global criminality (Gould & Gould, 1992), which may contribute to increases in violent crime as well as DUI arrests. As such, when a drunk driver with a criminal record is stopped in a high crime area the officer may be even more likely to arrest the driver to get the violent offender off the street.

Finally, another noteworthy issue is the increase in DUI arrest rate predicted by the increases in African-American and Hispanic population in these models. This is particularly interesting since more Caucasian drivers engage in DUI nationwide than African-American drivers (Lacey et al., 2009). On the one hand, this could be a function of structural disadvantage since it is related to minorities and increased coercive police behavior (such as arrests) (Sun & Payne, 2004; Sun, Payne, & Wu, 2008), however, this is not likely the case since these factors are controlled here. On the other hand, this controversial finding may be related to racial profiling (e.g. Albert & Ponder, 2006; Novak, 2004; Novak & Chamlin, 2008; Smith & Petrocelli, 2001). Specifically, if African-Americans are more likely to be stopped, it is possible that more African-American DUI offenders will be detected by police.

In sum, this project found limited support for the hypothesis that structural factors associated with community alcohol norms can influence enforcement. However, it appears that not all anti-alcohol religions are able to influence DUI enforcement, that universities have a positive effect on DUI enforcement, and enforcement is lower in dry counties compared to the others. This project also illustrates the importance of controlling for police department style. Finally, since outcomes were measured as formal interventions (DUI arrests) the results may be biased toward legalistic departments which are least likely to be affected by informal community norms.

DUI Arrests and Fatal DUI Crashes

This project shows little support for the effectiveness of DUI arrests at reducing fatal alcohol related crashes. In fact, the results are the exact opposite of the hypothesis. Specifically, the relationship does not present as hypothesized by deterrence theory, and DUI arrests and fatal crashes vary similarly over time. If there were an aggregate deterrent effect, one would expect to see the decrease in DUI crashes related to increases in arrests. Additionally, the multivariate results are not consistent with support for the hypothesis from deterrence theory that DUI arrests reduce DUI fatal crashes.

The positive relationship of DUI arrests with fatal DUI crashes is consistent with some prior research (Cameron, 2013); however, it diverges from others that find no relationship (Dula, Dwyer, & LeVerne, 2007), or even a negative relationship (Fell et al., 2014; Yao, Johnson, & Tippetts, 2015). This project expands this literature and helps to explain these mixed results in several ways. First, the change in the direction of the relationship between DUI arrests and fatal crashes illustrates how imperative it is to control for other factors that may influence DUI crashes. Much of the prior research does not implement adequate control measures, if any, which may contribute to the mixed findings. For example, much of the extant research does not control for per-capita alcohol consumption and total vehicle miles traveled which have a direct theoretical impact on DUI crashes. As previously noted, the DUI problem is an interaction between the problems of alcohol abuse and traffic safety (Ross, 1994), thus areas with little alcohol consumption and/or automobile travel will have a lower frequency of DUI crashes. This is consistent with the argument of Lakins and Colleagues (2008), that per capita alcohol consumption plays a significant role in alcohol related crashes.

Second, the prior research has some methodological inconsistencies which may further explain the diversity in the extant literature. Specifically, there are some differences in sampling frame and the unit of analysis since some assess this relationship in one state (Dula, Dwyer, & LeVerne, 2007), a sample of communities (Fell et al, 2014) or states (Yao, et al, 2015) across the country. Additionally, one study found a significant negative relationship between DUI arrests and DUI crashes only after statistical significance was redefined ($P<0.10$) (Fell et al, 2014), however, this is not generally used as a measure of statistical significance within the social sciences. The relationship between DUI arrests and fatal crashes is also non-linear, and none of the prior literature has tested for violations of assumptions of linearity. Additionally, the dependent variable has been operationalized diversely across studies. For example, while some use the frequency of alcohol related fatal crashes, like this project, others utilized the frequency of non-fatal crashes or the ratio of alcohol related crashes to non-alcohol related crashes (Fell et. al, 2014; Yao and Colleagues, 2015). Finally, much of the prior research has been cross-sectional. Therefore, given the longitudinal findings here, temporal validity may be a concern in the prior studies.

Furthermore, beyond these methodological issues, the reasons for the finding that arrests are positive predictors of crashes could lie in the theory. The effectiveness of deterrence theory's ability to deter crime has been the subject of significant criminological critique (see e.g. Pratt, et. al., 2006). However despite research that also suggests deterence based polices are inneffective at deterring drunk drivers (Freeman & Watson, 2006; Goodfellow & Kilgore, 2014; Greenberg, Morral, & Jain, 2005; Houston & Richardson Jr, 2004), some continue to advocate for deterence based policies to reduce drunk driving (Fell & Voas, 2013). Due to several factors, it may be even less effective at deterring drunk driving than other crimes.

Deterrence theory assumes a rational choice by the actor of whether to engage in criminal behavior or not after weighing the risks and benefits, and deciding whether the benefit outweighs the risk (Clarke & Cornish, 1985). However, intoxication may contribute to a violation of the assumption of rational thought (Chermack & Giancola 1997; Yu, Evans, and Clark, 2006). In other words, intoxicated individuals do not contemplate the risk of arrest and punishment prior to deciding to drive. In fact, research suggests that recidivists (Freeman and Watson, 2006), high BAC drivers (Houston and Richardson, 2004), and sufferers of alcoholism (Goodfellow and Kilgore, 2014) are not deterred by drunk driving policies. Some may argue that since recidivists have the highest possibility of involvement in fatal DUI crashes (Fell, 2014), that deterrent effects are not illustrated by the dependent variable (DUI fatal crashes) because it is biased toward the actions of the recidivist drunk driver which are less likely to be deterred. However, this is not likely since the models presented herein control for crashes that involve a recidivist drunk driver.

Interestingly, similar to Cameron (2013), this project not only suggests that DUI arrests are ineffective, but that they are positively related to crashes. While this may appear counterintuitive, it is not necessarily illogical and theoretical explanations can be proffered. For example, Stafford and Warr (1993) posit that while punishment is important, punishment avoidance is also a principal factor to the deterrence of crime because it can shape perceptions about the certainty of punishment. The measurement of arrests only gives information on the number of drunk drivers who have been caught, however it offers no information on the frequency of DUI trips that go unpunished and avoided within each county. Because the avoidance of punishment lowers the perceived certainty of punishment it may do more to encourage criminal behavior than punishment does to deter (Stafford and Warr, 1993). In fact, research finds that punishment avoidance has a negative impact on the perceived certainty of punishment for drunk drivers (Freeman & Watson, 2006; Piquero & Paternoster, 1998). Correspondingly, Freeman and Watson (2006) find that although certainty and severity of punishment is associated with DUI, punishment avoidance has the greatest influence on self-report DUI.

The prior theoretical work discusses punishment avoidance in the context of avoiding the punishment of the criminal justice system; however, this same logic of avoidance of the negative consequence of punishment can also be extended to crash avoidance. For example, drivers who have driven several times without crashing may have a decreased perceived certainty of crashing based on their prior experiences. This could also lead to decreases in the perceived legitimacy of DUI legislation which makes it less likely that an individual will comply with the DUI law (Platt, 1977; Tyler, 1990). Crash avoidance could also lead to the utilization of techniques of neutralization (see Sykes and Matza, 1957), to help justify the continued driving under the influence by rationalizing their DUI behavior as different from the other DUI drivers who crash and kill people.

Others have moved beyond Stafford and Warr's (1993) reconceptualization in order to explain the positive relationship between punishment and criminal offending (Piquero & Paternoster, 1998; Piquero & Pogarsky, 2002; Pogarsky & Piquero, 2003). After finding that punished offenders have a decreased perceived certainty of punishment when compared to unpunished offenders, these scholars posit that punishment may actually encourage offending. Pogarsky and Piquero (2003) argue that punishment creates a resetting effect which resets an offender's perceived certainty of punishment, and the apparent belief that they would have to be very unlucky to be arrested again in the near future. This is particularly interesting in light of the positive effects found for DUI arrests on DUI related crashes found here. Perhaps DUI arrest has little deterrent effect on the individual drunk driver because if they have driven drunk 1,000 times before getting arrested, they may assume that they can do so another 1,000 times as the odds are 1,000 to 1 of getting arrested.

Deterrence theory also assumes a consensus among society that everyone agrees that drunk driving is wrong and should be punished (see Beccaria, 1764/2003). However, the results suggest that there may be some conflict between the definition of DUI and community norms which may contribute to diversity of the effect of arrests on crashes. For example, DUI arrests were also found to interact with several other factors at both the county and state level. Although one study finds that DUI enforcement interacts with urban vs. rural areas (Yao et al. 2015), none of the other extant research explores the interaction of other factors with DUI enforcement. The findings here are consistent with the prior study which shows an interaction with DUI arrests and urban/rural areas. It is important that these interactions be modeled to provide accurate findings and account for the variation in DUI enforcement that is present across various places (Erickson et al., 2015). While urban vs. rural was implemented predominately as a control measure for this project, prior research indicating the traffic safety culture (Ward, 2007), as well as alcohol norms and use (Krohn et al., 1982) varies with rurality suggests this factor may play a more important role in DUI crashes than originally hypothesized.

The interaction of DUI arrests with community factors related to alcohol norms such as the university campus and religious composition of the county has theoretical relevance as well since it shows some support for the contention that deterrence can be expanded beyond formal sanctions to include informal sanctions when peers become aware of one’s arrest (Paternoster, Saltzman, Waldo, & Chiricos, 1985; Zimring & Hawkins, 1973). The findings are consistent with the idea that informal sanctions after an arrest may be greater in an area with a large anti-alcohol religious composition and lower in one with a large university campus. Furthermore, these informal sanctions such as the loss of a job, friendships, shame, embarrassment are often more influential than the fear of arrest (Anderson, Chiricos, & Waldo, 1977; MacKenzie & De Li, 2002; Petee, Milner, & Welch, 1994; Thomas & Bishop, 1984).

While the previous argument is based on self-reported DUI, this can be extended to the current findings for DUI fatal crashes. Theoretically, the number of drivers that are engaging in DUI should be related to the frequency of DUI related crashes, although no prior research has tested this assumption. However, DUI arrests may not have a direct effect on DUI fatal crashes, but rather that the effect of arrests on crashes operates indirectly by reducing the frequency of DUI. This issue brings to light two distinct and prominent issues within the findings here.

First, self-reported DUI provides an estimate of those who may be avoiding punishment for DUI, and this measure may mediate the indirect relationship between DUI arrests and crashes. However, the introduction of this measure has a minor impact on the relationship between DUI arrests and crashes, and most interestingly is not significantly related to DUI fatal crashes. This measure may not adequately measure punishment avoidance because it does not distinguish between those punished and those that avoided punishment. However, while the self-reported DUI measure is limited to the state level, it is peculiar that it does not significantly predict DUI crashes. This may be a key finding here since deterring the drunk driver should reduce the frequency of DUI and therefore crashes. Conversely, if the frequency of DUI is not related to DUI crashes, as is illustrated here, then the logic chain is broken and DUI arrests will not be likely to have the anticipated impact on DUI crashes.

Second, the failure to establish a relationship between DUI arrests and self-report DUI with fatal DUI crashes suggests that other factors may be contributing to the frequency of fatal alcohol related crashes more than the intoxication level of drivers in the community. In the interpretation of these findings one must remember that crashes, particularly fatal crashes, involve complex sequences of events with factors at many diverse levels such as the driver, vehicle, and environment which all come together to cause the crash and subsequent fatality (Haddon, 1972). This project attempted to control for these factors by including a measure of the total fatal crashes within each county. The interaction of DUI arrests with total fatal crashes illustrated in Figure 12 shows that baseline DUI crashes are much higher in counties with higher total fatal crashes. Therefore, the interaction of these other factors which contribute to fatal crashes in general play a role in the relationship from DUI arrest and fatal DUI crash relationship although the exact path cannot be discerned from these analyses. Clearly, however, the sole focus on alcohol may be a large oversimplification of a broader and more complex issue of traffic fatalities (Zylman, 1968).

Policy Implications

The history of DUI and policies aimed at its prevention has been controversial. Some scholars argue that policies have been based on symbolic lawmaking and cultural conflict (Gusfield, 1981). While there is a legitimate DUI problem in the United States, sometimes polices are not in the interests of society as a whole, but rather in the interest of those with greater social, economic, and political power (Lofland, 1969; Quinney, 1970). In fact, even policies based on a legitimate need can become a means of accomplishing control for other reasons (Simon, 2007). Over time society has increasingly stigmatized DUI and perpetuated the myth of the “killer drunk” and the assumption of malevolence, that every DUI driver will crash and kill someone (Gusfield, 1996). However, this is not the case in many circumstances (see Stringer, 2016), and when criminal justice policy is not based on solid facts it will be ineffective (Kappeler, Potter, & Blumberg, 2005). While criminal justice policies do not always achieve their intended results (Stringer & Holland, 2016), once research proves them ineffective at achieving the intended goals they should be amended, unless the goal is a symbolic one used to give legitimacy to some other illegitimate goal such as punishing those that drink alcohol.

Since this project evaluated several policies and practices aimed at reducing the drunk driving problem in the United States, these findings are conducive to several implications for public policy. By addressing a significant social problem within society (Drunk Driving), it is hopeful that these findings may aid in the improvement of the function and efficiency of the criminal justice system that will save both money and lives. Policymakers need to acknowledge that DUI is not simply a problem of individual alcohol use. Therefore, it is not a problem that can be resolved with policies aimed at deterring individuals from drinking and driving, and to quote Brian Payne: “If I had a hammer, I would not use it to control drunk driving” DeMichele & Payne, 2013, p. 1).

The analyses presented here raise doubt about the effectiveness of legislature and enforcement at deterring drunk driving and the fatalities that result therefrom. While these policies and practices may be effective at punishing offenders, it does not appear that they are effective at deterring this behavior. If policy is to effectively reduce fatal crashes, it will need to effectively prevent drunk driving rather than enacting subsequent punishment. Therefore, it would be prudent for policymakers to think outside of the box in order to explore alternative strategies that move beyond the mechanisms of punishment and deterrence in order to produce meaningful reductions in the fatal crashes.

Policies often attempt to deter drunk driving by increases in certainty, severity, and celerity of punishment as the theory dictates. However, policymakers often overlook important assumptions of the theory – the rational mind. If policymakers intend to continue to assume rationality, they may wish to ameliorate their policy agenda. Specifically, policies fail to account for the cost-benefit analysis that goes on prior to making the decision to drive or not. While policy makers address the costs of driving, they completely ignore the rational thoughts of the actor in relation to the benefits of driving and the costs of not driving. For example, those who do not drive must find another way home which involves things such as such as taxi fare home and back to retrieve your vehicle the next day, potentially walking for miles if you are in a rural area, calling a friend at 3am, having your vehicle towed because you left it there all night, etc. As previously discussed, alcohol impacts the rational thought process and judgement here as well. Ironically, policy makers base the need to crack down on DUI because of the impaired judgement associated with alcohol which contributes to crashes, and then develop policies the assume good judgement. Therefore, policy makers should attempt to develop policies that will reduce the costs and increase the benefits of not driving, rather than focusing only on the effects of driving.

Increasing the availability of alternative transportation for potential drivers who have been drinking is one way to encourage drinkers not to drive. In fact, Gruenewald, Johnson, & Treno (2002) found that increases in alternative ride campaigns are effective at reducing crashes. As noted earlier alcohol consumption is a significant social aspect of American culture, as is automobile transportation (see Jacobs, 1989). Thus, the DUI problem arises as a combination of the two (Ross, 1994). This reliance of automobile transportation, may therefore contribute to individual propensities for DUI. For example, New York city has the lowest per capita DUI crash rate in the country because, while the population is consuming plenty of alcohol, they do not rely on their own automotive transportation to get home after drinking. Conversely, in the mid-western states, which have the highest DUI rates, alternative means of transportation are not easily available. Recently Uber has begun trials to partner with localities to offer free rides to intoxicated drivers in New Jersey (Miller, 2015), and even developed a Kiosk in Toronto that would test one's BAC and if they were over the limit it would call them a free Uber to drive them home (Lankston, 2015). Thus, policymakers might wish to consider subsidizing free rides for those who have been drinking, particularly for the more economically challenged portions of society.

Additionally, as drinkers contemplate whether or not to drive and consider the costs and benefits of driving versus perusing alternative transportation, policies based on deterring DUI assume that the person knows they are drunk and are risking the consequences of driving. However, since alcohol significantly impairs judgement, drinker's awareness of the degree to which they are impaired may not be apparent to them. Interestingly, there is a solution to this that allows one to obtain an objective BAC test prior to driving and being stopped by the police in order to make an informed decision about driving. Specifically, there are now breath analyzing vending machines that can be placed in bars and restaurants, and are frequently used when available (Mitri, 2014), and one Utah congressman previously tried to advocate for the expansion of their use (Matyszczyk, 2014). Increases in the availably of these devices, and perhaps making them mandatory in bars, would prevent drinkers from guessing about their ability to drive and allow them to make an informed decision.

The aforementioned proposed policy changes may ameliorate the behavior of some DUI offenders, however despite these changes some will likely still choose to drive after drinking.

Furthermore, as noted herein policies aimed at deterring the intoxicated individual are inherently problematic and unlikely to be successful. However, the findings and literature suggest that informal norms and/or informal means of social control may provide an effective means of intervention and prevention of DUI. In fact, informal interventions tend to be successful in many situations (Collins & Frey, 1992; Mauck & Zagumny, 2000; Smith, Kennison, Gamble, & Loudin, 2004). Interestingly just as individual moral beliefs protect against DUI behavior (Greenberg, Morral, & Jain, 2005; Lanza-Kaduce, 1988; Piquero & Paternoster, 1998), senses of morality and social obligations also determine intervention efforts as well (Mauck & Zagumny, 2000).

Therefore, since this project illustrated that anti-alcohol sentiments within a community reduce DUI crashes, perhaps efforts could be made to increase the anti-DUI beliefs within communities. This could be carried out through community-based solutions such as education about the dangers of DUI. This information could be conveyed through increased media attention since it related to opinions about DUI (Voas et al., 1997) as well as other drugs (Stringer & Maggard, 2016). Increased attention toward the dangers of DUI may help increase informal community shaming which is effective at reducing and preventing DUI (Grasmick et al., 1993). Increases in informal interventions and anti-DUI norms within a community would make formal policies and practices, that appear less effective, unnecessary (Jacobs, 1989).

The relationship between the presence of a university campus and DUI fatal crashes give rise to some policy consideration. It may be a bit impetuous to say that Universities cause DUI crashes, and therefore we should abolish higher education. However, given the culture of drinking within the university student community, Universities should consider implementing policies that can dissuade students from driving after drinking. For example, universities could try to develop educational programs that make students aware of the dangers associated with drinking and driving, as well as provide alternative transportation methods such as shuttle buses for students.

Additionally, universities should examine current policies that may be contributing to drunk driving. Tailgating for example, may be one such policy. Tailgating allows students, alum, and other guests to consume alcohol in parking lots near their vehicles prior to football games. While this may not directly cause drunk driving, many universities require tailgaters to remove all vehicles from the parking lot immediately after the game. As such, the university allows drinking in the parking lot and then forces those who have been drinking to drive their vehicles afterwards. Although universities may be reluctant to eliminate tailgating, allowing tailgaters to leave their vehicles overnight and find alternative transportation could help reduce DUI related crashes.

Limitations and Future Research

Although this project can contribute to the literature, policy, and theoretical development on drunk driving, it is not without its limitations. First, one should be cautious about drawing causal inferences from the analysis here for several reasons. While a lag time is implemented to account for temporal ordering between the independent and dependent variables because these data are comprised of repeated observations of the same counties and states over time we cannot completely rule out the possibility of feedback within the models. This problem arises because of the potential for serial autocorrelation between observations at T and at T-1. For example, if a city arrests 500 people for DUI and has 50 fatal DUI related crashes in 1990, it is likely that this same city will experience a similar number of the same in 1989 as well. Although growth curve modeling can partially account for this by modeling the trend or trajectory and then using the lagged independent variable to predict changes in the trend, future research should consider utilizing time-series analysis to attempt to replicate the findings here.

Second, as with many research projects, the possibility of spurious effects cannot be ruled out. This is particularly important given that DUI crashes and DUI arrests may be measures of the same phenomenon, drunk driving. Thus, as the frequency of drunk driving increases within a county or state, both these measures will increase as well. This issue may contribute to the findings found here as well. Although self-reported DUI was measured as the percent of respondents who indicated they had engaged in DUI in the past year at the state level, this measure had its limitations given the imputation of the missing data and measurement at the state rather than county level. Future research should try to control for the frequency of drunk driving at the county level to build on this limitation this unknown “dark figure” of drunk driving. If possible, it would also be interesting to construct a measure of DUI arrests in relation to frequency of DUI to account for punishment avoidance, however, data acquisition would certainly be a significant limitation.

Third, the measures of structural factors related to community norms associated with alcohol are not without their limitations since they are used as a proxy for community norms toward alcohol. For example, while dry counties are likely to have increased anti-alcohol norms that may lead to decreases in DUI crashes, they also have decreased availability to purchase alcohol. Therefore, the measure used here was not able to separate the decrease in alcohol availability from anti-alcohol sentiments within the dry county. Additionally, the measures of anti-alcohol religion provide no information on strength of religion and may represent an overgeneralization to extent since it is possible that not all members of an anti-alcohol related religion have the same sentiments toward alcohol. It is also quite possible that the presence of a university campus does not have a profound impact on community norms, especially in larger cities where the student population makes up a very small percent of the population. As such, future studies might consider measuring the university student population in relation to the population of the county. These measures were also not exhaustive in their attempt to measure factors related to community norms about alcohol. Future research should try to collect or find survey data that can directly measure respondent's thoughts about alcohol which would provide much more valid information than the indirect measures implemented here. Furthermore, structural factors associated with alcohol norms were generalized within counties and therefore not able to capture differences within those counties.

Finally, this project only attempted to measure one facet of deterrence (arrests and the certainty of punishment). Therefore, future research may wish to explore other aspects such as punishment severity to examine the impact that it may have on DUI related crashes. Due to data availability, this study was limited in its ability to control for two important and necessary elements of alcohol consumption and vehicular travel as these data were only available at the state level and therefore do not account for variations in these factors within states. The data on police behavior only accounts for formal encounters (arrests) and therefore omits informal encounters (e.g. drivers given a ride home or asked to call a friend to pick them up), and does not account for differences in service, watchman, and legalistic police department styles.

In conclusion, despite these limitations this project has provided a significant addition to both the traffic safety and criminological literature on drunk driving. Based on these findings it appears that DUI enforcement does not have the anticipated effect of reducing fatal alcohol related crashes in the United States. Therefore, other policies aimed at preventing DUI may be more effective at reducing fatalities. While limited support was found for structural factors associated with community norms, these measures had significant limitations and clearly future research is needed to definitively determine their relationship with DUI crashes and enforcement. As such, the findings and conclusions here lay the foundation for similar future studies that explore this understudied social problem within our field.

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GRANTS

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