THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF ECONOMICS

QUANTIFYING THE RELATIONSHIP BETWEEN ALCOHOL PRIVATIZATION AND ALCOHOL RELATED FATAL TRAFFIC ACCIDENTS IN WASHINGTON STATE

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SPRING 2019

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Economics
with honors in Economics

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ABSTRACT

This paper studies the relationship between the privatization of alcohol and alcohol related fatal traffic accidents for Washington counties with a large proportion of college aged individuals. In 2011, Washington voters passed Initiative 1183, which transferred wholesale and retail control of alcohol from the state to private citizens, resulting in an increase in the availability of alcohol for purchasers. This paper uses crash data from the Fatality Analysis Reporting System (FARS) and fixed effects negative binomial regression models to analyze a potential relationship between increased alcohol availability and alcohol related fatal traffic accidents. Specifically, Washington counties with a large proportion of college aged individuals ('college counties') are compared to all other counties in order to determine if Initiative 1183 has skewed effects for college counties. This paper finds that Initiative 1183 does not correspond to a change in alcohol related fatal traffic accidents across Washington. However, for college counties, Initiative 1183 corresponds to a decrease in non-alcohol related fatal traffic accidents and total fatal traffic accidents, but corresponds to no effect for alcohol related fatal traffic accidents. Among the control variables, the unemployment rate and median age both correspond to a decrease in alcohol related fatal traffic accidents which for college counties are significantly different than the average county.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I would like to first and foremost thank my thesis supervisor and economics mentor, Dr. Jadrian Wooten, for his continuous support and encouragement. Not only would this thesis not have been possible without his guidance, but he has also inspired me to continue my economics journey through graduate school.

Thank you to my friends and family for always being there for me. Thank you to Ann for dealing with me over the past four years. Thank you to my parents and brothers for constantly pushing me to be my best. I appreciate all of you letting me ramble about this thesis and economics even though you had no idea what I was talking about half of the time. I couldn't have done it without any of you.

Chapter 1

Introduction

During the November 2011 elections, Washington state voters approved Initiative 1183, which privatized wholesale distribution and retail sale of alcohol for businesses with at least 10,000 square feet of retail space (Office of the Secretary of State, 2011, p. 2). Before this law was implemented, liquor stores were owned and operated by the state, essentially establishing monopoly power over the distribution and sale of alcohol. Initiative 1183 allowed the Washington State Liquor Control Board to grant liquor licenses to privately owned stores starting March 1, 2012. By May 31 of that year, all state-owned alcohol stores were closed or sold to private owners, causing the control of alcohol to shift from the state to the citizens (Privatization of Liquor, 2015). This eliminated any monopoly power over alcohol that the state had and introduced the wholesale distribution and retail sale of alcohol to a more competitive environment.

Before Initiative 1183, state-owned liquor stores imposed various restrictions on alcohol. One common restriction across the United States is the adoption of blue laws, which require state-owned alcohol stores to close on Sunday. However, Washington voters chose to repeal the state's blue law in 1966 (LeSourd, 2009). The more important alcohol restriction imposed by the state was limiting the number of liquor licenses available for stores. Before privatization, the number of liquor stores was capped at 330 (Privatization of Liquor, 2015). Because of this license cap, alcohol availability across Washington before Initiative 1183 was relatively constant.

Once alcohol control shifted from the public sector to the private sector, the number of liquor stores drastically increased. As of 2015, the number of retail liquor stores increased to 1,406, and liquor sales increased approximately 13 percent (Privatization of Liquor, 2015). This 326 percent liquor store increase shows the sharp increase in alcohol availability after Initiative 1183 was implemented.

This paper will focus on the link between the increase in alcohol availability and fatal traffic accidents in which alcohol was a contributing factor. According to the National Highway Traffic Safety Administration, alcohol related traffic accidents in 2018 resulted in 10,874 deaths, with 42 percent of these drivers between the ages of 16 to 24 (National Highway Traffic Safety Administration, 2018). College aged people are the largest age group to be involved in alcohol related fatal traffic accidents, which indicates the importance of studying this age group's drinking and driving behavior.

Not only do individuals tend to do the most binge drinking from the ages of 16 to 24 (United States Department of Health and Human Services, 2006), but full-time college students ages 18 to 22 drink 9.8 percentage points more per month than others in the same age group who are not in college (National Survey on Drug Use and Health, 2015). Depending on how this age group responded to the increase in alcohol availability following alcohol privatization, there could have been adverse effects for college aged individuals due to Initiative 1183.

The goal of this paper is to study the effect of Initiative 1183 on alcohol related fatal traffic accidents for areas with a large proportion of college aged individuals. Because of the prevalence of both alcohol consumption and alcohol related fatal traffic accidents among college aged individuals, the effects of Initiative 1183 could have skewed the effects for this age group. Depending on the sign of this relationship, there could be public health gains through decreased

fatal accidents, or alcohol privatization could raise new public health concerns if there is an increase in fatal accidents. This analysis can serve as evidence on the relationship between alcohol privatization and alcohol related fatal traffic accidents among college aged individuals for other states looking to implement similar policies.

The remaining sections of this paper are organized as follows. Chapter 2 summarizes the current findings pertaining to the link between changes in alcohol availability and alcohol related fatal traffic accidents. Chapter 3 describes the data used in the analysis and provides descriptive statistics. Chapter 4 provides the results of a negative binomial analysis. Chapter 5 is the concluding section, which includes a discussion on shortcomings and points of further analysis.

Chapter 2

Literature Review

Previous studies have focused on the effects of alcohol availability for both on- and off-premise alcohol sales. An on-premise license requires that alcohol be consumed where it is purchased, such as in bars and restaurants. An off-premise license permits the sale of pre-packaged alcohol that is meant to be consumed off site.

The existing literature presents mixed evidence on the impact of alcohol availability on alcohol related traffic accidents. Although the literature tends to lean more towards an inverse relationship between the availability of alcohol and traffic accidents, there has not been conclusive evidence to support this relationship.

There are various methods by which to decrease alcohol availability including the adoption of dry laws to restrict the purchase windows when alcohol can be sold. Two studies (Biderman, De Mello, & Schneider, 2010; Nakaguma & Restrepo, 2018) analyze temporary Brazilian dry laws to determine their effect. They find that decreasing, or even eliminating, the ability to purchase alcohol in bars and restaurants led to a decrease in driving accidents and driving fatalities in Brazil.

There are differences that may cause Washington state to have a different outcome than the results found in the Brazilian studies. Both Brazilian studies were over short time periods; the former over only three years and the latter only looked at a one-day ban. Biderman et al. (2010) focuses on availability of on-premise alcohol sales, which may have a different impact than Washington's off-premise privatization. Nakaguma and Restrepo (2018) focus primarily on on-

premise sales and used accident data, but only on federal roads, so their analysis missed all other roadways in Brazil where there could have been an accident.

There has been limited work on decreasing the availability of alcohol as most studies now focus on the effects of increasing alcohol availability. Policies that increase availability include issuing more alcohol licenses and eliminating state run alcohol stores, which often restrict Sunday sales of alcohol.

One way to increase availability is to lengthen the window of time bars can sell alcohol. Green, Heywood, and Navarro (2014) find that longer bar hours in England and Wales significantly and substantially decreased traffic accidents by about eight percent. McCarthy (2003) finds that when states issue more licenses to sell beer and wine, they see a decrease in non-fatal crashes, but more general on-premise licenses that include liquor increase non-fatal crashes. The overall effect is an increase in the number of traffic accidents, suggesting that liquor's higher alcohol content leads to the increase. While these studies lean towards an inverse relationship between alcohol availability and accidents, they may not be predictive for Washington because they focus on on-premise licensing.

There have been studies that more directly apply to Washington's alcohol privatization, which focus on the changes in off-premise alcohol licenses. Blue laws often apply to government operated alcohol stores that are required to be closed on Sunday, but studies on the effects of repealing blue laws are mixed. Kenkel (1993) finds the presence of state operated stores increases both heavy drinking and drunk driving. Lovenheim and Steefel (2012) conclude that allowing Sunday sales of alcohol across 15 states only slightly decreased fatal traffic accidents. McMillan and Lapham (2006) focus on the repeal of blue laws in New Mexico and find an increase in alcohol related crashes and fatalities. Stehr (2010) finds the same result in New

Mexico, but no other significant relationship across 47 other states. While McMillan and Lapham (2006) suggest some increase in alcohol related traffic fatalities can be attributed to allowing alcohol sales on Sunday, Stehr (2010) notes that New Mexico may have been an anomaly. The repeal of blue laws coincided with an increase in speed limits, which could explain the increase in fatalities. Sunday sales of alcohol in New Mexico increased more than any other state, which could have magnified the increase in fatalities.

Another way to increase off-premise alcohol availability is by increasing the number of outlets that sell packaged alcohol, not for immediate consumption, through granting more licenses. Again, there is little consensus among the literature analyzing these effects.

Jewell and Brown (1995) find that increasing licenses across Texas counties increased fatal accidents, and Wilkinson (1987) found the same result for the US as a whole. Both studies limited their samples to four years, which may not accurately capture the effect of an increase in alcohol availability. Least squares estimates, like those in Jewell and Brown (1995), may not be as precise when using count data common with accident data. Wilkinson's (1987) sample covers only 221 observations, which is much lower than the typical sample covered by others.

There is evidence that more off-premise liquor licenses may actually decrease traffic accidents. Between 1975 to 1996 in Texas, Baughman, Conlin, Dickert-Conlin, and Pepper (2001) and Tang (2013) find a slightly inverse relationship between traffic accidents and the number of general, as well as beer and wine only, licenses. From 1981 to 1989 across California, McCarthy (2003) also found a negative relationship between off-premise licenses and fatal alcohol related crashes.

Rickard, Costanigro, and Garg (2013) studied 48 states from 1980 to 2000 using crash data from the Fatality Analysis Reporting System. Using a three-stage model to estimate prices,

then consumption, then traffic fatalities, the authors find that allowing wine and liquor to be sold in grocery stores decreased overall traffic fatalities, while the opposite is true for beer. While this paper is most similar to the privatization of alcohol in Washington, it differs in the following ways. The following analysis focuses on the number of alcohol related fatal accidents rather than fatality rates from traffic accidents. This analysis does not make distinctions between different types of alcohol sold but instead focuses on the privatization of alcohol as a whole. Fatal accidents in Washington are compared across counties rather than comparing them across states.

Shifting control of alcohol sales from the state to the private sector increased alcohol prices. Due to alcohol taxes on both the distributor and retailer, Washington's average price of alcohol is higher than any other state (Wilson, 2014). Alcohol taxes are meant to compensate for the loss in government revenue from the closing of government operated alcohol stores. Taxes are passed onto consumers who must also pay sales tax. Theoretically, increases in alcohol prices should decrease the average quantity demanded for alcohol. If Washington residents decrease their quantity demanded for alcohol and decrease alcohol consumption, this could then decrease alcohol related fatal traffic accidents. The inverse correlation between alcohol prices and the number of alcohol related traffic fatalities can be seen in both Young and Bielinska-Kwapisz (2006) and Chaloupka, Grossman, and Saffer (2002). However, Chaloupka et al. (2002) point out that the price elasticity of demand for alcohol may be lower for college students, suggesting that college students may not have significantly changed their consumption patterns following Initiative 1183.

Following the implementation of Initiative 1183, there may have been other factors that influenced fatal accidents. In 2012, Washington voters passed Initiative 502 to decriminalize recreational marijuana. There is evidence that decriminalizing marijuana both decreases traffic

accidents (Anderson, Hansen, & Rees, 2013) and increases them (Cooper & Peterson, 2014; Salomonsen-Sautel, Min, Sakai, Thurstone, & Hopfer, 2014). Additionally, ride-sharing options such as Uber and Lyft became more prominent, but Brazil and Kirk (2016) found the introduction of Uber had no effect on traffic fatalities across the 100 most populated metropolitan areas of the US. However, Greenwood and Wattal (2017) found that the introduction of Uber led to a decrease in accidents in California. Though marijuana and ride-sharing apps may have played a role in Washington, because they do not directly impact the availability of alcohol, they are not the focus of this paper.

This paper contributes to the existing literature in the following ways. First, it takes a more granular approach to focus only on counties instead of studying the state as a whole. Second, it studies the link between colleges and alcohol related fatal traffic accidents by studying counties populated primarily of college aged individuals.

Chapter 3

Data Description

The primary dataset used is the Fatality Analysis Reporting System (FARS) from the National Highway Traffic Safety Administration (2018). FARS is a common dataset used to study traffic related issues (Lovenheim & Steefel, 2011; Rickard, Costanigro, & Garg, 2013; Stehr, 2010). The FARS dataset began in 1975 and includes individual level crash data such as the time and place of the accident, road conditions, and whether or not the driver was intoxicated.

This analysis uses FARS data from 2007 to 2017 to study the relationship between Washington's Initiative 1183 and traffic accidents involving a fatality. The dependent variable measures whether or not the driver was intoxicated. This binary variable is determined by either positive blood alcohol concentration or by the reporting officer indicating that the driver was intoxicated. This is used to develop the monthly count of alcohol related traffic accidents involving a fatality for each county in Washington.

Other dependent variables include the number of total fatal accidents and sober fatal accidents. Total fatal accidents are counted regardless of alcohol involvement, and sober fatal accidents are the monthly count of accidents involving a fatality where alcohol was not involved.

Control variables are used to account for differences across counties. Gender, race, age, and population variables were obtained from the United States Census Bureau (2010). Per capita income was obtained from the Bureau of Economic Analysis (2017) and adjusted to 2012 US dollars using the Consumer Price Index for all Urban Customers (Bureau of Labor Statistics, 2017). Non-seasonally adjusted unemployment rates were obtained from the Bureau of Labor

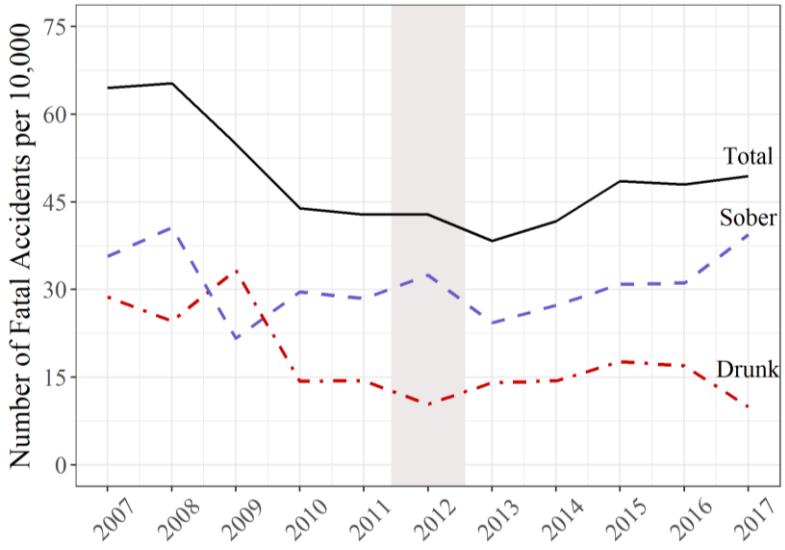
Statistics (2017)[1]. Annual vehicle miles traveled for each county was obtained from the Washington State Department of Transportation (2017).

Colleges and universities in this analysis are four-year major institutions defined in the Education Section of the Washington State Data Book (Office of Financial Management, 2017). There are twelve public institutions and seventeen private not-for-profit institutions. Table 6 in the Appendix lists included colleges and universities as well as Fall 2012 enrollment. Enrollment numbers for the Fall 2012 semester for these institutions were also collected from the Washington State Data Book. Along with county population, a subset of counties was identified as having a high proportion of college aged individuals. Counties with a college aged population percentage over 25 percent are labeled college counties. Two counties are identified as college counties; Whitman County and Kittitas County have enrollment to total population percentages of 43.8 and 26.4, respectively. Table 7 of the Appendix lists the enrollment percentages for all counties. To determine the effect of Initiative 1183 on alcohol related fatal traffic accidents in college counties, these college counties are compared to non-college counties.

Figure 1 shows how fatal accidents per 10,000 people across all counties have changed from 2007 to 2017. Fatal accidents per 10,000 people are used to get a better comparison among counties regardless of population. The number of fatal accidents per 10,000 people, regardless of alcohol involvement, decreased sharply from 2007 to 2012. After 2012, fatal accident rates increased but did not reach the same level as 2007. Before privatization, sober fatal accident rates slightly decreased with a sharp decrease in 2009. After privatization, sober fatal accident rates increased to roughly the same level as 2007. Drunk fatal accident rates

[1] Seasonally adjusted unemployment rates are not available at the county level.

Figure 1: Fatal Accident Rates Across All Counties



decreased from 2007 to 2012 despite a sharp upward spike in 2009. From 2012 to 2016, drunk fatal accident rates steadily increased. From 2016 to 2017 there was a sharp decrease in fatal accident rates.

Figure 2 and Figure 3 show how fatal accidents per 10,000 people have changed in college counties and non-college counties, respectively. College counties have lower rates of all types of fatal accidents. In college counties, fatal accident rates are volatile, but the fluctuations are only approximately ±2 accidents. Despite these fluctuations, the mean fatal accident rate across each accident classification is mostly unchanged before and after privatization in college counties. Non-college counties had a sharp decline in total fatal accident rates before privatization. This rate slightly increased after privatization, but is still lower than most of the pre-privatization rates. This is primarily due to falling drunk fatal accident rates as sober fatal accident rates have been relatively stable. With the exception of 2009 in non-college counties, sober fatal accidents are always higher than drunk fatal accidents.

Figure 2: Fatal Accident Rates Across College Counties

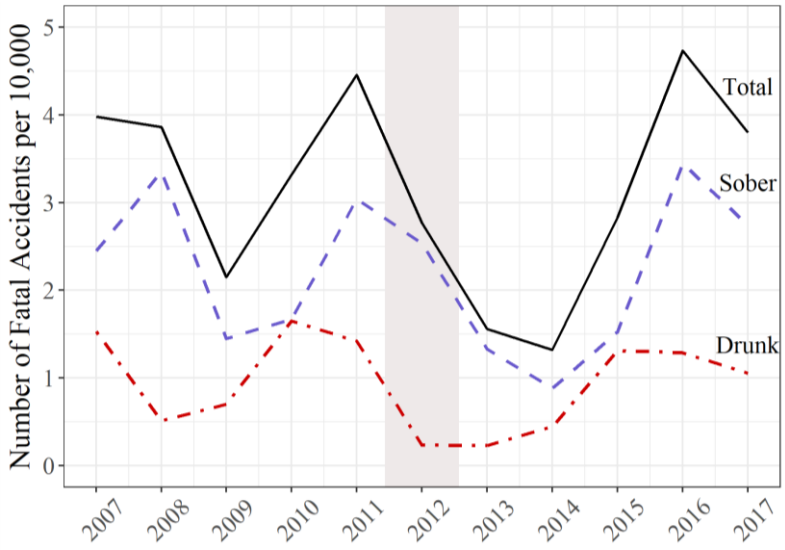


Figure 3: Fatal Accident Rates Across Non-College Counties

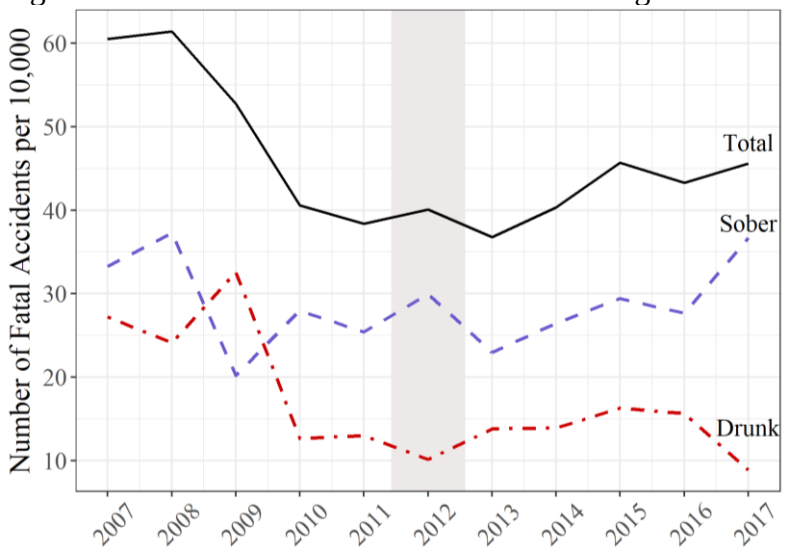


Table 1 and Table 2 provide summary statistics for college counties before and after alcohol privatization, respectively. The mean number of drunk, sober, and total fatal accidents was unchanged before and after privatization. However, the dispersion and maximum number of sober and total fatal accidents increased after privatization. The largest changes among the control variables are for percent Asian, percent Hispanic, and the unemployment rate. Percent Asian and percent Hispanic increased 0.8 and 1.7 percentage points, respectively. The

Table 1: Summary Statistics for College Counties Before Privatization

N = 120

Statistic	Mean	St. Dev.	Min	Max
Drunk Fatal Accidents	0.2	0.4	0.0	2.0
Sober Fatal Accidents	0.4	0.6	0.0	3.0
Total Fatal Accidents	0.6	0.8	0.0	3.0
Vehicle Miles Traveled	7.4	3.5	3.7	11.2
Population	4.2	0.2	3.8	4.5
Male (%)	50.8	0.1	50.5	50.9
White (%)	87.2	2.4	84.3	90.0
Black (%)	1.3	0.4	0.8	1.7
American Indian (%)	0.8	0.1	0.7	1.0
Asian (%)	4.8	2.8	2.0	8.1
Hispanic (%)	5.8	1.5	4.0	7.9
Median Age	27.5	3.1	24.4	30.8
Unemployment Rate (%)	6.8	2.1	3.5	12.2
Income	3.4	0.2	3.0	3.6

Notes: Vehicle miles traveled are reported per 100,000,000 Miles, population is reported per 10,000 people, and income per capita is reported per 10,000, adjusted to 2012 USD.

Table 2: Summary Statistics for College Counties After Privatization
N = 120

Statistic	Mean	St. Dev.	Min	Max
Drunk Fatal Accidents	0.2	0.4	0.0	2.0
Sober Fatal Accidents	0.4	0.7	0.0	6.0
Total Fatal Accidents	0.6	0.9	0.0	7.0
Vehicle Miles Traveled	7.8	3.8	3.9	12.3
Population	4.6	0.1	4.3	4.8
Male (%)	51.2	0.2	51.0	51.6
White (%)	85.5	2.6	82.2	88.6
Black (%)	1.4	0.4	1.0	1.9
American Indian (%)	0.9	0.2	0.7	1.1
Asian (%)	5.6	3.7	1.9	9.9
Hispanic (%)	7.5	1.9	5.2	10.1
Median Age	27.2	2.9	24.2	30.2
Unemployment Rate (%)	5.8	1.2	3.9	9.7
Income	3.6	0.2	3.3	3.9

Notes: Vehicle miles traveled are reported per 100,000,000 Miles, population is reported per 10,000 people, and income per capita is reported per 10,000, adjusted to 2012 USD.

unemployment rate decreased 1.0 percentage point. This is expected because the Great Recession took place before Initiative 1183.

Table 3 and Table 4 show summary statistics for non-college counties before and after privatization, respectively. The mean, standard deviation, and maximum number of drunk fatal accidents decreased after privatization. The opposite is true for sober fatal accidents. Total fatal accidents had statistics unchanged except for an increase in the standard deviation. The largest changes among the control variables are for population, percent Hispanic, the median age, and the unemployment rate. Population increased 24.1 percent. Percent Hispanic increased 2.6

Table 3: Summary Statistics for Non-College Counties Before Privatization
N = 2,220

Statistic	Mean	St. Dev.	Min	Max
Drunk Fatal Accidents	0.4	0.9	0.0	8.0
Sober Fatal Accidents	0.6	1.1	0.0	11.0
Total Fatal Accidents	1.0	1.7	0.0	15.0
Vehicle Miles Traveled	14.9	28.5	0.4	166.3
Population	17.4	34.1	0.2	195.2
Male (%)	50.0	0.8	48.1	51.8
White (%)	83.9	9.2	60.4	98.3
Black (%)	1.2	1.5	0.0	6.9
American Indian (%)	2.6	3.1	0.3	17.2
Asian (%)	2.2	2.7	0.3	15.0
Hispanic (%)	12.7	13.8	2.2	60.7
Median Age	41.2	6.3	28.3	54.6
Unemployment Rate (%)	8.9	3.1	2.5	22.4
Income	3.8	0.7	2.4	7.0

Notes: Vehicle miles traveled are reported per 100,000,000 miles, population is reported per 10,000 people, and income per capita is reported per 10,000, adjusted to 2012 USD.

Table 4: Summary Statistics for Non-College Counties After Privatization
N = 2,220

Statistic	Mean	St. Dev.	Min	Max
Drunk Fatal Accidents	0.3	0.8	0.0	6.0
Sober Fatal Accidents	0.7	1.3	0.0	13.0
Total Fatal Accidents	1.0	1.8	0.0	15.0
Vehicle Miles Traveled	15.6	28.9	0.4	173.1
Population	21.6	41.6	0.2	207.9
Male (%)	50.0	0.9	47.6	52.4
White (%)	82.6	9.6	59.5	99.2
Black (%)	1.3	1.5	0.0	6.8
American Indian (%)	2.5	3.0	0.2	16.2
Asian (%)	2.6	3.2	0.5	18.0
Hispanic (%)	15.3	15.4	2.4	69.5
Median Age	43.5	7.6	28.5	59.2
Unemployment Rate (%)	7.2	2.1	3.0	16.7
Income	4.1	0.8	2.8	7.9

Notes: Vehicle miles traveled are reported per 100,000,000 Miles, population is reported per 10,000 people, and income per capita is reported per 10,000, adjusted to 2012 USD.

percentage points. The median age increased 2.3 years. Again due to the Great Recession, the unemployment rate decreased 1.7 percentage points.

In pre- and post-privatization periods, non-college counties had higher mean numbers of drunk, sober, and total fatal accidents than college counties. Each measure has a higher standard deviation for non-college counties. Population in non-college counties is significantly larger than college counties due to the presence of metropolitan cities, such as Seattle, Spokane, and Tacoma, in non-college counties. Non-college counties have larger percentages of minorities than college counties. Part of this can be explained by the cities of non-college counties. The percentage of Native Americans is higher in non-college counties because there are no Native American Reservations in college counties. As expected, the median age of college counties is

lower by about 15 years. The unemployment rate in non-college counties is higher than in college counties. This is consistent with the fact that those with higher levels of education face lower unemployment rates than their less educated counterparts (Bureau of Labor Statistics, 2018), but this is inconsistent with the fact that metropolitan areas tend to have lower unemployment rates than in rural areas (United States Department of Agriculture, 2017). Per capita income is also larger in non-college counties than in college counties. This can be explained both by higher paying jobs in metropolitan areas than rural areas in conjunction with small incomes from students in college counties.

Chapter 4

Methodology

This paper uses a negative binomial model to estimate the effect of Initiative 1183 on alcohol related fatal traffic accidents for college counties. A negative binomial model is used because the FARS accident data is over-dispersed count data, which can be seen through the conditional variances exceeding the conditional means (Cameron & Trivedi, 2013, pp. 80-89). This is a common model to use for over-dispersed accident data (Green, Heywood, & Navarro, 2014; McCarthy 2003; Nakaguma & Restrepo, 2018; Picone, MacDougald, Sloan, Platt, & Kertesz, 2010; Stehr 2010; Tang 2013).

Specifically, three different fixed effects negative binomial models are estimated. The dependent variables used are the total number of fatal accidents regardless of alcohol involvement (total fatal accidents), non-alcohol related fatal traffic accidents (sober accidents), and alcohol related fatal traffic accidents (drunk accidents). The full models can be described as follows:

$$TYPE_{it} = \beta_0 + \beta_1 LAW_t + \beta_2 COLLEGE * LAW_{it} + \alpha_n Z_{it} + \delta_n T_t + \gamma_n C_i + \varepsilon_{it}$$

where *i* indexes the county and *t* indexes the month. $TYPE_{it}$ represents the number of total, sober, or drunk fatal accidents, respectively. LAW_t is a binary variable equal to 0 before 2012 and equal to 1 after 2012. Observations from 2012 are excluded due to possible lags or shocks that may be present immediately before or after Initiative 1183 was implemented. $COLLEGE_i$ is a binary variable which represents two counties: Whitman and Kittitas. The coefficient on the interaction of $COLLEGE_i$ and LAW_t will capture the effects for college counties after Initiative 1183 was

implemented. β_1 and β_2 are the primary coefficients of interest for this analysis. Z_{it} is a vector of exogenous control variables that vary across time and county including vehicle miles traveled per 1,000 miles per person, the natural log of population, percentage male, percentage white, percentage black, percentage American Indian, percentage Asian, median age, per capita income, and the unemployment rate. T_t represents a vector of monthly and yearly fixed effects to capture any effects that are the same across counties but vary over time. C_i represents a vector of county fixed effects to capture differences across counties that are time invariant and not included in the present control variables such as religiosity and attitudes toward alcohol. ε_{it} is the error term.

Chapter 5

Results

Table 5 summarizes the results of the model. The effect of Initiative 1183 was not statistically significant, indicating that there was not a state-wide change in total, sober, or drunk fatal accidents after Initiative 1183 was implemented. The interaction of college county and Initiative 1183 is significant at the 10 percent level for total and sober fatal accidents. Being a college county after Initiative 1183 is associated with a decrease in the difference in the logs of expected counts of total and sober fatal accidents of 0.327 and 0.467, respectively. There is no significant effect for drunk fatal accidents, which is discussed later in more detail.

As indicated by Table 7 in the Appendix, Whitman County and Kittitas County have the largest proportions of college enrollment numbers relative to their population. Because enrollment numbers were not included in this regression, the county fixed effects variable should capture this effect. There was no significant effect for any type fatal accident for Kittitas County. However, Whitman County is correlated with fewer total fatal accidents at the 10 percent significance level. This indicates that Whitman county tend to experience fewer fatal accidents overall, but a relationship cannot be made for sober or dunk fatal accidents. Because Whitman County has the highest percentage of college enrollment, this result indicates that counties dominated by a large university tend to see fewer fatal accidents.

Control variables that are statistically significant are median age and the unemployment rate, and each is significant across the three types of fatal accidents. A one-year increase in the median age is associated with a decrease in the difference in the logs of expected counts of total, sober, and drunk fatal accidents of 0.097, 0.094, and 0.092, respectively. The effect on total fatal

Table 5: Results of the Fixed Effects Negative Binomial Model

N = 4,680

	Dependent variable:		
	Total Fatal Accidents	Sober Fatal Accidents	Drunk Fatal Accidents
	(1)	(2)	(3)
Initiative 1183	0.014	0.161	-0.238
	(0.156)	(0.197)	(0.257)
College County * Initiative 1183	-0.327*	-0.467*	-0.108
	(0.198)	(0.242)	(0.345)
Whitman County	-3.314*	-2.725	-4.451
	(1.726)	(2.171)	(2.882)
Kittitas County	-1.597	-0.782	-3.092
	(1.549)	(1.953)	(2.578)
Median Age	-0.097***	-0.094**	-0.092*
	(0.033)	(0.042)	(0.053)
Unemployment Rate	-0.079***	-0.072***	-0.087***
	(0.016)	(0.020)	(0.025)
Constant	0.547	4.932	-11.068
	(6.185)	(7.746)	(10.414)
Log Likelihood	-4,774.35	-3,801.95	-2,883.59
theta	95.63 (113.60)	79.27 (122.10)	1,568.58 (4,087.29)
Akaike Inf. Crit.	9,688.70	7,743.89	5,907.18

Notes: The dependent variable of this analysis is the monthly count of each classification of fatal traffic accident for each county in Washington. All regressions include controls for vehicle miles traveled, the natural log of population, percentage male, percentage white, percentage black, percentage American Indian, percentage Asian, median age, per capita income, and the unemployment rate in addition to monthly, yearly, and county fixed effects. Vehicle miles traveled is measured per 1,000 miles per person, and per capita income is measured per 10,000 people.

** 10% Significance*

*** 5% Significance*

**** 1% Significance*

accidents is significant at the 1 percent level, the effect on sober fatal accidents is significant at the 5 percent level, and the effect on drunk fatal accidents is significant at the 10 percent level. This gives evidence that college counties have fewer fatal accidents because on average college counties are about 15 years younger than non-college counties. The unemployment rate is the most significant variable in this analysis and all coefficients are significant at the 1 percent level. A one percentage point increase in the unemployment rate corresponds with a decrease in the difference in the logs of expected counts of total, sober, and drunk fatal accidents of 0.079, 0.072, and 0.087, respectively. This is likely due to the effects of the Great Recession and the fact that lower economic activity during recessions leads to less driving (McCarthy, 2003).

Chapter 6

Conclusion

This analysis studies the effect of Initiative 1183 on alcohol related fatal traffic accidents for counties populated primarily of college aged people. In particular, Whitman and Kittitas counties were used as college counties, and were compared to other counties across Washington. Fixed effects negative binomial models were estimated to study these effects. For college counties after Initiative 1183, there was a decrease in total and sober fatal accidents, but no effect for drunk fatal accidents. Significant controls that correspond to a decrease in all types of accidents are the median age and the unemployment rate.

No significant effect for drunk fatal accidents among college counties is consistent with the fact that students living in or around larger campuses tend to not need to drive as much. The population of Whitman county is dominated by students from Washington State University. Because of how compact the campus and town are, students do not need to drive. They can walk, bike, or use public transportation to and from bars and parties. The same is true for Central Washington University in Kittitas County. After Initiative 1183, there may have been a change in the consumption of alcohol for college students, but because they are not driving themselves there was no change in drunk fatal accidents. On the other hand, the effect for drunk fatal accidents may not be significant due to a lack of observations. Drunk fatal accidents have the least number of accidents among the three types of accidents, so there may not be enough observations to get meaningful statistics. Using monthly or daily data or expanding the years could increase the sample size and increase the precision of the estimates. Moreover, because

whether or not the driver was intoxicated is indicated at the discretion of the reporting officer, drunk drivers may be undercounted in the FARS dataset.

Other events could be influencing the reduction in sober and total fatal accidents among college counties after Initiative 1183. For example, there could have been targeted efforts on college campuses to reduce all forms of distracted driving, such as texting and driving. There could also have been targeted advertisement for college aged people on social media or other digital platforms aimed at reducing distracted driving. If these efforts aligned with the implementation of Initiative 1183, it could explain why there was a decrease in total and sober fatal accidents but no change for drunk fatal accidents.

There may be factors leading to non-precise estimates, such as omitted variable bias. Including monthly enrollment numbers from 2007 to 2017 for each county could be used instead of creating a dummy variable for college counties. This would place higher weights on counties that have a larger college aged presence, such as in Whitman County and Kittitas County, and also include counties with smaller enrollment percentages, such as Whatcom County. Creating a variable to more accurately capture alcohol availability, such as the number of alcohol licenses across counties, could also be added. This will more precisely define the increase in alcohol availability after Initiative 1183. Because the median age is a significant variable in this analysis, this indicates that including the exact age of those involved in the fatal accident may increase the precision of the estimates.

This paper shows that there were public health gains for college counties in Washington after the implementation of Initiative 1183. Despite no statistically significant relationship between alcohol privatization and alcohol related fatal traffic accidents, the inverse relationship

between alcohol privatization and both sober and total fatal accidents show that there can be public health benefits for other states looking to privatize their alcohol market.

APPENDIX A

Select Tables

Table 6: Enrollment and Population by County

County	Population	Enrollment	Enrollment as Percentage of Population
Snohomish	736,784	176	0.02
Clark	663,654	2,970	0.45
Yakima	247,566	1,150	0.46
Benton	182,491	1,410	0.77
Pierce	815,451	10,568	1.30
Thurston	262,252	6,332	2.41
King	1,972,404	64,924	3.29
Spokane	482,597	24,162	5.01
Walla Walla	59,527	3,479	5.84
Whatcom	208,738	15,532	7.44
Kittitas	42,602	11,268	26.45
Whitman	45,626	19,989	43.81

Note: Population and enrollment are as of 2012.

Table 7: Colleges and Universities by County and 2012 Fall Enrollment

College/University	County	Enrollment
Public		
University of Washington - Seattle	King	42,570
UW - Tacoma	Pierce	3,907
UW - Bothell	King	4,160
Washington State University - Pullman	Whitman	19,989
WSU - Spokane	Spokane	1,223
WSU - Tri-Cities	Benton	1,410
WSU - Vancouver	Clark	2,970
Central Washington University	Kittitas	11,268
Eastern Washington University	Spokane	12,587
Western Washington University	Whatcom	14,833
The Evergreen State College	Thurston	4,509
Northwest Indian College	Whatcom	699
Private Not-for-Profit		
Antioch University - Seattle	King	887
Bastyr University	King	1,028
City University	King	2,297
Cornish College of the Arts	King	791
Faith Evangelical Lutheran Seminary	Pierce	335
Gonzaga University	Spokane	7,781
Heritage University	Yakima	1,150
Northwest University	King	1,612
Pacific Lutheran University	Pierce	3,473
Saint Martin's University	Thurston	1,823
Seattle Pacific University	King	4,095
Seattle University	King	7,484
Trinity Lutheran College	Snohomish	176
University of Puget Sound	Pierce	2,853
Walla Walla University	Walla Walla	1,940
Whitman College	Walla Walla	1,539
Whitworth College	Spokane	2,571

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Academic Vita
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Education

August 2015 – May 2019

The Pennsylvania State University – Schreyer Honors College
Bachelor of Science in Economics, Module: Theory and Quantitative Methods
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Relevant Coursework: Mathematical Economics, Cross-Sectional Economics, Economic Forecasting, Growth and Development, Labor Economics, Strategy, International Political Economy, Honors Intermediate Econometrics, Honors Intermediate Microeconomic Theory, Honors Intermediate Macroeconomic Theory, Calculus I, II, and III, Real Analysis, Differential Equations, Linear Algebra, Introduction to R, Introduction to SAS.

Research Experience

Fall 2018 – Present

Senior honors thesis: *Quantifying the Relationship Between Alcohol Privatization and Alcohol Related Fatal Accidents in Washington State*
This thesis uses the Fatality Analysis Reporting System dataset to determine the effect of the privatization of alcohol in Washington State for areas dominated by college populations.

Summer 2018 – December 2018

Research Assistant
Dr. Michael Gechter, Assistant Professor of Economics.
Worked on projects for topics in growth and development related to literature collection and data description using STATA and R.

Teaching Experience

Undergraduate grader

Duties include: grading exams and problem sets, proctoring exams, and inputting grades.

Spring 2019 – ECON 483: Economic Forecasting
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Duties included: weekly hour-long review sessions and office hours, proctoring exams, and reviewing regrade homework requests.

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Programming Experience:

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Activities and Miscellaneous:

Fall 2017, Spring 2018 - Founding President of the Penn State Women in Economics Society.
On campus organization focused on encouraging women to be successful in economics.

Fall 2017 – Spring 2018 - Facility attendant with Penn State Campus Recreation.
Worked 10-16 hours per week at Penn State's gyms on campus.

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Tasks included: managing lease details for tenants, researching demographics and economic characteristics of the Scranton area for a loan proposal, assisting in payroll and accounts payable.