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ABSTRACT

The Effects of Stepwise Minimum Legal Drinking Age Legislation on Mortality: Evidence from Germany

This study investigates the short-term mortality effects of two age-based restrictions on legal access to alcohol in Germany. We exploit sharp differences in legal access to alcohol at 16 and 18 years by implementing a regression discontinuity design. We find discontinuous increases in deaths at both age cutoffs, which are mainly driven by a "novice driver effect", whereas legal access to alcohol plays a marginal role at most. Overall, our results indicate that a stepwise introduction to alcohol has, at most, a minor impact on drunk driving and mortality at age 16 and 18 years. This study thus provides fresh impetus to the ongoing debate on the "optimal" MLDA legislation.

JEL Classification: I10, I18, C26, C31

Keywords: mortality, motor vehicle fatalities, minimum legal drinking age, regression discontinuity design

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1 Introduction

Alcohol consumption impairs a person's capacity to make decisions. The more alcohol individuals consume, the more they are willing to take risks, potentially leading to accidents, injuries, and unintentional deaths (Bonnie & O'Connell, 2004). A recent body of literature points to considerable health consequences and social costs of legal access to alcohol (e.g., Carpenter & Dobkin, 2009, 2015, 2017; Conover & Scrimgeour, 2013; Hansen & Waddell, 2018). Despite these adverse effects, drinking is culturally acceptable in many regions of the world, especially in high-income countries, which have the highest per capita levels of alcohol consumption and the highest prevalence of current drinkers (World Health Organization, 2018). Young people are particularly vulnerable to the immediate negative effects of alcohol consumption for at least three reasons. First, they usually lack experience of alcohol, second, despite drinking less frequently, they tend to drink more heavily than adults, and third, heavy alcohol consumption at a young age impairs brain development (e.g., Bonnie & O'Connell, 2004).

A wide-spread and accepted measure to protect minors from the harm of alcohol consumption is the introduction of a minimum legal drinking age (MLDA) law. Typically, a MLDA legislation determines a single age threshold below which the purchase and public consumption of alcohol is not permitted (Shults et al., 2001). Although the objective of an MLDA is unambiguous, some advocate a higher MLDA and others are in favor of a relatively low MLDA. Proponents of a high MLDA aim to keep adolescents away from alcohol for as long as possible. Those defending a low MLDA, in contrast, argue that placing trust in young people and allowing them to have experience of drinking at an earlier age leads to more responsible use of alcohol. The literature on the effects of MLDA laws on health outcomes almost exclusively focuses on countries with a single MLDA (e.g., US, Canada, New Zealand). The common finding of the studies conducted is that legal access to alcohol leads to immediate negative health consequences (e.g., Carpenter & Dobkin, 2009; Carpenter et al., 2016; Conover & Scrimgeour, 2013). This is why there is an ongoing debate on determining the "optimal" single MLDA. However, to date, little attention has been paid to alternative MLDA laws.

In this study, we investigate the mortality effects of two age-related restrictions on legal access to alcohol imposed at age 16 and 18 years in Germany. The German MLDA legislation differs from many other countries' laws, as it constitutes stepwise, age-dependent increases in access to alcohol. In fact, the MLDA cutoffs differentiate between the type of alcoholic beverages that are allowed to be purchased and consumed. The two age thresholds reached when an individual turns 16 and 18 distinguish between three different legal regulations.[1] First, young people aged between 14 and 16 years are prohibited from buying and publicly consuming alcohol. However, when accompanied by a parent or legal guardian, they are allowed to drink fermented alcoholic beverages, such as wine, beer, and sparkling wine. Second, adolescents aged 16-18 years are permitted to buy and consume wine, beer, and sparkling wine without the supervision of a legal guardian. Third, according to the German Youth Protection Act, individuals aged 18 and over are legally permitted to purchase and publicly consume all types of alcoholic beverage.

We examine whether there are discontinuities in mortality at age 16 and at age 18 by estimating a regression discontinuity (RD) design, taking advantage of the fact that the German legislation generates sharp differences in legal access to alcohol at two early age thresholds, the 16th and the 18th birthday.[2] We use two high-quality administrative data sets for our main analyses. The national Cause-of-Death Statistics comprise the exact age at death and the cause of death for all individuals, resident in Germany, who died between January 1992 and December 2015. In total, our data includes 44,194 deaths of adolescents aged 14-19 years. The data enables us to accurately assess the impact of legal access to alcohol on several cause-of-death categories, such as motor vehicle fatalities, alcohol- and drug-related deaths, homicides, and suicides. However, there is a potential threat to our identification strategy: at both age thresholds, individuals are also allowed to acquire a certain type of driving license (e.g., a moped license at age 16, and a license to drive a motorbike or a car at 18). In other words, there is a co-treatment at both cutoffs that is likely to be relevant for our outcome of interest, i.e., mortality. We tackle this issue by using national Road Traffic Accident Statistics, our second set of high-quality administrative data. The Road Traffic Accident Statistics comprise all mo-

[1] We do not examine possible mortality effects at age 14 in our study, because (fortunately) very few children die at around this age. Additionally, it is unlikely that the legal right to consume alcohol when accompanied by a legal guardian has an immediate impact on death rates.

[2] By way of comparison, the German MLDA law allows legal access to alcohol 3–5 years earlier than in the United States.

tor vehicle accidents in Germany for the period 2002–2015. Most importantly, it enables us to distinguish between alcohol- and non-alcohol related traffic fatalities. We are thus able to almost completely separate the effect of being allowed to drink from the effect of being allowed to drive. Third, drawing on a new register-based internet survey data set among young people (Youth Leisure Online Survey, YOLO), we also study drinking behavior and enforcement of the MLDA in Germany.

Both at age 16 and 18, a discontinuous jump in the total number of deaths is observed. This is primarily caused by a relatively large increase in deaths due to motor vehicle accidents (MVAs). However, since being given legal access to specific alcoholic beverages coincides with permission to acquire a certain type of driving license at age 16 as well as at age 18, we distinguish between alcohol- and non alcohol-related fatal motor vehicle accidents. We find no compelling empirical evidence that alcohol-related motor vehicle fatalities discontinuously increase at either age threshold. Thus, the increase in deaths due to MVAs around the age thresholds is most likely to be the consequence of the legal right to drive, i.e., a novice driver effect, but is unlikely to be due to drunk driving. Further, the RD estimates show that at both age thresholds, having legal access to alcohol does not cause statistically significant, discontinuous increases in the number of deaths due to internal causes, alcohol-related deaths, drug-related deaths, homicides, suicides, and other external causes of death. Various sensitivity analyses confirm our results (e.g., using kernel weights, varying bandwidths, applying a "birthday donut", different sample selections, alternative definitions of the dependent variables, balance tests, and placebo regressions at the age thresholds of 17 and 19 years). The gender-specific analyses show that young men are the main drivers of the findings at both age thresholds. In sum, we conclude that the German MLDA legislation has, at most, a very marginal impact on mortality in the short-run, although the RD estimates from the register-based internet survey show a significant change in drinking behavior at both age thresholds.

This paper contributes to the MLDA literature in several ways. First, to the best of our knowledge, it is one of the first studies to empirically investigate the mortality effects of a legal drinking age law that gradually introduces young people to alcohol.[3] Unlike the United States

[3]We are aware of only one other recent working paper by Heckley et al. (2018) that investigates the health effects of the Swedish MLDA. In Sweden, there are also two legal drinking age thresholds, the 18th and the 20th

and many other countries, the German law essentially constitutes two different and relatively early age thresholds for the legal access to alcohol, allowing adolescents to drink legally at the ages of 16 and 18. At the same time, our findings are contrary to most of the existing studies investigating the health effects of MLDA laws that constitute one single age threshold for all types of alcoholic beverages. Our study thus provides a new contribution to the ongoing debate on the "optimal" legal drinking age law. Second, in line with Lindo et al. (2016), we find that legal access to alcohol does not inevitably lead to an immediate increase in fatalities due to drunk driving among young people. Third, our study complements the vast MLDA literature by providing findings on the link between MLDA laws and mortality for a European country.[4] Moreover, we are not aware of any study that empirically assesses the impact of the German legal drinking age legislation on mortality. In light of this, we examine the consequences of early legal access to alcohol in an affluent country with low youth unemployment rates and a distinct drinking culture, where alcohol is comparably cheap[5], and where drinking alcohol in public is both legal and commonplace.

The remainder of the paper is structured as follows. The next section reviews the related literature, and section 3 describes the relevant legal context in Germany. Section 4 describes the data, section 5 discusses the RD design, and section 6 presents the main results. Section 7 presents estimates separately by gender, and section 8 probes the robustness of the findings. The final section concludes.

2 Related Literature

There is a large body of literature on the effects of MLDA laws on health and social outcomes. In a review of the literature, Wagenaar & Toomey (2002), for example, identify 241 studies published between 1960 and 2000 that empirically evaluate various MLDA laws. Many of these studies find that the MLDA is significantly inversely related to alcohol consumption (e.g., O'Malley & Wagenaar, 1991; Dee, 1999) and (fatal) traffic collisions (e.g., Joksch & Jones,

birthday. However, the thresholds do not regulate legal access to different alcoholic beverages, but instead they differentiate between the sale of alcohol on licensed premises and off-license sales.

[4]So far, there is very little empirical evidence on legal access to alcohol and health outcomes from Europe, with the exception of the studies by Heckley et al. (2018) and Datta Gupta et al. (2017).

[5]Price levels for alcoholic beverages are below the 2017 EU-28 average (Eurostat, 2017).

1993; Ruhm, 1996) that is, a higher MLDA is associated with a reduction in alcohol consumption and the number of traffic accidents, and vice versa.[6] However, not all studies estimate causal effects and, as Carpenter & Dobkin (2009) point out, policy endogeneity might be a concern for studies utilizing variation in the MLDA across US states in the 1970s and 1980s.

Carpenter & Dobkin (2009) address these issues by using a RD design exploiting that the MLDA in the US produces sharp differences in legal access to alcoholic beverages at age 21. The more recent MLDA literature largely adopts this empirical approach and finds, independent of the country under examination, that drinking behavior discontinuously changes when legal access to alcohol is given: Drinking participation, drinking frequency, and drinking intensity, or a multiple of these measures for alcohol consumption, discontinuously increase at the MLDA (e.g., Carpenter & Dobkin, 2009; Carpenter et al., 2016; Yörük & Yörük, 2011; Deza, 2015; Lindo et al., 2016).

Our outcome of interest, mortality, is presumably the most frequently used health outcome in the MLDA literature, while morbidity has been of increasing interest (e.g., Conover & Scrimgeour, 2013; Callaghan et al. 2013; Carpenter & Dobkin, 2017). The studies by Carpenter & Dobkin (2009) and Carpenter et al. (2016) are closely related to our work. The former study employs US data and finds a statistically significant discontinuous rise in overall mortality of nine percent at age 21, which is the US MLDA. The mortality effect is driven by deaths caused by external factors, with significant increases in deaths caused by motor vehicle accidents, alcohol-related deaths, and suicides. The heterogeneity analysis by gender reveals that the effects are largely driven by young men. Carpenter et al. (2016) scrutinize the same issue in the Canadian context. They also discover a significant discontinuous jump in total deaths of about six percent at the MLDA, which is almost completely driven by a rise in deaths caused by motor vehicle accidents. As in the US, the results are mainly driven by men.

A number of recent studies focus on the link between the MLDA and (fatal) motor vehicle accidents. The RD results of Callaghan et al. (2014) confirm the impact of the MLDA on motor vehicle collisions in Québec. However, Lindo et al. (2016), who use data for New South Wales (Australia), and Boes & Stillman (2017), who study an MLDA reduction in New Zealand,

[6] See also Shults et al. (2001), McCartt et al. (2010), Voas et al. (2003), Kypri et al. (2006), Fell et al. (2008), Lovenheim & Slemrod (2010).

produce contradictory results. Implementing a RD design, Lindo et al. (2016) find no empirical evidence that legal access to alcohol at age 18 increases the risk of being involved in an accident, despite observing significant increases in drinking behavior and hospitalizations due to alcohol abuse. Boes & Stillman (2017) conclude that reducing the MLDA from 20 to 18 in New Zealand did not lead to an increase in adverse outcomes for young people due to road accidents.[7] The findings for Australia and New Zealand suggest that the results of the MLDA studies on the US may not necessarily generalize to other countries, with potentially different norms, cultures, institutions, and alcohol control policies.

It is striking that the MLDA literature predominantly provides empirical evidence for the US, Canada and, more recently, for Australia and New Zealand—all countries that prescribe a single minimum legal drinking age. Apart from our own study, the recent working paper by Heckley et al. (2018), is the only article that examines the health effects of a MLDA law stipulating more than one legal drinking age. The authors investigate the effects of Sweden's two-part MLDA legislation on alcohol consumption, hospitalization, and mortality. They exploit the variation in MLDA laws at age 18 for the purchase of alcohol on licensed premises (i.e., consumption of alcohol at bars, clubs, and restaurants) and at age 20 for off-license purchases of alcohol using a RD design.[8] Heckley et al. (2018) find that drinking participation and frequency significantly increases at age 18, whereas hospital visits discontinuously increase at both age cutoffs due to external causes. The authors detect a large relative discontinuous rise in deaths at age 18, which is caused by a jump in motor vehicle fatalities. In Sweden, similar to Germany, young people may apply for a driving license when they turn 18. However, Heckley et al. (2018) are unable to disentangle alcohol-related from non-alcohol-related fatal motor vehicle accidents.

[7] Boes & Stillman (2017) conduct a threefold analysis: they use an event history approach, an RD design, and they estimate flexible parametric models. Their RD estimates show that motor vehicle accidents discontinuously increased after the MLDA was reduced, but this seems to have been a short-term phenomenon.

[8] In this respect, the Swedish MLDA laws differ from the equivalent German legislation. The German legal drinking age thresholds regulate legal access to specific alcoholic beverages. The Swedish MLDA law, in contrast, immediately grants legal access to all alcoholic drinks at age 18, but only under the supervision of the licensee. This restriction is removed at age 20.

3 Institutional Background

This section briefly summarizes the key aspects of Germany's legislation on legal access to alcohol, its age-based laws concerning attendance at public events, its driving license regulations, and its drunk driving laws. We also stress the relatively low alcohol prices in Germany.

Legal access to alcohol. By stipulating several age limits for different alcoholic beverages, German legislation on access to alcohol differs from many other countries' laws. The age thresholds and the regulations concerning the sale of alcoholic beverages are embodied in the German Youth Protection Act (*Jugendschutzgesetz*, Section 9). This law forbids persons under the age of 14 to purchase and consume alcohol in public.[9] Adolescents aged between 14 and 16 are prohibited from publicly consuming alcohol. However, if they are accompanied by a legal guardian, they are allowed to drink fermented alcoholic beverages, such as wine, beer, or sparkling wine. Adolescents aged 16 and older, however, are entitled to buy and consume wine, beer, and sparkling wine without the supervision of a legal guardian. From the age of 18, the German Youth Protection Act legally permits the consumption and purchase of all types of alcoholic beverage. This MLDA legislation was applicable law for the whole observation period (1992-2015).[10]

Attendance at public events. The Youth Protection Act also regulates the age at which young people are allowed to enter bars, restaurants, and clubs. From their 16th birthday, adolescents are allowed to visit bars and restaurants unaccompanied until midnight.[11] When they turn 18, individuals have the right to go out to bars, restaurants, and clubs for as long as they wish and to frequent all legal establishments of their choice. Thus, individuals are given additional legal entitlements in terms of going out when they turn 16 and 18, respectively. This, in turn, could increase the consumption of alcohol.[12]

Driving license regulations and drunk driving laws. One important institutional aspect

[9]Underage drinking on private premises is not regulated by the Youth Protection Act, but rather falls under parental responsibility.

[10]The only actual change to German MLDA legislation was in 2004. On July 23, 2004, an additional subparagraph was added to Section 9 of the Youth Protection Act. This addendum, forbidding the sale of alcopops (i.e., alcohol mixed with soft drinks) to anyone under the age of 18, entered into force on September 30, 2004. We address this point in the robustness section below.

[11]In general, this does not include bars and clubs that are run as late-night bars or night clubs.

[12]In the online Appendix, we present and discuss the going-out behavior of Germany's youth using survey data from the *Bundeszentrale für gesundheitliche Aufklärung* (Table A-1).

for our RD design is the right to obtain specific types of driving license at age 16 and age 18. From the age of 16, individuals are allowed to drive certain types of light motorcycle, and from the age of 18, they can drive regular cars.[13] Thus, we face the challenge of a co-treatment at both relevant age thresholds, the 16th and the 18th birthday. During the observation period, there were no significant changes to the Driving License Regulation (*Fahrerlaubnis-Verordnung*). The only potentially relevant change was the implementation of the accompanied driving program (AD17, *Begleitetes Fahren mit 17*). This is a special regulation allowing individuals to acquire a regular driving license, normally only possible from age 18, already at the age of 17. The constraint is that a predetermined accompanying person acts as co-driver. By January 1, 2008, all federal states had voluntarily implemented the accompanied driving program.

The German drunk driving laws are embodied in the Road Traffic Act (*Straßenverkehrsgesetz*). In recent years, these laws have become increasingly strict: The general blood alcohol concentration (BAC) limit for drivers has been lowered over time and a zero BAC limit came into force for young and inexperienced drivers. We discuss these legal changes in detail in the robustness section.

Alcohol prices. Finally, it is important to point out that we are examining the consequences of legal access to alcohol in a high-income country where the price of alcohol is comparably low. Prices for alcoholic beverages in Germany are lower than the European Union average, with a price level index of 84, relative to the European mean of 100 (Eurostat, 2017). Germany thus constitutes an interesting case study: Potentially larger negative effects of early MLDA thresholds on mortality and health outcomes might be expected when alcohol is relatively cheap and affordable for young people, compared to countries with higher relative prices for alcoholic beverages.[14]

[13]For some types of light motor vehicle, no driving license is required at all. In order to apply for a license to drive these vehicles, individuals need to be at least 15 years of age. Some driving licenses permiting individuals to drive special vehicles (e.g., specific tow vehicles) can only be acquired beyond the age of 18.

[14]A comprehensive body of literature documents that alcohol consumption is sensitive to prices. See, for example, Cawley & Ruhm (2012), Gallet (2007) and references therein.

4 Data

We use three data sets: two administrative data sets and a self-conducted online survey. The administrative data are our main data sets.

The two high-quality administrative data sets used are the official Cause-of-Death Statistics (1992-2015) and the Road Traffic Accident Statistics (2002-2015). The data are supplied by the German Research Data Centers of the Federal Statistical Office and Statistical Offices of the Länder. For both data sets, we use the maximum number of years available.[15]

The Cause-of-Death Statistics comprise the universe of all individuals with residence in Germany, who died between 1992 and 2015. Most important for our empirical strategy, the data set contains the exact age at death and the cause of death of every single deceased person. The information is obtained from the respective death certificates. The age at death is reported in years, months (0-11), and days (0-30), which unavoidably leads to the slight inaccuracy that each year consists of only 361 days. However, this minor imprecision is immaterial, since it does not affect the relevant age thresholds of our RD design, i.e., the 16th and 18th birthday.[16] The causes of death are reported according to the World Health Organization's International Classification of Diseases (ICD).[17] We distinguish between different cause-of-death categories. The first outcome measure includes all deaths. We then divide all deaths into two separate categories: deaths caused by internal factors and deaths caused by external factors. Next, we further divide the category of deaths caused by external factors into two mutually exclusive subgroups: deaths due to motor vehicle accidents (MVAs) and deaths due to external causes, excluding MVAs. The latter category consists of suicides, homicides, drug-related deaths, alcohol-related deaths, and deaths due to other external causes, each of which is closely related to excessive

[15]Summary statistics are reported and discussed in the online Appendix (see Table A-2 and Table A-3).

[16]For reasons of confidentiality, neither the birthday nor the exact day of death of the deceased individuals are included in the data. Thus, we calculate the age at death measured in days as follows: $Age\ at\ death = days\ at\ death + 30 * months\ at\ death + 361 * years\ at\ death$. As a result, an individual who died at the age of 17 years, 3 months, and 30 days, for example, has the same Age as an individual who died at the age of 17 years and 4 months. In contrast, a person who died at the age of 17 years, 11 months, and 30 days has a different Age to an individual who died on their 18th birthday.

[17]One single cause of death for each deceased person, typically the underlying disease, is recorded in the Cause-of-Death Statistics (Statistisches Bundesamt, 2017b). Additionally, the data indicates whether external causes, such as road accidents, played a pivotal role in an individual's death. The data contains the ninth (ICD-9, up to and including 1997) or tenth revision (ICD-10).

drinking (e.g., Bonnie & O'Connell, 2004).[18] We explicitly focus on deaths due to MVAs as it is precisely this form of death that is likely to be affected by the co-treatment, i.e., being allowed to acquire a certain type of driving license, at both relevant age thresholds. We aim to collect data only on those deaths in the MVA category, where the deceased person was the actual driver of a motor vehicle.[19] However, accurately identifying the deceased drivers is only possible to a certain extent.[20] We therefore distinguish between two MVA outcome variables, one can be interpreted as a lower and the other as an upper bound for the number of dead drivers. The first measure, MVAs, includes deceased individuals, some of whom might not necessarily be the driver. The second outcome variable, MVAs-adjusted, solely captures deaths where it is explicitly recorded that the deceased individual was the driver of a motor vehicle. This category presumably underestimates the real number of dead drivers and can be interpreted as a lower bound.[21]

Road Traffic Accident Statistics, our second main data set, contain the universe of all traffic accidents that occurred on German roads between 2002 and 2015. The information stems from the relevant police reports. Most importantly, the statistics include the age of each driver (year and month of birth) at the time of the accident, whether the driver involved in the accident died or not, and whether the driver was alcoholized or not.[22] Given this information, we are able to almost completely disentangle the effect of obtaining a driving licence (co-treatment) from the treatment effect of interest, i.e., having legal access to alcohol. Again, we construct different cause-of-death categories. First, we create a category which comprises all deceased drivers. We then split this category into two mutually exclusive subcategories: deceased drivers who were under the influence of alcohol at the time of the accident, and those who were not.

[18] We adopt the definition used by Carpenter & Dobkin (2009) for alcohol-related deaths, meaning that all deaths where alcohol is explicitly mentioned are included in this subgroup, irrespective of whether the cause of death is external or internal. The category "deaths due to other external causes" mainly contains accidental fatalities, such as deaths from falls, burns, and drowning. Among others, this subcategory also includes dead cyclists, pedestrians, horseriders, and passengers of motor vehicles.

[19] Our definition of the MVA category differs from other related studies. Typically, deceased passengers and sometimes even pedestrians, cyclists, or horseriders are also included in the MVA category (e.g., Carpenter & Dobkin, 2009). See online Apendix A for details.

[20] For some fatal MVAs, it is not specified whether the deceased person was the driver of the motor vehicle involved in the accident or a passenger. This is the case, for example, when just a three digit ICD code is reported instead of a more detailed four digit ICD code.

[21] Table A-4 provides an overview of the exact coding.

[22] In the Road Traffic Accident Statistics, drivers are regarded as alcoholized when they are found to have a blood alcohol level of 0.3 or more, which is the German threshold for "relative alcohol-related driving inability".

The double treatment concerns only the former subcategory, whereas the latter category should solely account for "novice driver effects" in our RD analyses.[23]

Third, we draw our own register-based online survey—the Youth Leisure Online Survey (YOLO)—to elicit drinking behavior and enforcement of the MLDA law in Germany.[24] YOLO also enables us to conduct balance tests for pre-determined variables around the threshold. Around 17,000 individuals aged 14 to 19 participated in the survey. In the online Appendix, we provide comprehensive information on the sampling strategy, report summary statistics, and compare the YOLO data with a representative sample of young people for the whole of Germany from the Federal Centre for Health Education (BZgA) (Tables A-5, A-6, and A-7).

5 Empirical Strategy

Our empirical strategy exploits the sharp differences in legal access to alcohol occurring at ages 16 and 18 years. To ascertain the treatment effects of interest, we estimate the population model

$$Y_j = \alpha + \tau D_j + f(age_j, D_j) + \epsilon_j \tag{1}$$

by means of local linear or local quadratic regressions as recommended by Gelman & Imbens (2018).[25] The observation unit, j, is the distance to the respective cutoff measured either in days (Cause-of-Death Statistics) or in months (Road Traffic Accident Statistics). In the administrative data sets, the outcome, Y_j, is the logarithm of the number of deaths for a specific cause-of-death category calculated for each j.[26] In the YOLO data set, the outcomes are dichotomous

[23]The Cause-of-Death Statistics and the Road Traffic Accident Statistics are not coherent. The former contains all individuals *resident in* Germany who died in the wake of an road accident. The latter, in contrast, includes all road fatalities that happened *within* Germany (Statistisches Bundesamt, 2017a).

[24]In 2018, we randomly sampled 120 registry offices (*Einwohnermeldeämter*) in three federal states (Saxony, Thuringia, Brandenburg), purchased 80 percent random samples of young people and invited them to participate in an online survey. The three states were chosen because they use the same registry software which facilitated the execution of the survey and allowed us to provide the registries with instructions on how to randomly draw the samples.

[25]See also Hahn et al. (2001) and Fan (1992).

[26]Alternatively, we could use death rates as the outcome variable. However, denominators of death rates are prone to measurement error in finite samples, which leads to less precise estimates even when using advanced methods to predict these denominators as proposed by Black et al. (2015). Using the logarithm of the number of deaths and pooling data for the period from 1992 to 2015 (combining cohorts) should smooth fluctuations across different age groups. In addition, $f(age_j, D_j)$ should capture the remaining age-related variation. We add 0.5 to all outcomes prior to taking logs to account for observations with zero deaths. Carpenter & Dobkin (2009) and Heckley et al. (2018) deal with zeros in the same way. To test whether the results are sensitive to the construction

and measure drinking behavior and enforcement.[27] D_j is the binary treatment variable being equal to one for individuals who had reached the respective cutoff age, and zero otherwise. Thus, τ is the parameter of interest that identifies the immediate causal effect of having legal access to specific alcoholic beverages on mortality and drinking behavior. τ can be interpreted as an intention-to-treat (ITT) effect: Treatment is inevitable after passing the respective age threshold, but not every treated individual exercises their legal right to access specific alcoholic beverages. α is the intercept, ϵ_j is a random error term, and $f(age_j, D_j)$ is some smooth low order polynomial (linear or quadratic) function of age_j. It also includes a full set of interaction terms between D_j and the polynomials. We thereby allow for different trends on each side of the respective cutoff, because the relationship between age and mortality might change due to treatment. The forcing variable, age_j, is centered at the respective age threshold. In our main specifications, we do not employ weights, which is equivalent to applying a uniform kernel as a weighting function, we use robust standard errors, and we select a bandwidth of two years. This is the largest reasonable bandwidth that we can choose, because the relevant age thresholds are two years away from each other.[28]

The underlying assumption is that individuals around the respective age threshold are similar in terms of the observable and unobservable characteristics that influence the outcome. The validity of the identification strategy is ensured if the expected values of counterfactual outcomes conditioned on the forcing variable are continuous (McCrary, 2008).[29] As shown by Lee & Lemieux (2010), these continuity assumptions are satisfied if individuals are unable to *precisely* manipulate the forcing variable, which implies local randomization of the treatment around the cutoff. The forcing variable in the present RD setting is age (time) and *exact* self-selection is therefore unlikely to be a concern. A further prerequisite is that no additional

of the outcomes, we also report results below, where 1 instead of 0.5 was added to the dependent variables before taking logs.

[27]In YOLO, the RDD regressions are estimated at the individual level.

[28]Since RD estimates tend to be sensitive to the choice of bandwidth, we also show the results for more than twenty smaller bandwidths. Further, to examine the robustness of our findings, we run regressions in which a triangular kernel is used as a weighting function, we control for potential birthday celebration effects, and we conduct placebo regressions at the age thresholds of 17 and 19. We also address several other issues in the robustness section that are specific either to the German context or to the data we are using.

[29]In our case, it is essentially a matter of the continuity of the functions $E[Y(1)|age]$ and $E[Y(0)|age]$, where $Y(1)$ is the outcome with treatment and $Y(0)$ is the outcome without treatment. In fact, Hahn et al. (2001) show that continuity of $E[Y(0)|age = c]$, where c is the respective age cutoff, is all that is needed for identification.

treatment should occur at the respective age threshold as this would make potential treatment effects hard to disentangle. This requirement is a challenge in our context, since, in Germany, individuals are legally entitled to acquire certain types of driving license at age 16 and 18. Fortunately, our high-quality administrative data enables us to almost completely separate the effect of being allowed to drink from the effect of being allowed to drive.

6 Main Results

6.1 Alcohol Consumption and Enforcement

To set the scene, we first examine the effects of the MLDA thresholds on drinking behavior and enforcement. Table 1 presents the estimated RDD results for eight different drinking outcomes from the Youth Leasure Online Survey (YOLO). We report estimates of τ from equation (1) with both a linear and a quadratic function of age and each point estimate comes from a different regression. The estimates in columns (1) and (2) of Table 1 show that turning 16 increases the likelihood of ever having consumed alcohol by 8-13 percentage points (15-24 percent)[30] and is statistically significant at the 1 percent level. Similarly, there is a noticeable increase in the propensity of alcohol consumption in the last four weeks (8-16 percentage points; 19-38 percent), in the last seven days (4-12 percentage points; 17-50 percent), and on binge drinking (by around 3 percentage points; 100 percent). Consistent with the MLDA legislation for 16–17-year-olds, which prohibits the consumption of liquors, there is no clear and robust jump in self-reported consumption of liquor.

Columns (3) and (4) in Table 1 contain estimates of the effects of the second age threshold (18th birthday) on drinking behavior. The results show smaller and less precisely estimated increases in alcohol consumption and no significant increases in binge drinking. This might indicate that young people learn (weiter) In contrast to the findings around the 16th birthday, we find a significant increase in liquor consumption by 5-6 percentage points (23-27 percent) among the 18–19-year-olds. Figures A-1, A-2, A-3 in the online Appendix display the findings for the drinking behavior outcomes for both age thresholds. The graphical evidence confirms

[30]Evaluated at the proportion of 14–15-year-olds who report ever having consumed alcohol in their lifetime. See Table A-5 in the online Appendix. We consistently use the precise way of calculating the percentage changes throughout the paper, i.e., $100 * [exp(\hat{\tau}) - 1]$.

the findings in Table 1.

Figure 4 summarizes RDD point estimates for 12 additional outcome measures, which help us to shed some light on the enforcement of the MLDA laws. The dichotomous outcomes capture (1) whether young people state that getting hold of beer and wine (liquor) is difficult; (2) the locations where they drink (at home, in public places, restaurants, bars/discos, friends' homes); (3) the locations where they buy alcoholic beverages (supermarkets, kiosks/gas stations, bars/discos/restaurants); (4) whether they receive alcoholic beverages from friends or relatives.[31]

In line with the MLDA laws, the estimated results in the upper left panel show that it is significantly easier to get hold of beer and wine for 16-17-year-olds, but not to get hold of liquor (with a point estimate being very close to zero). They are also significantly more likely to drink at home, in restaurants, bars, discos, and at friends' houses. The same is true for buying alcohol in off-premises. The likelihood of receiving alcoholic beverages from friends drops by around 18 percentage points when a young person turns 16, suggesting that some young people below the MLDA were partly successful in bypassing the law.

The findings in the right panel for the 18th birthday cutoff suggest that young people are not more likely to consume alcohol outside the home when aged 18 or older, but find it less difficult to buy liquor, which is again consistent with the German MLDA law. In sum, we interpret the results in Figure 4 as suggestive evidence for a certain degree of strictness of enforcement of the MLDA laws. However, there are ways to circumvent the laws, in particular by having older friends who are legally allowed to buy alcoholic beverages and who pass these beverages on to their younger peers. We now turn to our main empirical findings and examine whether these behavioral changes result in an increase in mortality and motor-vehicle fatalities.

6.2 Cause-of-Death Statistics

In this section, we report the main results of our RD analyses using the Cause-of-Death Statistics. The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category with the distance from the respective age threshold measured in days serving

[31]The outcomes are not mutually exclusive.

as the observation unit. Figure 1 graphically presents our findings for the first three outcome variables: all deaths, deaths due to internal causes, and deaths due to external causes for both the 16th and 18th birthday. The dots represent the 30-day averages of the respective outcomes. We also plot fitted lines of unweighted regressions for the linear and quadratic specification for each outcome, respectively. Figure 1 shows discontinuous positive jumps for the outcomes all deaths and deaths due to external causes at both cutoffs, irrespective of the polynomial specification. The discontinuities are more pronounced at the 18th birthday. However, the figure does not reveal any discontinuities for deaths due to internal causes at the thresholds, which means that the jumps in overall mortality at both thresholds are entirely driven by deaths due to external factors.

Figure 2 shows equivalent graphs for the two mutually exclusive subcategories of deaths due to external causes and for the outcome MVAs-adjusted.[32] For both MVA-outcomes, large jumps are visible at the 16th and 18th birthday. In contrast, no discontinuities in the outcome deaths due to external causes excluding MVAs are visible at the cutoffs, instead a continuous linear trend in age can be observed. These findings reveal that the discontinuities in deaths caused by external factors at the 16th and 18th birthday are entirely driven by the relatively large discontinuities in MVA-related deaths occurring at both age thresholds.

Table 2 reports the corresponding RD point estimates of the various local linear and local quadratic regressions. Columns (1) and (2) of Table 2 refer to the first cutoff (age 16), the last two columns relate to the second cutoff (age 18). Each estimate stems from a separate regression. All jumps detected in Figures 1 and 2 are statistically significant at least at the five percent level. At the 16th birthday, we find a statistically significant discontinuous increase of 11-15 percent in overall mortality. Relative to the total number of 14–15-year-olds who died in Germany between 1992 and 2015 (see Table A-2 in the online Appendix), this is equivalent to 833-1,136 additional deaths occurring at the threshold. There are relatively small and insignificant estimated discontinuities in deaths due to internal causes and deaths due to external causes excluding MVAs at the first cutoff. Externally caused deaths discontinuously rise by about 23-28 percent at age 16. For MVA-related deaths, we find an increase of around 61-91 percent at

[32]The 30-day averages for the outcome MVAs-adjusted were deleted by the German Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder for reasons of confidentiality.

the 16th birthday. The discontinuous jump for the outcome MVA-adjusted is between 67 and 100 percent. The large relative changes in MVA-related deaths are plausible for two reasons. First, very few individuals aged 14-15 died as a result of an MVA. Second, at age 16, individuals can apply for permission to drive specific light motor vehicles, which is not legally possible at younger ages.

At the 18th birthday, overall mortality significantly increases by around 34-36 percent. With respect to all 16–17-year-olds who died between 1992-2015, this corresponds to 4,626-4,899 additional fatalities occurring at age 18. This jump is driven by a 50-53 percent rise in deaths due to external factors. MVA-related deaths discontinuously increase by 119-124 percent at the second cutoff. For the outcome MVAs-adjusted, the estimated size of the jump is in the order of 168-195 percent. The results at the 18th birthday are very similar to those at the 16th birthday, but are more pronounced in terms of magnitude.[33]

Overall, we find no jumps at either age threshold for deaths caused by external factors once MVA-related fatalities are excluded. Table 3 reports the results for the five subcategories of deaths due to external causes excluding MVAs: alcohol-related deaths, drug-related deaths, homicides, suicides, and deaths due to other external causes, none of which should be impacted by the co-treatment of obtaining a driving licence. There are no statistically significant discontinuities at either cutoff for these categories, regardless of the polynomial specification used.

To sum up, we find considerable discontinuous increases in overall mortality at the 16th and 18th birthdays. These jumps are driven by the discontinuities in deaths caused by external factors, which, in turn, are evoked by relatively large changes in MVA-related deaths at both age cutoffs. Since the MVA categories are affected by the co-treatment, the discontinuous increases in MVA-related deaths, deaths due to external causes, and all deaths at the cutoffs cannot be ascribed to our treatment of interest alone. Instead, these discontinuities should be interpreted as a combined effect of having legal access to specific alcoholic beverages and being allowed to acquire certain types of driving license. However, for the causes of deaths unaffected by the

[33]The estimated relative changes for both MVA categories are considerably larger than the estimated relative increases in deaths due to MVAs in the US and Canada at the respective MLDA (e.g., Carpenter & Dobkin, 2009; Carpenter et al., 2016). This is unsurprising , since in the German context, the estimated jumps capture drunk driving and novice driver effects. Note also, that our definition of the MVA categories differs from Carpenter & Dobkin (2009) and Carpenter et al. (2016).

co-treatment, we do not detect significant mortality effects at either cutoff. This implies that our treatment of interest, i.e., having legal access to specific alcoholic beverages, does not play a role in these instances of death, at least in the short term. In the next step, we conduct a more in-depth examination of the MVA categories with the aim of isolating the effect of having legal access to alcohol from the effect of being entitled to acquire a specific type of driving license. Since this is not possible using the data at hand, we draw on the Road Traffic Accident Statistics.

6.3 Road Traffic Accident Statistics

Figure 3 presents the results graphically. Again, the respective dependent variable is the logarithm of the number of deaths for a specific cause-of-death category.[34] We consider three death categories. The superordinate category comprises all dead drivers. We then divide this category into two mutually exclusive outcomes: dead drivers who were under the influence of alcohol at the time of the accident and those who were not.[35] At both cutoffs, there are distinctive jumps for all dead drivers and those who were not under the influence of alcohol at the time of the accident, irrespective of the polynomial specification. Concerning the deceased drivers who were under the influence of alcohol at the time of the fatal accident, the graphic findings are inconclusive. At age 16, a small discontinuity is visible in both the linear and the quadratic case. The polynomial specification, in contrast, is relevant at the second age threshold. The linear specification exhibits a small discontinuity, whereas no jump is detectable when the quadratic term of the forcing variable and its interaction with the treatment indicator is added to the model.

Table 4 presents the corresponding RD point estimates. At the first cutoff, we find a discontinuous increase of 117-166 percent in the number of deceased drivers. In relation to the number of dead drivers among the 14–15-year-olds (see Table A-3 in the online Appendix), this corresponds to an additional 87-123 fatal road accidents occurring at age 16. The point estimate of the discontinuity of the linear specification is significant at the one percent level, whereas the

[34] The data enables us to observe the respective outcome only on a monthly basis. We know the exact date of each accident, but we only have information about the year and month of birth of each driver. Hence, we exclude deceased drivers who died at 192 or 216 months of age, since it is unclear whether these persons died before or after their 16th or 18th birthday, respectively.

[35] As before, we choose a bandwidth of two years and plot the fitted lines for both the linear and the quadratic specification for each outcome, respectively. The respective 30-day averages were deleted by the German Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder for reasons of confidentiality.

estimate for the quadratic specification is only significant at the ten percent level.[36] At the 18th birthday, the estimated size of the discontinuity in the total amount of dead drivers is in the order of 190-209 percent and statistically highly significant. Relative to the number of dead drivers in the 16-17 age group, this is equivalent to 1,465-1,611 deaths occurring at the second threshold. The discontinuities observed are similarly large in relative terms compared to those observed for the MVA categories. The results for dead drivers, who were not alcoholized, are very similar to those for the aggregate of all dead drivers with respect to the relative magnitude of the estimates at both cutoffs. Further, for this subcategory, all estimates of the jumps at age 16 and 18 are significant at least at the five percent level. We detect a discontinuous increase of 55-82 percent in the number of dead drivers who were alcoholized at the 16th birthday. This relative change appears to be quite large. However, compared to the total number of 14–15-year-old dead drivers who were alcoholized, this translates to "only" 4–6 additional deaths occurring at the first threshold. Moreover, the point estimates are not statistically significantly different from zero for either specification. The findings for the dead drivers, who were under the influence of alcohol, are contradictory at the second cutoff. In the linear specification, we predict a rise in fatalities of around 52 percent at age 18. By contrast, the quadratic specification estimates a decrease of 26 percent in the number of dead drivers, who were alcoholized. Further, neither point estimates are statistically significant.

Overall, the RD analyses for the Road Traffic Accident Statistics imply that the jumps in the total number of dead drivers at both cutoffs are largely driven by drivers who were not under the influence of alcohol at the time of the accident. For these deaths, our treatment of interest, i.e., having legal access to alcohol, has no impact. In contrast, the double treatment is relevant if the dead driver was alcoholized. One could argue that, at age 16, there is actually a combined mortality effect of being allowed to drink and being allowed to drive. However, this combined effect is extremely small in absolute terms and statistically insignificant. At age 18, it is ambiguous as to whether a double treatment effect on mortality even exists. In this respect, our findings are in line with Lindo et al. (2016) and Boes & Stillman (2017), who find that legal access to alcohol is not inevitably reflected in an immediate increase in mortality due to drunk

[36] This is not surprising, since adding polynomial terms of the forcing variable generally reduces the precision of the estimates. Further, due to the date restriction, the number of observations is rather small.

driving.

Connecting the results using the Road Accident Statistics with those using the Cause-of-Death Statistics, we conclude that the overall mortality effects both at age 16 and age 18 are mainly caused by a novice driver effect. On the other hand, the treatment of interest—having legal access to specific types of alcoholic beverage—plays a subordinate role at most.

7 Heterogeneity Analysis

7.1 Cause-of-Death Statistics

In this section, we examine whether there are gender-specific mortality effects at the two age thresholds. The results of the heterogeneity analyses using the Cause-of-Death Statistics are shown in Table 5.[37] We choose a bandwidth of two years in every regression and report robust standard errors. Columns (1) and (2) reveal that males account for our main findings at the first age threshold. Significant and substantial jumps in terms of relative size are detected for the outcomes all deaths and deaths due to external causes, which are mainly caused by relatively large and highly significant discontinuities in MVA-related deaths at age 16. We find no significant discontinuities for internal causes of death. We estimate a relative change of 13-14 percent in deaths caused by external factors excluding MVAs at age 16, which translates to about 225-242 deaths. This effect is moderate relative to the estimated 22-25 percent increase in overall male mortality at the first cutoff, which corresponds to roughly 1,000-1,136 deaths. The estimate of the linear specification is significant at the five percent level, whereas the estimated coefficient of the quadratic specification is insignificant. Thus, there is some indication that having legal access to beer, wine, and sparkling wine discontinuously increases the short-term mortality of men. In contrast, for women, the estimated discontinuities at age 16 are almost always negative and never statistically significant for the outcomes all deaths, deaths due to external causes, deaths due to internal causes, and deaths due to external causes excluding MVAs. At the first

[37]We also conduct heterogeneity analyses by region of residence, or more precisely, we run regressions separately for those deceased persons who were residing in western Germany and those who were residing in eastern Germany. The estimated discontinuities tend to be larger for eastern Germans at both cutoffs, except in the case of the MVA categories. The statistical significance of the respective point estimates is almost always identical. Results are presented in Table A-8 in the online Appendix. Similar analyses using the Road Traffic Accident Statistics are not possible, since we do not have information about the residence of the dead drivers.

threshold, we discover statistically significant jumps in MVA-related deaths for females in the linear specifications. However, in terms of both relative and absolute magnitudes, the estimated discontinuities are considerably smaller compared to those detected for males. In the quadratic specifications, the estimated jumps are not statistically significant for either MVA category.

Columns (3) and (4) depict the gender-specific results at the second age threshold. For each outcome and polynomial specification, the direction of the estimated discontinuity is, with one exception (the quadratic specification for internal causes of death), always the same for men and women. Overall, the estimated jumps at age 18 tend to be larger in relative terms for males, which is especially true when considering the MVA categories.

In summary, the gender-specific heterogeneity analyses reveal that the main results at age 16 can largely be attributed to the male mortality effects. At 18 years of age, the pattern is less pronounced in relative terms, but the mortality effects for men also drive the main results.[38] These findings are similar to those of Carpenter & Dobkin (2009) and Carpenter et al. (2016).

7.2 Road Traffic Accident Statistics

Table 6 depicts the gender-specific analyses using the Road Traffic Accident Statistics. The findings show that, at age 16, the main results are largely driven by the males. When considering only males, we detect huge relative and statistically significant jumps for all dead drivers and for those who were not alcoholized. The estimated discontinuity for dead drivers who were under the influence of alcohol is large in relative terms (105-114 percent). Moreover, the estimate of the linear specification is significant at the ten percent level. However, compared to the 14–15-year-old male dead drivers who were alcoholized, the estimated jump corresponds to approximately 6-7 deaths at age 16. It is important to bear in mind that these additional deaths occurring at the first threshold must be interpreted as the consequence of the combined effect of being allowed to drink specific types of alcoholic beverage and being allowed to acquire a specific type of driving license. Thus, having legal access to beer, wine, and sparkling wine plays, at most, a minor role in the death of male drivers dying in traffic accidents. For females, we only estimate insignificant jumps, which are much smaller in magnitude and even negative

[38]This becomes evident when we consider Table A-2: Between 1992 and 2015, over two thirds of deceased individuals both among 16-17 and 18–19-year-olds were males.

for deceased drivers who were under the influence of alcohol.

At the second age threshold, for both genders we find that the respective large relative and highly significant discontinuity in overall road fatalities is presumably entirely driven by novice drivers. When we consider all deceased female drivers, we find a highly significant discontinuous increase of 689-717 percent at age 18. This is an extremely large relative jump, but it is plausible when put into perspective. Referring to Table A-3, we know that approximately 73 female drivers aged 16-17 died between 2002 and 2015. Among the 18-19-year-olds, about 597 female drivers died in total. Thus, the estimated discontinuity corresponds to 503-523 deaths occurring at the second cutoff. The results in Table 6 lead us to the conclusion that all of these deaths are entirely due to a novice driver effect. The results for the males at the second age threshold are very similar to the main results (see Table 4). The males actually also drive the results at age 18, which is due to the fact that 90.5 percent of all 16–17-year-old and 79.1 percent of all 18–19-year-old dead drivers were males (see Table A-3).

8 Robustness Checks

In this section, we examine the robustness of our findings. For brevity, we mainly focus on the robustness checks for the Cause-of-Death Statistics using the linear specifications.[39] Sensitivity analyses for the Road Traffic Accident Statistics are presented in the online Appendix (see Tables A-11–A-14).

8.1 Sensitivity to the Choice of Bandwidth

RD estimates tend to be sensitive to the choice of bandwidth and we therefore report results for various different bandwidths.[40] Figure 5 depicts the extensive sensitivity analyses we conducted with respect to the bandwidth at the first cutoff using the Cause-of-Death Statistics. For each outcome, we run local linear regressions (LLR) for several different bandwidths.[41] With

[39] The findings of the quadratic specifications are qualitatively similar (see Table A-9 and Table A-10).

[40] There is no universal consensus on the most suitable bandwidth selection procedure, and several data-driven techniques are available, for example, the cross-validation approach (Ludwig & Miller, 2007) or the procedure proposed by Imbens & Kalyanaraman (2012). Regression results, where the bandwidth was chosen according to the procedures proposed by Ludwig & Miller (2007) and Imbens & Kalyanaraman (2012), are presented in Table A-15 and Table A-16.

[41] The equivalent graphs for the local quadratic regressions (LQR) can be found in the online Appendix (Figure A-5 and A-6).

each additional estimation, we increase the bandwidth by 30 days starting with 90 and ending with 720 days, in each case. The point estimate of the discontinuity and the corresponding 95 percent interval are shown for each regression. Panel (a) presents the results for the outcome all deaths. The point estimates are positive throughout and remain relatively stable with increasing bandwidth. The estimated jumps become significant at the five percent level from a bandwidth of 330 days onward. Panel (b) shows no significant jumps in deaths caused by internal factors at age 16. The estimated discontinuities for externally caused deaths are all positive and the majority are statistically significant at the five percent level. As is shown by panel (d), all estimated coefficients become insignificant at the five percent level when MVAs are excluded from the category deaths due to external causes. For the MVAs-category, we consistently find large and statistically significant relative increases at the cutoff, irrespective of the bandwidth. This also holds true for the outcome MVA-adjusted, with a few exceptions in terms of statistical significance for smaller bandwidths.[42] To sum up, Figure 5 shows that the main findings at the 16th birthday do not rely on a particular bandwidth.

The results at the second cutoff are even more straightforward, as shown in Figure 6. For the outcomes all deaths, deaths due to external causes, and both MVA categories, the estimated discontinuities are very stable and highly significant, independent of the choice of the bandwidth. In contrast, the estimated jumps for internal causes of death and deaths due to external causes excluding MVAs are hardly ever significant at the five percent level. In summary, the findings at the 18th birthday are very robust to the choice of the bandwidth. The distinctive and significant jumps in overall mortality and in externally caused deaths can be ascribed to the relatively large estimated discontinuities in MVA-related deaths.

8.2 Further Robustness Checks

Tables 7 and 8 present the results of additional robustness analyses using the Cause-of-Death Statistics for the linear specifications at the 16th and 18th birthday, respectively.[43] The two

[42]Smaller bandwidths imply smaller sample sizes, which usually increases the standard errors. Moreover, the findings for smaller bandwidths could be due to the fact that individuals might not immediately obtain a driving license when they turn 16 but rather in the course of the preceding months.

[43]The robustness checks for the quadratic specifications are reported in the online Appendix. Overall the findings are very robust in the sense that the main story always remains the same.

tables are identically structured: Column (1) presents estimates from regressions, where a triangular kernel is used as a weighting function. Cheng et al. (1997) show that a triangular kernel is the optimal weighting function for local polynomial regressions at boundary points, no matter which order of polynomial is involved. This weighting scheme places more weight on observations that are close to the threshold. In column (2), we address concerns related to the construction of the outcome variables. In order to deal with zeros, we add "1" instead of "0.5" to all outcomes before taking logs. In the third column, we control for extensive "birthday party effects" by applying a seven-day "donut", in other words, we exclude all deaths that occurred within a week before or after the 16th or 18th birthday, respectively. The reason for doing this is that if a birthday falls on a weekday, the actual birthday party may not take place until the following weekend. At the same time, individuals may reduce their partying behavior beforehand in anticipation of their birthday party (e.g., Lindo et al., 2016). In column (4), we test whether the transition from the ninth to the tenth revision of the ICD-coding impacts the findings. For this purpose, we restrict our sample to observations from 1998-2015, since 1998 was when the ICD-10 codes superseded the prior classification in the Cause-of-Death Statistics. In the last column, we examine whether a slight change in the legislation concerning the sale and consumption of alcoholic beverages affects our main results. In 2004, an addendum was added to Section 9 of the Youth Protection Act, which forbids the selling of alcopops to individuals younger than 18. Before this subparagraph was added, adolescents were legally allowed to purchase and consume alcopops from age 16. We therefore do not include observations prior to 2005 in the fifth column.

Columns (1)-(4) of Tables 7 and 8 show that our main findings are robust to using triangular kernel weights, an alternative construction of the outcomes, "birthday party effects", and to a change from the ICD-9 to ICD-10 coding. However, at both cutoffs, this is only partly true for the outcome MVAs-adjusted. There is noticeable variation in the size of the respective estimated discontinuity, but is always large in relative terms. The direction and the statistical significance is also always in line with the main results. Column (5) of Table 7 reveals that the estimated jumps for both MVA categories at the 16th birthday are substantially lower in magnitude compared to our main findings. This might suggest that the legal change did indeed lead to a reduction in deaths due to drinking and driving. We also see a considerably smaller estimated discontinuity for the outcome MVAs-adjusted at the second threshold, which is unexpected because the addendum should have primarily affected individuals younger than 18. However, these findings are consistent with our discussion on drunk driving laws in Section 8.3.[44] Moreover, in column (5), the estimated discontinuities in externally caused deaths excluding MVAs are substantially larger compared to our main findings at both cutoffs, which is counterintuitive in light of the law change under consideration.[45] Ultimately, despite some variations in terms of the size of the respective estimated discontinuity, the story told by our main results is retained in each and every robustness check conducted.

8.3 Drunk Driving Laws and Accompanied Driving at 17

Table 9 contains the results of the robustness analyses with respect to changes in the (drunk) driving laws. From 1973 to 1998, the Road Traffic Act (*Straßenverkehrsgesetz, StVG*) prescribed a BAC limit of 0.8 for all drivers. Driving when over this limit was considered an infringement. In August 1998, an additional BAC limit of 0.5 was introduced. A violation of this lower limit carried a lighter monetary penalty than a violation of the 0.8 limit. Column (1) of Table 9 excludes observations prior to 1999, that is, we leave out the years in which the drunk driving policies were less strict.[46] On April 1, 2001, the BAC limit of 0.8 was abandoned and since then only the 0.5 limit has been in place.[47] Column (2) addresses this change in the law by dropping observations prior to 2002. Finally, column (3) only shows observations from 2008-2015 taking into account two additional legal changes: Since August 2007, a zero tolerance policy has been applied making it illegal for individuals below the age of 21 and for new drivers within the first two years of acquiring their driving license to drive with any amount of alcohol in their system.[48] In addition, on January 1, 2008, the accompanied driving program

[44] We discover that the estimated relative jumps in deaths due to motor vehicle accidents have diminished at both cutoffs in more recent years, presumably due to several legal changes related to (drunk) driving.

[45] Since we exclude more than half of our observation periods for each cutoff from column (5), the findings might just reflect that we could be observing different populations.

[46] Since we neither know the birthday nor the day of death of the decedents, we cannot use the exact date the new law entered into force as the threshold.

[47] Contravening the BAC limit of 0.5 can result in a penalty of up to €3,000. First-time offenders normally have to pay €500 and receive a one-month driving ban.

[48] The standard fine for violating the zero tolerance law is €250, initially set at €125.

was implemented by all federal states.[49]

Starting with the MVA categories in Table 9, we can see that all estimated discontinuities are significant at the one percent level. We also find that the respective estimates diminish as the drunk driving regulation becomes stricter. In both cases, this holds true at both age thresholds. The decreasing trend becomes even more apparent when we consider the respective main specifications (see Table 2), where we include observations from 1992-2015.

The Road Traffic Accident Statistics are only available from 2002 onward, with the result that the specification in column (1) cannot be estimated and column (2) is actually our main specification. The focus is therefore on the third column. The difference between column (2) and (3) is that, in the latter case, we discard the years when the drunk driving laws were less strict for young and inexperienced drivers. Additionally, since 2008, the accompanied driving program is applicable law in all federal states of Germany. The zero tolerance law, provided it is effective, should only influence the number of dead drivers who were alcoholized at the time of the fatal accident. In the third column, we find that the estimated discontinuity for dead drivers who were under the influence of alcohol is negative and not statistically significant at either age threshold. Compared to the corresponding estimates in the second column, this finding indicates that the zero tolerance law might curb road fatalities. In column (3), when considering the dead drivers who were not under the influence of alcohol, we still detect a large relative discontinuity which is highly significant at both cutoffs. At the 16th birthday, the estimated discontinuity is even larger compared to our main specification. As expected, the zero tolerance law does not seem to affect the findings.[50] At the second age threshold, the estimate is somewhat smaller compared to column (2). This might indicate that the accompanied driving program achieves the desired impact to some degree. The results for all dead drivers are driven by the findings for dead drivers who were not alcoholized. Thus, a similar pattern is determined for all dead drivers and the same rationale applies. Taken together, the findings in Table 9 suggest that the tightening of the drunk driving laws and the accompanied driving program were both effective

[49]In addition, there is the “relative alcohol-related driving inability”. In practice, it means that having a BAC level of 0.3 or more could be construed as an infringement, if failure symptoms occur while driving, or even as a criminal act when serious drivin mistakes were committed. Driving with a BAC of 1.1 or more, which is the limit for the “absolute alcohol-related driving inabilit”, is regarded as a criminal offense.

[50]The accompanied driving program should mainly be relevant for the results at the second age threshold, i.e., the 18th birthday.

to some extent.

8.4 Placebo and Balance Tests

We conduct placebo tests at the 17th and 19th birthday. There are no legal changes at these placebo thresholds that could affect mortality. We therefore do not expect to detect any significant discontinuities at these age thresholds. The results for our six main outcomes of the Cause-of-Death Statistics are depicted in Table 10. We choose a bandwidth of one year in each regression in order that the estimates are not confounded by the treatments that come into play at the 16th or 18th birthday, respectively. Columns (1) and (2) show that the estimated relative change in the total number of deaths is virtually zero for both specifications at the 17th birthday. The estimated discontinuities for internal causes and external causes of deaths are always close to zero, insignificant, and the direction depends on the polynomial specification. This generally also holds true for external causes of deaths excluding MVAs. For the MVA categories, we find insignificant jumps of around six percent at age 17. However, in the quadratic specification for the category MVA-adjusted we predict a 29 percent increase at age 17, which is significant at the ten percent level. [51]

At the 19th birthday, we find a decrease of 17-24 percent in MVA-related deaths. All four estimated discontinuities are significant at least at the five percent level. Since there are no legal changes regarding driving or drinking laws at age 19, the discontinuous decrease is probably the aftermath of being entitled to acquire a certain type of driving license at age 18: In simplified terms, 18-year-old drivers are novices compared with their 19-year-old counterparts, who may have already gathered some driving experience, and may also be more mature overall. Further, some form of self-selection might also be present. It is conceivable that individuals acquiring their driving license shortly after turning 18 might tend to be more risk-seeking drivers. The discontinuities in MVA-related deaths drive the results for external causes of deaths and all deaths. However, the relative change in the total number of deaths is close to zero, negative, and insignificant in both specifications. For the outcome deaths due to external causes exclud-

[51] Since the point estimate deviates considerably from the other estimated jumps for the MVA categories, it might imply misspecification. The accompanied driving program might also help to explain the finding. However, since the accompanying person must always be the co-driver, it appears unlikely that this special regulation would strongly affect mortality at age 17.

ing MVAs we find insignificant, close to zero changes at the age threshold. Interestingly, we estimate an 8-9 percent increase in deaths due to internal factors at the 19th birthday, which is unexpected. The point estimate of the linear specification is significant, but only at the ten percent level.

Finally, the YOLO data set enables us to test for smoothness of various pre-treatment observables across the age thresholds, which are not available in the administrative data.[52] We estimate the same RDD models as before, but use different pre-determined variables as the response variable. Under the key identifying assumption that assignment around the age thresholds is as good as random, the control variables should not change discontinuously across the age thresholds. Figure 7 reports the results from local linear regressions for the dummy variables female, German, having siblings, grade repetition, and whether the respondent reports that they have art/artswork at home.[53] The figure shows that all point estimates are close to zero and not statistically significant.[54]

9 Conclusion

In this paper, we study the short-term mortality effects of two age-based restrictions at 16 and 18 years for legal access to alcohol in Germany. We provide first estimates of the mortality effects of a legal drinking age law that grants stepwise, age-dependent access to specific alcoholic beverages. To date, the extensive MLDA literature almost exclusively examines countries with a single MLDA (e.g., US, Canada, New Zealand, and Australia). The common result is that adverse health impacts arise immediately when people are granted legal access to alcohol. As a consequence, a lively debate on the optimal MLDA is underway. Proponents of a high MLDA argue that it reduces (binge) drinking, violence, crime, accidents, and traffic fatalities among minors and young adults. Critics of a high MLDA, on the other hand, contend that it does not stop minors from drinking, contributes to irresponsible behavior and extreme drinking, is hard

[52]One limitation of the YOLO data set is that we only collected information from an internet survey in the three eastern federal states Saxony, Thuringia, and Brandenburg. Tables A-18 and A-19 report the estimates from our main RDD regression using the Cause-of-Death Statistics for these three states. Overall, the findings are quite similar to the estimates in Tables 2 and 3, respectively. One notable exception, however, is the significant jump in suicides in the three states in Table A-19.

[53]We use the latter variable as a proxy for high socio-economic background. Grade repetition is equal to one if the young person reports ever having repeated a grade, and zero otherwise.

[54]The results for the quadratic specification are very similar. See Table A-4 in the online Appendix.

to enforce ("trickle down approach"), drives drinking underground, and deters young people from going to the hospital when they are injured or intoxicated for fear of being accused of drinking illegally. However, increasing or decreasing a single MLDA might simply shift the timing of potentially adverse effects (e.g., Carpenter & Dobkin, 2017; Dee & Evans, 2001).

Our results contribute fresh insights to the debate: In contrast to similar studies for countries with a single MLDA, we find that legal access to alcohol has, at most, a minor impact on short-term mortality at age 16 and 18 years, despite significant increases in drinking behavior at both age thresholds. In fact, we detect substantial and statistically significant discontinuous increases in overall mortality at both age thresholds. These are largely driven by a novice driver effect, however. In line with Lindo et al. (2016) and Boes & Stillman (2017), we find that legal access to alcohol does not trigger dramatic increases in deaths due to drunk driving. Our main results are robust to a wide range of alternative specifications in the sense that the key insights remain unaffected. Our gender-specific heterogeneity analyses indicate that males drive our main results, which is in conformity with Carpenter & Dobkin (2009) and Carpenter et al. (2016). There is weak evidence that having legal access to alcohol might affect the short-term mortality of male adolescents around the age of 16. However, an examination of the absolute numbers reveals that the alleged effect is not particularly large. Overall, our empirical findings reveal that the early and stepwise legal access to alcohol in Germany does not have considerable negative consequences resulting in earlier deaths in the short-run.

Several aspects should be kept in mind when interpreting our findings. First, similar to other RD studies, we are not able to isolate the long-term mortality effects of German MLDA legislation with our design. Second, legal access to alcohol may cause severe externalities for other people (e.g., deaths, injuries, and accidents) and inanimate objects (e.g., damage to or destruction of private or public property). Finally, we focus on drinking behavior and the most extreme health outcome: mortality. We do not consider the impact on young people's morbidity, long-term health, other risky health behaviors (e.g., smoking and drug abuse), or educational and work-related success. In particular, we should carefully point out that we observe a large and significant jump in young people's binge drinking around the age of 16 years. These behavioral changes might have negative consequences for young people's brain development and their health in the medium- and long-run. Evaluating the German MLDA law with respect to these outcomes is a topic for future research.

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10 Figures and Tables

Figure 1: Deaths Around the 16th and 18th Birthday

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations and depiction.

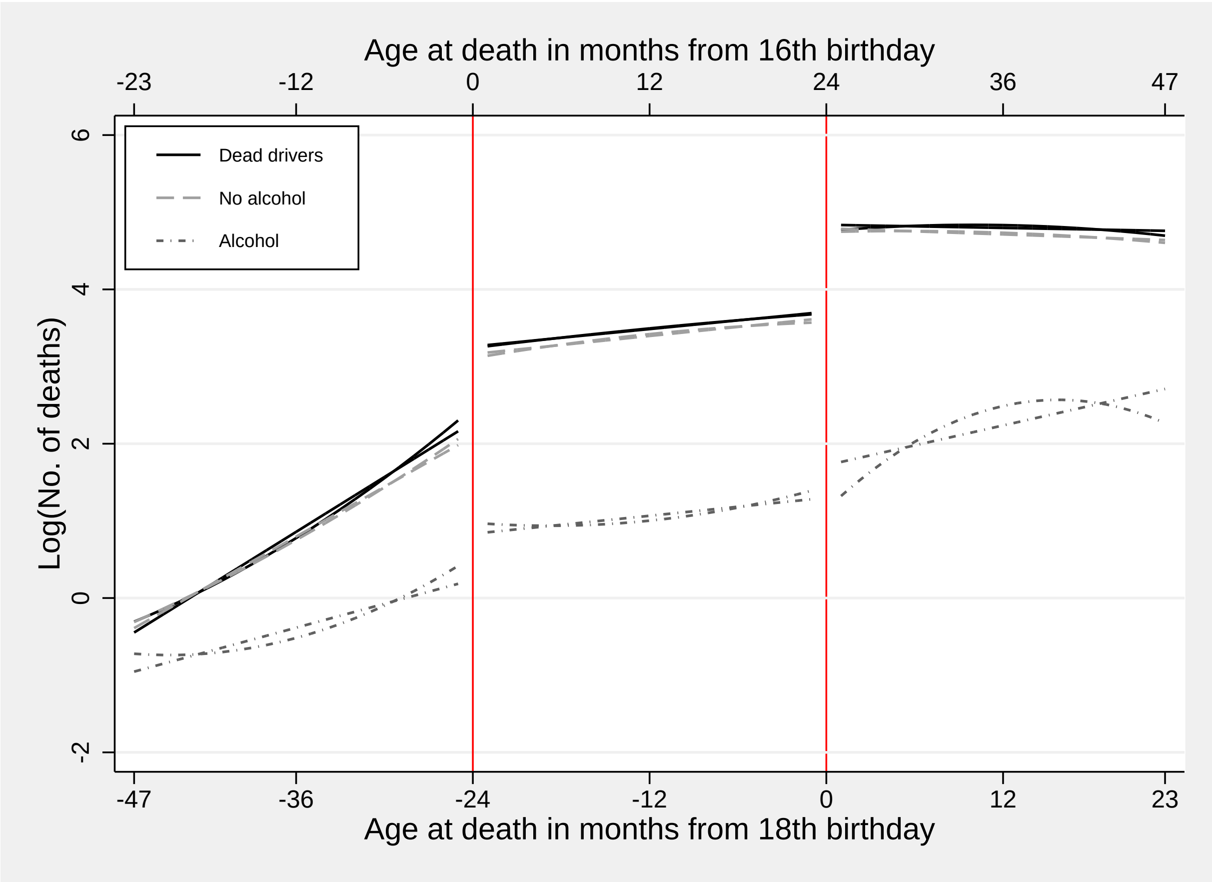
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Fitted lines are obtained from unweighted regressions conducted separately for the respective cutoff. For each outcome, two specifications are depicted: The first specification includes a linear term of the forcing variable, the second specification adds a quadratic term. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. The dots represent 30-day averages of each respective outcome.

Figure 2: Deaths Due to External Factors Around the 16th and 18th Birthday

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations and depiction.

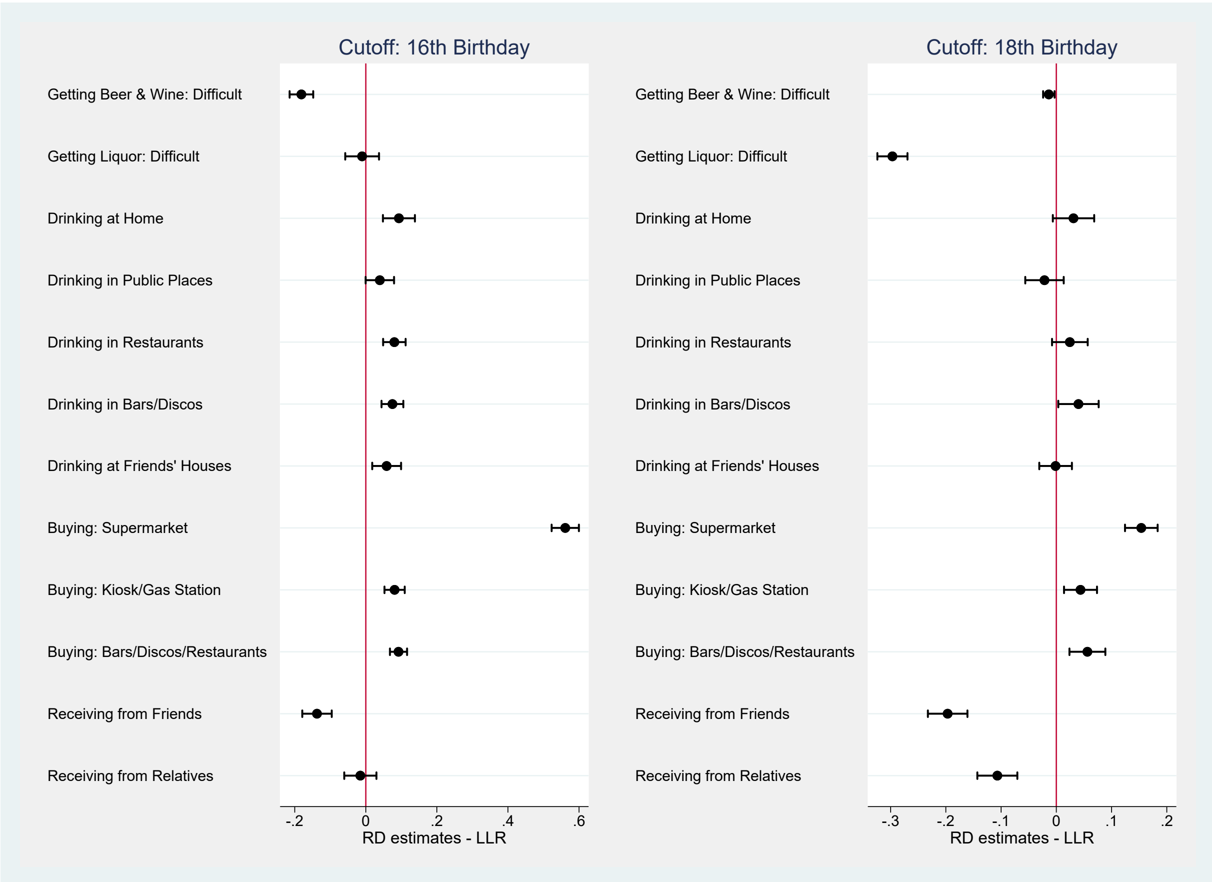
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Fitted lines are obtained from unweighted regressions conducted separately for the respective cutoff. For each outcome, two specifications are depicted: The first specification includes a linear term of the forcing variable, the second specification adds a quadratic term. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. The dots represent 30-day averages of each respective outcome. 30-day averages for the category MVAs-adjusted were deleted by the Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder for reasons of confidentiality.

Figure 3: Drivers Dying Around the 16th and 18th Birthday



Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Road Traffic Accident Statistics (2002-2015), own calculations and depiction.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x months from the respective cutoff. 0.5 was added to all outcomes before taking logs. Fitted lines are obtained from unweighted regressions conducted separately for the respective cutoff. For each outcome, two specifications are depicted: The first specification includes a linear term of the forcing variable, the second specification adds a quadratic term. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. Drivers who died at 192 or 216 months of age are excluded, since it is unclear whether these persons died before or after their 16th or 18th birthday, respectively. 30-day averages were deleted by the Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder for reasons of confidentiality.

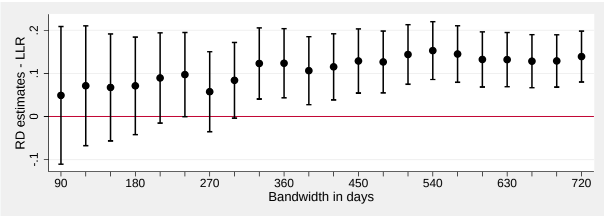
Figure 4: Discontinuities at the 16th and 18th Birthday - Enforcement



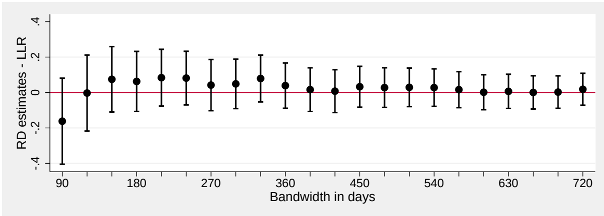
Source: Youth Leisure Online Survey (YOLO), 2018, own calculations and depiction.
Notes: Results stem from different local linear regressions (LLR). All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. For each point estimate, the 95 percent confidence interval is depicted.

Figure 5: Sensitivity to the Bandwidth - Cutoff: 16th Birthday

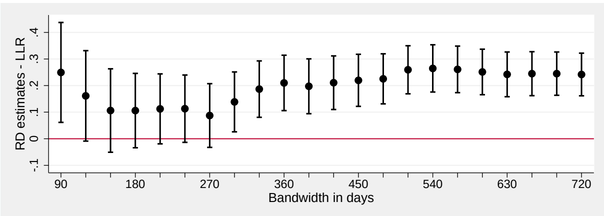
(a) All deaths



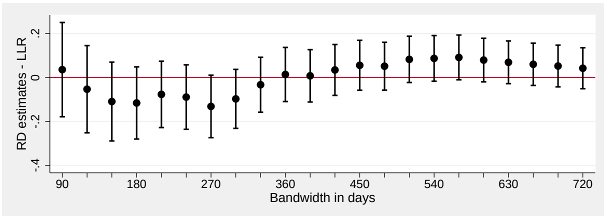
(b) Internal causes



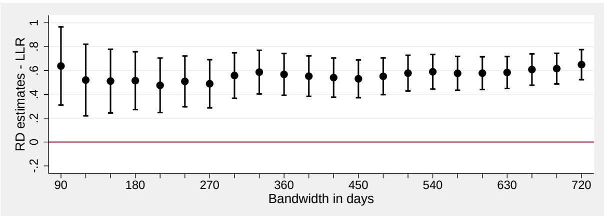
(c) External causes



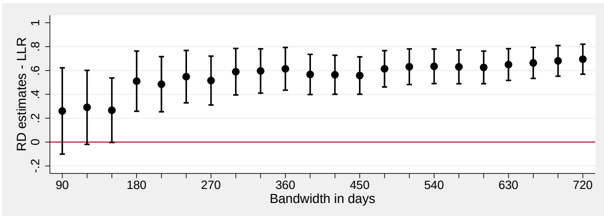
(d) External causes excluding MVAs



(e) MVAs



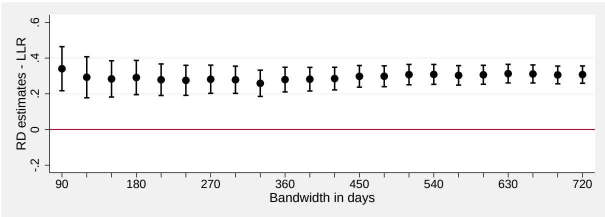
(f) MVAs-adj.



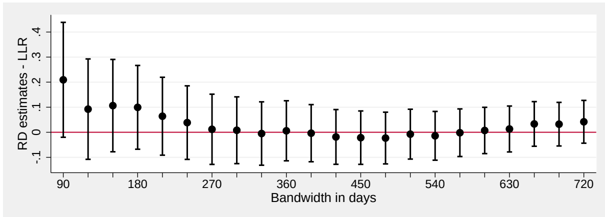
Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations and depiction.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 codes used to construct the different cause-of-death categories can be found in the online Appendix. In each panel, results for various local linear regressions (LLR) are presented. The bandwidth varies from 90 to 720 days. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. For each point estimate, the 95 percent confidence interval is depicted.

Figure 6: Sensitivity to the Bandwidth - Cutoff: 18th Birthday

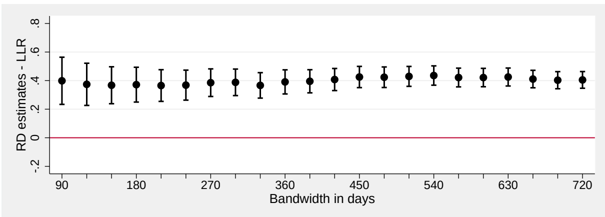
(a) All deaths



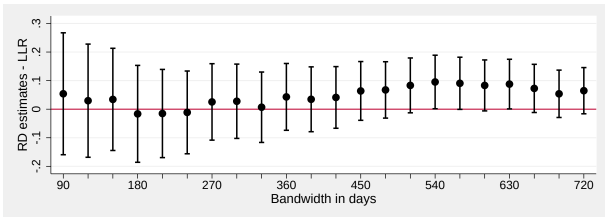
(b) Internal causes



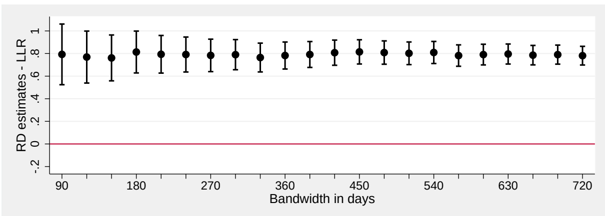
(c) External causes



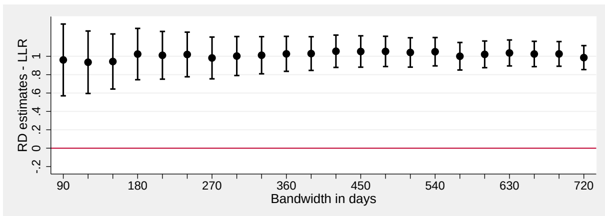
(d) External causes excluding MVAs



(e) MVAs



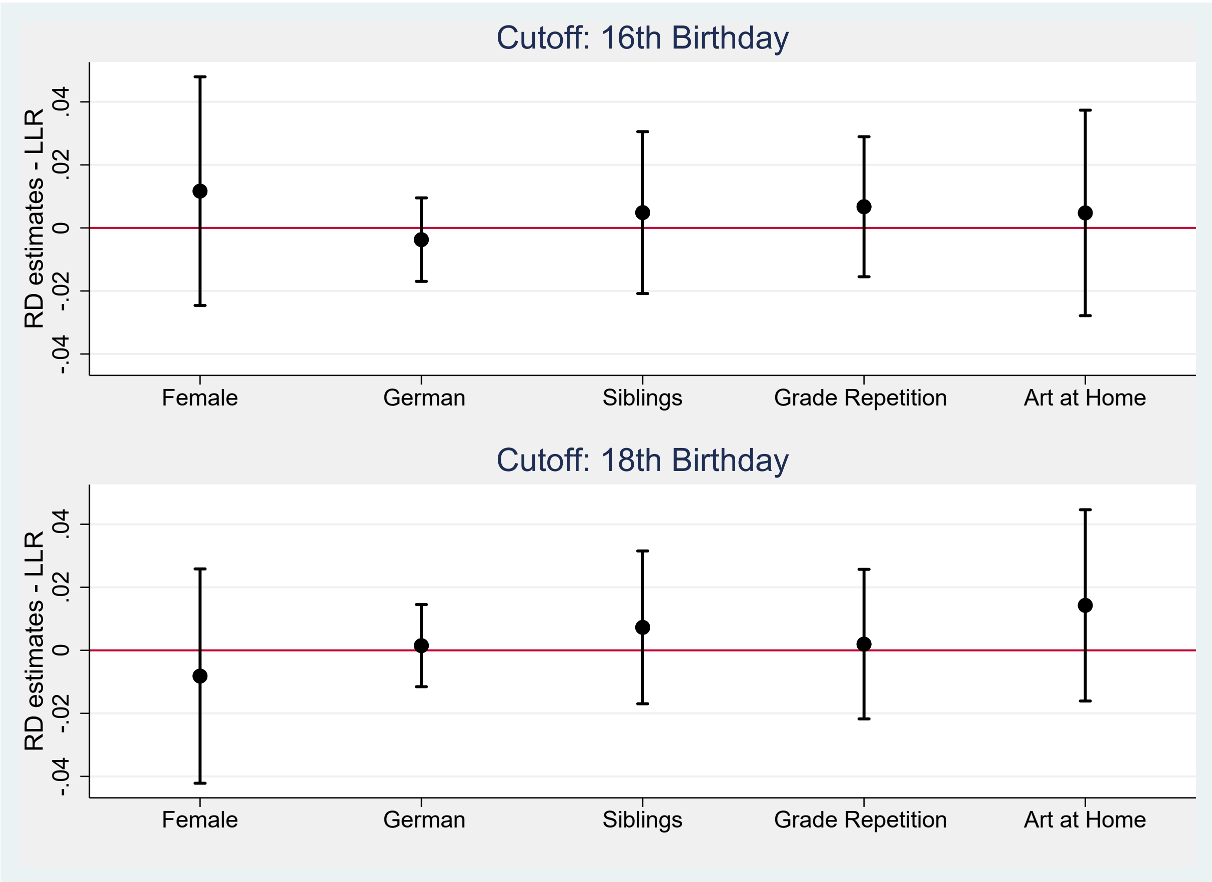
(f) MVAs-adj.



Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations and depiction.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 codes used to construct the different cause-of-death categories can be found in the online Appendix. In each panel, results for various local linear regressions (LLR) are presented. The bandwidth varies from 90 to 720 days. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. For each point estimate, the 95 percent confidence interval is depicted.

Figure 7: Discontinuities at the 16th and 18th Birthday - Pre-Treatment Covariates



Source: Youth Leisure Online Survey, 2018, own calculations and depiction.
Notes: Results stem from ten different local linear regressions. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. For each point estimate, the 95 percent confidence interval is depicted.

Table 1: Alcohol Consumption

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
Alcohol Consumption				
Lifetime	0.124***	0.076***	0.013	0.004
	(0.017)	(0.025)	(0.013)	(0.019)
N	11,411	11,411	12,892	12,892
Last 4 Weeks	0.150***	0.073***	0.040**	0.041*
	(0.018)	(0.026)	(0.016)	(0.023)
N	11,405	11,405	12,884	12,884
Last Week	0.115***	0.043*	0.041**	0.026
	(0.018)	(0.026)	(0.017)	(0.026)
N	11,408	11,408	12,888	12,888
Binge Drinking				
Last 4 Weeks	0.091***	0.049**	−0.011	−0.011
	(0.016)	(0.023)	(0.017)	(0.026)
N	11,315	11,315	12,792	12,792
Last Week	0.033***	0.025**	0.008	−0.013
	(0.009)	(0.012)	(0.012)	(0.018)
N	11,360	11,360	12,830	12,830
Consumption of Liquor				
Last Week	0.054***	0.019	0.062***	0.049**
	(0.013)	(0.019)	(0.016)	(0.025)
N	11,353	11,353	12,816	12,816
Pct. of Days Last Week	0.012***	0.006	0.022***	0.020***
	(0.003)	(0.004)	(0.004)	(0.007)
N	11,353	11,353	12,816	12,816
Quadratic terms	No	Yes	No	Yes

Source: Youth Leisure Online Survey (YOLO), 2018, own calculations.
Notes: Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. YOLO contains nearly 17,000 individuals aged 14-19 living in the federal states Saxony, Brandenburg and Thuringia.

Table 2: Discontinuities in Deaths

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
All deaths				
Discontinuity	0.141***	0.107**	0.308***	0.290***
	(0.030)	(0.044)	(0.025)	(0.037)
Internal causes				
Discontinuity	0.023	0.013	0.042	−0.034
	(0.046)	(0.070)	(0.043)	(0.063)
External causes				
Discontinuity	0.243***	0.209***	0.406***	0.422***
	(0.042)	(0.059)	(0.030)	(0.046)
External causes w/o MVAs				
Discontinuity	0.044	0.048	0.065	0.066
	(0.049)	(0.069)	(0.041)	(0.062)
MVAs				
Discontinuity	0.646***	0.477***	0.783***	0.808***
	(0.063)	(0.093)	(0.042)	(0.066)
MVAs-adj.				
Discontinuity	0.693***	0.515***	0.987***	1.084***
	(0.065)	(0.097)	(0.066)	(0.101)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 1,444 for each regression.

Table 3: Discontinuities in Deaths -
Subcategories of *deaths due to external causes excluding MVAs*

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
Alcohol-related				
Discontinuity	−0.018	−0.009	−0.025	−0.046
	(0.015)	(0.016)	(0.027)	(0.040)
Drug-related				
Discontinuity	−0.039	−0.047	−0.017	−0.098
	(0.041)	(0.061)	(0.066)	(0.098)
Homicides				
Discontinuity	0.028	0.099	0.087	−0.013
	(0.050)	(0.076)	(0.061)	(0.096)
Suicides				
Discontinuity	0.004	−0.026	0.065	0.111
	(0.072)	(0.109)	(0.064)	(0.098)
Other external causes				
Discontinuity	0.053	0.056	0.074	0.104
	(0.063)	(0.091)	(0.054)	(0.080)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 1,444 for each regression.

Table 4: Discontinuities in Deaths - Road Traffic Accident Statistics

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
All dead drivers				
Discontinuity	0.980^{***}	0.778^{*}	1.127^{***}	1.065^{***}
	(0.242)	(0.397)	(0.098)	(0.127)
Not alcoholized				
Discontinuity	1.073^{***}	0.916^{**}	1.161^{***}	1.167^{***}
	(0.267)	(0.401)	(0.100)	(0.124)
Alcoholized				
Discontinuity	0.596	0.439	0.420	-0.296
	(0.404)	(0.709)	(0.292)	(0.368)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Road Traffic Accident Statistics (2002-2015), own calculations.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x months from the respective cutoff. 0.5 was added to all outcomes before taking logs. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 46 for each regression. Drivers who died at 192 or 216 months of age are excluded, since it is unclear whether these persons died before or after their 16th or 18th birthday, respectively.

Table 5: Discontinuities in Deaths by Gender

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
All deaths				
Males	0.226^{***}	0.202^{***}	0.332^{***}	0.289^{***}
	(0.036)	(0.053)	(0.028)	(0.043)
Females	−0.014	−0.076	0.246^{***}	0.281^{***}
	(0.053)	(0.078)	(0.044)	(0.064)
Internal causes				
Males	0.037	0.088	0.048	−0.102
	(0.055)	(0.079)	(0.055)	(0.084)
Females	−0.034	−0.095	0.055	0.082
	(0.071)	(0.105)	(0.062)	(0.090)
External causes				
Males	0.362^{***}	0.310^{***}	0.419^{***}	0.423^{***}
	(0.051)	(0.076)	(0.033)	(0.050)
Females	0.044	−0.026	0.371^{***}	0.422^{***}
	(0.068)	(0.098)	(0.060)	(0.091)
External causes w/o MVAs				
Males	0.132^{**}	0.119	0.061	0.022
	(0.060)	(0.090)	(0.047)	(0.072)
Females	−0.074	−0.122	0.054	0.130
	(0.076)	(0.110)	(0.076)	(0.117)
MVAs				
Males	0.702^{***}	0.567^{***}	0.791^{***}	0.846^{***}
	(0.067)	(0.103)	(0.049)	(0.076)
Females	0.216^{***}	0.098	0.712^{***}	0.639^{***}
	(0.069)	(0.103)	(0.075)	(0.112)
MVAs-adj.				
Males	0.671^{***}	0.526^{***}	0.928^{***}	0.993^{***}
	(0.064)	(0.094)	(0.068)	(0.106)
Females	0.089^{**}	0.013	0.552^{***}	0.561^{***}
	(0.040)	(0.056)	(0.065)	(0.096)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.
Notes: Discontinuities are estimated separately for males and females. The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 1,444 for each regression.

Table 6: Discontinuities in Deaths by Gender - Road Traffic Accident Statistics

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
All dead drivers				
Males	1.177***	0.871**	0.984***	0.935***
	(0.264)	(0.429)	(0.098)	(0.141)
Females	0.404	0.071	2.065***	2.100***
	(0.396)	(0.519)	(0.400)	(0.652)
Not alcoholized				
Males	1.260***	1.001**	1.009***	1.041***
	(0.286)	(0.440)	(0.097)	(0.131)
Females	0.454	0.157	2.076***	2.110***
	(0.380)	(0.483)	(0.400)	(0.653)
Alcoholized				
Males	0.761*	0.719	0.446	−0.269
	(0.416)	(0.703)	(0.291)	(0.370)
Females	−0.165	−0.280	−0.144	−0.306
	(0.159)	(0.283)	(0.179)	(0.241)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Road Traffic Accident Statistics (2002-2015), own calculations.
Notes: Discontinuities are estimated separately for males and females. The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x months from the respective cutoff. 0.5 was added to all outcomes before taking logs. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 46 for each regression. Drivers who died at 192 or 216 months of age are excluded, since it is unclear whether these persons died before or after their 16th or 18th birthday, respectively.

Table 7: Discontinuities in Deaths at the 16th Birthday - Robustness Checks

	Weighted	Log(Y+1)	Birthday donut	ICD-10 Sample	Alcopop Sample
	(1)	(2)	(3)	(4)	(5)
All deaths					
Discontinuity	0.128***	0.136***	0.145***	0.129***	0.120**
	(0.032)	(0.029)	(0.030)	(0.038)	(0.053)
N	1,443	1,444	1,430	1,444	1,444
Internal causes					
Discontinuity	0.019	0.020	0.019	0.019	0.035
	(0.050)	(0.041)	(0.046)	(0.054)	(0.072)
N	1,443	1,444	1,430	1,444	1,444
External causes					
Discontinuity	0.229***	0.227***	0.251***	0.218***	0.228***
	(0.042)	(0.038)	(0.043)	(0.055)	(0.070)
N	1,443	1,444	1,430	1,444	1,444
External causes w/o MVAs					
Discontinuity	0.045	0.037	0.055	0.016	0.108
	(0.049)	(0.042)	(0.050)	(0.062)	(0.074)
N	1,443	1,444	1,430	1,444	1,444
MVAs					
Discontinuity	0.579***	0.523***	0.650***	0.576***	0.294***
	(0.070)	(0.048)	(0.065)	(0.069)	(0.064)
N	1,443	1,444	1,430	1,444	1,444
MVAs-adj.					
Discontinuity	0.622***	0.484***	0.715***	0.441***	0.150***
	(0.070)	(0.045)	(0.066)	(0.060)	(0.049)
N	1,443	1,444	1,430	1,444	1,444
Quadratic terms	No	No	No	No	No

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. In columns (1), (3), (4) and (5), 0.5 was added to all outcomes before taking logs. In column (2), 1 was added to all outcomes before taking logs. A bandwidth of two years is used in all specifications. In column (1), triangular kernel weights are used. The "birthday donut" specifications, column (3), exclude deaths that occurred within a week before or after the cutoff. The "ICD-10 Sample" spans the years from 1998 to 2015, whereas the "Alcopop Sample" includes the years from 2005 to 2015. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table 8: Discontinuities in Deaths at the 18th Birthday - Robustness Checks

	Weighted (1)	Log(Y+1) (2)	Birthday donut (3)	ICD-10 Sample (4)	Alcopop Sample (5)
All deaths					
Discontinuity	0.301***	0.303***	0.304***	0.275***	0.262***
	(0.027)	(0.025)	(0.026)	(0.030)	(0.040)
N	1,443	1,444	1,430	1,444	1,444
Internal causes					
Discontinuity	0.012	0.042	0.030	0.055	0.024
	(0.047)	(0.039)	(0.043)	(0.050)	(0.066)
N	1,443	1,444	1,430	1,444	1,444
External causes					
Discontinuity	0.412***	0.396***	0.404***	0.366***	0.392***
	(0.033)	(0.029)	(0.030)	(0.038)	(0.052)
N	1,443	1,444	1,430	1,444	1,444
External causes w/o MVAs					
Discontinuity	0.065	0.062	0.060	0.053	0.099
	(0.046)	(0.038)	(0.042)	(0.050)	(0.065)
N	1,443	1,444	1,430	1,444	1,444
MVAs					
Discontinuity	0.793***	0.737***	0.786***	0.754***	0.751***
	(0.048)	(0.038)	(0.043)	(0.055)	(0.070)
N	1,443	1,444	1,430	1,444	1,444
MVAs-adj.					
Discontinuity	1.025***	0.815***	0.993***	0.774***	0.529***
	(0.076)	(0.052)	(0.068)	(0.074)	(0.071)
N	1,443	1,444	1,430	1,444	1,444
Quadratic terms	No	No	No	No	No

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. In columns (1), (3), (4) and (5), 0.5 was added to all outcomes before taking logs. In column (2), 1 was added to all outcomes before taking logs. A bandwidth of two years is used in all specifications. In column (1), triangular kernel weights are used. The "birthday donut" specifications, column (3), exclude deaths that occurred within a week before or after the cutoff. The "ICD-10 Sample" spans the years from 1998 to 2015, whereas the "Alcopop Sample" includes the years from 2005 to 2015. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table 9: Robustness Checks - Drunk Driving Laws

	Cutoff: 16th birthday			Cutoff: 18th birthday		
	BAC limit: 0.8 & 0.5 (1999-2015) (1)	BAC limit: 0.5 (2002-2015) (2)	0-tolerance & AD17 (2008-2015) (3)	BAC limit: 0.8 & 0.5 (1999-2015) (1)	BAC limit: 0.5 (2002-2015) (2)	0-tolerance & AD17 (2008-2015) (3)
Cause-of-Death Statistics						
MVAs						
Discontinuity	0.528***	0.470***	0.163***	0.712***	0.725***	0.599***
	(0.070)	(0.069)	(0.056)	(0.057)	(0.066)	(0.070)
MVAs-adj.						
Discontinuity	0.368***	0.254***	0.110***	0.711***	0.621***	0.426***
	(0.059)	(0.055)	(0.042)	(0.074)	(0.073)	(0.067)
Road Traffic Accident Statistics						
All dead drivers						
Discontinuity	–	0.980***	1.186***	–	1.127***	1.035***
		(0.242)	(0.277)		(0.098)	(0.136)
Not alcoholized						
Discontinuity	–	1.073***	1.337***	–	1.161***	1.110***
		(0.267)	(0.308)		(0.100)	(0.151)
Alcoholized						
Discontinuity	–	0.596	−0.004	–	0.420	−0.229
		(0.404)	(0.400)		(0.292)	(0.490)
Quadratic terms	No	No	No	No	No	No

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), and Road Traffic Accident Statistics (2002-2015), own calculations.

Notes: In column (1), we only use observations from 1999-2015; in column (2), from 2002-2015; in column (3), from 2008-2015. 0.5 was added to all outcomes before taking logs. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. Cause-of-Death Statistics: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. N = 1,444 for each regression. Road Traffic Accident Statistics: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x months from the respective cutoff. Drivers who died at 192 or 216 months of age are excluded, since it is unclear whether these persons died before or after their 16th or 18th birthday, respectively. N = 46 for each regression.

Table 10: Discontinuities in Deaths - Placebo Tests

	Cutoff: 17th birthday		Cutoff: 19th birthday	
	(1)	(2)	(3)	(4)
All deaths				
Discontinuity	-0.009	0.001	-0.042	-0.040
	(0.037)	(0.058)	(0.029)	(0.044)
Internal causes				
Discontinuity	0.032	-0.038	0.091^{*}	0.078
	(0.058)	(0.084)	(0.053)	(0.077)
External causes				
Discontinuity	-0.034	0.006	-0.079^{**}	-0.074
	(0.047)	(0.072)	(0.036)	(0.055)
External causes w/o MVAs				
Discontinuity	-0.070	0.010	-0.016	0.039
	(0.065)	(0.102)	(0.050)	(0.073)
MVAs				
Discontinuity	0.064	0.061	-0.154^{***}	-0.185^{***}
	(0.069)	(0.098)	(0.046)	(0.070)
MVAs-adj.				
Discontinuity	0.066	0.256^{*}	-0.188^{***}	-0.214^{**}
	(0.102)	(0.148)	(0.064)	(0.092)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: Discontinuities are estimated at the 17th and 19th birthday, respectively. The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of one year is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 722 for each regression.

Online Appendix

Online Appendix: Data, Descriptive Statistics, ICD Codes, and further Robustness Checks

Data from the Federal Centre for Health Education (BZgA)

Table A-6 depicts the drinking behavior of young people in Germany using data from the survey *Die Drogenaffinität Jugendlicher in der Bundesrepublik Deutschland*.[55] The survey is conducted every three to four years.[56] The advantage of the survey is that it provides comprehensive information on the consumption of alcohol and going-out behavior. On the downside, implementing a RD design is not feasible, because there is insufficient information regarding the age of the respondents. The year and the month of birth of the surveyed individuals are reported, but the exact date of each interview is unknown. There are some other representative German surveys that ask questions about participants' drinking behavior. However, none of these provide data that would enable us to implement a RD design. Thus, we can only report drinking habits and going-out behavior in a descriptive manner and compare the summary statistics from the BZgA data with our own internet survey—the Youth Leisure Online Survey (YOLO)—of young people living in Saxony, Thuringia and Brandenburg. Descriptive statistics are categorized by the three relevant age groups.[57] Panel A includes information that is available in the survey years 1993/1994, 1997, 2001, 2004, 2008, and 2011. In total, 9,278 individuals aged 14 to 19 participated in the survey waves considered. The share of males and females is balanced in all three age groups. The proportion of Germans among the respondents is relatively high and the proportion of west German residents varies from 73 to 77 percent across the age groups.[58] In all waves considered, respondents are asked how often they had been drunk in their lifetime so far. This can be interpreted as a measure of drinking intensity. About three-quarters of the 14–15-year-olds surveyed had never experienced drunkenness in their lifetime. This proportion

[55] To be precise, survey data from the Federal Centre for Health Education (*Bundeszentrale für gesundheitliche Aufklärung*, BZgA; 1999, 2000, 2001, 2005, 2015a, 2015b) is employed to illustrate the drinking and going-out behavior of adolescents and young adults in Germany.

[56] For each wave, about 3,000-5,000 individuals are randomly selected from the target population, which consists of 12–25-year-olds. In the survey years 1993/1994, 1997 and 2001, the random draw was conducted separately for East- and West-Germany. As a consequence, East-Germans are oversampled in these three survey years.

[57] In our main RD specifications, we choose a bandwidth of two years.

[58] As a benchmark: On December 31, 2015, about 89.5 percent of the overall population in Germany had German citizenship and around 84 percent were west German residents (Statistisches Bundesamt, 2016, own calculations).

decreases to 41 percent among the 16–17-year-olds and drops to 28 percent for the oldest age group. A contrasting pattern can be observed when we consider the share of people who had been drunk more than ten times in their lifetime.

Panel B focuses on drinking participation with respect to different alcoholic beverages. In the survey years 2001, 2004, 2008, and 2011, respondents were asked how often they had drunk certain alcoholic beverages in the past twelve months.[59] Among the 14–15-year-olds, none of whom are legally entitled to purchase any alcoholic beverages, 30 percent report that they had drunk beer at least once a month in the last twelve months. 15 percent state that they had consumed wine or sparkling wine, 11 percent had drunk spirits (neat), and 20 percent had consumed cocktails or long drinks at least once a month. The respective shares increase dramatically when 16–17-year-olds are also considered. This group is allowed to buy beer, wine, and sparkling wine. This is reflected in drinking participation with regard to beer: 57 percent of the 16–17-year-olds had drunk beer at least once a month. When they turn 18, individuals are entitled to purchase and publicly consume all types of alcoholic beverage. When comparing the middle age group with the oldest age group, we therefore expect to detect increases in the share of people who drink spirits or cocktails at least once per month. Indeed, the fraction of people who drank spirits at least once a month rises by seven percentage points, and by 11 points when cocktails are also taken into account. The share of monthly wine drinkers also increases, but the proportion of monthly beer drinkers falls from 57 to 54 percent. This might be due to substitution effects.[60]

In the survey years 2004, 2008, and 2011, additional questions with respect to drinking participation and intensity were included. The reference period is the last 30 days. Panel C shows the respective descriptive statistics. Almost half of the 14–15-year-olds had drunk alcohol at least once in the past 30 days. This share increases to 79 and 81 percent when we also consider

[59]For some of the 16 and 18-year-olds surveyed, these questions refer, in part, to a period before they reached their 16th or 18th birthdays, respectively. However, responses were not given in terms of absolute frequency (e.g., “on 21 different days”), but instead in terms of occurrences within a month or week (e.g., “several times per month”). Answers therefore may be influenced by more recent drinking habits, which would be in our favor. Carpenter & Dobkin (2009) face a similar problem and they stress that the chosen reference period of the answer plays a crucial role. In their case, 37 percent of respondents used a week or a month as the reference period instead of a year. Their findings suggest that there is a “reference period effect” that only lasts for one month.

[60]Other than this, there is, in general, no reason why the share of beer drinkers among the 18–19-year-olds should deviate from the share of beer drinkers among the 16–17-year-olds. This also holds true for wine and sparkling wine. However, it is said, that the enjoyment of wine increases with advancing age.

the two older age groups. The share of individuals who had drunk alcohol on at least ten days in the past month rises from two to five and then to seven percent across age groups. If individuals had consumed alcohol in the past 30 days, they were asked on how many days they had consumed five or more alcoholic drinks on one occasion, which is the common definition of binge drinking. Among the 14–15-year-olds, 31 percent of those who had drunk alcohol at least once in the last 30 days had also participated in binge drinking at least once. The share increases to 50 percent for the 16–17-year-olds and to 56 percent for the 18–19-year-olds. Binge drinking on ten days or more in the past month is relatively rare in all age groups.

Overall, Table A-6 reveals that drinking participation is relatively high in all three age groups. The rather high participation rate among 14–15-year-olds and the prevalent consumption of spirits and cocktails among 16–17-years-olds raises the question as to how strictly the MLDA laws are enforced. However, these numbers do not necessarily mean that the laws are not respected, since young people could drink alcohol in private. Instead, the figures indicate that young people do adhere to the MLDA laws to a great extent. The share of wine and beer drinkers roughly doubles, in each case, when we compare the youngest age group with the middle age group. Further, the share of individuals drinking spirits and cocktails among the 18–19-year-olds noticeably exceeds the respective fraction of 16–17-year-olds. Drinking intensity increases with advancing age, but heavy drinking is, in general, relatively rare.

Going-Out Behavior of Young People in Germany - Descriptive Evidence. Table A-1 outlines the going-out of young people in Germany. The data stems from the survey years 2001, 2004, 2008, and 2011 and the reference period is always the past three months. 17 percent of the 14–15-year-olds surveyed report that they go to a disco at least once a month. This is explicitly forbidden by the Youth Protection Act. The fraction increases to 46 percent among the 16–17-year-olds and reaches 60 percent among the 18–19-year-olds. All age groups go to bars and restaurants quite regularly and attend private parties relatively often. Interestingly, about half of the 14–15-year-olds go to private parties at least once a month, where they may have easy access to alcoholic beverages, which might explain the numbers in Table A-6. Across all age groups, the share of those who never go out is relatively small. The proportion of those who usually drink alcohol when going out increases with age. This pattern is reversed when we consider those who never drink alcohol when going out. For both of the two oldest age groups, this share is quite small. This supports the conjecture that drinking and going out is closely intertwined from age 16 onward.

Cause-of-Death Statistics

Table A-2 shows descriptive statistics of the Cause of Death Statistics, i.e., of our outcomes, grouped by the three relevant age groups. In total, 44,194 individuals aged between 14 and 19 with residence in Germany died in the period from 1992 to 2015. The first thing to note is the increasing trend in the number of deaths by age group, with by far the most fatalities occurring in the 18–19 age group. When considering the causes of death, the dramatic increase in the share of deaths due to external factors with rising age is striking. Among the 14–15-year-olds, internal and external causes of death virtually balance each other out, whereas about three-quarters of the deaths in the 18–19 age group can be attributed to external factors. Examining the two mutually exclusive subcategories of deaths due to external causes reveals that the MVA category seems to be responsible for the upward trend in the share of externally caused deaths. While the share of deaths due to external causes excluding MVAs remains more constant across age groups, the proportion of MVA-related deaths increases with age. Comparing the youngest with the medium age group, the share of deaths due to MVAs initially rises by 15 and then by a further 14 percentage points compared to the 18–19 age group. A similar but less pronounced pattern can be observed for the category MVA-adjusted.[61] The shares for both MVA categories are relatively large among both the 16–17-year-olds and the 18–19-year-olds, which suggests that the co-treatment is of genuine importance. Looking at the subcategories of deaths due to external causes excluding MVAs, it is apparent that the proportions for each category are quite balanced across age groups. The one exception is deaths due to other external causes, for which we observe a declining trend with age. Regarding alcohol-related deaths we find that dying from the immediate consequences of excessive alcohol consumption is a rare event, at least in the short run. It is also remarkable that the share of males who died substantially increases

[61] Discovering MVA-related deaths among 14–15-year-olds seems odd at first glance, but it is plausible, since some vehicles with low power ratings are allowed to be driven without a driving license from the age of 15. Moreover, it cannot be ruled out that some individuals may violate the law by driving motor vehicles without being permitted to do so.

with rising age, which finds expression in the 18–19 age group: Only approximately 27 percent of the deceased individuals in this group are female. The proportion of Germans among those who died stays quite constant at around 90 percent across the age groups. The same applies for deceased persons with residence in western Germany. The relevant share here varies between 79 and 76 percent across age groups.

Road Traffic Accident Statistics

Table A-3 depicts descriptive statistics of the Road Traffic Accident Statistics and the Cause of Death Statistics listed by the three relevant age groups for the period from 2002 to 2015. The former contain information on whether a dead driver was alcoholized or not at the time of the accident. In a first step, we filter out all deceased drivers from the Road Traffic Accident Statistics in order to compare numbers with the MVA categories stemming from the Cause of Death Statistics. However, the two sets of statistics are not coherent. The Cause of Death Statistics include all individuals *resident in* Germany who died in the wake of a road accident. The Road Traffic Accident Statistics, in contrast, comprise all traffic fatalities that happened *within* Germany, i.e., on German roads. This implies that, among the deceased, there are potentially individuals domiciled abroad (Statistisches Bundesamt, 2017a). Unfortunately, the Road Traffic Accident Statistics do not provide data on the residence of the persons involved in an accident. In fact, the number of all dead drivers always lies between the death count due to MVAs and the number of fatalities of the adjusted MVA category across all three age groups. This substantiates the presumption made at the beginning that the category MVA-adjusted might underestimate the total number of dead drivers, whereas the category MVAs might overestimate the true count. Table A-3 also reveals that fatalities where the dead driver was alcoholized are a rather rare event. The share of alcoholized drivers among all deceased drivers is relatively constant across the three age groups and never exceeds ten percent. Thus, Table A-3 highlights that in over 90 percent of the cases our treatment of interest, having legal access to alcohol, was not relevant for the road fatalities.

The descriptive statistics regarding the vehicle type are logical. Riding motorcycles, which are exempt from registration, does not require any type of driving license in many cases. By contrast, in most instances, in order to ride motorcycles requiring registration, a driving license is needed.[62] At age 16, it is possible for an individual to acquire a driving license permitting them to ride motorbikes. At age 18, a young person can acquire a driving license entitling them to drive many types of automobile.[63] In the 14–15 year group, around 70 percent of the dead

[62]Exempt from registration means that no license number is required. Mandatory registration means that a license number is required.

[63]The group of automobiles includes motor vehicles such as cars, buses, trucks, and camper vans.

drivers rode a motorcycle for which no registration was required. Among the remaining 30 percent, it is likely that some were driving a motor vehicle without legal permission. Regarding the medium age group, about 61 percent were killed in an accident whilst riding a motorbike requiring registration. Among the 18–19-year-old deceased drivers, around 86 percent were driving an automobile, and only roughly two percent of motorcycles are exempt from registration. The gender distribution confirms that males are, in general, more prone to risky behavior than females. The share of males among the dead drivers varies between 79 and 91 percent across the three age groups.

Robustness Checks: Road Traffic Accident Statistics

Robustness Checks - Bandwidth. Our outcomes based on the Road Traffic Accident Statistics are only observable on a monthly basis, which severely limits the number of observations in the regressions. We thus refrain from extensive bandwidth sensitivity analyses and only present estimates from the alternative bandwidth of 18 months.[64] The results in Table A-11 show that the findings are robust to this choice of alternative bandwidth. Especially for the outcomes all dead drivers and not alcoholized, the estimates of the discontinuity are similar to those of the respective main specifications in terms of both size and statistical significance. In conclusion, the main finding persists: The novice driver effect is crucial for the mortality effects discovered at the 16th and 18th birthday. Having legal access to alcohol, in contrast, is of minor importance in terms of short-term mortality at both age thresholds.

Further Robustness Checks. Table A-12 shows the results of three different robustness checks using the Road Traffic Accident Statistics.[65] In this case, the sensitivity analyses with respect to the change from the ninth to the tenth revision of the ICD-coding lapses. We also do not conduct the “birthday donut” specification, because, due to data constraints, we always exclude drivers who died at 192 or 216 months of age, since it is ambiguous whether they died prior to or following their 16th or 18th birthday, respectively. Thus, our main specifications can already be interpreted as a type of “donut” specification. Table A-12 reveals that the main results

[64]In unreported regressions, we also estimated models with a bandwidth of 12 months. The findings were in line with those presented here.

[65]With the quadratic specifications, the overall picture remains, regardless of the robustness analysis conducted.

are robust to the various alternative specifications in the sense that the large and statistically highly significant estimated discontinuities in the number of all dead drivers are strongly driven by a novice driver effect at both age thresholds. Similar to the MVA-adjusted category, in the alcopop specification, the estimated jump for dead drivers who were under the influence of alcohol is much smaller as compared to the main specification at the first cutoff. At the second age threshold, the estimated jump is even negative. This is also in keeping with our discussion on the drunk driving laws, where we discover a general decline in the size of the estimated discontinuity in traffic fatalities at both age thresholds in more recent years.

Placebo Tests. Table A-13 presents the results of the placebo tests for the Road Traffic Accident Statistics. We set the bandwidth to one year and exclude individuals who died at 204 or 228 months of age, since it is unclear whether these persons died prior to or following their 17th or 19th birthday, respectively. At both thresholds, all estimated discontinuities are far from being statistically significant at conventional levels, which partly might be ascribed to the small number of observations in each regression. Contrary to the findings for the MVA categories, we detect negative effects at the 17th birthday when considering the outcomes all dead drivers and not alcoholized. For these two outcomes, results at the 19th birthday are in line with those for the MVA categories. The imprecisely estimated jumps for deceased drivers who were alcoholized at both thresholds depend largely on the polynomial specification. Compared to the findings for the MVA categories, this points to misspecification that presumably appears in the quadratic models.

Youth Leisure Online Survey

YOLO is based on a two-stage sampling strategy. First, we randomly sampled 120 registry offices (*Einwohnermeldeämter*) in Saxony and the neighboring states of Brandenburg and Thuringia (with sampling probabilities proportional to population size). The three states were chosen because they use the same registry software which facilitated the execution of the survey and allowed us to provide the registries with instructions on how to randomly draw the samples. By law, Germany requires residents to register with the resident offices of their municipality. Second, we contacted the sampled registry offices and purchased from them 80 percent random samples of individuals born between 1997 and 2003. Third, we posted an invitation letter to these young people and invited them to participate in an online survey, with the incentive to win a lottery prize including two iPads, worth €500 each, and ten Amazon vouchers, worth €20 each. Surveys were completed in 2018 and the final response rate was 20 percent.

The YOLO sample includes around 17,000 individuals aged 14-19. We collected information on whether young people ever consumed alcohol (Alcohol - Lifetime), whether they consumed alcohol during the last four weeks and during the last seven days, whether they were binge drinking during the last four weeks and during the last 7 days, and whether they consumed liquor in the last seven days. Further, we elicited information on the MLDA enforcement (for those who report alcohol consumption) and where they buy and consume alcohol. Table A-5 reports the summary statistics. There are several notable findings. First, for all alcohol consumption measures, there is a stepwise increase in the proportion of young people consuming alcohol. Second, we find some descriptive evidence for the strictness of the enforcement of the MLDA laws. For example, 60 percent (47 percent) of the 14-15-year-olds (16-17-year-olds) report that it is difficult to get hold of liquor, and “only” seven percent of the 14-15-year-olds report drinking in bars and discos. The descriptive statistics also suggest how young people manage to get hold of alcoholic beverages, with 66 percent (51 percent) of the 14-15-year-olds reporting that they receive alcoholic beverages from friends (relatives). Next, we also present summary statistics on drinking behavior from a survey that is representative for young people in the whole of Germany, as YOLO was only conducted in the (eastern) states Saxony, Brandenburg, and Thuringia.

Figure A-1: Alcohol Consumption around the 16th and 18th Birthday - Participation

Source: Youth Leisure Online Survey (YOLO), 2018, own calculations and depiction.
Notes: Fitted lines are obtained from unweighted regressions conducted separately for the respective cutoff. For each outcome, two specifications are depicted: The first specification includes a linear term of the forcing variable, the second specification adds a quadratic term. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. The dots represent four-week averages of each respective outcome.

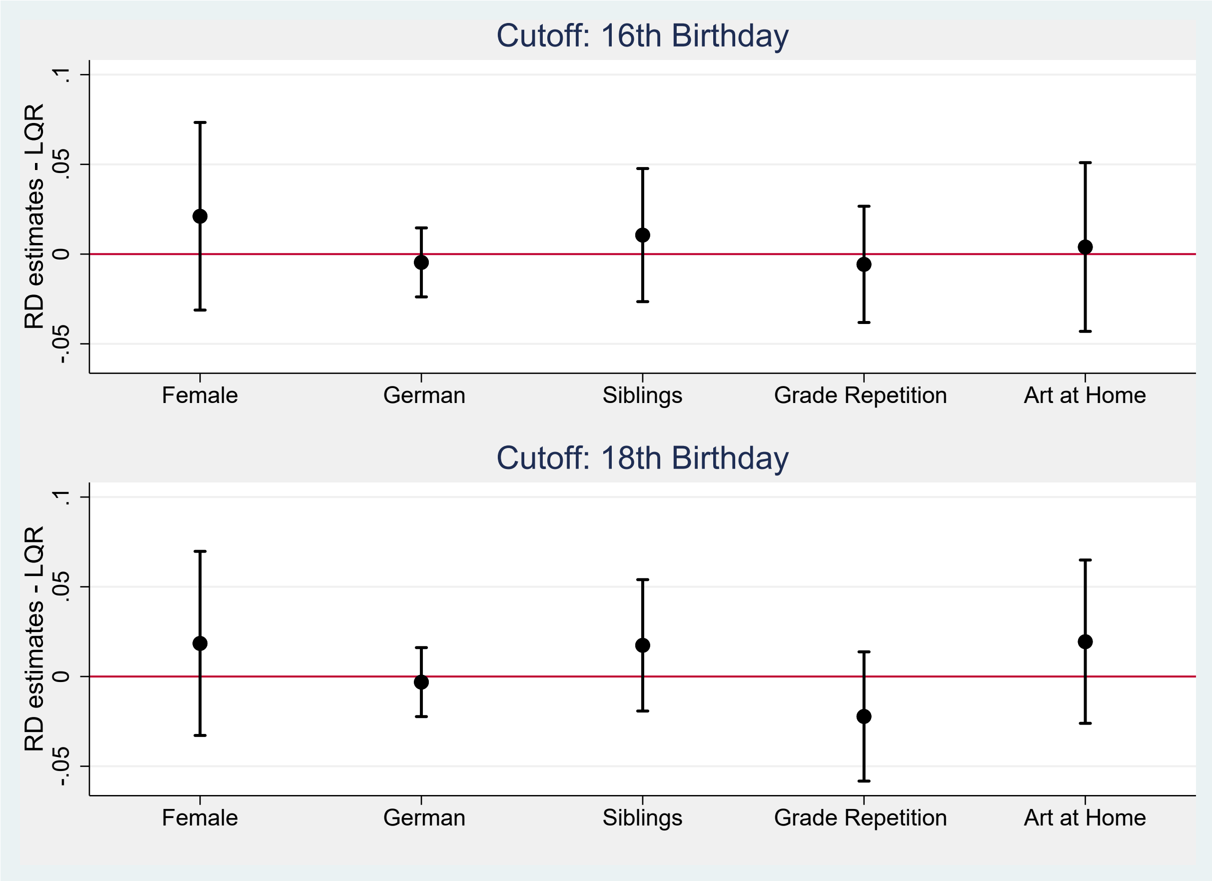
Figure A-2: Alcohol Consumption around the 16th and 18th Birthday - Intensity

Source: Youth Leisure Online Survey (YOLO), 2018, own calculations and depiction.
Notes: Fitted lines are obtained from unweighted regressions conducted separately for the respective cutoff. For each outcome, two specifications are depicted: The first specification includes a linear term of the forcing variable, the second specification adds a quadratic term. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. The dots represent four-week averages of each respective outcome.

Figure A-3: Alcohol Consumption around the 16th and 18th Birthday - Liquor

Source: Youth Leisure Online Survey (YOLO), 2018, own calculations and depiction.
Notes: Fitted lines are obtained from unweighted regressions conducted separately for the respective cutoff. For each outcome, two specifications are depicted: The first specification includes a linear term of the forcing variable, the second specification adds a quadratic term. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. The dots represent four-week averages of each respective outcome.

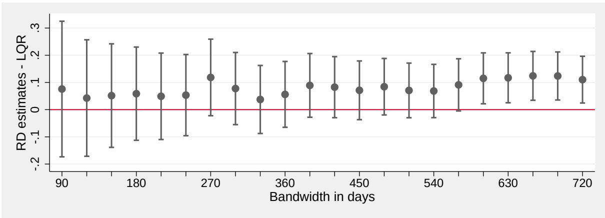
Figure A-4: Discontinuities at the 16th and 18th Birthday - Covariates (LQR)



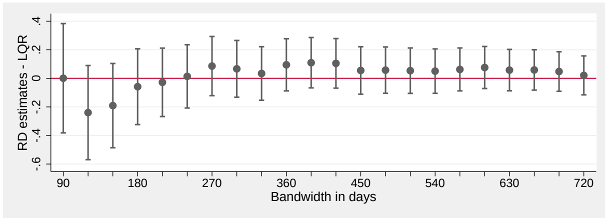
Source: Youth Leisure Online Survey, 2018, own calculations and depiction.
Notes: Results stem from different local quadratic regressions (LQR). All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. The bandwidth is set to two years in all regressions. For each point estimate, the 95 percent confidence interval is depicted.

Figure A-5: Sensitivity to the Bandwidth -
Cutoff: 16th Birthday, Quadratic Specifications

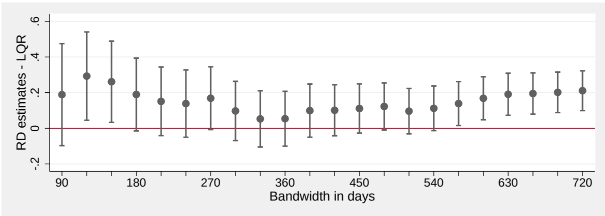
(a) All deaths



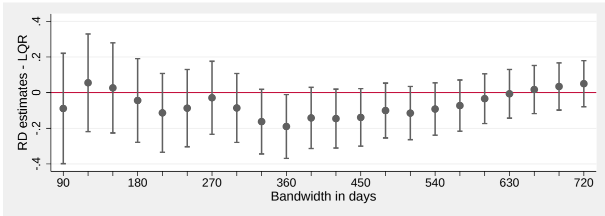
(b) Internal causes



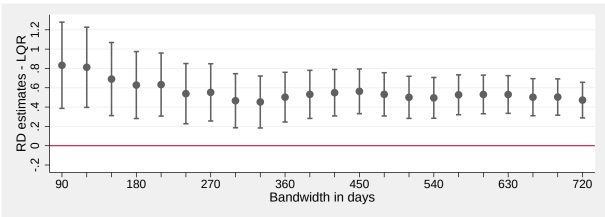
(c) External causes



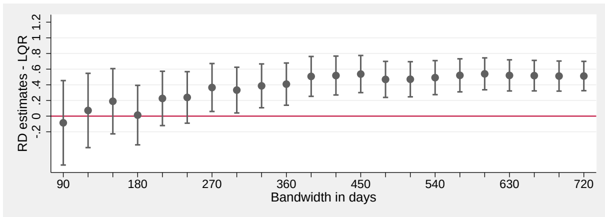
(d) External causes excluding MVAs



(e) MVAs



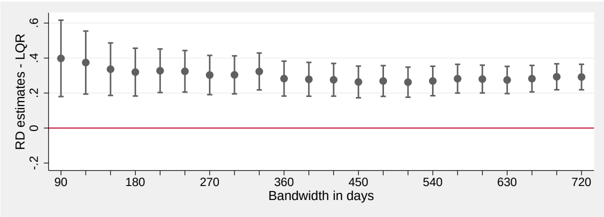
(f) MVAs-adj.



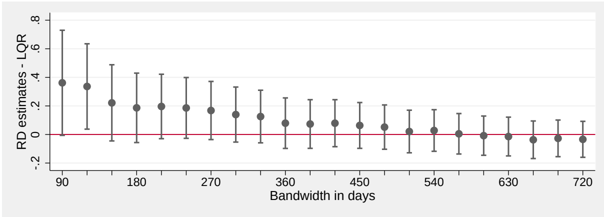
Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations and depiction.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 codes used to construct the different cause-of-death categories can be found in Appendix A. In each panel, results for various local quadratic regressions (LQR) are presented. The bandwidth varies from 90 to 720 days. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. For each point estimate, the 95 percent confidence interval is depicted.

Figure A-6: Sensitivity to the Bandwidth -
Cutoff: 18th Birthday, Quadratic Specifications

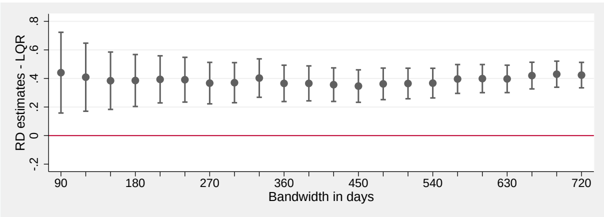
(a) All deaths



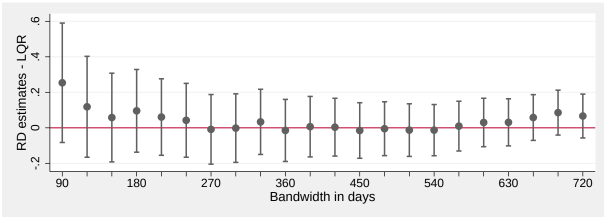
(b) Internal causes



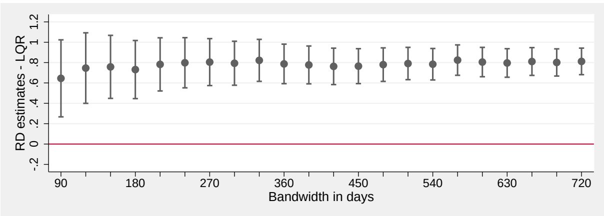
(c) External causes



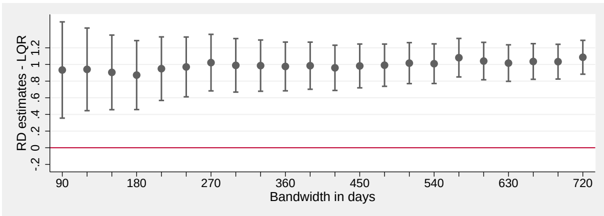
(d) External causes excluding MVAs



(e) MVAs



(f) MVAs-adj.



Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations and depiction.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 codes used to construct the different cause-of-death categories can be found in Appendix A. In each panel, results for various local quadratic regressions (LQR) are presented. The bandwidth varies from 90 to 720 days. All specifications include the full set of interaction terms between the treatment and the polynomials of the forcing variable. For each point estimate, the 95 percent confidence interval is depicted.

Table A-1: Descriptive Statistics - Going-Out Behavior

	Age group		
	14 - 15	**16 - 17**	**18 - 19**
Last 3 months:			
Disco at least monthly	0.17	0.46	0.60
Bar/Restaurant at least monthly	0.46	0.68	0.77
Private party at least monthly	0.48	0.67	0.71
Never go out	0.05	0.02	0.01
N	2,082	2,062	2,038
When going-out:			
Usually drink alcohol	0.14	0.36	0.40
Never drink alcohol	0.45	0.15	0.14
N	1,983	2,027	2,012

Source: Bundeszentrale für gesundheitliche Aufklärung, *Die Drogenaffinität Jugendlicher in der Bundesrepublik Deutschland*, 2001, 2004, 2008, 2011, own calculations.
Notes: Shares are reported for all variables and are rounded to two decimal places. Survey data is used from 2001, 2004, 2008 and 2011.

Table A-2: Descriptive Statistics − Cause-of-Death Statistics (1992-2015)

	Age group		
	14 - 15	**16 - 17**	**18 - 19**
Total number of deaths	7,573	13,607	23,014
Deaths due to internal causes	0.52	0.36	0.26
Deaths due to external causes	0.48	0.64	0.74
Subcategories: deaths due to external causes			
Deaths due to external causes excluding MVAs	0.38	0.39	0.35
Motor vehicle accidents (MVAs)	0.10	0.25	0.39
Subcategory of motor vehicle accidents (MVAs)			
Motor vehicle accidents (MVAs): drivers	0.02	0.10	0.16
Subcategories of deaths due to external causes excluding MVAs			
Alcohol-related deaths	0.00	0.00	0.00
Drug-related deaths	0.01	0.02	0.03
Homicides	0.02	0.01	0.02
Suicides	0.12	0.14	0.14
Deaths due to other external causes	0.24	0.22	0.16
Baseline Variables			
Males	0.60	0.68	0.73
German	0.91	0.93	0.92
West-Germany	0.79	0.76	0.76

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: All German residents who died between 1992 and 2015 are recorded. Shares are reported for all variables except for *Total number of deaths*. Shares are rounded to two decimal places. The total number of decedents for each cause-of-death category and age group is greater than zero in every case. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in Appendix A. The cause-of-death categories *Suicides* and *Drug-related deaths* have 109 overlapping observations, the categories *Suicides* and *Alcohol-related deaths* have less three overlapping observations.

Table A-3: Descriptive Statistics - Road Traffic Accident Statistics & Cause-of-Death Statistics

	Age group		
	14 - 15	**16 - 17**	**18 - 19**
Cause-of-Death Statistics (2002-2015)			
Number of deaths due to MVAs	272	1,292	3,417
Number of deaths due to MVAs-adj.	66	509	1,463
Road Traffic Accident Statistics (2002-2015)			
Number of all dead drivers	74	771	2,857
Share of alcoholized drivers	0.095	0.084	0.080
Share of motorcycles (exempt from registration)	0.689	0.253	0.021
Share of motorcycles (mandatory registration)	0.122	0.607	0.116
Share of automobiles	0.189	0.140	0.863
Share of males	0.838	0.905	0.791

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), and Road Traffic Accident Statistics (2002-2015), own calculations.

Notes: Cause-of-Death Statistics: All German residents who died between 2002 and 2015 are included. The ICD-10 codes used to construct the cause-of-death categories *MVAs* and *MVAs-adj.* can be found in Appendix A. Road Traffic Accident Statistics: All drivers who died due to road accidents in Germany between 2002 and 2015 are reported. Drivers who died at 168, 192 and 216 months of age are included in the age group "14 - 15", "16 - 17", and "18 - 19", despite it being unclear whether these persons died before or after their 14th, 16th or 18th birthday, respectively. The statistics consider a driver as being "alcoholized" if he has a blood alcohol level of 0.3 per mille or higher. The vehicle type "automobiles" comprises cars, buses, camper vans, trucks, and other motor vehicles. Exempt from registration means that no license number is needed. Mandatory registration means that these vehicles need to have a license number when used on public roads.

Table A-4: ICD-10 & ICD-9 codes for the Cause-of-Death Categories

Cause-of-death category	ICD-10 codes	ICD-9 codes
Deaths due to external causes:	V* W* X* Y* E244 F10* F11* F12* F13* F14* F15* F16* F17* F18* F19* F55* G312 G621 G721 I426 K292 K70* K852 K860 R780 R781 R782 R783 R784 R785 R786 T40* T41* T423 T424 T427 T43* T51 T510 T513 T518 T519 Z502 Z714 Z721	E8* E9* 291* 292* 303 304* 3050 3051 3052 3053 3054 3055 3056 3057 3058 3059 3575 3576 4255 5353 5710 5711 5712 5713 7903 9090 980 9800 9803 9808 9809
Deaths due to internal causes:	All ICD-codes which are not included in the category Deaths due to external causes.	
Subcategories of deaths due to external causes		
Motor vehicle accidents (MVAs):	V20 V20α V21 V21α V22 V22α V23 V23α V24 V24α V25 V25α V26 V26α V27 V27α V28 V28α V29 V29ψ V30 V30ζ V31 V31ζ V32 V32ζ V33 V33ζ V34 V34ζ V35 V35ζ V36 V36ζ V37 V37ζ V38 V38ζ V39 V39ψ V40 V40ζ V41 V41ζ V42 V42ζ V43 V43ζ V44 V44ζ V45 V45ζ V46 V46ζ V47 V47ζ V48 V48ζ V49 V49ψ V50 V50ζ V51 V51ζ V52 V52ζ V53 V53ζ V54 V54ζ V55 V55ζ V56 V56ζ V57 V57ζ V58 V58ζ V59 V59ψ V60 V60ζ V61 V61ζ V62 V62ζ V63 V63ζ V64 V64ζ V65 V65ζ V66 V66ζ V67 V67ζ V68 V68ζ V69 V69ψ V70 V70ζ V71 V71ζ V72 V72ζ V73 V73ζ V74 V74ζ V75 V75ζ V76 V76ζ V77 V77ζ V78 V78ζ V79 V79ψ V83 V83ζ V84 V84ζ V85 V85ζ V86 V86ζ V87* V88* V89*	E810 E8100 E8102 E8109 E811 E8110 E8112 E8119 E812 E8120 E8122 E8129 E813 E8130 E8132 E8139 E814 E8140 E8142 E8149 E815 E8150 E8152 E8159 E816 E8160 E8162 E8169 E817 E8170 E8172 E8179 E818 E8180 E8182 E8189 E819 E8190 E8192 E8199 E820 E8200 E8202 E8209 E821 E8210 E8212 E8219 E822 E8220 E8222 E8229 E823 E8230 E8232 E8239 E824 E8240 E8242 E8249 E825 E8250 E8252 E8259
MVAs-adj.:	V20γ V21γ V22γ V23γ V24γ V25γ V26γ V27γ V28γ V29γ V30λ V31λ V32λ V33λ V34λ V35λ V36λ V37λ V38λ V39γ V40λ V41λ V42λ V43λ V44λ V45λ V46λ V47λ V48λ V49γ V50λ V51λ V52λ V53λ V54λ V55λ V56λ V57λ V58λ V59γ V60λ V61λ V62λ V63λ V64λ V65λ V66λ V67λ V68λ V69γ V70λ V71λ V72λ V73λ V74λ V75λ V76λ V77λ V78λ V79γ V83λ V84λ V85λ V86λ	E8100 E8102 E8110 E8112 E8120 E8122 E8130 E8132 E8140 E8142 E8150 E8152 E8160 E8162 E8170 E8172 E8180 E8182 E8190 E8192 E8200 E8202 E8210 E8212 E8220 E8222 E8230 E8232 E8240 E8242 E8250 E8252
External causes excluding MVAs:	All ICD-codes of the category deaths due to external causes except for the ICD-codes that are part of the category motor vehicle accidents (MVAs).	
Subcategories of external causes excluding MVAs		
Alcohol-related deaths:	E244 F10* G312 G621 G721 I426 K292 K70* K852 K860 R780 T51 T510 T513 T518 T519 X45* X65* Y15* Y90* Y91* Z502 Z714 Z721	291* 303 3050 3575 4255 5353 5710 5711 5712 5713 7903 980 9800 9803 9808 9809 E8600 E8601 E8604 E8608 E8609
Drug-related deaths:	F11* F12* F13* F14* F15* F16* F17* F18* F19* F55* R781 R782 R783 R784 R785 R786 T40* T41* T423 T424 T427 T43* X40* X42* X61* X62*	292* 304* 3051 3052 3053 3054 3055 3056 3057 3058 3059 3576 9090 E850* E851 E852* E853* E854* E855* E856 E857 E858*
Homicides:	X85* X86* X87* X88* X89* X9* Y0*	E960* E961 E962* E963 E964 E965* E966 E967* E968* E969
Suicides:	X6* X7* X80* X81* X82* X83* X84*	E950* E951* E952* E953* E954 E955* E956 E957* E958* E959
Deaths due to other external causes:	All ICD-codes of the category external causes excluding MVAs except for the ICD-codes that are part of the categories alcohol-related deaths, drug-related deaths, homicides and suicides.	

*: Including all existing 4-digit subcategories. α: 0, 2, 4, 9. ψ: 0, 2, 3, 4, 6, 8, 9.
ζ: 0, 3, 5, 9. γ: 0, 4. λ: 0, 5.

Table A-5: Descriptive Statistics − Alcohol Consumption (2018)

	Age group		
	14 - 15	**16 - 17**	**18 - 19**
Alcohol Consumption			
Alcohol - Lifetime	0.55	0.78	0.87
N	4,079	7,332	5,560
Alcohol - Last 4 Weeks	0.42	0.66	0.76
N	4,077	7,328	5,556
Alcohol - Last Week	0.24	0.45	0.57
N	4,078	7,330	5,558
Binge Drinking - Last 4 Weeks	0.17	0.35	0.42
N	4,041	7,274	5,518
Binge Drinking - Last Week	0.03	0.10	0.14
N	4,059	7,301	5,529
Liquor - Last Week	0.09	0.22	0.33
N	4,060	7,293	5,523
Pct. of Days Drinking Liquor Last Week	0.02	0.04	0.07
N	4,060	7,293	5,523
Covariates			
Females	0.55	0.57	0.56
N	4,079	7,332	5,560
German	0.96	0.96	0.96
N	4,049	7,286	5,523
Siblings	0.86	0.85	0.86
N	4,017	7,225	5,504
Grade Repetition	0.09	0.12	0.16
N	4,057	7,318	5,548
Art at Home	0.72	0.73	0.72
N	4,050	7,282	5,521
Enforcement			
Getting Beer & Wine: Difficult	0.25	0.04	0.01
N	1,986	5,401	4,706
Getting Liquor: Difficult	0.60	0.47	0.02
N	1,976	5,220	4,674
Drinking at Home	0.45	0.47	0.49
Drinking in Public Places	0.21	0.31	0.28
Drinking in Restaurants	0.12	0.21	0.29
Drinking in Bars/Discos	0.07	0.28	0.54
Drinking at Friends' Houses	0.66	0.79	0.81
Buying: Supermarket	0.15	0.68	0.89
Buying: Kiosk/Gas Station	0.07	0.16	0.21
Buying: Bars/Discos/Restaurants	0.04	0.17	0.31
Receiving from Friends	0.66	0.68	0.50
Receiving from Relatives	0.51	0.46	0.31
N	2,253	5,694	4,831

Source: Youth Leisure Online Survey, 2018, own calculations.
Notes: Proportions are reported for all variables and rounded to two decimal places. Only people who drank alcohol at least once in their lifetime were asked the questions with respect to the enforcement of the MLDA laws.

Table A-6: Descriptive Statistics - Drinking Behavior

	14 - 15	16 - 17	18 - 19	14 - 15 – 16 - 17	16 - 17 – 18 - 19
Panel A					
Males	0.496	0.500	0.511	−0.005	−0.010
German	0.956	0.952	0.950	0.004	0.002
West-Germany	0.734	0.765	0.765	−0.031***	−0.001
Lifetime:					
Never been drunk	0.731	0.413	0.279	0.317***	0.134***
Drunkenness, >10 times	0.020	0.063	0.130	−0.043***	−0.068***
N	3,210	3,207	2,861		
Panel B					
Last 12 months:					
Beer at least monthly	0.302	0.571	0.544	−0.270***	0.027*
Wine or sparkling wine at least monthly	0.149	0.317	0.383	−0.168***	−0.066***
Spirits at least monthly	0.105	0.285	0.358	−0.180***	−0.073***
Cocktails at least monthly	0.200	0.459	0.570	−0.259***	−0.111***
N	2,082	2,056	2,033		
Panel C					
Last 30 days:					
Alcohol at least once	0.490	0.785	0.812	−0.295***	−0.027*
Alcohol, $\geq$ 10 days	0.021	0.050	0.075	−0.030***	−0.024***
N	1,644	1,608	1,590		
5 drinks on one occasion at least once	0.313	0.495	0.558	−0.182***	−0.063***
5 drinks on one occasion, $\geq$ 10 days	0.009	0.011	0.022	−0.002	−0.011**
N	798	1,254	1,286		

Source: Bundeszentrale für gesundheitliche Aufklärung, *Die Drogenaffinität Jugendlicher in der Bundesrepublik Deutschland*, 1993/1994, 1997, 2001, 2004, 2008, 2011, own calculations.
Notes: Shares are reported for all variables and are rounded to three decimal places. Panel A includes survey data from 1993/1994, 1997, 2001, 2004, 2008, and 2011. Panel B includes survey data from 2001, 2004, 2008, and 2011. Panel C includes survey data from 2004, 2008, and 2011. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively.

Table A-7: Descriptive Statistics -
Drinking Behavior: BB, SN, TH vs. Other Federal States

	14 - 15			16 - 17			18 - 19		
	Other	**BB, SN, TH**	**Diff**	**Other**	**BB, SN, TH**	**Diff**	**Other**	**BB, SN, TH**	**Diff**
Panel A									
Males	0.494	0.504	−0.009	0.495	0.535	−0.040	0.512	0.506	0.006
German	0.948	0.994	−0.046***	0.944	1.000	−0.056***	0.943	0.987	−0.043***
Lifetime:									
Never been drunk	0.736	0.704	0.032	0.405	0.461	−0.056**	0.269	0.332	−0.063***
Drunkenness, >10 times	0.022	0.009	0.013*	0.065	0.049	0.016	0.143	0.060	0.083***
N	2,670	540		2,734	473		2,412	449	
Panel B									
Last 12 months:									
Beer at least monthly	0.298	0.328	−0.030	0.579	0.514	0.065*	0.559	0.448	0.111***
Wine or sparkling wine at least monthly	0.140	0.220	−0.080***	0.307	0.389	−0.081***	0.373	0.452	−0.079**
Spirits at least monthly	0.106	0.100	0.006	0.286	0.275	0.011	0.372	0.267	0.105***
Cocktails at least monthly	0.192	0.257	−0.065**	0.458	0.462	−0.003	0.580	0.500	0.080**
N	1,841	241		1,809	247		1,763	270	
Panel C									
Last 30 days:									
Alcohol at least once	0.475	0.648	−0.173***	0.778	0.856	−0.078**	0.812	0.815	−0.004
Alcohol, $\geq$ 10 days	0.021	0.014	0.008	0.052	0.034	0.018	0.071	0.108	−0.037*
N	1,499	145		1,462	146		1,433	157	
5 drinks on one occasion at least once	0.312	0.323	−0.011	0.502	0.435	0.066	0.566	0.484	0.082*
5 drinks on one occasion, $\geq$ 10 days	0.009	0.011	−0.002	0.011	0.016	−0.006	0.024	0.000	0.024*
N	705	93		1,130	124		1,158	128	

Source: Bundeszentrale für gesundheitliche Aufklärung, Die Drogenaffinität Jugendlicher in der Bundesrepublik Deutschland, 1993/1994, 1997, 2001, 2004, 2008, 2011, own calculations.
Notes: Shares are reported for all variables and are rounded to three decimal places. Panel A includes survey data from 1993/1994, 1997, 2001, 2004, 2008, and 2011. Panel B includes survey data from 2001, 2004, 2008, and 2011. Panel C includes survey data from 2004, 2008, and 2011. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively.

Table A-8: Discontinuities in Deaths by Region

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
All deaths				
West Germany	0.110***	0.087*	0.291***	0.266***
	(0.034)	(0.050)	(0.028)	(0.042)
East Germany	0.278***	0.197**	0.386***	0.347***
	(0.063)	(0.091)	(0.049)	(0.069)
Internal causes				
West Germany	0.013	0.013	0.046	−0.030
	(0.049)	(0.072)	(0.048)	(0.072)
East Germany	0.074	0.055	0.021	−0.078
	(0.076)	(0.116)	(0.078)	(0.117)
External causes				
West Germany	0.197***	0.164**	0.389***	0.394***
	(0.047)	(0.067)	(0.035)	(0.053)
East Germany	0.312***	0.271**	0.461***	0.471***
	(0.071)	(0.105)	(0.053)	(0.077)
External causes w/o MVAs				
West Germany	0.050	0.051	0.032	0.011
	(0.057)	(0.082)	(0.046)	(0.072)
East Germany	0.036	−0.040	0.085	0.182
	(0.074)	(0.110)	(0.076)	(0.118)
MVAs				
West Germany	0.534***	0.336***	0.824***	0.871***
	(0.066)	(0.097)	(0.050)	(0.077)
East Germany	0.525***	0.510***	0.717***	0.618***
	(0.066)	(0.100)	(0.066)	(0.096)
MVAs-adj.				
West Germany	0.519***	0.375***	0.952***	0.994***
	(0.064)	(0.095)	(0.072)	(0.110)
East Germany	0.350***	0.248***	0.726***	0.799***
	(0.050)	(0.073)	(0.071)	(0.105)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: Discontinuities are estimated separately for decedents resident in western Germany and eastern Germany. The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in Appendix A. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 1,444 for each regression.

Table A-9: Discontinuities in Deaths at the 16th Birthday - Robustness Checks - Quadratic Specifications

	Weighted	Log(Y+1)	Birthday donut	ICD-10 Sample	Alcopop Sample
	(1)	(2)	(3)	(4)	(5)
All deaths					
Discontinuity	0.101**	0.104**	0.113**	0.102*	0.159**
	(0.046)	(0.042)	(0.045)	(0.057)	(0.077)
N	1,443	1,444	1,430	1,444	1,444
Internal causes					
Discontinuity	0.057	0.009	0.003	0.002	−0.038
	(0.072)	(0.062)	(0.072)	(0.081)	(0.109)
N	1,443	1,444	1,430	1,444	1,444
External causes					
Discontinuity	0.160***	0.193***	0.225***	0.198**	0.287***
	(0.058)	(0.054)	(0.062)	(0.078)	(0.101)
N	1,443	1,444	1,430	1,444	1,444
External causes w/o MVAs					
Discontinuity	−0.039	0.039	0.073	0.018	0.133
	(0.068)	(0.061)	(0.072)	(0.090)	(0.109)
N	1,443	1,444	1,430	1,444	1,444
MVAs					
Discontinuity	0.517***	0.389***	0.471***	0.484***	0.424***
	(0.099)	(0.071)	(0.099)	(0.103)	(0.094)
N	1,443	1,444	1,430	1,444	1,444
MVAs-adj.					
Discontinuity	0.502***	0.356***	0.551***	0.458***	0.177**
	(0.102)	(0.066)	(0.101)	(0.090)	(0.071)
N	1,443	1,444	1,430	1,444	1,444
Quadratic terms	Yes	Yes	Yes	Yes	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. In columns (1), (3), (4) and (5), 0.5 was added to all outcomes before taking logs. In column (2), 1 was added to all outcomes before taking logs. A bandwidth of two years is used in all specifications. In column (1), triangular kernel weights are used. The "birthday donut" specifications, column (3), exclude deaths that occurred within a week before or after the cutoff. The "ICD-10 Sample" spans the years from 1998 to 2015, whereas the "Alcopop Sample" includes the years from 2005 to 2015. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in Appendix A. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table A-10: Discontinuities in Deaths at the 18th Birthday - Robustness Checks - Quadratic Specifications

	Weighted	Log(Y+1)	Birthday donut	ICD-10 Sample	Alcopop Sample
	(1)	(2)	(3)	(4)	(5)
All deaths					
Discontinuity	0.282***	0.284***	0.279***	0.284***	0.223***
	(0.040)	(0.037)	(0.039)	(0.044)	(0.060)
N	1,443	1,444	1,430	1,444	1,444
Internal causes					
Discontinuity	0.009	−0.028	−0.070	0.004	0.037
	(0.069)	(0.058)	(0.065)	(0.071)	(0.101)
N	1,443	1,444	1,430	1,444	1,444
External causes					
Discontinuity	0.396***	0.408***	0.419***	0.408***	0.316***
	(0.049)	(0.044)	(0.047)	(0.057)	(0.075)
N	1,443	1,444	1,430	1,444	1,444
External causes w/o MVAs					
Discontinuity	0.032	0.062	0.056	0.104	0.062
	(0.068)	(0.058)	(0.065)	(0.076)	(0.097)
N	1,443	1,444	1,430	1,444	1,444
MVAs					
Discontinuity	0.798***	0.752***	0.817***	0.735***	0.607***
	(0.073)	(0.059)	(0.070)	(0.086)	(0.104)
N	1,443	1,444	1,430	1,444	1,444
MVAs-adj.					
Discontinuity	1.027***	0.875***	1.109***	0.672***	0.482***
	(0.114)	(0.079)	(0.107)	(0.114)	(0.108)
N	1,443	1,444	1,430	1,444	1,444
Quadratic terms	Yes	Yes	Yes	Yes	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. In columns (1), (3), (4) and (5), 0.5 was added to all outcomes before taking logs. In column (2), 1 was added to all outcomes before taking logs. A bandwidth of two years is used in all specifications. In column (1), triangular kernel weights are used. The "birthday donut" specifications, column (3), exclude deaths that occurred within a week before or after the cutoff. The "ICD-10 Sample" spans the years 1998 to 2015, whereas the "Alcopop Sample" includes the years from 2005 to 2015. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in Appendix A. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table A-11: Sensitivity to the Bandwidth - Road Traffic Accident Statistics

	Cutoff: 16th birthday		**Cutoff: 18th birthday**	
	(1)	(2)	(3)	(4)
Bandwidth: 18 months				
All dead drivers				
Discontinuity	0.723**	1.423***	1.099***	1.072***
	(0.300)	(0.345)	(0.108)	(0.136)
N	36	36	36	36
Not alcoholized				
Discontinuity	0.836**	1.540***	1.158***	1.154***
	(0.324)	(0.387)	(0.107)	(0.135)
N	36	36	36	36
Alcoholized				
Discontinuity	0.515	0.661	0.190	−0.166
	(0.479)	(0.808)	(0.294)	(0.375)
N	36	36	36	36
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Road Traffic Accident Statistics (2002-2015), own calculations.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x months from the respective cutoff. 0.5 was added to all outcomes before taking logs. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. Drivers who died at 192 or 216 months of age are excluded, since it is unclear whether these persons died before or after their 16th or 18th birthday, respectively.

Table A-12: Road Traffic Accident Statistics - Robustness Checks

	Cutoff: 16th birthday			**Cutoff: 18th birthday**		
	Weighted	Log(Y+1)	Alcopop Sample	Weighted	Log(Y+1)	Alcopop Sample
	(1)	(2)	(3)	(1)	(2)	(3)
All dead drivers						
Discontinuity	0.899***	1.012***	1.104***	1.102***	1.118***	1.096***
	(0.159)	(0.202)	(0.265)	(0.102)	(0.097)	(0.106)
N	44	46	46	44	46	46
Not alcoholized						
Discontinuity	1.010***	1.087***	1.229***	1.163***	1.152***	1.173***
	(0.200)	(0.226)	(0.275)	(0.104)	(0.099)	(0.117)
N	44	46	46	44	46	46
Alcoholized						
Discontinuity	0.533	0.472	0.161	0.134	0.392	−0.205
	(0.526)	(0.289)	(0.411)	(0.287)	(0.258)	(0.456)
N	44	46	46	44	46	46
Quadratic terms	No	No	No	No	No	No

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Road Traffic Accident Statistics (2002-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. In columns (1) and (3), 0.5 was added to all outcomes before taking logs. In column (2), 1 was added to all outcomes before taking logs. A bandwidth of two years is used in all specifications. In column (1), triangular kernel weights are used. The "Alcopop Sample" includes the years from 2005 to 2015. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table A-13: Discontinuities in Deaths - Placebo Tests - Road Traffic Accident Statistics

	Cutoff: 17th birthday		Cutoff: 19th birthday	
	(1)	(2)	(3)	(4)
All dead drivers				
Discontinuity	-0.081	-0.235	-0.102	-0.093
	(0.183)	(0.328)	(0.102)	(0.232)
Not alcoholized				
Discontinuity	-0.107	-0.168	-0.107	-0.116
	(0.174)	(0.328)	(0.098)	(0.216)
Alcoholized				
Discontinuity	0.108	-0.928	-0.082	0.276
	(0.423)	(0.706)	(0.373)	(0.699)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Road Traffic Accident Statistics (2002-2015), own calculations.

Notes: Discontinuities are estimated at the 17th and 19th birthday, respectively. The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x months from the respective cutoff. 0.5 was added to all outcomes before taking logs. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of one year is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 22 for each regression. Drivers who died at 204 or 228 months of age are excluded, since it is unclear whether these persons died before or after their 17th or 19th birthday, respectively.

Table A-14: Road Traffic Accident Statistics - Robustness Checks Quadratic Specifications

	Cutoff: 16th birthday			**Cutoff: 18th birthday**		
	Weighted	Log(Y+1)	Alcopop Sample	Weighted	Log(Y+1)	Alcopop Sample
	(1)	(2)	(3)	(1)	(2)	(3)
All dead drivers						
Discontinuity	1.328***	0.850**	0.731	1.045***	1.056***	1.157***
	(0.210)	(0.322)	(0.460)	(0.141)	(0.126)	(0.151)
N	44	46	46	44	46	46
Not alcoholized						
Discontinuity	1.421***	0.963***	0.865**	1.124***	1.157***	1.300***
	(0.261)	(0.330)	(0.411)	(0.135)	(0.123)	(0.171)
N	44	46	46	44	46	46
Alcoholized						
Discontinuity	0.836	0.406	0.016	−0.136	−0.279	−0.979
	(0.860)	(0.498)	(0.737)	(0.454)	(0.323)	(0.653)
N	44	46	46	44	46	46
Quadratic terms	Yes	Yes	Yes	Yes	Yes	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Road Traffic Accident Statistics (2002-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. In columns (1) and (3), 0.5 was added to all outcomes before taking logs. In column (2), 1 was added to all outcomes before taking logs. A bandwidth of two years is used in all specifications. In column (1), triangular kernel weights are used. The "Alcopop Sample" includes the years from 2005 to 2015. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table A-15: Discontinuities in Deaths at the 16th Birthday - Different Bandwidth Selection Procedures

	(1)	(2)	(3)	(4)
All deaths				
Discontinuity	0.128***	0.100**	0.108**	0.071
	(0.033)	(0.050)	(0.044)	(0.058)
N	1,231	475	1,443	817
Internal causes				
Discontinuity	0.000	0.047	0.079	0.108
	(0.048)	(0.072)	(0.075)	(0.091)
N	1,301	581	1,231	771
External causes				
Discontinuity	0.200***	0.121*	0.075	0.099
	(0.052)	(0.070)	(0.077)	(0.076)
N	811	401	741	785
External causes w/o MVAs				
Discontinuity	−0.126*	−0.133	−0.099	−0.139
	(0.074)	(0.090)	(0.079)	(0.086)
N	531	327	951	829
MVAs				
Discontinuity	0.553***	0.559***	0.526***	0.540***
	(0.089)	(0.091)	(0.101)	(0.117)
N	741	689	1,231	921
MVAs-adj.				
Discontinuity	0.552***	0.520***	0.476***	0.527***
	(0.084)	(0.109)	(0.118)	(0.122)
N	811	507	951	891
Quadratic terms	No	No	Yes	Yes
Bandwidth selection procedure				
CV	Yes	No	Yes	No
IK	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. CV stands for the cross-validation procedure proposed by Ludwig & Miller (2007), and IK stands for the procedure suggested by Imbens & Kalyanaraman (2012). The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in Appendix A. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table A-16: Discontinuities in Deaths at the 18th Birthday - Different Bandwidth Selection Procedures

	(1)	(2)	(3)	(4)
All deaths				
Discontinuity	0.305^{***}	0.297^{***}	0.288^{***}	0.274^{***}
	(0.028)	(0.030)	(0.037)	(0.040)
N	1,091	925	1,443	1,223
Internal causes				
Discontinuity	0.027	0.012	0.021	0.047
	(0.046)	(0.067)	(0.076)	(0.080)
N	1,301	627	1,021	937
External causes				
Discontinuity	0.388^{***}	0.391^{***}	0.429^{***}	0.356^{***}
	(0.047)	(0.047)	(0.047)	(0.057)
N	601	605	1,371	931
External causes w/o MVAs				
Discontinuity	0.085^{*}	0.015	0.083	-0.009
	(0.045)	(0.072)	(0.065)	(0.078)
N	1,231	503	1,371	937
MVAs				
Discontinuity	0.787^{***}	0.800^{***}	0.749^{***}	0.753^{***}
	(0.060)	(0.049)	(0.088)	(0.090)
N	741	1,107	881	851
MVAs-adj.				
Discontinuity	1.023^{***}	1.020^{***}	0.996^{***}	0.968^{***}
	(0.097)	(0.102)	(0.130)	(0.140)
N	741	667	951	825
Quadratic terms	No	No	Yes	Yes
Bandwidth selection procedure				
CV	Yes	No	Yes	No
IK	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.
Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. CV stands for the cross-validation procedure proposed by Ludwig & Miller (2007), and IK stands for the procedure suggested by Imbens & Kalyanaraman (2012). The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in Appendix A. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions.

Table A-17: Robustness Checks - Drunk Driving Laws - Quadratic Specifications

	Cutoff: 16th birthday			Cutoff: 18th birthday		
	BAC limit: 0.8 & 0.5 (1999-2015)	BAC limit: 0.5 (2002-2015)	0-tolerance & AD17 (2008-2015)	BAC limit: 0.8 & 0.5 (1999-2015)	BAC limit: 0.5 (2002-2015)	0-tolerance & AD17 (2008-2015)
	(1)	(2)	(3)	(1)	(2)	(3)
Cause-of-Death Statistics						
MVAs						
Discontinuity	0.487***	0.505***	0.198**	0.676***	0.621***	0.580***
	(0.104)	(0.101)	(0.081)	(0.090)	(0.102)	(0.104)
MVAs-adj.						
Discontinuity	0.382***	0.301***	0.106*	0.609***	0.512***	0.409***
	(0.088)	(0.081)	(0.058)	(0.115)	(0.114)	(0.101)
Road Traffic Accident Statistics						
All dead drivers						
Discontinuity	–	0.778*	0.906**	–	1.065***	1.119***
		(0.397)	(0.419)		(0.127)	(0.183)
Not alcoholized						
Discontinuity	–	0.916**	0.983**	–	1.167***	1.320***
		(0.401)	(0.380)		(0.124)	(0.191)
Alcoholized						
Discontinuity	–	0.439	0.501	–	−0.296	−1.664**
		(0.709)	(0.689)		(0.368)	(0.669)
Quadratic terms	Yes	Yes	Yes	Yes	Yes	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), and Road Traffic Accident Statistics (2002-2015), own calculations.
Notes: In column (1), we only use observations from 1999-2015; in column (2), from 2002-2015; in column (3), from 2008-2015. 0.5 was added to all outcomes before taking logs. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust std. errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. Cause-of-Death Statistics: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in online Appendix A. N = 1,444 for each regression. Road Traffic Accident Statistics: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x months from the respective cutoff. Drivers who died at 192 or 216 months of age are excluded, since it is unclear whether these persons died before or after their 16th or 18th birthday, respectively. N = 46 for each regression.

Table A-18: Discontinuities in Deaths - BB, SN, TH

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
All deaths				
Discontinuity	0.234***	0.179*	0.375***	0.327***
	(0.069)	(0.101)	(0.058)	(0.084)
Internal causes				
Discontinuity	0.045	0.015	−0.041	−0.129
	(0.072)	(0.108)	(0.075)	(0.112)
External causes				
Discontinuity	0.267***	0.249**	0.459***	0.460***
	(0.072)	(0.108)	(0.063)	(0.091)
External causes w/o MVAs				
Discontinuity	0.026	0.021	0.132*	0.225**
	(0.071)	(0.105)	(0.075)	(0.114)
MVAs				
Discontinuity	0.390***	0.390***	0.649***	0.507***
	(0.060)	(0.092)	(0.072)	(0.107)
MVAs-adj.				
Discontinuity	0.221***	0.157**	0.563***	0.613***
	(0.044)	(0.064)	(0.070)	(0.106)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in Appendix A. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 1,444 for each regression. The sample consists of decedents that were resident in Brandenburg (BB), Saxony (SN), or Thuringia (TN), respectively.

Table A-19: Discontinuities in Deaths - BB, SN, TH
Subcategories of *deaths due to external causes excluding MVAs*

	Cutoff: 16th birthday		Cutoff: 18th birthday	
	(1)	(2)	(3)	(4)
Alcohol-related				
Discontinuity	0.002	−0.001	0.000	−0.004
	(0.002)	(0.001)	(0.001)	(0.003)
Drug-related				
Discontinuity	−0.008	−0.031	−0.001	−0.022
	(0.014)	(0.020)	(0.021)	(0.030)
Homicides				
Discontinuity	0.019	0.044	0.029	0.019
	(0.021)	(0.033)	(0.027)	(0.042)
Suicides				
Discontinuity	0.038	0.021	0.155**	0.242***
	(0.046)	(0.065)	(0.061)	(0.093)
Other external causes				
Discontinuity	0.011	0.029	0.099	0.148
	(0.069)	(0.101)	(0.074)	(0.112)
Quadratic terms	No	Yes	No	Yes

Source: Research Data Centres of the Federal Statistical Office and Statistical Offices of the Länder, Cause-of-Death Statistics (1992-2015), own calculations.

Notes: The dependent variable is the logarithm of the number of deaths for a specific cause-of-death category that occurred x days from the respective cutoff. 0.5 was added to all outcomes before taking logs. The ICD-10 and ICD-9 codes used to construct the different cause-of-death categories can be found in the online Appendix A. Each specification includes the full set of interaction terms between the treatment and the polynomials of the forcing variable. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively. A bandwidth of two years is used in all specifications. Each estimated discontinuity and the corresponding robust standard error stem from separate regressions. N = 1,444 for each regression. The sample consists of decedents that were resident in Brandenburg (BB), Saxony (SN), or Thuringia (TN), respectively.