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Reducing binge drinking? The effect of a ban on late-night off-premise alcohol sales on alcohol-related hospital stays in Germany

Jan Marcus* and Thomas Siedler†

Abstract

Excessive alcohol consumption among adolescents and young adults is a major public health concern. On March 1, 2010, the German federal state of Baden-Württemberg banned the sale of alcoholic beverages between 10pm and 5am at off-premise outlets (e.g. kiosks, petrol stations, supermarkets). We use rich monthly administrative data from a 70 percent random sample of all hospitalizations for the years 2007-2010 in Germany in order to evaluate the impact of this policy on alcohol-related hospitalizations. Applying a difference-in-difference approach, we find that the policy change reduces alcohol-related hospitalizations among adolescents and young adults by about 9 percent, with larger effects for men in absolute terms and larger effects for women in relative terms. The empirical results suggest that limiting late hours during which alcoholic beverages are allowed to be sold is an effective and rather "costless" public health initiative for reducing high-risk drinking among adolescents and young adults.

JEL: I12, I18, D04

Keywords: Binge drinking, drinking hours, alcohol control policies, difference-in-difference, hospital diagnosis statistics

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I. Introduction

According to the World Health Organization, excessive alcohol consumption is responsible for around 2.5 million preventable deaths worldwide each year. The harmful use of alcohol constitutes the third-leading cause of preventable death, disability, and loss of health.[1] A major public health concern is the excessive alcohol consumption among the youth. The Centers for Disease Control and Prevention reports that, among U.S. adults aged 18 years and older in 2010, binge drinking prevalence (28 percent) and intensity (9.3 drinks) was highest among those aged 18-24 years (Kanny et al. 2012).[2] Since drinking is habit forming (see e.g. Enoch 2006), early drinking onset might have long-lasting adverse consequences. Indeed, a comprehensive literature documents a significant relationship between (extensive) alcohol consumption and various negative outcomes for young people, such as crime (Carpenter 2005a), risky sexual behavior and teenage pregnancy (Sen 2003; Carpenter 2005b), suicide (Birckmayer and Hemenway 1999; O'Connell and Lawlor 2005), lower academic performance (Carrell et al. 2011), lower employment and higher risk of unemployment (Mullahy and Sindelar 1996), adverse health effects such as mortality and hospitalization (Chaloupka and Xu 2011; Kim et al. 2012), and motor vehicle fatalities (Ruhm 1996; Dee 1999).

High-risk drinking has been increasing among young people across much of Europe in the last ten years, including Germany (DHS 2008). Figure 1 reports the development of alcohol-related hospitalization rates for various age groups in Germany. Panel A displays the trend in the annual number of hospitalizations due to alcohol intoxication per 100,000 inhabitants of the same age between 2002 and 2010. Panel B displays the corresponding growth rates. The figure shows that the alcohol-related hospitalization rates doubled for individuals aged 15-19 and 20-24. Also, for children aged 10-14, hospitalizations due to alcohol intoxication increased by more than 50 percent. The German Federal Statistical Office reports that in 2010, 25,995 teenagers were treated in hospital due to excessive alcohol consumption, compared to 12,807 in 2002.[3]

In March 2010, the German federal state of Baden-Württemberg[4] banned the sale of alcoholic beverages between 10pm and 5am at off-premise outlets (e.g. petrol stations, supermarkets, kiosks). One of the law's main intentions was to reduce youth binge drink-

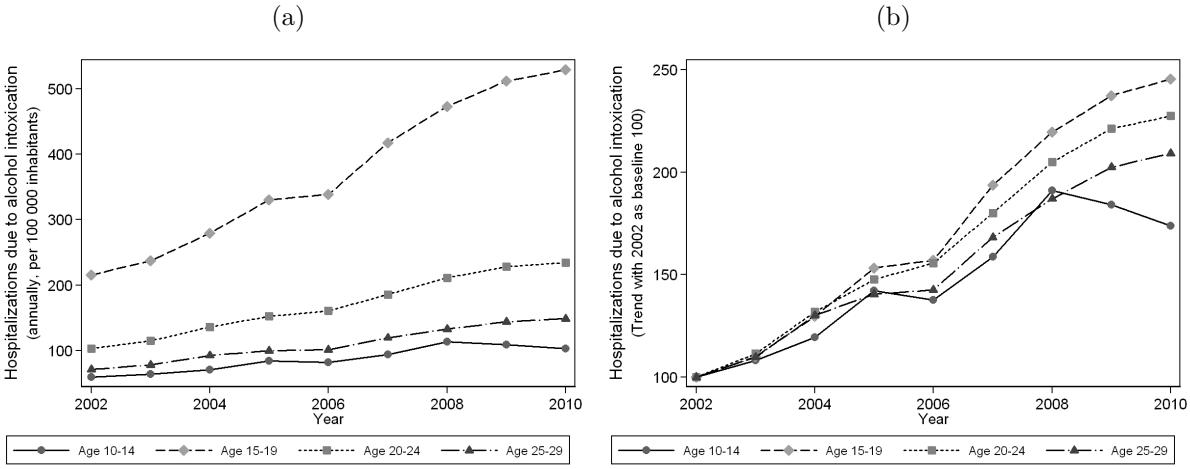
[1] `www.who.int/substance_abuse/facts/alcohol/en/index.html`. Accessed on February 24, 2013.

[2] The Centers for Disease Control and Prevention defines binge drinking as consuming four or more drinks for women, and five or more drinks per occasion for men during the past 30 days.

[3] `https://www.destatis.de/EN/FactsFigures/SocietyState/Health/Hospitals/Tables/DiagnosisAlcoholAgYears.html`. Note that the numbers of alcohol-related hospitalizations in Figure 1 are taken from the same source. Accessed on March 01, 2013.

[4] Baden-Württemberg is the third largest of the German states in terms of population size (10.7 million) and located in Germany's south west.

Figure 1: Trends in alcohol-related hospitalizations



Note: The figure displays the trend in alcohol-related hospitalization rates for various age groups of young individuals (ages 10-14, 15-19, 20-24, 25-29) between 2002 and 2010. Panel (a) provides the annual number of hospitalizations due to alcohol intoxication per 100,000 inhabitants of the same age. Panel (b) shows growth rates of these alcohol-related hospitalizations compared to the base year 2002. Source: German Federal Statistical Office 2013.

ing. This study presents first evidence on the effects of this late-night alcohol sales ban on alcohol-related hospitalizations. We exploit rich monthly data from a 70 percent random sample of the German hospital diagnosis statistics for the 2007-2010 period. This nationwide hospitalization data contains information about all inpatients in all German hospitals.

We study the effect of the reform on alcohol-related hospitalizations in general and specifically for young people, as there are various reasons to assume that the reform impacts in particular on young individuals. We find that the policy change reduces alcohol-related hospitalizations among adolescents (ages 15-19) and young adults (ages 20-24) by about 9 percent. In our preferred specification we account for time-invariant differences in the level of alcohol-related hospitalizations between the counties, common time shocks, changes in the counties demographic and economic situation as well as seasonal differences between states. Our findings are robust to alternative definitions of the control group (e.g. only states in West Germany, only the southern federal states of Bavaria and Hesse, a synthetic control group), and different lengths of the pre-treatment period. We show that the results are also robust when using alternative estimation methods (e.g. tobit model) and when controlling for county-specific time trends. We provide evidence that the ban impacts both male and female adolescents/young adults. While the effects are larger for men in absolute terms, in relative terms (i.e. taken into account the lower level of alcohol-related hospitalizations) the effects are larger for women. Overall, our empirical results suggest that the late-night off-premise alcohol ban is an effective policy strategy

for reducing binge drinking and related harms among adolescents and young adults. The findings are not only informative with respect to the actual policy that we analyze, but also contribute to the literature on whether and how policies can influence problematic drinking behaviors.

II. Related literature

There exist various alcohol control policies designed to reduce alcohol consumption and alcohol-related problems. One can distinguish between several approaches to how governments might regulate access to alcohol (Wicki and Gmel 2011): (i) economic access (e.g. price policies and alcohol taxes); (ii) demographic access (e.g. minimum legal drinking ages, drunk driving laws); and (iii) temporal access (e.g. hours and days of sale).[5]

Studies exploiting variation in state-alcohol price policies include, for example, Manning et al. (1995), Dee (1999), Carpenter et al. (2007) and Chaloupka and Xu (2011). Overall, the literature on regulating economic access to alcohol finds that alcohol consumption decreases with rising prices, and increases in alcohol taxes are found to be effective in preventing alcohol-related problems in the majority of studies (see Cook and Moore 2000, 2002). Ruhm (1996) and Young and Bielinska-Kwapisz (2006) report fewer alcohol-related traffic fatalities after increasing alcohol-beverage taxes, and Wagenaar et al. (2009) find a significant decline in mortality.[6] In addition, several studies report significant effects of prices on risky sexual behavior and teen pregnancy (Sen 2003), violence, abuse and crime (Markowitz 2000; Markowitz and Grossman 2000), suicide (Birckmayer and Hemenway 1999; Markowitz et al. 2003; Chatterji et al. 2004) and poor educational performance (Carrell et al. 2011). For recent and comprehensive surveys see, for example, Grossman et al. (1993), Cook and Moore (2002), Wagenaar et al. (2010) and Chaloupka and Xu (2011).

Regarding policies that restrict demographic access to alcohol, most studies focus on policies regulating the minimum legal drinking age. There is an extensive literature on the effects of minimum legal drinking age on young people's alcohol consumption (Carpenter et al. 2007), educational outcomes (Carrell et al. 2011), teen childbearing (Dee 2001), teenage drunk driving and traffic fatalities (Lovenheim and Slemrod 2010), mortality (Carpenter and Dobkin 2009) and youth suicide (Birckmayer and Hemenway 1999). The general consensus in this literature is that the introduction of the minimum legal drinking

[5]See, for example, Cook and Moore (2000), Carpenter et al. (2007) and Wicki and Gmel (2011). For a detailed discussion and overview about the literature on the relationship between alcohol outlet density, drinking behavior and drinking-related problems see Wicki and Gmel (2011).

[6]Dee (1999) and Dee and Evans (2001), however, do not find empirical evidence that beer taxes in the U.S. decreases teen drinking and youth traffic fatalities.

age of 21 in the late 1970s and 1980s in the United States was effective in reducing drinking participation and intensity (see, for example, Wagenaar and Toomey (2002), Carpenter et al. (2007) and references therein).

The literature most closely related to ours investigates restrictions in the temporal access of alcohol. These studies analyze changes in the hours and days of sales of alcohol on consumption, hospitalizations, traffic fatalities and crime (Norstroem and Skog 2005; Vingilis et al. 2005; Chikritzhs and Stockwell 2006; McMillan and Lapham 2006; Vingilis 2007; Middleton et al. 2010). Vingilis (2007), Popova et al. (2009) and Middleton et al. (2010) provide recent surveys on the effects of changes in hours and/or days of alcohol sales on alcohol consumption and alcohol-related harm. Newton et al. (2007) examine the impact of the UK licensing law that came into effect in November 2005 and that made the opening hours for licensed premises more flexible. Using data from March 2005 and March 2006 from one emergency hospital in London, the study finds that the proportion of alcohol-related assaults resulting in overnight hospitalization increased by roughly 1 percentage point, alcohol-related injuries by 2.5 percentage points and alcohol-related hospital admission rates by nearly 2 percentage points. Norstroem and Skog (2005) study the impact of Saturday openings of alcohol retail shops in Sweden on alcohol sales, assaults and drunk driving. The authors exploit both time and regional variation in Saturday openings of alcohol retail shops. First, in February 2000, a trial phase started during which six counties implemented Saturday openings, followed by an extension across the whole of Sweden in July 2001. The authors report that alcohol sales increased by nearly 4 percent due to this change in trading days, but they find no effects on various assault indicators and mixed effects for drunk driving).[7] Vingilis (2007) studies the Liquor Licence Act in Ontario, Canada, that extended on-premise hours of sales from 1am to 2am in Ontario. Their findings suggest that the small extension of opening hours contributed to a small increase in drinking-related problems in some areas of Ontario.

Closely related to our study is an analysis by Wicki and Gmel (2011). The authors examine a similar ban on late-night alcohol sales in the Swiss canton of Geneva. However, they can not distinguish the effect of this late-night alcohol sales ban from a general ban on alcohol sales in petrol stations and video stores, which came into effect at the very same time. They obtain large decreases in alcohol-related hospitalizations in the Swiss canton of Geneva due to the joint effect of these reforms (e.g. a reduction of 40 percent in alcohol-related hospitalizations among teenagers). Yet, it remains unclear whether this large decrease can be attributed to the late-night alcohol sales ban, to the general ban on

[7]Norstroem and Skog (2005) argue that the increase in drunk driving during the trial period (February 2000-June 2001), but not after the nationwide implementation (July 2001-July 2002) can be explained by a change in the surveillance strategy of the police.

alcohol sales at petrol stations and video stores, or to both bans.

To date, there exists inconclusive evidence on the effectiveness of limiting the hours of sale of alcoholic beverages at off-premises in the literature. Indeed, in its recommendations on maintaining limits on days and hours of sales of alcoholic beverages, the Task Force on Community Preventive Services in the United States concludes: "The Task Force found insufficient evidence to determine the effectiveness of increasing existing limits on hours of sale at off-premises outlets, because no studies were found that assessed such evidence" (Task Force on Community Preventive Services 2010: 606). Our study aims at filling this gap in the literature by studying a recent legislative change in hours of alcohol sales in Germany.

III. Institutional background

The policy change that we analyze bans the sale of alcoholic beverages between 10pm and 5am at off-premise outlets (e.g. petrol stations, supermarkets, kiosks) in the German state of Baden-Württemberg. The law has two main intentions: to reduce binge drinking (especially among the youth) and to reduce alcohol-related violence (Landtag 2009). Violating the ban results in a fine of up to 5,000 Euro. There are reasons to assume that the ban was immediately enforced as the police were in favor of this policy (see Landtag 2009). Furthermore, when reviewing newspapers published around the time of introduction, we found little evidence of complaints about a lack of enforcement.

Before the ban came into effect on March 1, 2010, in Baden-Württemberg it was theoretically possible to buy alcoholic beverages around the clock at off-premise outlets. Petrol stations were the main place that people could buy alcohol around the clock. Therefore, both the law's public debate and the reasoning for the law's introduction (Landtag 2009) primarily focused on petrol stations. Bars, restaurants and other on-premise outlets were not affected by this policy change as the ban is only directed toward off-premise sales.

The ban on late-night off-premise alcohol sales can be considered as a fairly light-touch regulation compared to other alcohol control policies. Unlike alcohol taxes, it is easy to legally avoid the ban, e.g. by buying the alcohol before 10pm (i.e. pre-stocking). Moreover, unlike minimum legal drinking age regulations, the ban does not exclude entire demographic groups from the legal consumption of alcohol. Compared to other policies regulating the temporal access to alcohol, the ban neither prohibits the off-premise sale of alcohol for entire days nor does it regulate the purchase of alcoholic beverages on-premise.

The basic idea why the ban might nevertheless be effective is that the ban suppresses the spontaneous purchase of alcohol at off-premise outlets. The ban works through com-

plicating the access to alcoholic beverages in situations when those who have already started alcohol consumption might otherwise continue to do so in an abusive and unhealthy way (Landtag 2009: 13-14). As the consumption of alcoholic beverages leads to the desire for more alcohol, the risk of losing control increases. In such situations, the ban can be seen as an interruption in the alcohol supply chain as it increases the effort needed to consume more alcohol. As such, the law might be very effective in curbing binge drinking, as it restricts access to alcohol at a crucial time of the day when the overwhelming majority of excessive drinking takes place. The study by Bouthoorn et al. (2011), for example, reports that most hospital admissions due to excessive alcohol consumption happen in the late evening (36.9 percent) and at night (55.1 percent). Therefore, the ban on late-night off-premise alcohol sales could be more effective at curbing binge drinking and alcohol-related harms than restricting access to alcohol on specific days, such as the Sunday liquor laws (Stehr 2010; Heaton 2012).

We expect the ban to impact young individuals in particular for several reasons. First, young people might be less likely to avoid the ban by buying and storing the alcohol ahead. Often they do not have places, like personal apartments, where they can safely store alcohol. Second, in the justification for the introduction of the ban it is argued that in particular young people use petrol stations as gathering points and for buying alcohol for "predrinking" (Landtag 2009: 8,11). Third, young individuals might be less likely to avoid the ban by going to bars: Alcohol is more expensive in bars, which is particularly relevant for young individuals with their limited budgets. Additionally, the German Law for the Protection of the Youth (*Jugendschutzgesetz*) regulates the hours that children and adolescents can stay in bars and pubs: Children younger than 16 can visit bars and pubs only with their parent or legal guardian; adolescents aged 16 or 17 are not allowed to stay in bars and pubs after midnight unless they are with their parent or legal guardian. Additionally, minimum legal drinking ages are better enforced in bars and pubs (Landtag 2009: 14).

The advantage of the German setting for a clean analysis of the reform's effect is that many other laws that might have an impact on alcohol-related hospitalizations are federal laws. This means that those regulations do not differ between the German states. Examples for these federal laws are drunk driving laws, alcohol taxes, minimum drinking ages, and youth protection laws. However, there are also a few potentially relevant laws that differ between the states.

The legal opening hours of supermarkets vary between the states. In the course of a reform of the German federalistic system in 2006 (*Föderalismusreform I*) the legislative competence with respect to shopping hours was transfered from the federal level to the states. Following this reform all states (except Bavaria) enacted own laws regulating the

shopping hours that came into force between November 2006 and July 2007.[8] Hence, all changes in the opening hours took place about three years before the late-night alcohol sales ban that we analyze. However, in order to rule out potential effects of these policy changes, we include a set of dummy variables capturing the effect of different shopping hour regimes. Furthermore, in the robustness section, we restrict our period of analysis to a period without changes in the shopping hours of any federal state.

Also closing hours in bars differ between the federal states. However, there is more variation within states than between states as most states leave it open to the municipalities to enact specific closing hours. On January 1, 2010, Baden-Württemberg changed the general legal closing time of bars, clubs and restaurants from 2am to 3am on weekdays and from 3am to 5am on weekends. Municipalities were still allowed to extend or reduce the general closing hours. As there is some evidence in the literature (e.g. Newton et al. 2007; Vingilis 2007) that extended bar opening hours might slightly increase extensive alcohol consumption, we might underestimate the effect of the late-night ban on off-premise alcohol sales, which came into force two months after the extension of the legal bar opening hours. In the section on robustness tests we include an indicator variable capturing the change in the general legal opening hours.

IV. Data

We use data from the German hospital diagnosis statistics for the years 2007-2010. This nationwide hospitalization statistic is a very rich source of data as it provides information about *all* inpatients in *all* German hospitals (excluding police hospitals and hospitals of the penal system). Due to data protection, we work with a 70 percent random subsample of all hospitalizations.

This data set has three main strengths. First, it has a huge sample size (e.g. for the year 2010, almost 13 million hospitalizations are recorded in our 70 percent subsample). Second, as the data are not self-reported, we do not have to worry about panel attrition, social desirability bias and the like. Third, while other data sets on alcohol consumption provide information only on an annual basis, this data set allows us to identify the relevant outcome on a *monthly* basis. This is crucial as the ban did not start at the beginning of a year. Furthermore, the monthly basis allows distinguishing the effect of the ban on alcohol sales from other changes that took place in the same year (but not in the same month).

[8] Most states extended the shopping hours in such a way that shops can open 24 hours a day (except Sundays) if they wish so. In some states the legal opening hours on weekdays is restricted to 6am to 8pm (Saarland, Bavaria) or 6am to 10pm (Saxony, Rhineland-Palatinate).

The data set has some shortcomings, too. First, it includes for each patient only information about the main diagnosis and a few demographic variables (age, gender, county of residence), but no socio-economic variables. This is not a major concern for the present analysis, which focuses on the average effect of the reform. Yet, it prevents from analyzing whether the reform had differential effects on specific socio-economic groups. Second, the number of alcohol-related hospitalizations is possibly underestimated in the data set as only the main diagnosis is recorded for each inpatient. For instance, an individual who got physically injured (e.g. a laceration) due to excessive alcohol consumption, might not be classified based on the alcohol intoxication but based on the injury (Stolle et al. 2010).[9] This kind of misclassification might result in an underestimate of the policy reform's effect.[10] Third, the latest available hospitalization information are from December 2010 because the data collection process is quite complex: the data are filled-in by the individual hospitals, checked by the statistical offices of the German states and distributed by the German Federal Statistical Office. Hence, we can only analyze short-term consequences of the reform.

In order to define alcohol-related hospitalizations (ARH), we follow Wicki and Gmel (2011) in relying on the codes F10 ("Mental and behavioral disorders due to alcohol use") and T51 ("Toxic effect of alcohol") of the 3-digital ICD-10 classification ("International Statistical Classification of Diseases and Related Health Problems") constructed by the WHO.[11]

We aggregate the number of alcohol-related hospitalizations by month of admission and inpatient's county of residence. Hence, we construct a balanced panel of the 412 German counties (as of January 2010) covering a period of 48 months. This gives rise to 19,776 county-month observations. In order to make the ARH number's comparable across counties with different population sizes, we calculate hospitalization rates per 100,000 inhabitants.[12] For this purpose, we combine the hospital diagnosis statistics with county population data from the German Federal Statistical Office.

In addition, we map further information at the county level into the hospital diagnosis statistics for the construction of control variables: the size of the county in square kilometers, the general unemployment rate and the youth unemployment rate (defined as

[9]Stolle et al. (2010) provide also some empirical evidence that the German hospital diagnosis statistics underestimate the alcohol-related hospitalizations of children and adolescents.

[10]Though, when we express the reform's effect as percentage changes in the overall level of alcohol-related hospitalizations, we might estimate these *percentage* changes consistently, if the share of misclassified hospitalizations is constant.

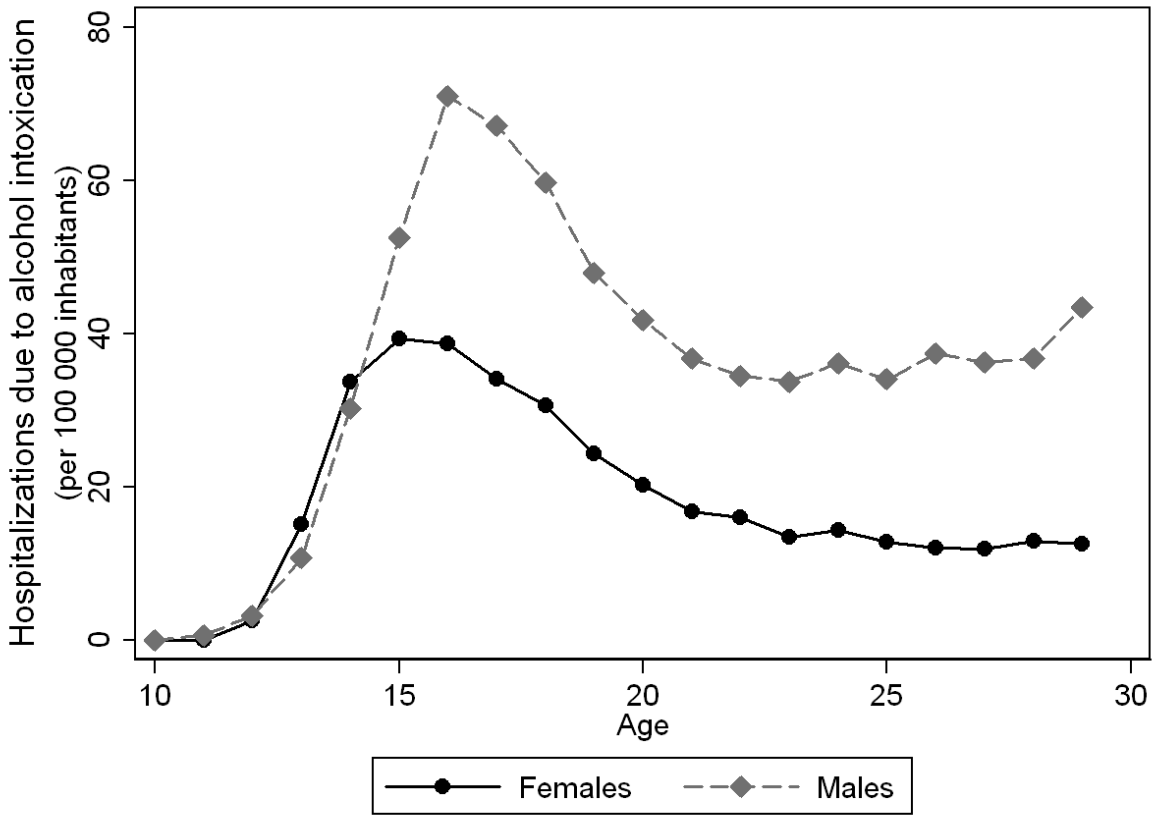
[11]In section VII, we show that our results are robust to only using the code F10, which accounts for about 98 percent of the cases that we classify as alcohol-related hospitalizations.

[12]We reweight the number of alcohol-related hospitalizations by the inverse of 0.7, in order to take into account that we are only provided with a 70 percent random sample.

unemployment rate among individuals below 25).[13] We also merge data on the state's GDP.[14]

In our analysis, we study the effect of the reform on alcohol-related hospitalization rates for the entire population and for specific age groups. We specifically inspect the reform's effect on young people as there are several reasons to assume that the reform especially impacts young individuals (see section III). We look at four different age groups of young people, each consisting of five year bins: Ages 10-14, 15-19, 20-24, and 25-29.[15] We also analyze all individuals who are aged 30 and older. In the robustness section, we differentiate between further age groups. We do not consider individuals younger than 10 as there are almost no alcohol-related hospitalizations in this age group.

Figure 2: Alcohol-related youth hospitalizations in 2009 by age and gender



Note: The figure displays gender specific alcohol-related hospitalization rates for various ages in Germany, i.e. the average monthly number of hospitalizations in 2009 due to alcohol intoxication per 100,000 inhabitants of the same age and gender.

[13]These annual data are publicly available from `https://www.regionalstatistik.de/genesis/online/data` (county level) and `https://www-genesis.destatis.de/` (state level).

[14]GDP data are not yet available on the county level for 2010.

[15]These age brackets are also used in publications of the Federal Statistical Office on ARH among the youth.

Figure 2 displays average monthly alcohol-related hospitalizations per 100,000 inhabitants of the same age and gender in 2009, the year prior to the ban. One can see that there are not many alcohol-related hospitalizations prior to age 13. Moreover, among individuals aged 14 and younger, gender differences are not large (ARH rates are even larger among females for ages 13 and 14). Starting at 15, male ARH rates always exceed female ARH rates and are about twice as large.[16] Among males, ARH rates peak at the age of 16, the minimum legal drinking age, and remain at a similar level after age 20. Similarly, female ARH rates peak at 15/16 years of age, and level off after 20. Figure A.1 in the appendix shows that ARH rates increase after age 30 again and peak for males and female at ages 45-50. For males, this peak at ages 45-50 exceeds the peak at age 15/16, and for females the peak is on a similar level as the peak at age 15/16.

V. Empirical strategy

We estimate basic difference-in-difference (DiD) models and regression difference-in-difference models with various control variables in order to inspect the effect of the late-night alcohol sales ban on alcohol-related hospitalization rates. The basic DiD model takes on the form:

$$ARH_{cst} = \beta \cdot ban_{st} + \alpha_1 \cdot post_t + \alpha_2 \cdot BaWu_s + \varepsilon_{cst}, \tag{1}$$

where ARH_{cst} refers to the alcohol-related hospitalization rate in county c in state s in month t. ban_{st} denotes our prime variable of interest, a binary variable that equals one if the late-night alcohol sales ban is in force in federal state s at month t, and zero otherwise (i.e. the interaction term of $post_t$ and $BaWu_s$). The other two regressors in the basic DiD model are binary variables for the post-treatment period ($post_t$) and the treatment state Baden-Württemberg ($BaWu_s$). We estimate equation (1) for hospitalization rates in different age groups.

In the regression difference-in-difference models with various control variables, we refine and supplement equation (1) and estimate equations of the following form:

$$ARH_{cst} = \beta \cdot ban_{st} + \gamma_c + \delta_t + X'_{cst}\lambda + \kappa_{s,season} + \varepsilon_{cst}. \tag{2}$$

Instead of the $BaWu_s$ indicator of the basic DiD model, we include a set of county fixed effects, γ_c, accounting for time-invariant differences in the level of alcohol-related hospitalizations between the counties (and, hence, also between the German states). We replace the indicator for the post-treatment period, $post_t$, with a maximum set of time

[16] The magnitude of this gender difference is in line with with findings from self-reported binge drinking rates (BZgA 2012).

(month-year) dummy variables, δ_t, controlling for time shocks that commonly influence alcohol-related hospitalizations in the German states (e.g. federal drunk driving laws).[17] X_{cst} denotes a set of time varying control variables at the county and state levels. It includes the state's share in total German GDP, the county's general unemployment rate and the county's youth unemployment rate as measures of the economic situation. Furthermore, in order to monitor changes in the population composition, X_{cst} includes the county's population density and the county's number of individuals in the analyzed age as a share of the county's total population. Additionally, X_{cst} includes a set of dummy variables for different shopping hour regimes, to pick up the issue of changes in legal opening hours in supermarkets (see section III).[18] $\kappa_{s,season}$ is a set of season-specific federal state dummies capturing seasonal differences between states.[19] There may be seasonal differences in ARH rates between states due to variations in celebrations. For example, Baden-Württemberg is known for its big Carnival celebration, which takes place in February.

In section VI we start with the basic DiD models and than gradually incorporate the control variables of equation (2). We estimate equations (1) and (2) by weighted least squares, where the weights are given by the county's population in the analyzed age, in order to get the right overall effect for Baden-Württemberg. Draca et al. (2011) and Kelly and Rasul (2012) apply similar weighting procedures on their aggregated data. All standard errors in this study are clustered by federal state.

VI. Main results

A. Basic difference-in-difference results

Table 1 reports the results from basic difference-in-difference models. The first panel of the table shows the results for the entire population, i.e. the alcohol-related hospitalization rate for all persons aged 10 and older. The lower panels display the results of separate models by age groups (ages 10-14, 15-19, 20-24, 25-29, 30 and older), since risky drinking behavior varies considerably by age and the impact of the law is more likely to affect the youth. Figures in the first column of the table display averages in the monthly number of alcohol-related hospitalizations per 100,000 inhabitants prior to the implementation of the

[17] By substituting the post-treatment period and the treatment state indicators with time and county fixed effects, our regression DiD can also be regarded as a twoway fixed effects regression.

[18] More specifically, this set includes three indicator variables: (i) shopping is allowed around the clock except Sundays; (ii) shopping is allowed around the clock except Saturdays and Sundays; and (iii) shopping is allowed until 10pm during the week and on Saturdays. Shopping allowed until 8pm during the week and on Saturdays (i.e. the federal regulation prior to 2007) constitutes the reference category.

[19] Seasons are defined as January-March, April-June, July-September, and October-December.

ban on March 1, 2010.[20] Figures in the second column show the corresponding averages for the period March 2010 - December 2010. The basic difference-in-difference approach estimates the impact of the law by comparing the difference in the hospitalization rates between Baden-Württemberg (treatment) and all other German states (control), before and after the introduction of the late-night alcohol sales ban.

The figures in the first row show that the hospitalization rate for the entire population in Baden-Württemberg remained very stable over time, with around 33.4 monthly alcohol-related hospitalizations per 100,000 inhabitants aged 10 and older both before and after the implementation of the alcohol ban. In contrast, the number of alcohol-related hospitalizations increased by around 0.3 in the other federal states, resulting in an estimated overall reduction of 0.37 alcohol-related hospitalizations per 100,000 inhabitants due to the late-night alcohol ban. The reduction of 0.37 hospitalizations corresponds to a an overall decrease in alcohol-related hospitalizations by 1.09 percent ($= 0.37/(0.37 + 33.41)$).[21]

The separate estimates for the five different age groups show striking results. First, the alcohol-related hospitalization rate of children aged 10-14 decreased by 7.7 percent. The effects are even more pronounced among adolescents (ages 15-19) and young adults (ages 20-24), with a drop in alcohol-related hospitalizations of around 9 percent and 8 percent, respectively. The effect for individuals aged 25 to 29 is much smaller. The last panel indicates that the reform involved no reduction in alcohol-related hospitalizations for individuals aged 30 and older. This finding suggests that the overall reform effect found in panel A is basically driven by individuals under the age of 30.

Table 1 also shows that, in Baden-Württemberg, the average monthly ARH rate is smaller after the ban than before, for children, adolescents and young adults, but not for older adults. Contrary, alcohol-related hospitalizations in all other states are higher after the ban (except for children).

B. Regression difference-in-difference

Taking the basic, unconditional DiD estimates from table 1 as a starting point, the models in this section gradually incorporate more control variables. Table 2 reports estimated coefficients and standard errors from several difference-in-differences regressions. Each coefficient represents an estimate from a separate regression, with standard errors clustered on the federal state level. Column 1 replicates the results from the basic difference-in-difference models. The other columns gradually include further control variables as indicated by the column headings.

One can see that four of the six point estimates in the first column are significantly

[20] All hospitalization rates in this study are reweighted from the 70 percent sample to the full population.
[21] Without the reform, we estimate that there would be 33.78 ($= 0.37 + 33.41$) hospitalizations.

Table 1: Basic difference-in-difference results

	Before	After	Difference	%-change
Panel A: Overall				
Treatment	33.47	33.41	-0.06	
Control	35.40	35.71	0.31	
Difference	-1.93	-2.30	-0.37	-1.09
Panel B: Age 10-14				
Treatment	9.44	8.05	-1.39	
Control	9.67	8.94	-0.72	
Difference	-0.22	-0.89	-0.67	-7.70
Panel C: Age 15-19				
Treatment	45.87	44.00	-1.87	
Control	44.20	46.72	2.52	
Difference	1.66	-2.72	-4.38	-9.06
Panel D: Age 20-24				
Treatment	26.25	25.48	-0.77	
Control	25.03	26.59	1.57	
Difference	1.22	-1.12	-2.34	-8.41
Panel E: Age 25-29				
Treatment	24.06	25.55	1.49	
Control	23.92	25.87	1.95	
Difference	0.15	-0.32	-0.47	-1.80
Panel F: Age 30+				
Treatment	35.85	35.99	0.14	
Control	38.44	38.48	0.04	
Difference	-2.59	-2.49	0.10	0.28

Note: Average monthly alcohol-related hospitalizations per 100 000 inhabitants in the respective age before and after the policy change for treatment (Baden-Württemberg) and control group (all other states). The last column indicates percentage changes in alcohol-related hospitalizations due to the reform.

Table 2: The ban's effect on alcohol-related hospitalizations - main results

	Basic DiD	+ time/county dummies	+ controls	+ state-spec. seasonal eff.
Panel A: Overall				
Effect	−0.37∗	−0.41 ∗ ∗	−0.86∗∗∗	−0.63∗∗∗
	(0.18)	(0.17)	(0.16)	(0.20)
%-change	−1.09	−1.22	−2.51	−1.86
Panel B: Age 10-14				
Effect	−0.67∗	−0.68∗	−0.54	0.00
	(0.36)	(0.36)	(0.39)	(0.40)
%-change	−7.70	−7.82	−6.26	0.02
Panel C: Age 15-19				
Effect	−4.38∗∗∗	−4.22∗∗∗	−4.72∗∗∗	−4.18∗∗∗
	(1.04)	(1.01)	(1.23)	(1.19)
%-change	−9.06	−8.74	−9.68	−8.68
Panel D: Age 20-24				
Effect	−2.34∗∗∗	−2.42∗∗∗	−2.90∗∗∗	−2.55∗∗∗
	(0.55)	(0.53)	(0.54)	(0.52)
%-change	−8.41	−8.68	−10.22	−9.11
Panel E: Age 25-29				
Effect	−0.47	−0.54	−0.36	−0.28
	(0.62)	(0.63)	(0.73)	(0.75)
%-change	−1.80	−2.07	−1.38	−1.10
Panel F: Age 30+				
Effect	0.10	0.07	−0.35	−0.16
	(0.24)	(0.24)	(0.29)	(0.32)
%-change	0.28	0.20	−0.96	−0.45

Note: The table displays the reform's effect on the monthly number of alcohol-related hospitalizations per 100,000 inhabitants for various age groups, together with its standard error clustered on the state level (in parentheses). The last line in each panel indicates the percentage change in alcohol-related hospitalizations due to the reform. All regressions are weighted by county population in the respective age, and based on 19776 county-month observations. The first column repeats the results of the basic diff-in-diff results from table 1, the second column includes fixed effects for the 412 counties as well as for the 48 months. Additionally, the third column includes time varying control variables on the county and state level. The last column adds federal state specific seasonal dummies. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

different from zero at conventional significance levels. Note, however, that the overall decline in hospitalizations (Panel A, first column) and the decline in hospitalizations among those aged 10-14 (Panel B, first column) is only significant at the 10 percent level. The second column reports difference-in-difference estimates, including fixed effects for the 412 counties and the 48 months. The estimates in the second column are very similar in magnitude as the basic difference-in-difference estimates. In the third column we also add time-varying county characteristics (general and youth unemployment rate, state's share in total German GDP, county's population density, share of individuals in the analyzed age, dummy variables for different shopping hour regimes). The inclusion of these additional explanatory variables slightly changes the estimated coefficients. For adolescents (aged 15-19) and young adults (aged 20-24) as well as in the overall population, the impact of the ban becomes somewhat stronger (more negative), whereas the size of the coefficient decreases among those aged 10-14 and becomes insignificant.

The last column adds federal state specific seasonal dummy variables, to control for potential differential seasonal influences across states. This is our preferred specificiation. The results in the last column suggest that the decline in alcohol-related hospitalizations among children is not robust to controlling for seasonal time trends. The estimated coefficient from the raw difference-in-difference specification of -0.67 becomes virtually zero, and is not statistically significant. However, the inclusion of these additional control variables shows relatively little effect on the estimated coefficients for young people aged 15-19 and 20-24. The estimated coefficients of -4.15 and -2.59 for these two age groups suggest that the alcohol-related hospitalizations among adolescents and young adults decreased by around 9 percent. The effects for those aged 25-30 as well as aged 30 and older are not significant in any of the specifications in this table.

Overall, the estimates in table 2 point to two important findings. First, the results suggest that the late-night alcohol ban significantly reduced alcohol-related hospitalization among adolescents and young adults. Second, alcohol-related hospitalization rates among adults older than 25 did not change significantly with the introduction of the late-night alcohol ban. The significant overall reform effect is basically driven by adolescents and young adults.

VII. Robustness checks

This section performs various robustness tests. The first part investigates the sensitivity of the results to applying different control groups and the second part performs further robustness tests.

A. Different control groups

The key assumption for our identification strategy is that in the absence of the ban the alcohol hospitalization rates in Baden-Württemberg (the treatment state) would follow the same trend as in the control group. As we cannot test this assumption directly, this section investigates in how far the results are sensitive to the selection of the control group.

We work with four different control groups. The first group constitutes of all other German states (as in table 2), the second control group considers only counties in West Germany, and the third control groups includes only counties in the southern German states of Bavaria and Hesse. Bavaria and Hesse are most similar to Baden-Württemberg in terms of location (South Germany), the orientation of the government in the period under analysis (center-right), and economic performance (the three states are the largest contributors to the financial equalization scheme between the Federal Government and the states). They also have similar overall ARH rates before the ban. The fourth control group constitutes a synthetic control group. The counties in the synthetic control group are reweighted in such a way that the ARH rates follow exactly the same trend as the treatment counties before the onset of the ban. This means that the fourth control group exhibits the same average hospitalization rate as in Baden-Württemberg in *every* month in the period January 2007 through February 2010. We construct this synthetic control group applying the matching/reweighting technique "entropy balancing" (Hainmueller 2012). We rely on a separate synthetic control group for every age group.

Table 3 confirms the findings from the main specification (see last column in table 2). No matter which control group is used, the ban is estimated to reduce ARH rates for adolescents and young adults, but not for children (at least not significantly) and older adults. While the effects are similar when only using counties in West Germany as control group, the third and fourth column in table 3 indicate that the estimates based on all German counties are rather conservative estimates. Relying on Hesse and Bavaria or on the synthetic control group, the ban is estimated to reduce alcohol-related hospitalizations among adolescents and young adults by 12 and 10-11 percent, respectively - compared to 9 percent when using all federal states or only West German states.[22]

B. Further robustness checks

This subsection investigates the sensitivity of the results to various modifications. First, we apply an alternative method to estimate equation 2, the Tobit model, as the ARH

[22]Due to the many control variables (e.g., fixed effects for county, time, state-season) in comparison to the number of observations, the effect on adolescents becomes insignificant when relying on only Hesse and Bavaria for the control group. However, the coefficient increases in magnitude.

Table 3: The ban's effect on alcohol-related hospitalizations - different control groups

	All states	Western states	Southern states	Synthetic control group
Panel A: Overall				
Effect	−0.63***	−0.49*	−0.87 **	−1.08
	(0.20)	(0.25)	(0.09)	(0.64)
%-change	−1.86	−1.44	−2.55	−3.12
Panel B: Age 10-14				
Effect	0.00	0.05	−0.48	−0.52
	(0.40)	(0.40)	(0.76)	(0.46)
%-change	0.02	0.60	−5.64	−6.10
Panel C: Age 15-19				
Effect	−4.18***	−4.20 **	−6.13	−6.15***
	(1.19)	(1.29)	(3.27)	(1.05)
%-change	−8.68	−8.72	−12.23	−12.27
Panel D: Age 20-24				
Effect	−2.55***	−2.42***	−3.16 **	−2.91***
	(0.52)	(0.55)	(0.45)	(0.90)
%-change	−9.11	−8.66	−11.04	−10.24
Panel E: Age 25-29				
Effect	−0.28	−0.21	0.75	0.66
	(0.75)	(0.79)	(1.95)	(1.01)
%-change	−1.10	−0.83	2.86	2.53
Panel F: Age 30+				
Effect	−0.16	−0.07	−0.43	−0.24
	(0.32)	(0.41)	(0.63)	(0.53)
%-change	−0.45	−0.20	−1.18	−0.66
N	19776	15600	8448	19776

Note: All specifications are based on the specification in the last column of table 2. See also the note below that table. The first and last column are based on all 19776 county-month observations, the second column draws only on the 15600 county-month observations in West Germany, and the third column only uses the 8448 county-month observations in the Southern German states of Bavaria, Hesse, and Baden-Württemberg. The synthetic control group in the last column is built on a reweighted control group that follows exactly the same trend as the treatment group prior to the introduction of the late-night ban on alcoholic beverages. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

rates are censored at zero. Second, we restrict the analysis time to 2008-2010. In this period, there occurred no changes in the shopping hours in any federal state. Third, we include county-specific linear time trends as our estimates might be confounded by natural time trends in ARH rates, which might differ between the counties. Fourth, we only use the diagnosis F10 ("Mental and behavioral disorders due to alcohol use") in order to construct ARH rates, as press releases and governmental reports on youth binge drinking often only consider hospitalizations with this diagnosis.[23] Fifth, we only consider individuals who are released from hospital in the same year they are admitted. This is done in order to eliminate any potential bias from the fact that we do not observe cases in our data that entered hospital before 2011, but were released in 2011 or later.[24] Sixth, we perform a placebo regression by pretending that the ban in Baden-Württemberg took place one year earlier (i.e. on 1 March, 2009). For this purpose, we estimate equation (2) with two modifications. On the one hand we now construct the treatment indicator using the placebo policy change, and on the other hand we do not consider those time periods when the actual ban was in effect, i.e. we drop the months from March 2010 through December 2010.

The first five columns in table 4 show that the results from the main specification are strikingly robust. While among those aged 15-19 and 20-24 the decreases in ARH rates due to the ban are significant in all specifications in table 4, among those aged 10-14, 25-30, and 30 and older, the ban never exhibits a significant effect on ARH rates. For individuals aged 15-19, the effects vary between 7.2 percent and 10 percent,[25] while for young adults the effect sizes vary between 8.9 percent and 12.6 percent - depending on the specification.

The results of the placebo regressions in the last column show that the placebo policy one year earlier has no significant effects on ARH rates. These findings add further credibility to the identification assumption and indicate that the estimated effects of the actual ban are not merely due to volatility in the ARH rates.

When we use federal states as unit of analysis, we obtain similar results to our main results (see table A.1 in the appendix). The effects for adolescents and young adults are significant and of similar magnitude, but not as precisely estimated. Similarly, the findings for adolescents and young adults are robust to the inclusion of an indicator variable

[23] Accordingly, the calculated percentage changes in table 4 also only rely on hospitalizations with the coding F10.

[24] This restriction basically drops cases that were admitted to hospital in December of one year, and released in January of the following year.

[25] The smallest effect in this age group is for the specification with linear trends for the 412 counties. However, when assuming different functional forms of the time trend, e.g. quadratic or cubic, the effects for both adolescents and young adults increase to over 10 percent. We obtain similar effects when using state-specific trends instead of county-specific trends (see table A.1 in the appendix).

Table 4: The ban's effect on alcohol-related hospitalizations - further robustness checks

	Tobit	w/o 2007	county-spec. trends	only diagnosis F10	only same year	placebo reform
Panel A: Overall						
Effect	−0.63∗	−0.63 ∗ ∗	−0.87	−0.66∗∗∗	−0.34	0.29
	(0.37)	(0.28)	(0.57)	(0.18)	(0.20)	(0.57)
%-change	−1.85	−1.86	−2.53	−1.96	−1.00	0.84
Panel B: Age 10-14						
Effect	0.32	0.19	−0.62	−0.05	−0.00	0.21
	(1.59)	(0.63)	(1.00)	(0.30)	(0.39)	(0.51)
%-change	3.88	2.29	−7.16	−0.62	−0.06	2.20
Panel C: Age 15-19						
Effect	−4.64∗∗∗	−4.43∗∗∗	−3.42∗	−4.78∗∗∗	−4.06∗∗∗	−0.56
	(1.68)	(1.22)	(1.64)	(1.12)	(1.21)	(0.59)
%-change	−9.55	−9.16	−7.21	−10.00	−8.44	−1.13
Panel D: Age 20-24						
Effect	−2.99 ∗ ∗	−3.00∗∗∗	−3.66∗∗∗	−2.45∗∗∗	−2.49∗∗∗	0.54
	(1.34)	(0.75)	(1.24)	(0.56)	(0.53)	(0.56)
%-change	−10.50	−10.53	−12.57	−8.86	−8.89	1.89
Panel E: Age 24-29						
Effect	0.04	−1.11	−1.31	−0.28	−0.10	0.46
	(1.40)	(0.79)	(1.00)	(0.76)	(0.76)	(0.47)
%-change	0.15	−4.15	−4.88	−1.09	−0.40	1.76
Panel F: Age 30+						
Effect	−0.16	−0.05	−0.38	−0.15	0.22	0.21
	(0.44)	(0.39)	(0.52)	(0.31)	(0.32)	(0.67)
%-change	−0.45	−0.14	−1.05	−0.43	0.60	0.56
N	19776	14832	19776	19776	19776	15656

Note: All specifications are based on the specification in the last column of table 2. See also the note below that table. The first column presents coefficients from Tobit regressions, the second column only uses observations in the 2008-2010 period, the third column includes county-specific linear trends, the fourth column only relies on the diagnosis F10 in order to construct hospitalization rates, the fifth column only considers individuals who are released from hospital in the same year they are admitted, and the last column performs a placebo regression with the reform starting one year earlier. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

capturing the extension of the general legal bar opening hours in Baden-Württemberg in January 2010 (see table A.1 in the appendix). Including this dummy variable does not change the results for adolescents, but increases the effect for young adults suggesting that we might underestimate the effect of the ban for young adults.[26]

VIII. Further results

This section presents further results. The first part investigates whether the effect of the ban differs according to individual characteristics (gender, further ages). The second part analyzes the (short-run) development of the ban's impact over time.

A. Heterogeneity of the treatment effect

There are considerable differences in alcohol consumption, binge drinking behavior and ARH rates between men and women. Therefore, we estimate separate models by gender.

Table 5 reports the results separately for women and men. We only report estimated coefficients for our preferred specification, which controls for county and time fixed effects, time-varying explanatory variables, as well as state-specific seasonal fixed effects (as in the last column of table 2). The table shows that for both males and females the ban reduces ARH for adolescents and young adults. While the effects of the ban are larger for males in absolute terms, in relative terms (i.e. taken into account the lower level of ARH rates) the effects are larger for females. We find the strongest relative impact of the reform for female adolescents. In this group the ban is estimated to reduce ARH by about 10.5 percent. For neither gender we find significant effects for the other age groups.

In figure 3, we break up the specific age groups of young people used in the previous sections in order to investigate whether the grouping hides differences in the ban's effect within the age groups. More specifically, we estimate the ban's effect and the corresponding 95-percent confidence interval for three year rolling age windows. This means that we estimate the effect for ages 10-12, 11-13, 12-14 and so on. When we investigate the effect for single age years or five year rolling age windows, we obtain similar pictures.[27] Figure 3 shows that the ban's effect is estimated to reduce ARH rates for all three year age groups

[26] Yet, this is not our preferred specification. The effect of the extended opening hours is identified basically by only two months, January and February 2010. Hence, it cannot be ruled out that the effect is driven by time-series volatility, and/or specific events that only occurred in January/February 2010 in Baden-Württemberg. This concern is corroborated by the fact that we also obtain a significant effect of the ban for children aged 10-14 in this specification. Children in this age should not be affected by the extension of the bar opening hours as they are not allowed to legally stay in bars that long. Additionally, the treatment effects are estimated rather imprecisely.

[27] When using five year rolling age windows, the estimated treatment effects are more smoothed over the ages. The treatment effects are less precisely estimated and slightly more volatile, when using single years.

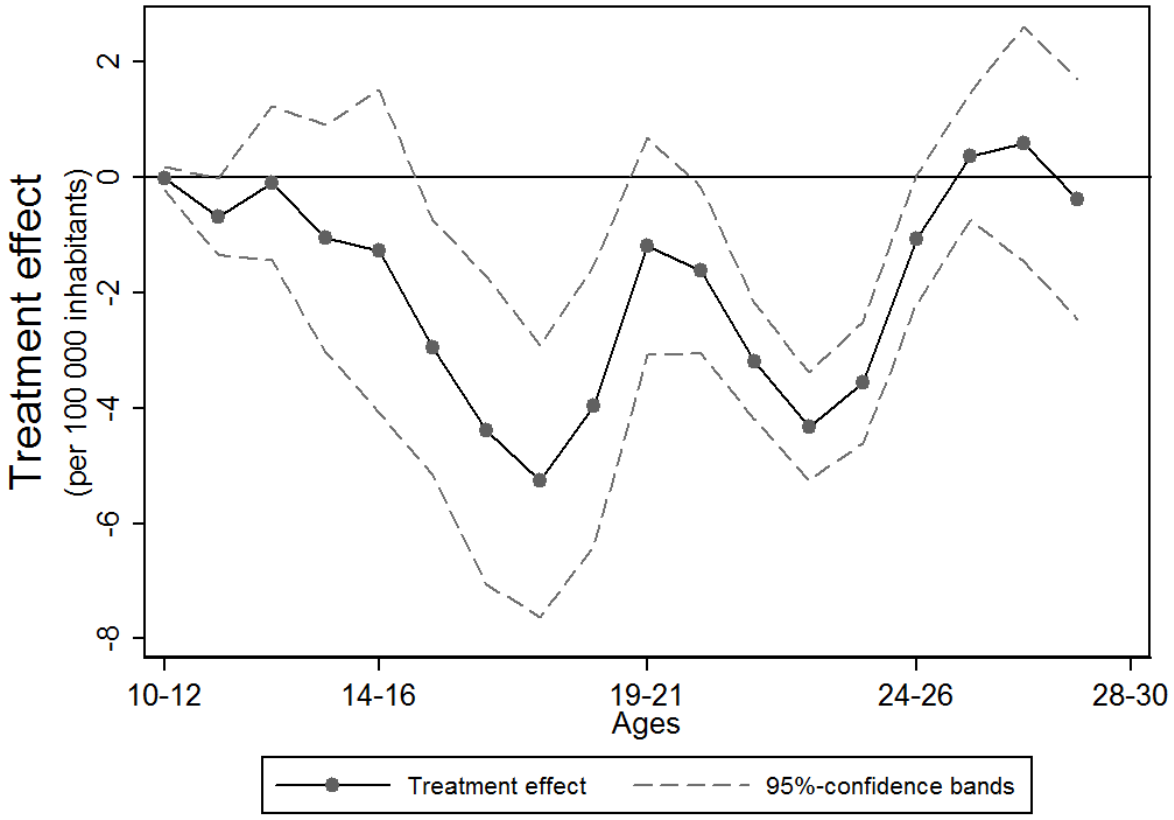
Table 5: Differential effects of the ban for men and women

	females	males
Panel A: Overall		
Effect	$-0.62***$	$-0.67**$
	(0.20)	(0.31)
%-change	-3.30	-1.34
Panel B: Age 10-14		
Effect	-0.56	0.54
	(0.50)	(0.43)
%-change	-6.37	6.39
Panel C: Age 15-19		
Effect	$-3.57***$	$-4.88**$
	(0.81)	(1.78)
%-change	-10.54	-7.88
Panel D: Age 20-24		
Effect	$-1.61**$	$-3.45***$
	(0.55)	(0.86)
%-change	-9.31	-9.00
Panel E: Age 25-29		
Effect	0.13	-0.71
	(0.53)	(1.16)
%-change	1.13	-1.78
Panel F: Age 30+		
Effect	-0.33	-0.00
	(0.26)	(0.43)
%-change	-1.74	-0.00

Note: All specifications are based on the specification in the last column of table 2. See also the note below that table. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

between 12 and 25. However, the effect is only statistically significant for age groups between 16 and 24 (except for the age group centered around age 20, where the effect is not estimated precisely enough). Outside this age range, we do not find any significant effects of the ban on young people, giving us confidence that the age categories used in the previous section covers the relevant ages quite well. We find the largest reduction in ARH rates for individuals between 17 and 19, i.e. around the time when they come of age and obtain the legal right to buy heavy alcohol as well as to stay in bars and clubs as long as they want. Figure A.2 in the appendix displays the ban's effect for further age groups. It shows that breaking the age group of individuals aged 30 and older into 10 year age bins confirms that the ban has no effect on older individuals.

Figure 3: Treatment effect by ages



Note: The figure displays the impact of the ban for 3-year rolling age windows centered around the age given on the horizontal axis. The vertical axis displays the effect of the ban in terms of monthly alcohol-related hospitalization rates per 100,000 inhabitants of the same age.

B. Evolution of the treatment effect

This subsection investigates how the effect of the late-night alcohol ban evolves over time. Analyzing the dynamic of the treatment effect is important to analyze. It might be that

the impact of the ban eventually converges to zero due to improved avoidance strategies on both the demand side for alcohol and on the supply side. For instance, owners of petrol stations might open restaurants or bars on the same spot. On the demand side, individuals might improve their pre-stocking opportunities (e.g. by finding hideouts) or might bring forward their pre-drinking behavior to earlier hours. Also, a black market for off-premise sales of alcoholic beverages might take some time to develop. However, it is difficult to distinguish consequences of improved avoidance strategies from differential seasonal effects of the ban. For instance, the reform might be more effective in summer time, when people are more likely to drink outside.

Table 6: The evolution of the ban's effect over time

Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec
		Age 15-19		
$-3.84**$	$-9.48***$	-3.75	-0.27	$-3.60*$
(1.36)	(2.10)	(2.18)	(1.14)	(1.72)
		Age 20-24		
-0.82	$-5.82***$	$-4.19***$	$-2.27***$	0.14
(0.68)	(0.91)	(0.75)	(0.74)	(1.44)

Note: All specifications are based on the specification in the last column of table 2. See also the note below that table. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 6 presents how the treatment effect evolves over time for adolescents and young adults, the two age groups for whom we find significant effects in the previous specifications. The underlying regression equation resembles the main specification, i.e. equation (2), with the only difference that instead of a single treatment indicator combining the ten months from March to December 2010, there are five mutually exclusive treatment indicators, each depicting the treatment effect for two subsequent months.[28]

The table shows that for both adolescents and young adults the effect of the ban is largest in the late spring months Mai and June. For young adults the continuous decrease after the peak in May/June might suggest a fading out of the ban's effect. However, the effects in July/August and September/October are larger than the effect in March/April, and when looking at the effects in individual months, the effect in December is significant and larger than the effect in November. The evolution of the ban's effect for young adults might also suggest that, for this age group, the ban basically works in the warmer half of

[28]Similar pictures emerge when we group more months together, e.g. three or five, and when we look at each month separately. The more months we group, the less volatile the point estimates become. Grouping two months together seems to be the best trade-off between reducing volatility and being able to analyze the evolution of the treatment effect in a detailed manner.

the year. This is also the time with the highest monthly ARH rates for both adolescents and young adults. For adolescents there is no clear pattern in the treatment effect's evolution as the effect size is quite similar in May/April, July/August and November/December. Only the effects in May/June (largest effect) and September/October (smallest effect) deviate. Overall, there is no evidence that the effect for adolescents dies out. The findings in table 6 also show that our main findings are not driven by a single month (and, hence, not by a single event).

IX. Conclusion

The question of how to effectively reduce binge drinking among youth is of perennial importance given increasing numbers of alcohol-related hospitalizations among adolescents and young adults in many industrialized countries. This study exploits the introduction of a ban on late-night off-premise alcohol sales and estimates its impact on alcohol-related hospitalizations.

We find that the policy change in the German federal state of Baden-Württemberg reduces alcohol-related hospitalizations among adolescents and young adults by about 9 percent. This corresponds to reductions of 4.2 fewer admissions among adolescents (ages 15-19) and 2.6 among young adults (ages 20-24) per month and 100,000 same-aged people. Regardless of whether we compare alcohol-related hospital admissions in Baden-Württemberg to admissions in all other federal states, in western federal states, in the southern states of Bavaria or Hesse, or in a synthetic control group, we find that the implementation of the late-night off-premise alcohol ban significantly reduces alcohol-related hospital admissions among young people. Moreover, we present estimates for several alternative specifications to probe the robustness of our findings. All of these robustness exercises confirm a significant decline in alcohol-related hospitalizations among adolescents and young adults. Furthermore, we provide evidence that the estimated effects are not driven by single events or single months. However, we do not find any evidence that the ban reduces alcohol-related hospitalization rates among individuals aged 24-29 and older individuals (aged 30 and above). While in the basic difference-in-difference model, we also find a significant reduction in alcohol-related hospitalization rates for children (ages 10-14), this effect disappears when we include further control variables.

We show that the ban impacts both male and female adolescents/young adults. While the effects are larger for males in absolute terms, in relative terms (i.e. taken into account the lower level of alcohol-related hospitalizations) the effects are larger for females.

According to these estimates, the ban prevented the hospitalizations of about 252 adolescents and 169 young adults in the 10 month after its enactment in March 2010.

The *Techniker Krankenkasse*, a large German health insurer, estimates that on average each alcohol-related hospitalization of an adolescent costs about 540 Euro.[29] Taking the 540 Euro at face value, our estimates indicate that in 2010, the German statutory health insurance system saved about 227,000 Euro as a result of the ban. This value might be a lower bound of the total health costs for various reasons. First, the amount of 540 Euro per admission includes only the direct short-run costs of the health insurer. Costs of after-treatments are not considered in this amount. Second, we only observe the main diagnosis in our hospitalization data. However, the ban might also reduce hospitalizations where alcohol is only a secondary diagnosis. Hence, our point estimates of the ban's effect are likely to be lower bounds. Third, the calculated amount does not include any short-run and long-run costs for the affected individuals. Fourth, we only look at an extreme form of binge drinking, namely the kind of binge drinking that ends in hospitals. Health costs might be also reduced if the ban reduces other forms of binge drinking as well. Additionally, the amount of 227,000 Euro does not include any non-health costs (like potential reductions in alcohol-related crimes, sickness leaves, and traffic accidents).

The main finding of this paper is that the late-night off-premise alcohol sales ban is effective at reducing alcohol related hospitalization among adolescents and young adults in the short term. This finding is relevant since there is a large literature documenting adverse health effects of binge drinking behavior. Furthermore, adolescence and young adulthood are often seen as key ages for the prevention of alcoholism (Enoch 2006).

The findings are likely to be informative for policy debates in a number of jurisdictions in Germany and in other countries that are thinking about implementing late-night alcohol bans.[30] This study provides evidence of the benefits of such a ban. However, these benefits have to be compared against the potential losses of owners of off-premise outlets and especially against the encroachment upon individual liberties. Although the ban is a rather light touch regulation (as it is easy to be legally avoided by buying the alcohol before 10pm or by going to bars), it is still an intervention in the private sphere. This final trade-off cannot be resolved by researchers; policy-makers and, hence, the voters are ultimately responsible for this decision.

There are several avenues for future research. First, we aim to investigate whether the late-night alcohol sales ban influences illicit drug related hospital admissions. This is important, as an increase in drug related hospitalizations might offset positive health effects from fewer alcohol-related admissions. Second, it would be interesting to know whether

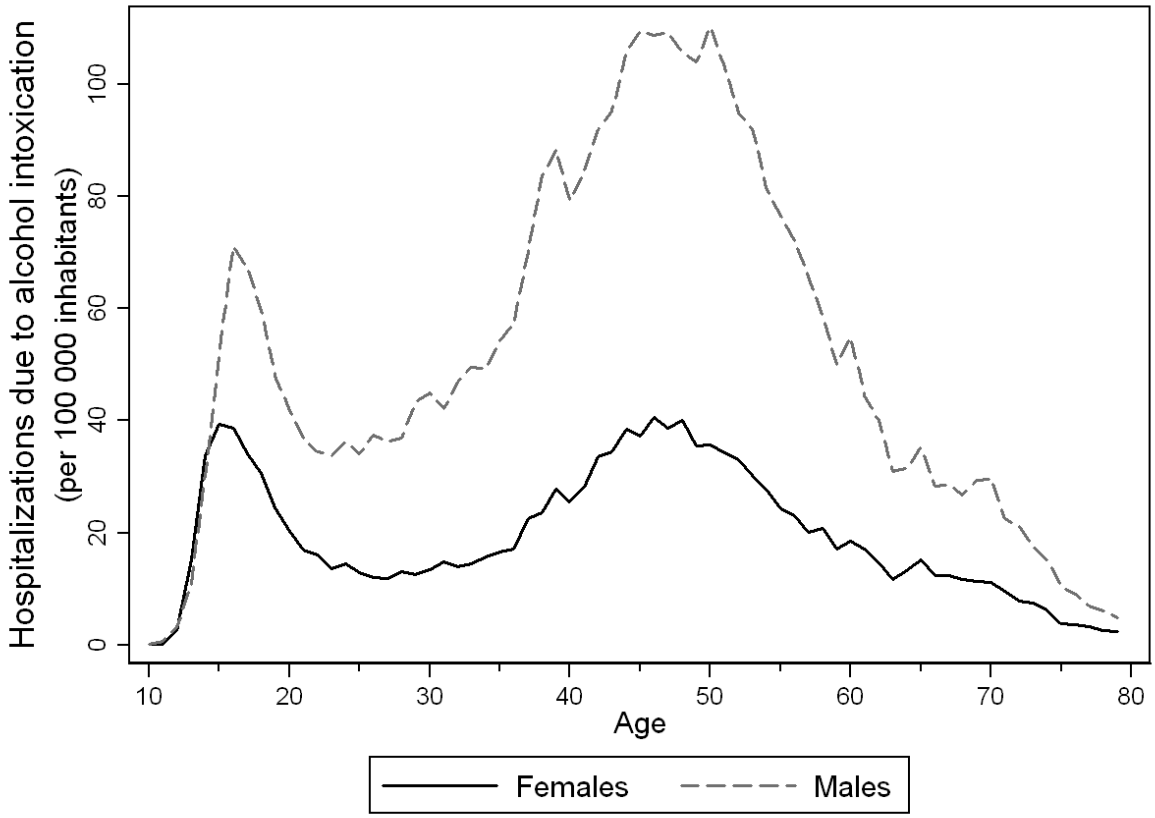
[29] See `http://www.welt.de/2108614`, last accessed March 02, 2013. The health insurer calculates with an average length of the hospital stay of about 1.2 days, which exactly coincides with our estimates of the average length of the hospital stay for adolescents and young adults.

[30] Indeed, several other German states are considering the implementation of similar policies (see `http://www.faz.net/-gpg-15w1k`, accessed March 02, 2013).

the late-night off-premise alcohol sales ban has even more far reaching consequences for society, as it might reduce teenage pregnancy, decrease young people's truancy in school or absenteeism from work. Finally, in future work, we plan at studying whether the law impacts on crime and reduces car accidents and traffic fatalities.

A. Appendix

Figure A.1: Alcohol-related hospitalizations in 2009 by age and gender



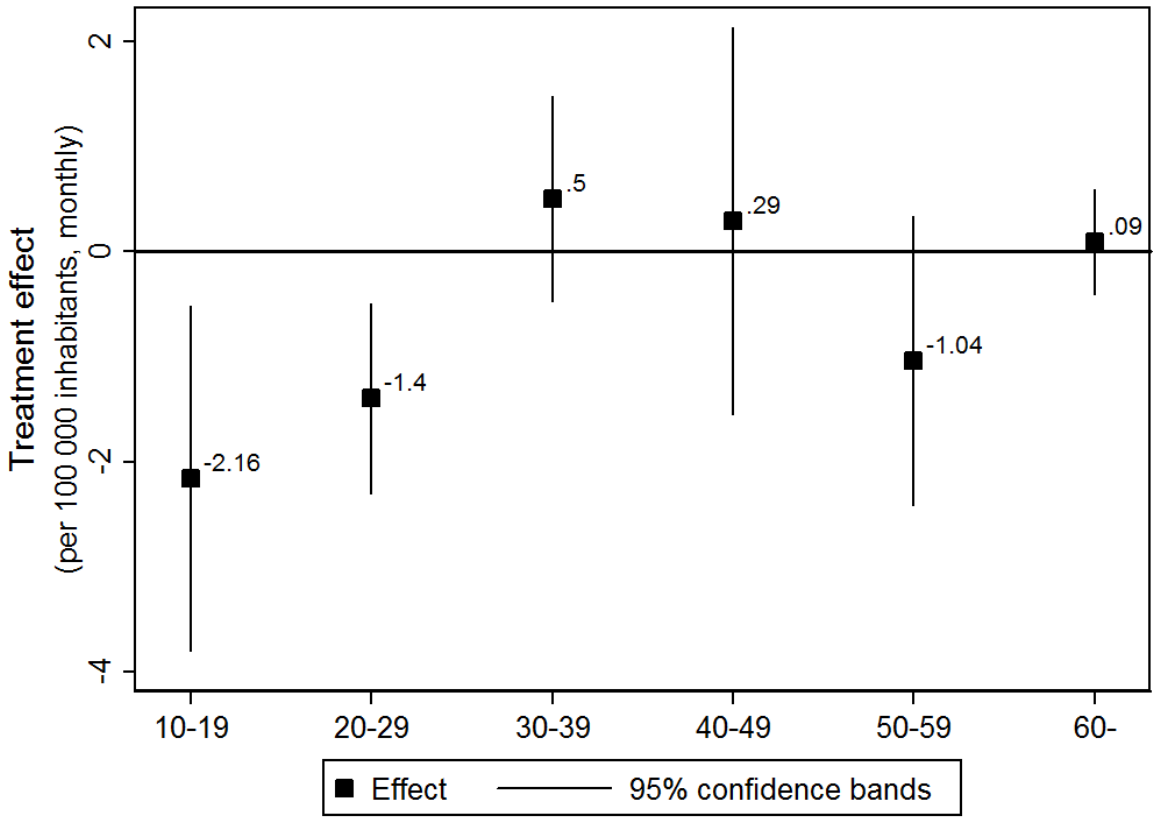
Note: The figure displays gender specific alcohol-related hospitalization rates for various ages in Germany, i.e. the average monthly number of hospitalizations in 2009 due to alcohol intoxication per 100,000 inhabitants of the same age and gender.

Table A.1: Additional robustness tests

	State trends	Federal states	Opening hours
Panel A: Overall			
Effect	−0.78	−0.71∗	−1.00 ∗ ∗
	(0.57)	(0.34)	(0.41)
%-change	−2.27	−2.07	−2.91
Panel B: Age 10-14			
Effect	−0.35	−0.34	−2.70∗∗∗
	(0.93)	(0.60)	(0.59)
%-change	−4.20	−4.01	−25.13
Panel C: Age 15-19			
Effect	−3.35∗	−3.89∗	−4.17∗
	(1.76)	(1.97)	(2.07)
%-change	−7.08	−8.13	−8.65
Panel D: Age 20-24			
Effect	−3.59 ∗ ∗	−3.39∗∗∗	−8.04∗∗∗
	(1.24)	(0.80)	(0.85)
%-change	−12.36	−11.75	−23.99
Panel E: Age 25-29			
Effect	−1.20	−0.30	−0.17
	(0.87)	(0.86)	(0.88)
%-change	−4.48	−1.16	−0.65
Panel F: Age 30+			
Effect	−0.29	0.23	0.15
	(0.53)	(0.62)	(0.41)
%-change	−0.79	0.62	0.41
N	19776	768	19776

Note: All specifications are based on the specification in the last column of table 2. See also the note below that table. The first column includes state-specific linear time trends. The second column is based on federal states instead of counties as unit of analysis. In addition to the main specification, the third column controls for the extension of the general legal bar opening hours in Baden-Württemberg in January 2010. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Figure A.2: The ban's effect on ARH rates - further ages



Note: The figure displays the ban's effect on alcohol-related hospitalization rates for 10-year age groups (see specification four of table 2).

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