University of Economics in Prague

Faculty of Economics

Study Program: Economic Analysis

DID ALCOHOL PROHIBITION REDUCE NUMBER OF ROAD TRAFFIC ACCIDENTS RELATED TO ALCOHOL?

Master thesis

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Year: 2016

Prohlašuji na svou čest, že jsem diplomovou práci vypracoval samostatně a s použitím uvedené literatury.

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V Praze, dne 16. 8. 2016

I would like to thank my supervisor Josef Montag for his valuable comments and unflagging support.

Abstract

This paper tries to find out whether a short ban on sales of liquors reduced the harmful use of alcohol with respect to motor vehicle accidents. I make use of short (two weeks) alcohol prohibition which was imposed by the Ministry of Health Care in the Czech Republic in September 2012 aiming to stop the deadly wave of methanol poisoning. To estimate the effect of prohibition on the number of road traffic accidents, I exploit the methodology of differences-in-differences. I use daily data about traffic accidents from the Czech Republic (treatment group) and from neighboring countries such as Austria, Germany and Poland (control group). The result suggests that there is no significant drop in term of road traffic accidents.

Key words

driving under influence, alcohol, prohibition, road traffic accidents

JEL Classification

D04, I10, H23

Abstrakt

Tato práce zkoumá, zda v důsdledku krátkodobé prohibice uvalené na prodej alkoholu došlo ke snížení počtu dopravních nehod způsobených řidiči pod vlivem alkoholu. Abych tento efekt zjistil, využívám situace ze září roku 2012, kdy Ministerstvo Zdravotnictví uvalilo krátkodobě (2 týdny) zákaz na prodej tvrdého alkoholu ve snaze zamezit dalším otravám způsobeným methanolem. Abych odhadl vliv prohibice na počet dopravních nehod, vyžívám metody rozdíly v rozdílech. Používám denní data o počtu dopravních nehod v České Repubuplic (tj. cílová skupina) a z okolních zemích jako Rakousku, Německo a Polsko (tj. kontrolní skupina). Výsledky zplna nenasvědčují vlivu alkoholové prohibice na pokles dopravních nehod.

Klíčová slova

řízení pod vlivem, alkohol, prohibice, dopravní nehody

JEL klasifikace

D04, I10, H23

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1. Introduction

The excessive consumption of alcohol increases risk of many diseases such as high pressure, heart attack and brain damage, and it is one of the leading cause of death. From the point of whole economy, consequences of heavy drinking are enormous ranging from higher expenditure on health care, faster depreciation of human capital to loss of productivity.

The overall consumption of alcohol in the Czech Republic is one of the highest in the world. According to World Health Organization (WHO) the average consumption of pure alcohol per capita was 13 liters in 2010 of which a quarter is consumed in the form of spirits. Less alcohol beverages are consumed by females compared to males, who drink twice more than females. WHO transportation statistics show that in the Czech Republic died on average 12.9 age-standardized males per 100 000 populations older than 15 years in 2010 due to road traffic accidents related to alcohol, death rate for females is 4 deaths per 100 000 populations older than 15 years. More importantly, almost one third of all road traffic accidents caused by males is related to alcohol, for females the ratio is proportionally the same (15 %) (WHO, 2014).

Moreover, consumption of alcohol may have negative external effects, because some costs of drinking are transferred to other parties. Drinking and driving is one example which illustrates negative externality of alcohol consumption. Drunk driver may cause a traffic accident and transfer costs to other driver or pedestrian, because the victim suffers injury or car damage.

How do external effects of alcohol consumption depend on availability of alcohol? In this paper I try to answer this kind of question using method of natural experiment (differences-in-differences). I make use of incident which happened in the September 2012 when the Ministry of Health of the Czech Republic took measure to ban the selling of liquors with alcohol content over 20%. During the banned period (two weeks) restaurants, pubs, bars and all stores were not allowed to sell, serve or offer any beverage with alcohol content above 20%.

I use data about traffic accidents and related measures such as number of fatalities, etc. to estimate the effect of the fourteen days' prohibition of liquors on road traffic accidents. Primarily, I compare the development of traffic accidents in the Czech Republic (treatment group) with the development in Austria, Germany and Poland (control group) before and after the prohibition using method of differences-in-differences.

The estimates suggest that the alcohol prohibition in the Czech Republic did not reduced the number of traffic accidents related to alcohol or any other measure regarding road traffic

accidents. The only exception was found when I focused on the situation in regions along the borders between the Czech Republic and Austria. For these border regions, the estimated effect is -1,7 which means that one additional day of prohibition induce a drop in the number of accidents related to use of alcohol by 1,7 per day on average in regions of South Moravia, South Bohemia and Vysočina altogether.

The reminder of this paper is organized as follows. In chapter 2 I review literature, in chapter 3 the theory which is behind the imposition of ban on sales of liquors is discussed, the data are presented in chapter 4, chapter 5 discusses methodology and identification strategy, chapter 6 provides results and chapter 7 concludes.

2. Background

When a government imposes a ban on something, it uses the strictest form of regulation at its disposal. By imposing a ban on alcohol, some activities related to alcohol become illegal. Based on the extent of alcohol prohibition, the range of prohibited activities may differ. In the past, the bans on alcohol have included activities such as manufacturing, sale, possession, distribution and international trade. Even the consumption of alcohol may be a subject to prohibition, but not always. The most famous alcohol prohibition from the US, as well as the prohibition from the Czech Republic, shows that the consumption of alcohol may still be legal and regulated according the same rules which were valid before the enactment of prohibition.

It might seem as ineffective that a government tries to reduce consumption of alcohol through enacting a ban on alcohol, which does not directly apply to consumption, but the opposite might be true. By forbidding the sale, trade and production of alcohol; the government tries to reduce the market supply of alcohol to the extent that consumers are not able to buy alcohol beverages. Even though that consumers are still allowed to drink, it becomes costlier to do so. In order to get any alcohol beverage, consumers can bring something from abroad, or buy it illegally in home country. In both cases it seems to be more expensive for consumers to drink alcohol beverages than it was before imposing the ban. On the contrary, the approach focused on the consumption of alcohol could be costlier to enforce. That is probably why, the imposition of ban on all consumption of alcohol is rather rare. Yet if there is a ban on consumption, it is usually very limited and takes into account specific circumstances of drinking. For instance, driving while drinking or drinking alcohol in public places are two examples in which consumption of alcohol is regulated or even prohibited, but only with limited binding force of law.

However, the imposition of ban on alcohol sale is not the only way how to limit alcohol availability to consumers. For instance, the measure known as minimum legal drinking age, which allows to consume alcohol based on consumer's age is one of them. In the literature review that follows, I review effectiveness of all the main policy instruments, which were used to decrease the availability of alcohol. Firstly, the focus is set on the effectiveness of policies with respect to the reduction of the motor vehicle accidents, and afterwards I describe in detail the progress of the Czech alcohol prohibition.

2.1. Literature review

The consumption of alcohol may influence human perception and behavior in a way that may lead to damage, injury or even death. It means that a consumer under influence of alcohol could hurt himself, but also other members of society might be negatively affected, because of some external effects. Driving under influence is one of the examples of harmful use of alcohol. When a drunken driver causes a motor vehicle accident, the incurred costs burden him as well as other members of society. Such a situation is perceived as undesirable and therefore plenty of regulations in this area are aimed at preventing harmful use of alcohol. Most of the current regulations aim at modifying constraints to which people may respond to. Constraints could be legal or economic in nature.

There are many different policy instruments employed in recent times, whose main goal is to limit an access to alcohol. But which one is the most effective in preventing harmful effects of drunk driving? That is the question which is addressed by researchers from different fields. Reviewing the literature on motor vehicle accidents related to alcohol, there are many empirical studies evaluating how effective different policies are in limiting availability of alcohol[1].

[1] In addition to policy instruments which are based on reducing the availability of alcohol to consumers, there are other ways how to discourage harmful use of alcohol and prevent driving under influence. A worldwide review of policies carried out by the World Health Organization (WHO, 2014) lists different approaches to this issue. Cited instruments include a formation of national alcohol policies, efforts of raising awareness about alcohol influence on the human body, providing health service treatments to those who suffer by consequences of alcohol drinking or organizing preventive programs and community actions aimed at risky population. An example, that such a community preventive program may work, shows study by Holder, et al. (2000). The examined program took place in some communities in the California and Southern Carolina between April 1992 and December 1996. The study results prove that a mobilization of local community combined together with application of other policy tools may reduce number of motor vehicle accidents related to alcohol by 6 percent in comparison to the development of controlled community.

2.1.1. Minimum legal drinking age (MLDA)

Frequently used policy tool for reducing availability of alcohol to consumers is the minimum legal drinking age. It is a restriction, which puts additional legal constraint on certain part of population. Mostly young people are concerned. This constraint binds consumers' choices, because they face stricter rules than the others. It restricts their possibilities how to get alcohol and also they or sellers of alcohol can be punished if they break the legal rules. MLDA is applied in many countries and allows consumer to possess, purchase and consume alcohol based on his age. Usually consumers have to be at least 18 or 21 years old to be allowed to buy and consume alcohol beverages.

MLDA is aiming at young people by limiting them an access to alcohol. How effective it is, show studies from the USA, where in the 1970s legal limit decreased to 18 years in some states, and by contrast in the following 1980s the minimum legal drinking age in all states returned to 21 years of age. Using changes in MLDA across US states, many researchers tried to find out what is the effect of MLDA on different areas related to drinking of the youth. Summary review of many of these studies was done by Wagenaar (2002). He shows that 58 percent of the examined studies (in total, 46 out of 79 studies) with a high methodological quality[2], which were carried out between years 1960 and 2000, show significant inverse effect between minimum legal age limit and traffic accidents, it means that increasing minimum legal drinking age leads to decrease of traffic crashes and vice versa. On the other hand, none of the 79 studies proves significant positive effect. This implies that 42 percent of studies show either insignificant effect or no effect at all.

However, new findings coming from studies done on data from recent times shed new light on this relationship. Using regression discontinuity design as a new research method uncovers that the minimum legal drinking age induce youths in the USA (at the age of 21) to drink more alcohol and increase their mortality related to motor vehicle accidents (Carpenter, 2009). To be more specific, Carpenter estimated that 1 percent rise in heavy drinking days of youths at the age of 21 years is related to their mortality rate increase by 0.4 percent.

On the other hand, recent studies from New Zealand and Australia are not as supportive as findings from the USA in assertion of beneficial effect of minimum legal drinking age on the number of related motor vehicle accidents. Even though that for both countries was used

[2] High methodological quality studies are characterized by using longitudinal data; treatment and control groups; higher quality of sampling or use of census data.

regression discontinuity design, their findings prove no relationship between minimum legal drinking age and the amount of motor vehicle accidents (Lindo, Siminski, & Yerokhin, 2014), (Boes & Stillman, 2013). Mentioned reasons of apparent discrepancy between their findings and those from the USA might be found as a consequences of different traffic safety regulations (Australia employs many policy instruments aimed at traffic safety compared to other countries) and/or cultural differences between both continents.

2.1.2. Economic Incentives to Reduce Abuse of Alcohol

Another way how to limit an access to alcohol is based purely on an economic incentive. Relying on the law of demand, the effective way how to reduce demanded quantity of alcohol is to increase its price. To make alcohol beverages more expensive, an excise tax on alcohol is usually used as a policy tool, which could achieve such a goal. Based on meta-analysis, which encompasses 112 studies, the average price elasticity of spirits is -0.8, compared to beer with less elastic demand (-0.46) and wine (-0.69) (Wagenaar, 2009). It shows that consumers are more responsive to changes in prices of spirits than prices of alcohol beverages with lower content of alcohol.

Excise taxes on alcohol beverages may induce people to decrease their consumption of alcohol or induce them to consume it less often. As it is shown in study by Son & Topyan (Son & Topyan, 2011) ,which is based on state-level data from the USA for years 1995 and 2004, the excise tax on alcohol could lead to lower harm related to motor vehicle accidents. The estimated effect of one year lagged beer tax on the number of motor vehicle accident mortality is significantly negative. More precisely, when the excise beer tax is increased by 10 percent in previous year, the motor vehicle accidents mortality decrease by 2.2 percent in current year. It shows that excise taxes on alcohol might be a way how to minimize harmful effects of alcohol consumption, which is also showed in another study (Young & Bielinska-Kwapisz, 2006).

Another way how to restrict an access to alcohol is perhaps more straightforward than the previous two. That is because it imposes ban on sale or/and consumption of alcohol in a given geographic area at all. Throughout a history there were used many different variants of alcohol prohibition. Some prohibitions were very strict and involved a ban on all alcohol beverages in the whole country, by contrast some prohibitions were moderate and included only liquors letting beer and wine untouched and thus might be regarded as partial prohibitions. In addition, how long a prohibition was in enforce also influence its consequences. If a ban is temporary

and lasts few weeks, its effects could be different compared to a prohibition, which is in force for several years.

When reviewing the history of prohibitions during 20th and 21st century, it seems the biggest prohibition era came during the first half of 20th century in the Northern America and in some European states. Countries such as USA (U.S. Constitution), Norway (Johansen, 2013), Finland (Wuorinen, 1932) and Soviet Union (Nemtsov, 2011, p. 16) experienced periods of ban on alcohol sale and manufacturing, which lasted from a few years to even several decades.

Many of these bans on alcohol sales shared the same origin. Already in early 19th century there were efforts to prevent harmful effects of alcohol use by reducing its availability. The social initiative called the temperance movement promoted the reduction of alcohol consumption and pointed out undesirable effects of alcohol use. Even though that it aroused in USA, the temperance movement spread to other countries. During the 19th century supporters of this social movement achieved high political influence which led to restrictions on alcohol sale through establishing new legal rules and prohibition in some countries (Anderson & Baumberg, 2006, p. 40). Majority of the enacted prohibitions were repealed after several years, because it did not bring desired benefits and caused new problems. Nowadays most of the countries in the West regulate alcohol production and usage, but no country bans alcohol sale totally. By contrast there are several countries in the rest of the world, which enacted the ban on alcohol. These are mostly Muslim countries, which use prohibition over a long period because of religious reasons[3].

What the effect of prohibition from the first half of 20th century on the motor vehicle accidents was is hard to say because of lack of evidence. Besides that, in the 1920s the road transportation was just starting its massive expansion, therefore motor vehicle accidents were not so important social issue as it is now. On the other hand, there is a lot of evidence about the overall effects of prohibition. Mainly, the most famous one from the USA provoked huge debate about effectiveness of prohibition. Also the US noble experiment - how the US prohibition is sometimes called – provides in general way evidence about crime and social issues related to the prohibition.

[3] Some of these countries may allow to sell alcohol beverages to non-muslim occupants such as tourists or memebers of other religion groups.

2.2. The prohibition on sales of liquors in the Czech Republic

In the late summer 2012 the Czech Republic experienced the heavy wave of methanol poisoning[4]. It began on the 6th of September, when the Police from the city of Karviná announced that several people died after drinking poisonous liquors (ČTK, 2012). A deadly poison was identified as the methanol, which was added into spirits such as vodka, rum or plum brandy - widely popular and cheap spirits among alcohol consumers in the Czech Republic[5]. At the start of series of poisonings, the origin of methanol was unknown, because victims bought toxic spirits at different places in the market. The methanol was already included in bottles with spirits, so the deadly methanol was added to bottles during production or distribution. In following days, other people were hospitalized and died of methanol poisoning in neighboring regions. The situation was getting serious.

While the number of victims increased each day, the source of methanol and the amount of dangerous alcohol in the circulation was still unknown. Due to the extraordinary range of affected consumers, very soonthe alcohol related deaths became the main topic in newspapers and TV for several weeks. Also, it triggered a huge criminal investigation by Police aimed at finding the source of fatal mixture of alcohol and methanol, which in short time killed many people mostly in the east of Moravia. In addition, for regular consumers, it was rather difficult to distinguish between spirits with admixture of methanol and ones with alcohol only[6].

As more and more people suffered from drinking poisonous spirits, the Czech administrative and governmental institutions were obligated to react in way that would prevent other casualties. The aim to prevent further casualties began with less severe measures which were focused on the supply side of the market with alcohol. Later, more severe measures were put in place.

A first emergency measure was taken by the Ministry of Health of the Czech Republic few days after the start of methanol poisonings. It was aimed at increasing control activities by responsible public agencies. They focused mainly on controlling the quality of alcoholic beverages served in pubs, restaurants and other relevant places of business. On the 12th of

[4] Poland and Slovakia were also affected by the poisonous beverages imported from the Czech Republic. Even though that a harmful impact of poisonous alcohol was significantly smaller in Poland, several people died due to poisoning and others were hospitalized.

[5] There are many records of occurrences of methanol poisoning from all over the world, which are in many cases related to illegal production and distribution of alcoholic beverages (World Health Organization, 2014).

[6] There was a possibility to carry out a test which would detect the presence of methanol in the liquid, but this test was usually more expensive than the price of the tested spirit.

September, another step toward limiting the sales of alcohol beverages aroused, when the Ministry of Health of the Czech Republic imposed restriction on operators of outdoor kiosks. On that day a ban on the sales of beverages with alcohol containing more than 30 percent of alcohol came into force for all operators of kiosks (MZČR, Emergency Measure - 1st Prohibiton, 2012).

Since some of the victims were poisoned during their visit of pub or restaurant, and at the same time poisoning spread across the country the Ministry of Health of the Czech Republic took much tougher measure to stop methanol poisoning. On the 14th of September 2012 the Ministry imposed a ban on selling of liquors with alcohol content over 20 percent (MZČR, Emergency Measure - 2nd Prohibition, 2012). The measure was revoked on the 27th of September. Practically, it meant a temporary and partial prohibition on sales of alcohol to final consumers[7].

Few things need to be stressed out in relation to this partial prohibition. During the banned period (two weeks in total) restaurants, pubs, bars and all grocery stores were not allowed to sell, serve or offer for sale any beverage with alcohol 20 percent by volume and higher[8]. All bottles with banned alcohol had to be kept out of shelves and bars so that consumers would not be able to see them. Also advertisements of alcoholic beverages, which were subject to the ban, disappeared from TV and radio broadcasting (RRTV, 2012). When the ban has begun, the enforcement increased too because more policemen, controllers and the media focused on obeying the law. A person, who would eventually break the law would commit regulatory offence. In such a case the perpetrator could be fined up to 3 million of Czech Crowns and her business could be closed. In case of repeated violations, the punishment would be more severe. On the other hand, not all alcoholic drinks were restricted to sell, mainly beer, wine and other light alcoholic drinks stayed unaffected due to smaller alcohol content. The main focus was on liquors.

The emergency measure came into force immediately after it was announced by the Minister of Health, but at the time of announcement, nobody knew when the measure will be revoked. It was merely expected that it will last several weeks. In addition, it could be hardly expected that the partial alcohol prohibition will come, even two days before it actually began.

[7] Sale of alcohol beverages between firms was still possible. The new measure prohibited only selling liquors to final consumers (i.e. households). The consumption of alcohol by households, for instance, during homemade parties was allowed.

[8] On the 20th of September the Ministry of Health imposed a ban on export of the same products to other countries (MZČR, Emergency Measure - 3rd Prohibition, 2012).

Within few hours after the announcement, selling of liquors to consumers was not possible anymore. Store shelves which were usually full of liquors stood empty. Even drinking some of the mixed drinks and shots in pubs and bars passed away. The sales of alcohol beverages containing more than 20 percent of alcohol was reduced to zero very fast, so there was not much time to stock up with alcoholic beverages before the prohibition came into effect.

The imposed ban on selling of liquors negatively influenced the whole market with spirits. Not only the credibility of industry decreased, but pubs, restaurants, kiosks, retailers and other businesses, which usually sell liquors suffered by drop of sales, because they were not allowed to sell it anymore. Mainly producers of liquors increased their pressure on the government to revoke the ban. In the meantime, some producers of liquors with alcohol content with 20 percent or slightly above this threshold, tried to adapt to new legislative constraint by producing liquors with the reduced alcohol content. As a result of their effort, new products with 19.9% or lower alcohol content were supplied on the market. Also pubs, restaurants, kiosks, retailers and other businesses, which regularly sell alcoholic beverages to final consumers, experienced drop of sales and faced a problem of frozen money in stock of temporary unsellable spirits.

After 14 days since the announcement, the prohibition was revoked, but new less strict rules aimed at regulating sales of alcohol were applied (MZČR, Emergency Measure - 4th Prohibition, 2012). All opened bottles with liquors in pubs, restaurants etc. should be destroyed or it should be proved by test from authorized laboratory that the content of bottles is not harmless to health. In addition, all bottles (in consumer package) with liquors, which were produced after the 31st of December 2011 should be accompanied by a document which would prove the origin of liquor, in particular, where it comes from and who produced it. Exported liquors were subject to the same rules[9].

Outstanding wave of methanol poisoning, which took place in September 2012 influenced living conditions in the country for many months after the end of partial ban imposed on liquors. In summary, due to poisoning 49 people died in the Czech Republic since the beginning of September 2012 till January 2014 and many others were injured and suffer longstanding effects of poisoning such as loss of sight (Macalíková, 2014). But the poisoned victims were not the only group of people who were affected. Due to subsequent prohibition on the sale of alcohol,

[9] The ban on import of liquors from the Czech Republic to Poland and the Slovak Republic was canceled on the 9th October 2012 (EUbusiness Ltd., 2012).

many other areas of life have been influenced too. The focus of this paper is on one of them, that is, traffic accidents related to alcohol.

3. Theory

To theoretically consider the relationship between alcohol availability and motor vehicle accidents, firstly I examine the prohibition as a policy instrument by which the Ministry of Health has intervened into the market with alcohol. Secondly, I pay attention to negative externalities related to traffic accidents and finally I consider a model of human behavior in which alcohol availability relates to motor vehicle accidents.

3.1. The ban on sale of alcohol as a policy tool

Governments from all over the world use different policy instruments to prevent and reduce consequences of harmful use of alcohol. The Czech government is no exception. It uses the excise tax on alcohol, runs prevention programs, uses minimum legal drinking age and criminalize driving under influence. All these are initiatives that are aiming to reduce the (excessive) consumption of alcohol and its harmful effects in the long run. The imposed ban on sale of liquors with alcohol content of 20 percent and higher was rather different. The measure has been taken with an intention to immediately affect the whole drinking population for limited period of time. Taking into consideration all the regular policy instruments, the prohibition seems to be the strictest form of regulation at disposal of government, because it actually does not regulate the sale, it absolutely forbids it.

The ban on the sale of alcohol is a policy tool, which is focused on the supply side of the market with alcohol. It was focused on those who sell alcohol, even though the major objective was to limit consumption of specific type of alcohol beverages. After the ban became effective, restaurants, pubs, retailers and others were not allowed to sell alcohol beverages to households anymore. It was a substantial and unexpected shock for the supply side of the market. After such an intervention was carried out, the supply of alcohol should decline close to zero, because it was not legal to sell alcohol anymore. In a theoretical model of partial equilibrium, the shock may be identified as a shift of supply curve to the left. At the same time, holding other things constant, the drop of supply led to the higher equilibrium price of liquors. Even the price is higher there could be still some consumers who are willing to pay for spirits. For instance, people who are addictive to heavy drinking could have high reservation price.

On the other hand, higher prices motivate sellers to sell alcohol beverages, despite they have to bear higher costs. It means that they face new type of risk, which was not present in their

business before the ban. It is risk of being punished and eventually pay a fine or even go to a jail for selling alcohol beverages with high alcohol content. To adjust to new circumstances, they have to allocate more resources into other activities in order to be hidden from police. Likewise, enforcement contracts between seller and customers could be difficult, because legal solutions were not available anymore in similar situations. It is worth to note, that the official prediction about the duration of prohibition was that it will not last more than six weeks. Therefore, all investments of sellers into the adjustments for illegal sale of alcohol could be very small.

However, from a theoretical point of view, the temporal ban on sale of alcohol accompanied with its strict enforcement implies the reduction of supplied quantity of alcohol to the market. The crucial thing here is the enforcement ability of police. The extent to which the prohibition is effective in reducing sale of alcohol depends on the police ability to deter and eventually apprehend perpetrators from continuing sale of alcohol beverages. Even the reporting activity of public media such as the Czech Television or the Czech Radio Broadcasting could have helped police, because these public organizations have monitored and reported how the ban is carried out by major retailers and other relevant parties. They also played the important role in the announcement of prohibition, so that everybody could learn very quickly about the ban on sale of high-alcohol content drinks.

Since the prohibition was general in the sense that it affected the whole country, the more police troops were needed to be deployed to achieve the enforcement. However, because of relocation of police forces, some other police tasks such as roadside check might have suffered a drop of enforcement.

It shows that police face trade-off in the short-run. It takes few months to train new policemen. So since police had limited resources to struggle against the illegal sale of liquors, it is not optimal to deter all illicit behavior related to prohibition. Only the more severe crimes where additional benefit of deterrence or apprehension is higher than marginal costs. In optimum, the marginal cost of enforcement equals marginal benefit of enforcement, as a result such an optimum is usually greater than zero (Thorton, 1991). And some crimes are then committed.

It is also necessary to examine another question. What could be the effect of prohibition on the consumption of alcohol? Even if the ban on the sale of spirits would reduce its sale close to zero, the consumption of alcohol could have stayed the same and quite high. There are several reasons for it. First of all, the ban on sale of alcohol is not a ban on consumption of alcohol.

After the prohibition became effective the consumption was still regulated according the same rules as before. So if the households had some stock of alcohol at their homes, they could consume it during the prohibition without legal risk of being punished. However, the deadly wave of poisoning caused by fake-alcohol, which was included in cheap brand name bottles with spirits posed risk to some consumers of liquors, because they could not be sure whether their home-stocked spirits do not include methanol. At the time of prohibition and even many months after, there were doubts about the quality of spirits. Only the risk of poisoning by itself could induce many people to consume less alcohol at all. So even without the prohibition, the consumption of alcohol could decrease anyway.

Secondly, the neighboring countries of the Czech Republic did not impose ban on the sale of alcohol, even though that some of them temporarily prohibited its import from the Czech Republic. Since the Czech Republic is rather small country tightly surrounded by other neighbors, it is not difficult to reach by car within few hours the Germany, Austria, Poland or Slovakia. Therefore, when the prohibition was effective in the Czech Republic, many people could travel abroad, in order to buy alcohol beverages. They could consume either abroad, or, more importantly, they could bring it back with them and drink it in the Czech Republic. This seems to be more probable for inhabitants who live nearby the borders, because for them it is much cheaper to go abroad than for occupants who live farther away from borders. Mainly due to less time spent by travelling and lower expenses on the fuel, etc. To summarize, during the prohibition, inhabitants who could easily travel abroad, especially those who live in the borderlands, could drink spirits more often than others.

Finally, it is important to stress that the imposed ban on sale of alcohol was related to the part of alcohol assortment. Specifically, it means that only alcohol beverages with alcohol content of 20 percent or higher were not allowed to be sold. All the other products such as beer, wine and low-alcohol drinks were sold according to the same rules as before the prohibition. On top of that particularly beer and wine became relatively more credible drinks during the ban. It happened because wine and beer was not related to any poisonings. Only spirits were mixed up with poisonous methanol. These two things contributed to the fact that people might substitute more credible and available beer and wine for suspicious and unavailable spirits. Even though that wine and beer could not be regarded as perfect substitute for spirits, it is probably the closest one. So during and after the prohibition many people could switch from drinking spirits to consuming wine and beer.

Taking all three reasons about the influence of prohibition on the consumption together, it could be predicted that the amount of drinking spirits with high content alcohol have been reduced during two weeks when the prohibition was in force. Mainly for reasons that the sale of liquors in pubs, restaurants, retail chains and other grocery shops have decreased to zero. This could affect many people who were used to drinking spirits in pubs or buying something in local stores and then consume it at their homes. Since considerable subgroup of drivers drink before they drive, their drinking habits could be affected as well by the prohibition.

3.2. Negative externality related to motor vehicle accidents

Cars as means of transportation play the important role in today's societies. Most of people do not buy a car just for the sake of owning it, but because they want to use it. Nevertheless, the car is not the only one thing which is needed for driving. It seems that there are four major complements of using cars, which are necessary for car's regular use. It is fuel (or other source of energy), driver's time and skills and definitely roads. While the technological progress is finding new and more efficient ways how to power cars (electricity from batteries, hydrogen engines, solar energy, etc.) and self-driving cars are being developed, the roads remain the essential part of motor vehicle traffic since lately.

And it is the roads where drivers interact between each other. Sometimes driving a car is even more demanding with respect to driver's own proper reactions to what other drivers do than what manual control of car itself is about. Each driver can influence other drivers in different ways. The driver's effect on others (as they perceive it) may be positive, negative or neutral. Imagine a situation in which an oncoming driver on two-way road warn you about unexpected danger (not yet visible) on your way. Or, on the other hand, another oncoming driver may put you in danger by distractive driving.

These two examples illustrate the common feature of driving. That is the fact that drivers may transfer some of their costs or benefits of driving to other drivers. Likewise, in the previous example, the costs could be identified as a higher risk of accident to which drivers are exposed due to another driver's distractive driving. Since the distracted driver does not bear fully the cost of producing risk of collision, the suboptimal situation might occur among drivers on the roads. As is shown by Parry, Walls, & Harrington (2007), the negative externality related to motor vehicle accidents is estimated to be around 4 percent of GDP in the US. Therefore, not only due to huge part of GDP lost, but also from principal reasons, this undesirable situation needs to be solved.

The proposed solution is suggested by Coase (1960) in his seminal contribution. According to Coase if the property rights (to external effects) are well defined and transaction costs are close to zero, then the drivers could trade the property rights between themselves. And as a result, their trading can lead to Pareto optimum situation and internalization of externalities. To illustrate that by example, imagine that a driver has a right to drive inattentively, then this right can be bought by other drivers, who demand driving without additional risk of being hit by an inattentive driver. Such a transaction can occur if parties find a price which is mutually acceptable.

Even though that it seems to be a reasonable solution from the theoretical point of view, in the reality it could be hardly achievable. Mainly due to the fact that there are millions of drivers and thousands of different property rights that could be traded between drivers. The transaction costs are so huge, that it is impossible to have some functional market with this sort of property rights. Additionally, thorough definition of property rights could not be possible[10].

Instead of the market with property rights, there are other solutions which might be used. The one which is applied on the negative externalities related to motor vehicle accidents is government's regulation. To correct the negative externalities, the government imposes restrictions on driving behavior. The goal of restrictions is to minimize negative externalities by trying to incorporate full costs of driving into driver's decision. It is carried out by use of legal punishment. Forms of punishment may differ. These could be fines or harsher penalties based on the extent of offence. Drivers, who produce more risk than it is allowed by law should be punished. The threat of punishment should make them not to produce risk of collision for other drivers, that is, to prevent negative externalities at all.

Surprisingly even though that the regulation (i.e. traffic law) could decrease the size of negative externality, it could not be possible to reduce it to zero. What are the factors which influence the success of the traffic law in reducing car accidents? They are the severity of punishment, the probability of apprehension and other important aspects related to enforcement. However, even though the drivers would obey the law, there could still exist some negative externalities related to motor vehicle accidents. That is because the traffic law allows drivers to produce some legal risk of car accident. As a result, some car accidents could be a permanent part of the transportation. Since the negative externalities related to this sort of motor vehicle

[10] The great discussion of this topic is done by (Montag, 2010).

accidents is out of effect of deterrence of law, another way for their correction might be applied. It could be an excise tax on fuel, some sort of Pigouvian tax or others.

Of course, there are other types of externalities related to traffic such as congestion, air pollution, traffic noise, etc. But for the sake of objective of this paper, I focus solely on the negative externality related to the motor vehicle accidents. To be even more specific, I am interested in the negative externality in the form of driving under influence of alcohol. The traffic law defines a legal maximum limit of alcohol in blood of driver. In the Czech Republic there is a maximum blood alcohol content equal to zero. It means zero tolerance for drunken drivers.

So if having zero tolerance for drunken drivers, then even a small content of alcohol in driver's blood is regarded as violation of traffic law – illegal risk to which other drivers are exposed. By definition a drunken driver increases risk of car accidents above what is allowed by law, therefore transfer eventual costs incurred due to car accident to other parties. The incurred costs could be damage of car, injury or even loss of life etc.[11] To decrease the production of excessive risk and the amount of motor vehicle accidents related to driving under influence by police, drivers are deterred to drive while drunk by the threat of punishment.

Besides the threat of punishment there are other determinants of drinking and driving. Other public policies used to limit alcohol consumption include the informative-preventive programs, excise taxes on alcohol, limiting operating hours of liquor pubs, etc. The important factor which may influence driving under influence is also availability of alcohol. In the next section, it is shown, how the police enforcement and alcohol availability might be related to driving under influence.

3.3. Model of market with alcohol

It was already mentioned that the alcohol prohibition influenced the supply side of the market with alcohol. To show the effect analytically, suppose there is a partial and competitive market with alcohol beverages. The demand of alcohol is as follows

$$Q_D = Q_D(P, A) \qquad \text{Eq. 1}$$

where Q_D is the market demand. The price of alcohol is represented by P. The argument A stands for other factors which could influence the market demand. For instance, it could represent the income of consumers. On the other hand, the supply side of market is as follows

[11] How large are negative externalities related to drinking driving is shown by Levitt and Porter (2001).

$$Q_S = Q_S(P, B) \qquad \text{Eq. 2}$$

where Q_s is the market supply of alcohol. The P stands for price of alcohol and the B similarly as in the case of demand stands for other determinants of supply. Due to the goal of this analysis, this factor is the most important. That is because it represents the shocks on the supply side of the market. Therefore, the imposed ban on the sale of alcohol may be identified as the change of factor B.

In the equilibrium holds that the market supply is equal to the market demand. The equilibrium equation is as follows

$$Q_D(P^*, A) = Q_S(P^*, B) \qquad \text{Eq. 3}$$

where P^* signifies the equilibrium price. Next, consider how the market price depends on the shock to the market supply, ΔB. Before that, focus on the negative supply shock on the supply, that is

$$\frac{\partial Q_S}{\partial B} < 0 \qquad \text{Eq. 4}$$

To show the supply shock on the market equilibrium, firstly it starts with total differentiation of equilibrium as follows

$$\frac{\partial Q_D}{\partial P} dP^* + \frac{\partial Q_D}{\partial A} dA = \frac{\partial Q_S}{\partial P} dP^* + \frac{\partial Q_S}{\partial B} dB \qquad \text{Eq. 5}$$

where dB represents the shock due to prohibition (ΔB). Since the shock to the demand is not consider now, dA is equal to zero. So the term including dA vanishes. The Equation 5 may be further rearranged as follows

$$\left(\frac{\partial Q_D}{\partial P} - \frac{\partial Q_S}{\partial P}\right) dP^* = \frac{\partial Q_S}{\partial B} dB \qquad \text{Eq. 6}$$

Because the goal is to show how the equilibrium price depends on the change of B, dB, it is needed to rearrange the equation by one more step. The final equation is as follows

$$\frac{dP^*}{dB} = \frac{\frac{\partial Q_S}{\partial B}}{\left(\frac{\partial Q_D}{\partial P} - \frac{\partial Q_S}{\partial P}\right)} \qquad \text{Eq. 7}$$

where we have the final derivative. To qualitatively examine the effect of prohibition on the market price, it is necessary to determine the sign of the right side of equation 7. The sign depends on three factors. Firstly, it is the derivative $\frac{\partial Q_S}{\partial B}$,which is in the numerator and is negative by definition, because it stands for the influence of shock on the market supply.

Secondly, there are two terms in the denominator. The derivative $\frac{\partial Q_D}{\partial P}$ is negative, since it is assumed that, ceteris paribus, the quantity demanded decreases with increasing price. The third term, it is the derivative $\frac{\partial Q_S}{\partial P}$,which is positive, because it is assumed that the quantity supplied by suppliers, ceteris paribus, increases with an increasing price. It implies that the denominator is negative.

Since the numerator as well as denominator have negative values the important derivative $\frac{dP^*}{dB}$ has positive sign. It means that the imposed ban on the sale of alcohol, holding other things equal, leads to the higher equilibrium price on the market with alcohol.

Even though that people could switch from drinking liquors to drinking softer drinks like beer or wine, it could be expected that less people is excessively drunk or people drink less than before. Consequently, less excessively drunk drivers and pedestrians on the roads. It leads to the hypothesis that less car accidents related to alcohol could be expected. And that is what I test in this paper.

4. Data

4.1. Road Traffic Accidents

Since the main goal of this paper is to examine the effect of short-term prohibition of sales of liquors with alcohol content over 20% on the number of road traffic accidents in the Czech Republic, I have collected data about road traffic accidents in the Czech Republic, Germany, Austria and Poland[12]. The motivation of collecting data for other countries is driven by the identification strategy.

The short-term ban on sales of liquors was imposed on the 14th of September 2012 and the ban was revoked about two weeks later on the 27th of September 2012. Therefore, the data about traffic accidents covers the 14 days when the prohibition was in force, but also the period before the prohibition and the period after. For most countries the data about traffic accidents span the period from the 1st of August 2012 till the end of November of 2012. The one exception is Austria, for which the data are available only till the end of October 2012.

The data about road traffic accidents are aggregated on daily basis. It means that for each day there is a total number of road traffic accidents, a number of injured and killed individuals

[12] The aim was to collect data about road traffic accidents from all neighboring countries of the Czech Republic. The only country which is missing is Slovakia, because I did not succeed to get about road traffic accidents for Slovakia on daily basis.

involved in road traffic accidents. On top of that, for the Czech Republic, Austria and Germany, there is also information about how many accidents are related to driving under influence of alcohol. The data are mostly aggregated for whole countries, but there are two exceptions. For the Czech Republic and Austria, the data are available on the regional level. This richness of data may be exploited with an aim for deeper examination of the effect of prohibition with respect to the closely bordering regions to the Czech Republic in neighboring countries. Namely, it includes regions of the Upper and Lower Austria.

Because the aggregated data about road traffic accidents on daily basis are not available from the single source such as Eurostat, I have collected data for each country separately. It means that the data for the Czech Republic were provided on request by the Police Presidium of the Czech Republic. Also data from Austria were requested and they were provided by the Statistical Office of Austria (i.e. Bundesanstalt). In case of Germany the data come from the Federal Statistical Office Germany, more precisely from the publication called *Fachserie 8, Reihe 7, 2012*[13]. The data for Poland was obtained from the official web pages of the Police of Poland, where is an online database with records about number of road traffic accidents and other crimes per day in Poland[14].

[13] The publication is available on the web page https://www.destatis.de/DE/Publikationen/Thematisch/TransportVerkehr/Verkehrsunfaelle/VerkehrsunfaelleJ2080700127004.pdf (last accessed on August 6, 2016).

[14] The data are available on the web page http://www.policja.pl/pol/form/1,Statystyki-dnia.html (last accessed on August 6, 2016).

In order to explore data in detail and to find out its characteristics, first I describe data using basic statistics for the main dataset. Table 1 summarizes daily data about the road traffic accidents from all four countries which happened between the 1st August and the 30st November 2012. In order to make the number of traffic accidents more comparable across the countries, the figures are expressed per 100 000 inhabitants[15]. The average number of road traffic accidents for the Czech Republic is about 2,2 per day, which is the highest number from all four countries. On contrary, Germany has around 1,1 accidents on average, which is by 50 percent less compared to the Czech Republic. Austria has 1,4 accidents, which is pretty close to Germany's level. The lowest average of number accidents per day is Poland with only 0,26 accidents per day, that is almost 90 percent less than in the Czech Republic.

Table 1: Summary Statistics of Traffic Accidents (per 100 ths. inhabitants) and Holidays

	Country	N	Mean	St. Dev.	Min	Max
Accidents	Czech Republic	122	2,20	0,43	1,17	3,64
	Austria	92	1,51	0,32	0,59	2,26
	Germany	122	1,10	0,23	0,45	1,51
	Poland	122	0,26	0,05	0,16	0,37
Injured	Czech Republic	122	0,73	0,18	0,30	1,35
	Austria	92	1,87	0,37	0,84	3,06
	Germany	122	1,41	0,26	0,61	1,91
	Poland	122	0,31	0,06	0,18	0,45
Killed	Czech Republic	122	0,020	0,017	0,000	0,095
	Austria	92	0,019	0,016	0,000	0,059
	Germany	122	0,013	0,005	0,001	0,029
	Poland	122	0,025	0,010	0,000	0,053
Accidents Related to Use of Alcohol	Czech Republic	122	0,136	0,068	0,029	0,343
	Austria	92	0,094	0,048	0,000	0,202
	Germany	122	0,057	0,021	0,022	0,120
	Poland	NA	NA	NA	NA	NA
Holidays[(a)]	Czech Republic	122	0,025	0,16	0	1
	Austria	92	0,022	0,15	0	1
	Germany	122	0,016	0,13	0	1
	Poland	122	0,025	0,16	0	1

Notes: (a) If the day is holiday, then it is 1 otherwise 0. Holidays are not calculated per 100 ths. inhabitans.
Data comes from the Police Presidium of the Czech Republic, Federal Statistical Office of Germany, Statistical Office of Austria and the Police of Poland.

[15] It is not the only way how to make figures comparable across countries. Other ways might use the number of cars, volume of passenger-kilometers, length of roads etc.

Next summary statistics in the same table shows how many people were injured on average per 100 000 inhabitants during accidents on roads. The average number of injured people involved in accidents is highest in Austria (1.87) followed by Germany[16] (1,41) injuries per day. That is more than one injured individual per traffic car accident in these countries. Poland has still the lowest value with only 0,31 injuries per day. It means that also in Poland the average number of injured people is higher than the average number of accidents. But what holds in other countries does not hold in case of the Czech Republic. There are relatively lot of car accidents in the Czech Republic, but only every third accident results to injury of its participant. The Czech Republic[17] ranks in the middle with 0,73 injuries per day. It is also rather surprising that there are relatively less car accidents in Austria and Germany than in the Czech Republic, but the comparison is opposite with respect to resulting injuries.

Probably, the most important characteristics about road traffic accidents is the number which reflects how many people died as result of car accidents. Table 1 shows this figure as number of killed people on average per day per 100 000 inhabitants. The highest number of fatalities is in Poland, in which 0,025 individuals died on average per day. On the other hand, Germany has the lowest value with only 0,013 individuals killed per day. It means that Poland has on average almost by 100 percent more fatalities than in Germany. Taking into account also information about the average number of accidents in Poland, it seems that almost every tenth car accidents in Poland results to a fatality. By contrast, in the Czech Republic, roughly one out of hundred accidents results in fatality. There is a huge difference between the Czech Republic and Poland with respect to share of fatalities on total accidents. In Germany and Austria, the share is close to the situation in the Czech Republic.

Table 1 also includes a comparison which shows the average number of accidents related to use of alcohol per day and per 100 000 inhabitants. Data about this feature of road traffic accidents is available for all countries except Poland. In addition, only for the Czech Republic data are available in such a detail, which enables to find out what amount of alcohol, if any, was in blood of participants of car accidents. Table 1 shows accidents related to use of alcohol. It includes all accidents in which at least one of the participants was under influence of alcohol. In the Czech Republic, the share of alcohol related accidents on total number of accidents is around 6 percent. Austria and Germany have similar share as the Czech Republic.

[16] For Germany, the number of injuries is total number of injuries i.e. including light and hard injuries.
[17] For the Czech Republic, the number of injuries is total number of injuries i.e. including light and hard injuries.

The last characteristics which is shown in Table 1 is an overview of public holidays for each country in period from 1st August to 30th November 2012. It is not characteristics directly linked to road traffic accidents, but in broader context it is related to factors which might have an influence on traffic intensity, composition of drivers on roads, traffic jams etc. Therefore, it might influence the volume of car accidents and it is relevant to show how many public holidays were during that period. From Table 1 it is apparent from mean value that only 1,6 percent of days were public holidays in Germany, which is the lowest figure. On the other hand, Poland and the Czech Republic had 2,5 percent of public holidays, which is not significantly different. However, public holidays may be on different dates in different countries. So, even though that the total number of holidays is the same in Poland and the Czech Republic, their effect on road traffic may differ due to different timing in each country.

To summarize, described data seems to be peculiar in some aspects. For instance, in Poland the relatively lower values of accidents and injuries contrast with the highest value of fatalities. Or, in the Czech Republic there is roughly one injury per three accidents, which is too low compared to other countries. So, in order to verify road traffic data, I used data from different source, i.e. from Eurostat, which are aggregated on yearly basis. Thus I used data only for year 2012 from Eurostat and tried to compare them with main dataset which covers only four months in the same year. The aim was to find out whether the features and patterns of data from two sources are the same and if not then tries to explain why.

Table 2 shows the mean values of accidents, injured individuals and number of fatalities per each country in the year 2012. To make figures comparable with previous Table1, the values are expressed per day and per 100 000 inhabitants. When comparing the number of accidents for each country in both tables, only the Czech Republic suffer the significant drop. The average number of accidents in main dataset was 2,2 accidents per day, but the data from Eurostat shows only 0,53 accidents per day. It is a decrease of more than 75 percent. The number of injuries as well as its ranking across the countries remains similar in the data from Eurostat. The smallest differences between two sources of data is in case of fatalities. Not only that ranking of countries is the same in both tables, but also the mean values are almost similar.

Table 2: Daily Mean of Traffic Accidents (per 100 ths. inh.) in 2012 from Eurostat

Country	Accidents	Injured	Killed
Czech Republic	0,533	0,664	0,019
Austria	1,204	1,656	0,017
Germany	1,019	1,307	0,012
Poland	0,214	0,329	0,026

Notes: Data about traffic accidents comes from the Eurostat, i.e. publication Road Safety Evoluation in EU, January 2016. Available on http://ec.europa.eu/transport/road_safety/pdf/observatory/historical_evol.pdf. Population data are from Eurostat, too.

Based on the comparison between two different data sources, the number of accidents in the Czech Republic reported by the Czech Police is probably systematically higher than the number from Eurostat. The reason for such a difference might be different standards of reporting about road traffic accidents on the country level in the Czech Republic and on the level in European Union (EU). In case of EU there are probably less strict conditions than in the Czech Republic to qualify a situation as an accident which is part of the official statistics. However, even though that data is mostly consistent between two sources except accidents in the Czech Republic, it does not mean that standards for recording and reporting information about road traffic accidents are the same in all countries. For instance, a traffic situation in one country is regarded as an accident and with no doubts it enters the official road traffic accidents statistics. But in other countries, the same situation may not be reported at all, because there is no obligation of participants to inform about the collision the Police.

In order to qualify a car collision as an accident, it is necessary that certain conditions are met. In case of Poland, it means that a traffic accident resulted in the death or injury of one of the participants (Elżbieta Alke, 2015). The Czech Police qualify a situation as an accident if it results to death or personal injury or property damage in excess on any of the involved vehicles including the transported goods amount of 100 000 CZK[18]. In Austria, an accident is recorded if the accident results in the death or injury of at least one of the participants. But only accidents

[18] A situation is also qualified as an accident if one of the following condition is satisfied: (a) material damage to third persons, except for damage to a vehicle whose driver has a part in the accident or damage to the goods transported in the vehicle, (b) there is damage to or destruction of part or accessory roads by the Road Act, or (c) participants in road traffic accidents cannot by themselves without exerting undue effort to secure the restoration of the flow of traffic on roads. The details can be find on http://www.policie.cz/clanek/co-je-vlastne-dopravni-nehoda.aspx.

which happened on public roads are counted (Dietel & Pfeiler, 2013). And in Germany, to qualify a collision as an accident, it is necessary that one of the participants suffered an injury[19].

So there are differences across the countries regarding the conditions which needs to be fulfilled in order to qualify a collision as an accident. Besides different conditions across the countries, there might be incentives for participants of accidents to avoid informing Police about the road traffic accident. That is because participants might be punished by Police for breaking the traffic law after they inform them about an accident. And more importantly, in case that one of the drivers was under influence of alcohol while driving, there is a threat of serious punishment for him.

Therefore, in some cases there is an incentive that drivers would compensate each other with respect to damage caused without intervention of Police. Since the goal of this paper is to estimate the effect of alcohol prohibition on the number of alcohol related car accidents, it is important that motivation of participants to inform Police about car accidents and Police motivation to record accidents did not change during, before and after prohibition. Fortunately, to my knowledge there was no distortion which would induce change of incentives during period under consideration.

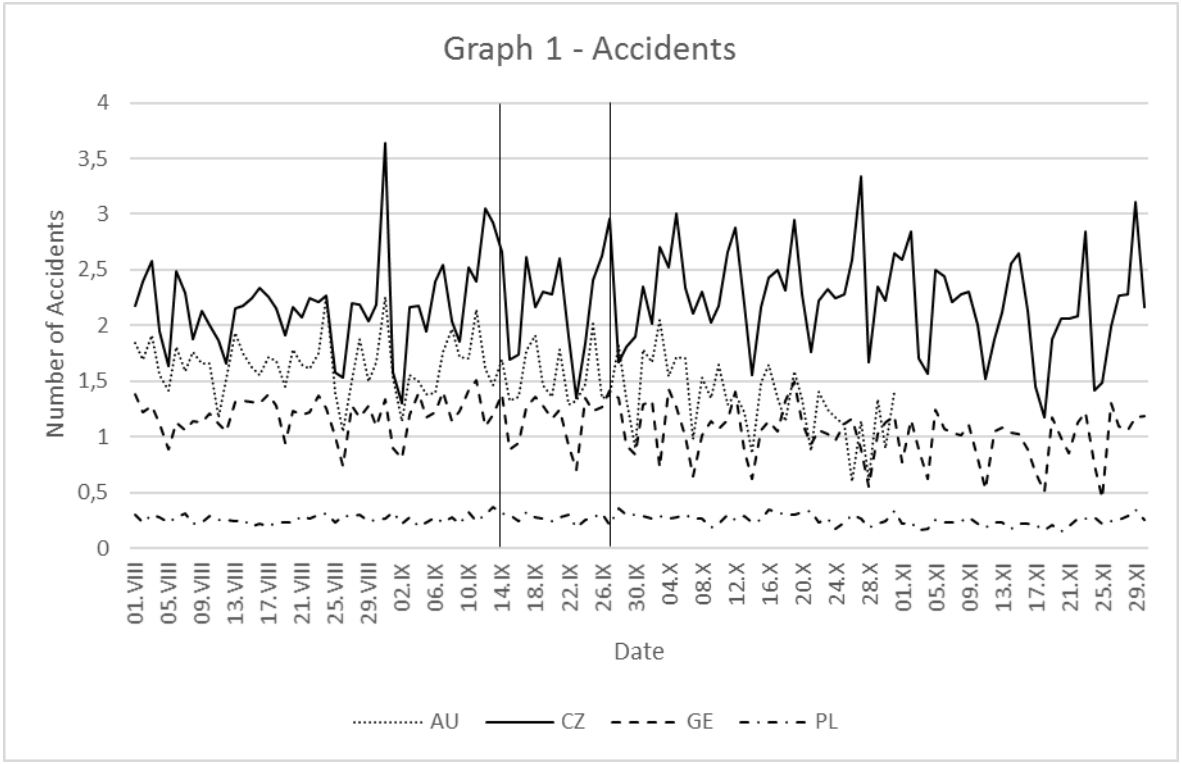
Even though that criteria for qualifying a collision as an accident differ across countries, in case of fatalities the criteria are almost the same in all four countries. Fatalities include all people who died as result of road traffic accidents within 30 days after the date of accident. Thus, this measure is the most comparable across all countries. And of course, it also gets rid of possibility that drivers would compensate each other or that Police would not record death. This makes the number of fatalities the most reliable measure to look at when comparing the different levels of road traffic accidents across all four countries. However, it does not exclude other characteristics regarding to car accidents from further analysis, because they may still be valuable provided that incentives of car accident participants to report the accident and incentives of police officers to record the accident did not change over the four months under consideration.

[19] More on https://www.destatis.de/DE/Publikationen/Thematisch/TransportVerkehr/Verkehrsunfaelle/VerkehrsunfaelleJ2080700127004.pdf (last accessed on August 6, 2016).

4.2. Development of Road Traffic Accidents over Time

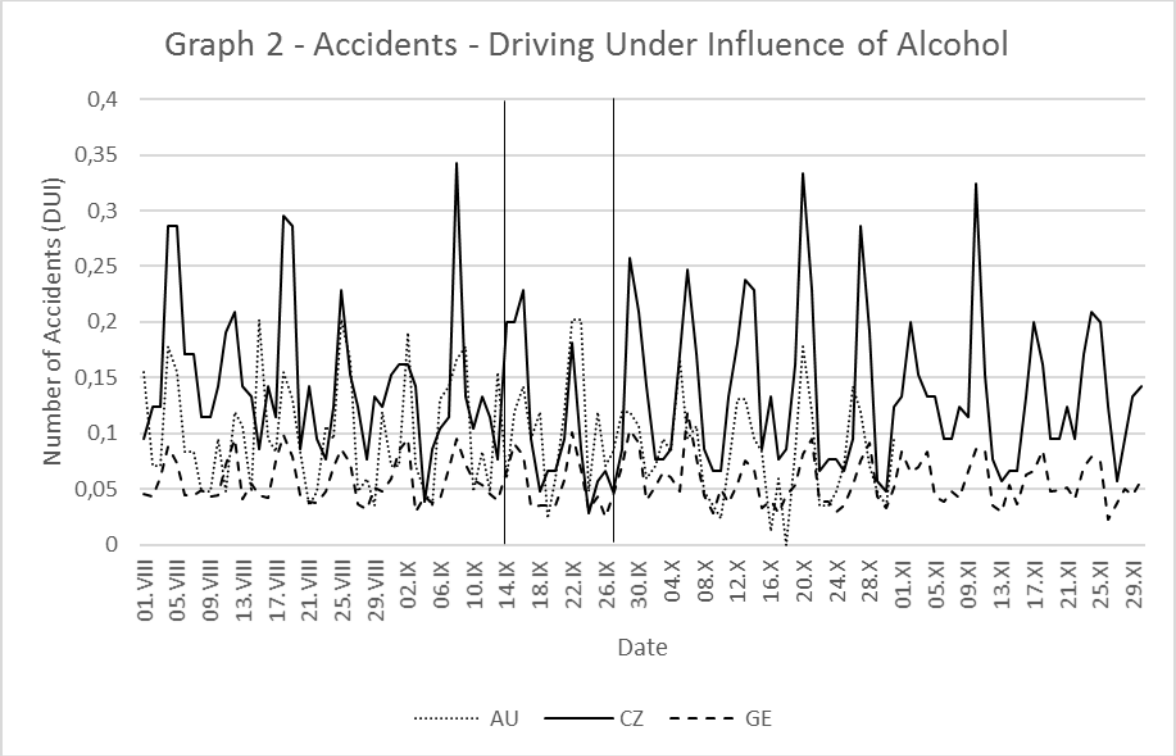
The previous section was focused on levels of main characteristics regarding road traffic accidents. These include number of accidents, number of injuries, number of accidents related to use of alcohol and also number of fatalities. How did these characteristics develop in period before, during and after the prohibition? It is question which is being addressed in this and next two sections.

Graph 1 shows the development of road traffic accidents per day and per 100 000 inhabitants for each country. The apparent feature of this time series of accidents is some sort of regularity, which is driven by weekdays. And it is similar across all countries, so there seems to be similar pattern of accidents development in different countries. The smallest number of accidents is mostly related to Sundays. On the other hand, usually the highest number of accidents happen on Fridays, but it is not so rigid as in the case of Sundays with minimums. The Graph 1 and other graphs in this section are divided into three time periods using two straight vertical lines. When focusing on the period of alcohol prohibition, there seems to be no obvious drop in number of accidents in the Czech Republic. Other countries also experience the similar behavior during prohibition as in the period before. In period after, Austria seems to suffer slight overall drop of accidents compared to period before and during period when the Czech alcohol prohibition was in force.



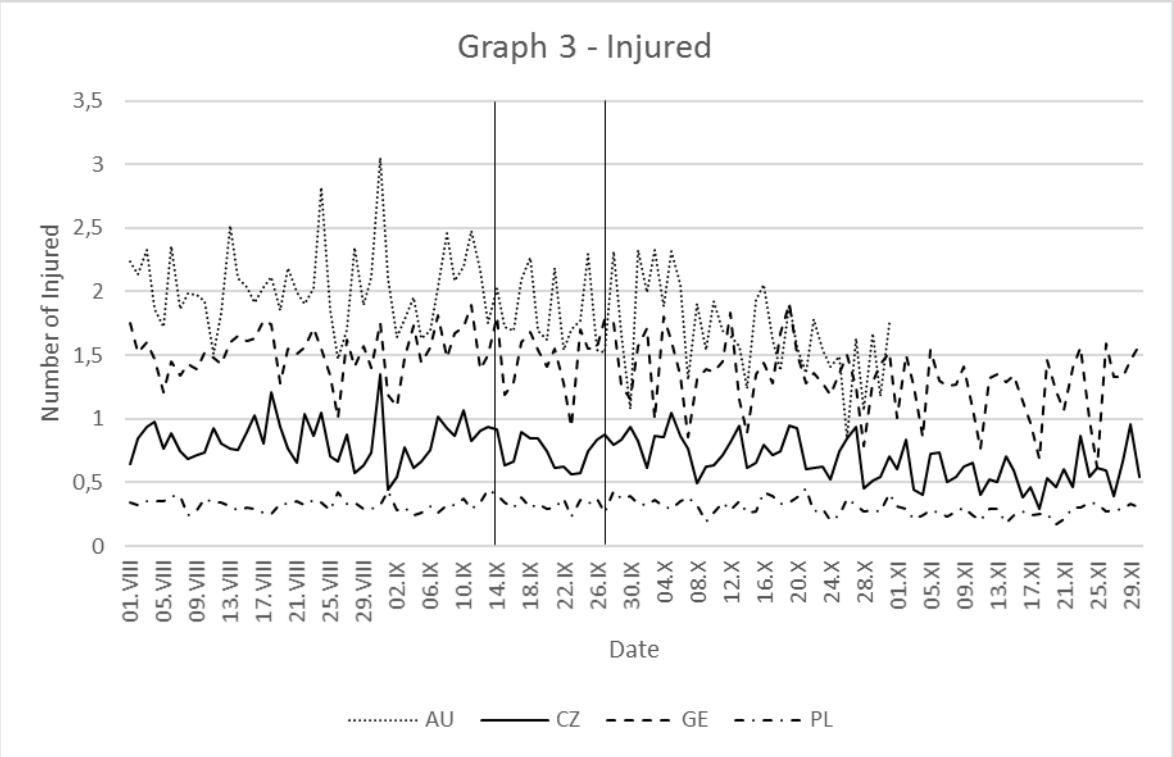
Graph 2 shows the development of road traffic accidents related to use of alcohol. As in the previous case the data are expressed per 100 000 inhabitants. This category of car accidents is usually labeled as driving under influence of alcohol, so I keep the same convention in this paper too. On first sight, it might seem that first two graphs about car accidents are the same with respect to workday regularity. But it is not true because the workday pattern is different in case of driving under influence of alcohol. Unlike the development of total accidents, accidents related to abuse of alcohol reaches the highest values on weekends. Most traffic accidents related to alcohol happen on Saturdays, slightly less on Fridays and even less on Sundays, but it is still more than average number during days between Mondays and Thursday.

Focusing on the development of accidents regarding to driving under influence in the Czech Republic during prohibition there seems to be tiny decline in the level, but the workday pattern is still there. Austria and Germany seems to follow the same movement during days of prohibition as in the period before and after.



After all, it is important to mention that there are different minimum limits of blood alcohol content (measured in milligrams per milliliter) for drivers across countries. Officially, there is zero tolerance in case of the Czech Republic, so it is not legal to have any amount of alcohol in blood while driving. However, since human beings naturally might have some small amount of

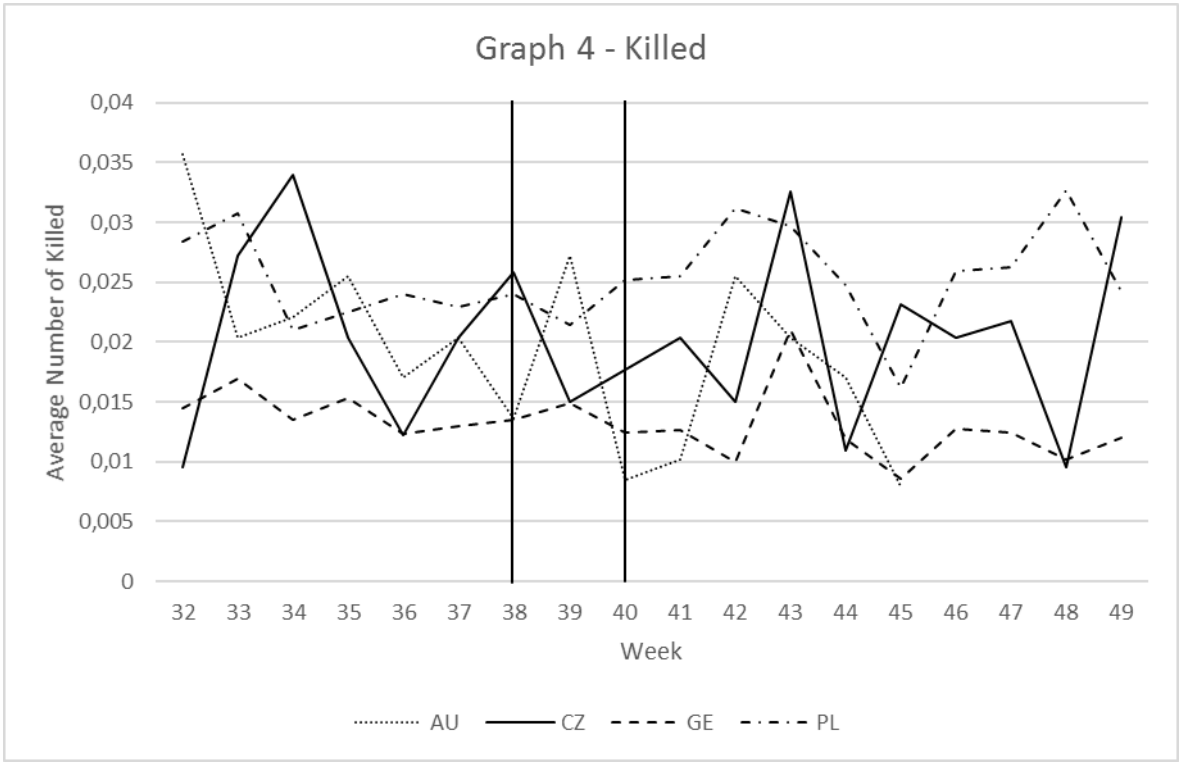
alcohol in their blood, the alcohol blood content up to 0,21 could not be punished at all. Other relevant countries are more tolerant than the Czech Republic. Officially, Poland has the minimum level of blood content set at level of 0,2, which is the same as in the Czech Republic, but because it is official in Poland, the effect on drivers' perception might be different in both countries. In Germany and Austria, the law is even more tolerant, because it permits to have blood alcohol content up to 0.5 milligrams per milliliter. But this does not hold for new drivers, who are obligated to follow the zero tolerance rules[20]. So it implies that statistical data about accidents related to driving under influence of alcohol are country specifics, because they reflect different standards in different countries.



In order to see the development of injuries for each country during the days of Czech prohibition, Graph 3 shows that. Based on visual inspection of the graph it seems that neither the Czech Republic nor other countries suffered drop in number injured participants of road traffic accidents during days of prohibition. As in two previous cases, there seems to be subtle effect of weekdays. For number of injured people, the systematic influence is more similar to one regarding total number of accidents where minimums happen to be on Sundays.

[20] Overview of blood alcohol concentration limits in all countries is available on http://www.iard.org/policy-tables/bac-brac-limits.

The last graph in the series shows how many people were killed due to road traffic accidents. However, Graph 4 is slightly different than the previous ones, because it shows the average number of killed people per week. It is because a graph with daily numbers of killed would be unclear and hard to read due to large day-to-day volatility of number of killed people. The period of prohibition is mostly covered by weeks 38, 39 and 40. During these three weeks there is a drop in week 39 in the Czech Republic, but this decline is not unusual compared to other minimums in period before and after. So based on visual inspection of Graph 4, there seems to be no obvious decrease of killed people during period of prohibition. The development in other countries seems to be rather similar without any visible regularity in data. When focusing on bigger countries such as Germany and Poland, their time series are more smooth compared to the Czech Republic and Austria, which are rather smaller with respect to size of population.



To summarize, comparing all four graphs regarding the developments of accidents, accidents related to use of alcohol, injuries and fatalities, the only graph which enables us to detect at least slight drop in value during the days of prohibition is the Graph 2. The Graph 2 shows the number of accidents related to driving under influence of alcohol. And it is worth to note, that this drop is rather small and needs to be examine deeper to find out whether it is statistically significant, which is the goal of next chapter.

4.3. Development of Road Traffic Accidents in Regions

Since the first official news regarding alcohol poisoning occurred in the East part of the Czech Republic where was also located the company producing poisonous liquors, it is desirable to examine data on lower level than whole country. Having data on regional level enables us to spot, whether there are some differences across the Czech Republic with respect to time. It would help us to uncover if there is any sort of lag in regions, which are located further away from the regions, which suffered by poisoning at first. But it is also worth to look at regional data in the closest regions in neighboring countries. This is because regions which are close to borders are more similar with respect to other characteristics, than regions which are located further from the borders. Therefore, it might show better the effect of prohibition. Since this sort of data is available only for the Czech Republic and Austria, in this section I focus exclusively on these two countries.

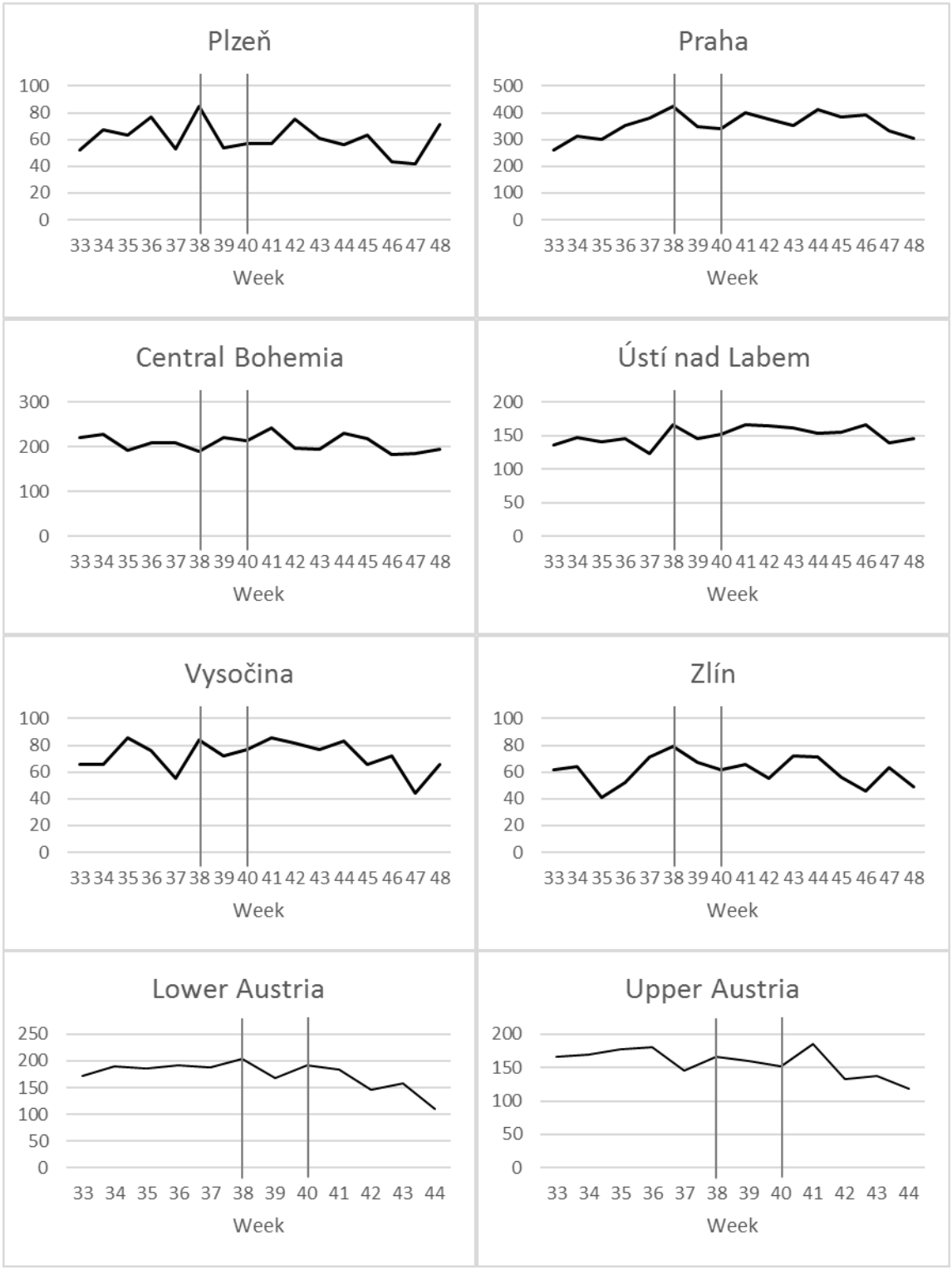
Graphs 5 and 6 show total numbers of road traffic accidents for each week across regions in the Czech Republic and two neighboring regions in Austria, which are closest to the Czech borders. We can see that South Moravia, Zlín and Moravia-Silesia, these are the regions which were affected firstly by deadly wave of poisonings, did not experience any unusual drop in number of accidents during days when prohibition was in force. For these affected regions there is also no obvious decrease in period before the prohibition, it means in the beginning of September, when first cases of poisoning occurred. Maybe the one exception is Zlín, which increased before the prohibition by almost 50 percent and in the period after it decreased by 25 percent.

Graph 5 - Regional Development of Road Traffic Accidents

It is also interesting to compare developments of number of accidents in border regions of the Czech Republic and Austria. We can see that regions in Austria are slightly larger than regions in the Czech Republic with respect to absolute level of accidents. There is a small drop in Lower Austria during the prohibition, but it is not rather unusual compared to its overall

development. On the other hand, Upper Austria had almost stable development during the prohibition. So based on visual inspection of graphs regarding regional developments of total road traffic accidents, there seems to be no significant drop before and during the prohibition.

Graph 6 - Regional Development of Road Traffic Accidents



4.4. Police Activity during Prohibition

The last part which is presented in this chapter is related to activity of Police in the Czech Republic. That is because the Police in the Czech Republic could increase the level of traffic law enforcement during the prohibition, and therefore to increase probability that drivers will be apprehend while driving under influence of alcohol. There could be even more police force put in place to enforce the rules regarding the ban on sales of liquors with alcohol content over 20 percent. So it could have indirect effect on how drivers abided the traffic law. But also without an increase without an increase of police force, they could also be stricter in enforcing traffic law compared to period before the prohibition or spend more time doing monitoring and enforcement. In result it would mean more or stricter enforcement.

Or, on the other hand, in the beginning of prohibition there was a huge effort to find out the source of poisoning. This effort could have induced police officers to relocate policemen from enforcing traffic law to other tasks which were closely related to finding out the source of methanol poisoning and offenders. At that time some policemen who usually do the enforcement of traffic law could be out of roads. So it would imply less policemen to enforce the traffic law and lower level of enforcement at all.

Thus both factors could impact the level of road traffic accidents in different direction and it is not clear which one would dominate. Since both effects could be important in different times, it is necessary to take into account the police activity. This section explores in more detail the development of activity Police in the Czech Republic during the year 2012. Unfortunately, available data about Police activity are available only on monthly basis[21].

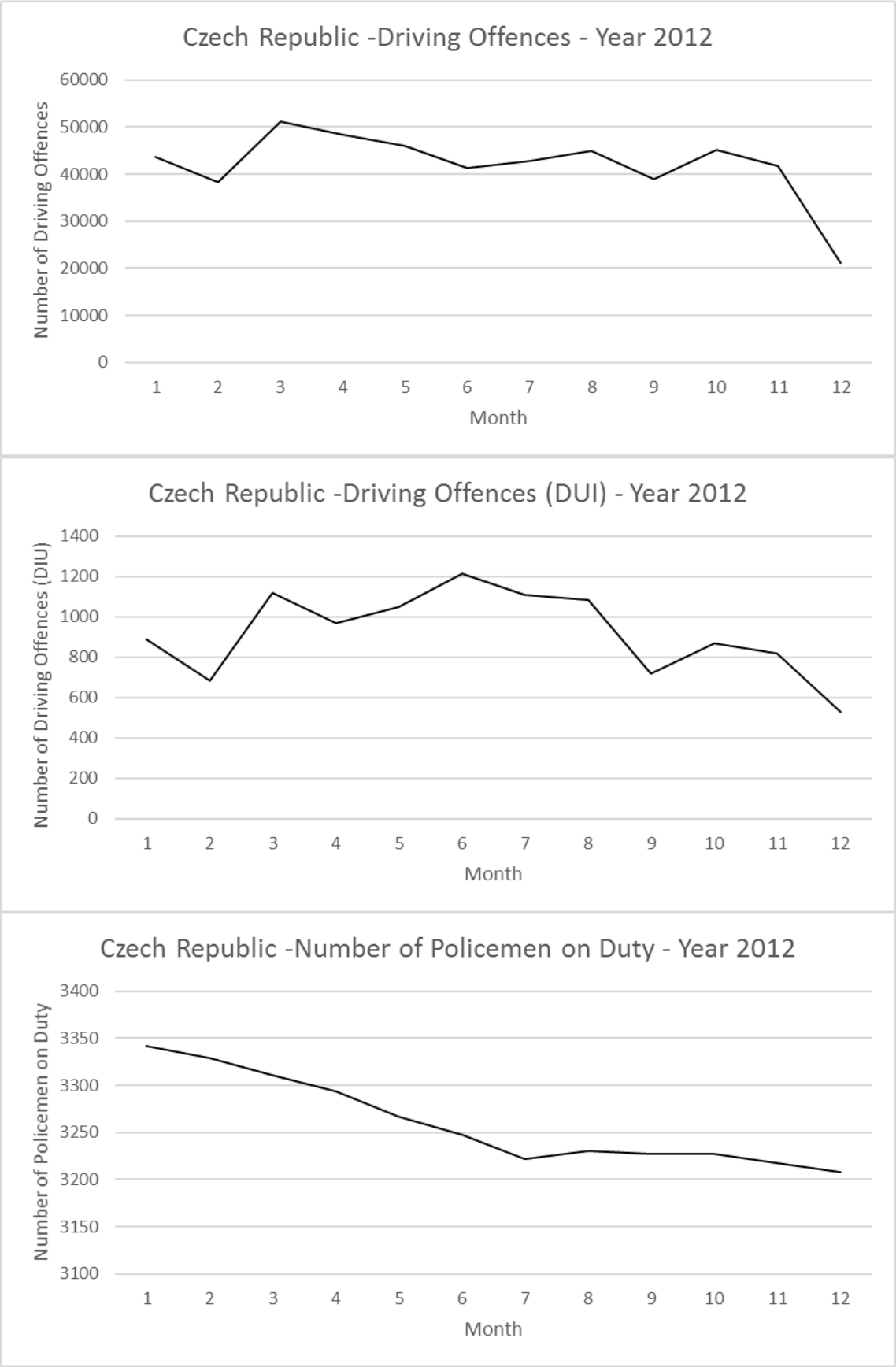
Graph 7 shows how many driving offences were committed in each month during the year 2012. There seems to be slight drop in number of total driving offences during September. This feature is also visible, when focusing just on driving offences related directly to driving under influence. It is worth to note that on average only around 2,2 percent of total driving offences is due to driving under influence, which is not so big compared to share of alcohol related accidents on total accidents, which was 6 percent for the Czech Republic.

Taking into account that total number of driving offences as well as number of offences linked to driving under influence differ from month to month, thus it is hard to say that there is a drop induced by prohibition. But even there would be a drop due to prohibition, there might

[21] Data about Police activity as well as data about road traffic accidents come from the Police Presidium of the Czech Republic. Both were provided upon request.

still be at least two different reasons for that. Firstly, the level of enforcement could have stayed the same, but the number drunk drivers decreased. Or, secondly, the police effort to enforce decreased and the number of drunken drivers remained the same or decreased less than decline of police enforcement. To shed more light on this issue could be done by looking at next graphs regarding police workforce.

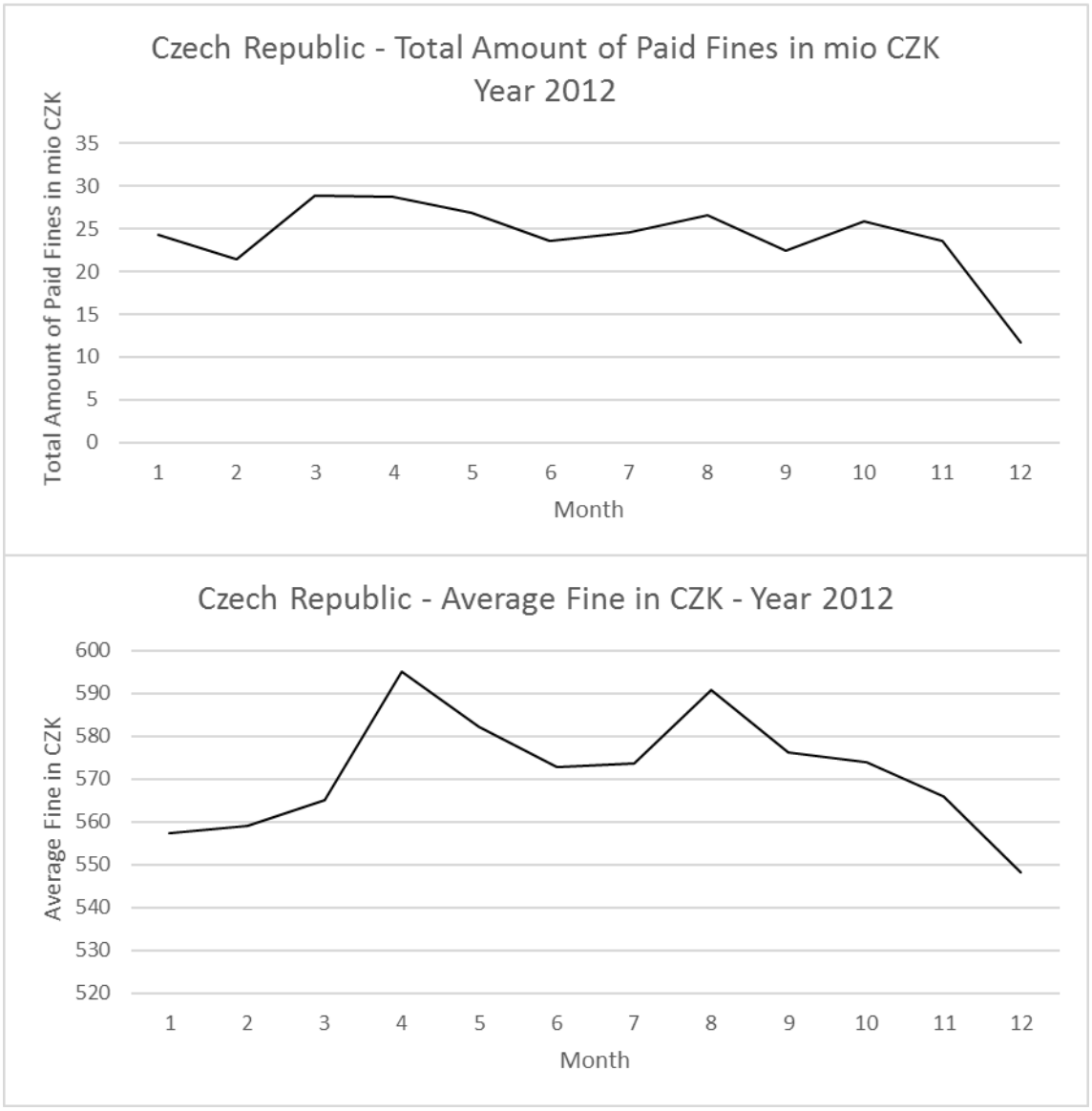
Graph 7 - Activity of Police in the Czech Republic



Last part of Graph 7 shows how many policemen were on duty in each month. It is apparent that the number of policemen changes very smoothly and there is no significant change in September. So it seems that number of policemen who are allocated to enforcing traffic law was the same as in the period before and after the prohibition.

Graph 8 shows the development of total amount of money in millions CZK, which come from imposed fines by Police in the Czech Republic during year 2012. The graph also shows decrease in September as the previous ones. On the other hand, the average fine does not experience any exceptional drop or increase in September 2012.

Graph 8 - Fine Paid in the Czech Republic



5. Identification strategy

In order to examine whether the imposed ban on sales of alcohol with alcohol content over 20 percent affected the road traffic accidents in the Czech Republic, I make use of method called differences-in-differences (Bertrand, Duflo, & Mullainathan, 2004). This method tries to evoke conditions which we usually encounter in laboratory experiments. It means that this method is trying to use a logic of random controlled experiments and apply it in situations where there are only nonexperimental data at all. That is, there are no data available which would be generated in laboratory, but we try to regard naturally observed occasions, under certain conditions, as experiments.

This method is based on comparison between two or more units (i.e. groups, individuals, countries, etc.), which behave very similarly. One group is a treatment group, which is affected by treatment, and the other units are regarded as a control group, because they did not get any treatment. Having these two groups, it is necessary to have for each group value of outcome variable from period before and after when a treatment was applied. Finally, to find out the effect of treatment, firstly it is necessary to get an average change for each group (difference between value of outcome variable in period after and before treatment). Secondly, it is necessary to subtract the average change (i.e. difference) of control group from the average change of treatment group. The result is the average treatment effect on treated. So it means that the effect cannot be generalized to all countries from all around the world, but is locally limited.

In order to estimate the effect of the ban on the number of car accidents and related measures[22], I use the OLS method. The specification of the econometric model which takes into account the method of differences-in-differences is as follows

$$Y_{it} = \beta_0 + \beta_1 D_i + \beta_2 T_t + \beta_3 T_t D_i + X_{it} + \varepsilon_{it} \qquad \text{Eq. 8}$$

Eq. 8 includes Y_{it} which stands for the number of total accidents or the number of accidents in the country i and in the period t. β_0 is the intercept which stands for the effect of the control group before the ban was effective. D_i is a dummy variable and equals to 1 if it is the treatment group, otherwise 0. T_t is also a dummy variable and equals 1 if it is in the period with the ban in force, otherwise 0. β_1 is the effect of treatment without regarding time. β_2 is the effect of

[22] For short accidents in following text is used as generalized term which stands for accidents, injuries, accidents under influence of alcohol and number of killed people.

change of period and β_3 is the estimate of difference-in-difference. That is the goal of this paper. X_{it} stands for other control variables specific for country i and in the period t. ε_{it} represents error term.

To estimate correctly β_3, certain conditions must be fulfilled. Among others it means that treatment effect, that is the period when the prohibition on sales of liquors with alcohol content over 20 percent was in force, must not be related to other explanatory variables and outcome variable. To put it differently, I have to get rid of possibilities that prohibition took place as consequence of changes in the development of road traffic accidents, or the prohibition was in force because preferences of citizens change in favor for stricter restrictions on use and abuse of alcohol. As it was already described above, the timing of prohibition was very fast and hardly to be anticipated. So it could be concluded that the timing was sort of exogenous, which fulfills the assumption.

On the other hand, since the wave of poisonings which lasted for few weeks and resulted to imposition of ban on sales of alcohol, the risk of drinking liquors slightly at the time before, during and after prohibition could increase. Because you could die after consumption of liquors. It could induce people to switch from drinking liquors to drinking, for instance, wine and beer. To generalize, the preferences of people to drink alcohol could be negatively influence by prohibition too. If it would be the case, the effect of prohibition on the number of accidents would be weakened by it. So the estimated effect of prohibition would be biased downward. To overcome this problem, I try to focus on longer period than few weeks before and after prohibition.

Another important assumption requires that error term is not correlated with explanatory variables. It means that all relevant factors which influence the number of road traffic accidents are explicitly included in the estimated equation (i.e. within X_{it}). In the estimated model I do control only for few important factors. Besides controlling for country fixed effects and time effects, I took into account the effect of public holidays and weekdays on the number of car accidents as was described in the previous chapter.

Of course, there are more factors which influence the number of car accidents ranging from intensity of traffic, number of cars on roads, quality of roads, number of passenger-kilometers, amount of freight transport etc. Because I focus on period of few months, I assume that most of these factors are fixed in the short-run and therefore I do not control for them. And also data for many other relevant variables are not available on daily or monthly level.

Additionally, I use neighboring countries of the Czech Republic as control group, because they are located in the same region and have much in common with respect to cultural, economic and political background. Therefore, any general shocks induced by weather for instance, or by anything else could be the same for all countries. By using Germany, Austria and Poland as control group I am trying to control for all those general shocks which could occurred during the short-run period under consideration.

Besides those assumptions which were already mentioned, there is one key assumption regarding use of differences-in-differences method. It requires that control group and treatment group are the same in that they respond to changes in the same way. In other words, it means that both groups would have experienced the same trend in situation if no ban was implemented. To test this assumption, we can look at the trends of countries before the prohibition. This can be done using Graphs 1 through 4 together with visual inspection. Focusing on the period before there is similar trend in the graph regarding total accidents. In other cases, such as injuries, killed and accidents related to driving under influence the similar trend across countries is less visible. To help fulfill this assumption I use logarithms of outcome values.

6. Results

Table 3 shows estimates of the model in form of Equation 8 using OLS. To estimate the model, I used daily data for four characteristics of road traffic accidents. The Czech Republic is the treatment group and other countries (Germany, Austria and Poland) are used as control group with respect to differences-in-differences method. The period of prohibition includes all days from 14th September till 27th September 2012. The aim of the estimate is to find out whether the imposed prohibition on the sales of liquors with alcohol content over 20 percent affected negatively (i.e. decrease) the number of road traffic accidents and related characteristics.

In the first column of Table 3 are shown estimates of the effect of prohibition on the logarithms of total accidents. The effect of prohibition is almost zero, but more importantly it is not statistically significant. And neither the effect of period of time nor the effect of Czech Republic is statistically significant.

Column 2 in Table 3 shows more important characteristics. It is the estimate of the effect of prohibition on the number of accidents related to driving under influence of alcohol. In this case I do not use logarithms. As in the previous case, there is no statistically significant effect of

prohibition. Even the effect of prohibition in the Czech Republic is positive which goes against the theoretical expectation.

In last two columns of Table 3 are shown the estimated effects of prohibition on the number of killed people and number of injured people (in log form). However, the effects on both characteristics are very small, but more importantly they are statistically insignificant.

Based on the estimates of the main model there seems to be no significant effect of prohibition on the number of road traffic accidents, accidents related to use of alcohol, number of injuries and also no effect on number of killed people during the car accidents. It means that the main theoretical prediction that the prohibition would decrease the number of alcohol related accidents is not proved by empirics.

However, the effect of prohibition could not be present on the level of whole countries, but it could be subtler. In order to find out whether the influence of prohibition could be present on lower level, I focused on regions. More precisely, I took into consideration regions which are very close to each other, thus they could be more similar and they could be also affected by same local shocks as changes of weather.

Table 3: Estimates of Effects of Prohibition on Traffic Accidents

	Accidents	DUI	Injured	Killed
Constant	5.350***	20.445*	5.480***	4.198*
	(0.513)	(11.644)	(0.527)	(2.364)
Prohibition	0.081	0.753	0.068	-1.529
	(0.731)	(16.728)	(0.751)	(3.368)
Czech Rep.	-0.011	-16.336***	-1.349***	-5.792***
	(0.116)	(2.459)	(0.119)	(0.533)
Prohibition*Czech Rep.	0.012	1.551	0.052	0.268
	(0.337)	(7.029)	(0.346)	(1.551)
Holiday	-0.434	-0.259	-0.380	0.116
	(0.394)	(9.487)	(0.405)	(1.817)
Observations	458	336	458	458
R2	0.034	0.362	0.318	0.381
Adjusted R2	-0.326	-0.013	0.064	0.150
Residual Std. Error	1.024 (df = 333)	20.118 (df = 211)	1.053 (df = 333)	4.720 (df = 333)
F Statistic	0.094 (df = 124; 333)	0.964 (df = 124; 211) 1	.250* (df = 124; 333)	1.651*** (df = 124; 333)

Since data on regional level are available only for the Czech Republic and Austria, I examined the regions of South Bohemia, South Moravia and Vysočina on the Czech side of borders and compared them to regions of Lower and Upper Austria.

Table 4: Estimates of Effects of Prohibition on Border between Czech Rep. and Austria

	Accidents	DUI
Constant	3.893***	1.364**
	(0.016)	(0.661)
Prohibition	-0.387***	-1.864***
	(0.069)	(0.643)
Czech Rep.	-0.132***	0.273
	(0.032)	(0.269)
Prohibition*Czech Rep.	-0.046	-1.701**
	(0.080)	(0.772)
Holiday	-0.124	0.750
	(0.278)	(2.004)
Observations	184	184
R2	0.675	0.603
Adjusted R2	0.331	0.183
Residual Std. Error (df=89)	0.196	1.702
F Statistic (df = 94; 89)	1.965***	1.437**

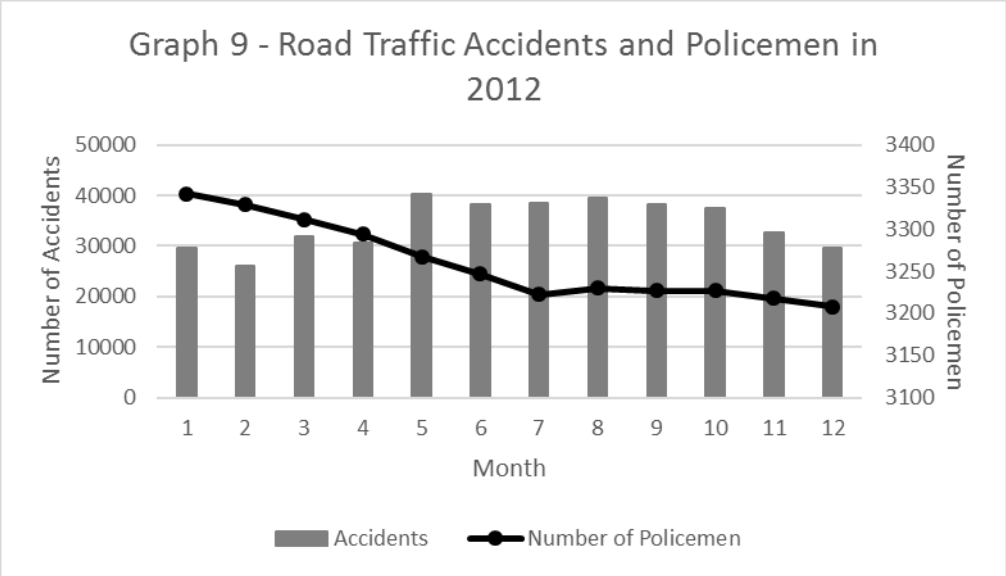
Table 4 uncovers estimates of the model which compares only two countries and only few regions from both countries. The first column in Table 4 shows the effect of prohibition on log total number of accidents. As in the case of whole countries, the effect of prohibition is not statistically significant, but on the other hand the effect is negative which is with line with the theoretical expectation.

Column 2 of Table 4 shows the effect of imposed ban on sales of liquors with alcohol content over 20 percent on the number of accidents related to driving under influence of alcohol. In this case the effect of prohibition is statistically significant and negative. Specifically, the magnitude of effect is -1,7 which means that one additional day of prohibition induce a drop of the number of accidents related to use of alcohol by 1,7 per day on average. However, this estimate holds only for three regions in the Czech Republic compared to development in neighboring regions in Austria. Since the error terms may have been correlated over time, I

corrected estimated standards errors to show cluster robust standard errors for model estimation in Table 4. It increases the validity of estimates. So in the area very close to borders between the Czech Republic and Austria was empirically proved the effect of ban on sales of liquors with alcohol content over 20 percent. The effect is very limited because it includes only few regions and it was not proved on the level of whole countries.

The last question which is desirable to examine more in detail regards the role of enforcement. Among other factors which influence the number of accidents the law enforcement is rather unique, because it could be changed operationally during few days or weeks. For instance, police may relocate more people to monitor the abiding the traffic law.

Graph 9 shows the development of number policemen allocated to traffic police within the year 2012 and compares it with the development of total number of road traffic accidents. Based



on the visual inspection there seems to be no relationship between number of accidents and traffic policemen.

7. Conclusion

The effects of alcohol consumption and its (ab)use on various things are studied by economists for many years. The US alcohol prohibition from twenties is probably the most famous example which showed how the total ban imposed on the production and sales of alcohol could result to undesirable situation. The prohibition did not reduce significantly demand for alcohol, but it heavily influenced the demand side. Thus, the prohibition imposed prohibitive costs on the production and sales of alcohol. The alcohol prohibition from the September 2012 which was in force in the Czech Republic was too short to induce such costs.

On the other hand, the short ban on sales of liquors could have induced a desirable drop in some other areas which are related even indirectly to consumption of alcohol. These could be criminal activity, violence, health care costs or traffic accidents related to alcohol. To test the effect of short time prohibition on the number of traffic accidents was the goal of this paper. I found out that I cannot prove the effect of prohibition on the level of whole countries, but it could be verified only on small scale. That is only in neighboring regions along the border between the Czech Republic and Austria. It could be hardly generalized to other regions or even to whole countries. So it would be nice to have data from other countries on regional level, to examine whether the same effect holds also under different local specific conditions.

Another way how to improve current paper is to involve more rigorous test for the important assumption of differences-in-differences method. Such a test would examine more precisely whether the trends of treatment and control group behave similarly in period before the treatment took place.

On top of that, higher robustness of results could be accomplished by controlling for other variables such as petrol price, traffic density, road conditions and changes in legal environment (police activity, probability of apprehension). To include socioeconomic conditions would be also great. To divide the number of accidents by population would be fruitful too, but mostly when longer period would have been taken into consideration.

In optimal case, it would be nice to have almost the same both groups (both from Czech Republic and for the same time period) except that one was treated and the other not. However, it is not the case because I have data for four different countries. Maybe, it would be better to have data for Slovakia instead of Austria, Germany and Poland, because Slovakia is probably more similar to the Czech Republic than Austria.

Another extension of this paper could try to estimate the model using different length of prohibition. It means to divide the prohibition into subgroups of days. For instance, the effect of prohibition was biggest in the first or last two days. Or, try to test whether there was effect even before the beginning of prohibition, or in the period after.

The future research could extend this analysis in many ways. For instance, it would be better to have more detailed data (i.e. on level of each individual) to conduct more complex analysis. As it was mentioned above, the consumption of alcohol is widely spread custom, which influences many different areas. Next steps of researchers could focus on some other areas of life such as criminality (for example child abuse, etc.), to examine the effects of prohibition more fully. To find out how the short prohibition influence other things.

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