Minimum Legal Drinking Age and Educational Outcomes

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Abstract

Many European countries have raised the minimum legal drinking age (MLDA) from 16 to 18 over the past decades. These policies often comprise a bundle of reforms including restrictions on alcohol sales to minors, venue access limitations, and advertising controls. We provide novel evidence of the impact of MLDA changes on educational outcomes by exploiting their staggered timing across Spanish regions. Alcohol consumption among adolescents aged 14–17 decreased by 7 to 17% and exam performance improved by 4% of a standard deviation. We also observe a 10% decrease in the use of anxiolytics and hypnosedatives, suggesting improved mental health. There are no significant changes in the use of other substances, leisure habits or study effort. These findings are consistent with neurobiological evidence that alcohol directly impairs cognitive development and increases anxiety-related behaviours. Reducing teenage alcohol consumption represents a substantial opportunity to improve educational outcomes in Europe, where youth drinking rates remain notably high.

Keywords: alcohol, adolescence, minimum legal drinking age, PISA

JEL codes: I18, I12, I21

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1 Introduction

Despite a decreasing trend, alcohol consumption among European teenagers remains notably high compared to other regions of the world. Nearly half (47%) of European adolescents aged 15–16 report having consumed alcohol within the last 30 days, with 30% engaging in at least one binge drinking episode during the same period (ESPAD 2019). In contrast, in the U.S., only 12% of teenagers aged 14–17 report drinking alcohol and 6% binge drinking in the past month (SAMHSA 2020). Alcohol consumption rates among adolescents are generally even lower in the rest of the world (see Figure 1).

Over the past few decades, many European countries have implemented a range of policies to reduce alcohol consumption among adolescents, including increasing alcohol taxes, restricting advertising and tightening regulations on alcohol licensing. A key policy shift has been the widespread increase in the minimum legal drinking age (MLDA). At the turn of the millennium, in most European countries the MLDA was 16, in stark contrast to the United States' limit of 21. During the past two decades, many European nations have raised their MLDA to 18 through comprehensive reforms that restrict alcohol sales to minors, limit their access to alcohol-selling venues, and regulate alcohol advertising. These policy changes have generally lowered alcohol consumption, although at times only moderately with decreases ranging from 7% to 39% across different countries, presumably reflecting differences in enforcement (Dehos & Mensen 2022, Ahammer et al. 2022, Carpenter & Dobkin 2011, Yörük & Yörük 2011).[1]

There are compelling reasons to expect that decreases in alcohol consumption might impact academic performance and human capital accumulation. Extensive medical research indicates that the adolescent brain is particularly vulnerable to alcohol consumption. Alcohol-consuming youths exhibit lower grey matter volumes and reduced white matter integrity compared to their non-consuming peers (Luciana et al. 2013, Daviet et al. 2022, Ewing et al. 2014, Jacobus & Tapert 2013, Guerri & Pascual 2010, Morris et al. 2019, Robert et al. 2020). Furthermore, alcohol has been linked to risk-taking behaviours which could impede human capital accumulation, including

[1]For instance, in Germany when individuals turn 16 – the legal drinking age for softer types of alcohol – their alcohol consumption increases by 20% (Dehos & Mensen 2022). In Austria, the effects are even more pronounced, with a 39% increase in alcohol consumption at the MLDA age of 16 (Ahammer et al. 2022)). Estimates from the United States show that alcohol consumption increases by 7–21% when individuals reach the legal drinking age of 21 (Carpenter & Dobkin 2011, Yörük & Yörük 2011).

traffic accidents, emergency department visits and crimes (Bindler et al. 2024, Carpenter & Dobkin 2009, 2017, Chalfin et al. 2022, Datta Gupta & Nilsson 2020, Dee & Evans 2001, Dehos & Mensen 2022, Dehos 2022, Hingson et al. 2006, Kamalow & Siedler 2019, Luukkonen et al. 2023, McCarty et al. 2004, O'Malley & Wagenaar 1991). Several studies have also documented that adolescents who consume alcohol tend to have higher anxiety and worsened mental health (Skogen et al. 2014, Holtes et al. 2015, Spear 2018), and alcohol consumption may reduce the time and energy available for academic pursuits. On the other hand, drinking could also have potential benefits. Alcohol-consuming teenagers report having larger social networks, increased social time and greater peer trust (WHO 2019, Hoel et al. 2004), potentially indicating that alcohol helps some adolescents develop social skills that are increasingly valuable in the labour market (Deming 2017, Izadi & Tuhkuri 2024). The impact of alcohol consumption may also depend on whether it complements or substitutes other substance use, which may itself harm educational performance (Marie & Zölitz 2017).

Despite the relevance of this question, the existing empirical evidence on the causal impact of MLDA laws on educational outcomes is relatively scarce and, to the best of our knowledge, limited to the US. Findings are mixed, ranging between no effects and some moderate declines in performance when students reach the MLDA (Koch & Ribar 2001, Dee & Evans 2003, Renna 2008, Balsa et al. 2011, Carrell et al. 2011, Lindo et al. 2013).[2] The effect of MLDA changes on educational outcomes might differ in European contexts. First, the neurological impact of alcohol is likely more severe at 16 than at 18 or 21 as brain plasticity is higher at younger ages (El Marroun et al. 2021, Phillips et al. 2021). In addition, the economics literature has shown that peer effects are magnified at younger ages (Card & Giuliano 2013, Yakovlev 2018) and that adolescence is a critical period in taste-formation (Kueng & Yakovlev 2021). Second, European youth drink disproportionately more than youth in other parts of the world, making policy action a more pressing need. Third, there may be important differences in social and cultural

[2]Evidence from regression discontinuity designs at age 21 shows that college students' GPA tends to decrease when they are allowed to drink legally. Lindo et al. (2013) observe a decrease of 0.03 standard deviations at the University of Oregon and Carrell et al. (2011) a decrease of 0.09 standard deviations at the US Air Force Academy. Contrasting these findings, some studies that have exploited the increase in the MLDA from 18 to 21 across US states in the early 1980s do not find a significant impact on high school graduation rates (Dee & Evans 2003). Similarly, Koch & Ribar (2001) argue that the actual effects of youthful drinking on education are likely to be small, based on between-siblings comparisons. Balsa et al. (2011) arrive at a similar conclusion using individual fixed-effects models with data from the National Longitudinal Study of Adolescent Health.

environments, legal enforcement and the availability of alternative leisure activities.

This paper provides novel evidence on the impact of raising the MLDA from 16 to 18 on educational performance by exploiting its staggered implementation across Spanish regions. Before 1991, the MLDA was 16 years throughout Spain. From 1991 to 2019, regions gradually raised the MLDA to 18 years, typically accompanied by restrictions on minors' access to alcohol retail venues and alcohol advertising. Throughout this paper, we refer to these comprehensive policy packages as 'MLDA changes'. Our analysis focuses on reforms that took place between 2003 and 2019, due to data constraints. During this period, four regions implemented MLDA increases: Castile and Leon, Galicia, Asturias, and the Balearic Islands.

We measure teenage consumption of alcohol and other substances using the information provided by the *High School Survey on Drug Use in Spain*, a large-scale survey conducted every two years on a representative sample of high school students. Our analysis covers the period 2004–2021, including information for approximately 250,000 students. These surveys are conducted in classrooms and are anonymous, which may help reduce misreporting concerns. During our study period, alcohol consumption was prevalent among Spanish teenagers: 60% of those aged 14–17 reported consuming alcohol at least once in the preceding month, with 34% binge drinking and 24% experiencing intoxication. A concerning 19% reported experiencing memory loss of the previous day's events at least once in the past year, 15% reported difficulty focusing at school after drinking, and 33% experienced hangovers. The survey also provides information on the use of other substances and, in recent waves, on leisure activities.

Information on educational outcomes comes from two sources. First, we assess academic performance using data from the Programme for International Student Assessment (PISA). The OECD conducts this survey every three years on a representative sample of children born sixteen years earlier. An important advantage of PISA is that it measures students' performance using a standardised test which is comparable across regions. PISA also collects data on educational inputs such as student-teacher ratios, instruction time, and school resources, enabling us to rule out confounding effects from contemporaneous educational policy changes. We use data for the years 2003 to 2022, covering approximately 180,000 students. Second, we measure educational attainment using the 2021 census. We focus on individuals born between

1987 and 2002, with a sample of around 600,000. Close to 78% of them had completed secondary education and 42% were attending or had completed college.

We estimate the effect of the MDLA changes using a difference-in-differences strategy.[3] To account for the limited number of regions, we employ wild bootstrap methods to compute standard errors. We start by analysing the extent of compliance with the law. When the MLDA is increased to 18, underage individuals acknowledge that it became more difficult to access alcohol (0.11 standard deviations, p-value=0.01), but the modest magnitude of the effect reflects adolescents' adaptive behaviours in response to the policy change, altering how they acquire and consume alcohol. While alcohol purchases in bars declined by 5 percentage points (10%, p-value=0.05) and teenagers were 12 percentage points (25%, p-value=0.05) less likely to report purchasing alcohol themselves, purchasing through someone above the age of 18 increased by 10 percentage points (42%, p-value=0.05). Parental leniency toward their offsprings' alcohol consumption seems unaffected, but youth became more likely to report that heavy drinking is a problem.

Overall, the probability of having consumed alcohol in the last 30 days decreased by around 4 percentage points (7%, p-value=0.05). We also observe a 5 percentage point (17%, p-value=0.04) decline in the probability of getting drunk and a 5 percentage point (14%, p-value=0.04) decrease in the probability of binge drinking. The effect on adolescents who were already below the previous MLDA (i.e., aged 14 and 15) is similar in magnitude to the effects on those aged 16 and 17, presumably reflecting that it became more difficult for them to circumvent the law. The effects are more pronounced among teenagers with parents with higher educational attainment but do not differ across gender or region of residence. Interestingly, we also observe a decrease in individuals reporting that their friends drank in the previous month by about 4 percentage points (8%, p-value=0.05) or that they got drunk by 4 percentage points (17%, p-value=0.05). The consistent pattern in reported peer behaviour alleviates concerns that our results are driven by changes in self-reporting bias, since individuals are generally less likely to misreport their friends' drinking habits (Tourangeau & Yan 2007).

The MLDA changes had significant positive effects on educational outcomes, improving average student performance in PISA exams by 4% standard deviations

[3]In our main specification we use a two-way fixed effects estimator, which relies on the assumption of homogeneity of the treatment. We conduct a number of tests to validate this assumption.

(p-value=0.03). The effect is stronger for children of more educated parents, consistent with this group experiencing a larger decrease in alcohol consumption. These results are not driven by contemporaneous changes in other educational inputs measured in PISA, such as instructional hours, class size, or school resources, nor by changes in student effort as measured by hours devoted to homework.

We also investigate whether the effects on educational performance at ages 15–16 persist in time using information on young adults' educational attainment from the census. We do not observe any impact of MLDA on the probability of completing mandatory secondary education (β=-0.01, p-value=0.49, baseline 79%), but there is some suggestive evidence of positive effects on college attendance (β=0.02, p-value=0.09, baseline 42%).

Our findings also reveal that, beyond these educational improvements, raising the MLDA yielded significant mental health benefits. Limiting alcohol access led to a substantial reduction in adolescents' consumption of anxiolytics and hypnosedatives (tranquillisers, sedatives, and sleeping pills commonly prescribed for anxiety and insomnia). The proportion reporting consumption decreased by 0.4 percentage points (7%, p=0.03) in the previous month and by 1.1 percentage points (10%, p=0.05) over the previous year. This decrease in anxiety-related medication is consistent with alcohol's documented neurological effects on mood regulation and anxiety pathways.

We find no significant changes in the use of other illegal substances. Smoking, only allowed at age 18, declined by 1.4 percentage points (from a baseline of 23%) and cannabis use increased by 0.3 percentage points (baseline 12%), but neither estimate is statistically significant. Similarly, the increase in the MLDA did not affect adolescents' socialisation or their engagement with other leisure activities. We do not observe substantial changes in their prevalence of going out, time spent on the internet, playing videogames, or practising sports, although some of these estimates are relatively imprecise.

Given that the policy produced no detectable effects on other substance use or leisure activities, the improvement in educational performance appears to result directly from the policy's impact on alcohol consumption rather than from broader behavioural changes. While cognitive ability cannot be directly observed in our study, these findings align with extensive medical literature documenting alcohol's direct neurological effects on cognitive function, memory formation, and executive processing.

Our paper contributes to several strands of the health and education economics literature. First, we extend the literature on the effect of alcohol on educational performance. Our paper is the first to assess the impacts of raising the MLDA from 16 to 18 on educational outcomes, thereby affecting a younger population than previous studies, and the first to examine these effects outside the US context.

While previous studies in the US context have typically exploited regression discontinuity designs (RDD) around the minimum legal drinking age (e.g., Lindo et al. 2013, Carrell et al. 2011), our analysis employs a difference-in-differences (DiD) approach, which is arguably more appropriate in this context.[4] Though this empirical strategy generally requires stronger identifying assumptions than RDD, it targets a more policy-relevant estimand in our setting. RDD estimates a local treatment effect at the minimum legal drinking age threshold, potentially capturing only the short-term impact of newly acquired legal access to alcohol. In contrast, our DiD strategy identifies the effects of reduced drinking behaviour over a more extended period. Moreover, RDD identifies only the direct policy impact through individual drinking behaviour, overlooking indirect peer effects, as individuals just below and above the MLDA threshold likely have similarly affected peer groups. Instead, our DiD design captures both direct and indirect effects through peer-related reductions in alcohol consumption – a potentially critical channel for understanding policy effectiveness.

Second, we add to research examining the efficacy of MLDA policies in reducing alcohol consumption by presenting novel evidence in a European context and by exploring alcohol access alongside drinking measures. Our results, which are based on evidence from Spain for the period 2004 to 2021, align with Brachowicz & Vall Castello (2019), who found that increases in the MLDA across Spanish regions between 1994 and 2002 reduced adolescent alcohol consumption by approximately 20%. The magnitude of our effect is consistent with estimates from other countries, where impacts range from 7% to 39%. Our analysis also shows that the moderate magnitude of the effect can be attributed to adolescents' ability to circumvent the prohibition by accessing alcohol through adult friends.

Third, we contribute to the literature on the relationship between the consumption

[4] An exception is Dee & Evans (2003) who used a difference-in-differences strategy to examine the impact of raising the MLDA from 18 to 21 across some US states in the early 1980s on high school graduation rates.

of alcohol and other drugs, which is characterised by mixed results. Some studies have found that stricter alcohol laws lead to increased marijuana use (DiNardo & Lemieux 2001), while others have found a null effect (Crost & Rees 2013) or concluded that higher alcohol consumption increases hard drug use (Deza 2015).[5] In the Spanish setting, we do not find that the MLDA significantly affected the consumption of cannabis, the main alternative drug.

Fourth, we contribute to the literature on the impact of alcohol consumption during adolescence on mental health. Most of the existing evidence is correlational, showing a strong association between higher alcohol consumption and poorer mental health (e.g. Skogen et al. 2014, Holtes et al. 2015). By exploiting exogenous variation in alcohol consumption induced by changes in MLDA, our analysis shows that there is a causal impact on the use of anxiolytics and hypnosedatives among adolescents, consistent with an improvement in psychological well-being. This finding complements previous research documenting a causal link between MLDA and youth suicide (e.g. Birckmayer & Hemenway 1999).

2 Institutional setup

Alcohol regulations in Spain are set by its 17 regions.[6] Until 1991, the minimum legal drinking age was 16 across all regions. From 1991 to 2019, all regions raised the minimum drinking age to 18. A map of the timing of the reforms is available in Figure 2.

In addition to banning alcohol sales to minors, the new regulations typically restricted minors' entry into venues like discotheques, limited alcohol sales in public spaces frequently attended by young people, controlled the use of vending machines for alcohol purchases, tightened rules around the promotion and advertising of alcoholic beverages, and in some cases, explicitly banned consumption. Some regions introduced the ban in two phases, first restricting the sale of hard liquors to those under 18 and subsequently restricting the sale of all alcoholic beverages. Table A1 summarises all the reforms and describes some implementation details.[7]

[5] In another study, Yörük & Yörük (2011) argued that in the US marijuana use increases at age 21, suggesting a complementarity between alcohol and marijuana, but this finding has been refuted by Crost & Rees (2013), who found a methodological error.

[6] Each region may consist of one or more provinces, which are smaller administrative divisions of which there are 50. There are also two autonomous cities, Ceuta and Melilla.

[7] The table expands the content in Table C.1 in Brachowicz & Vall Castello (2019) with some

Given data availability constraints, we focus on the more recent reforms. These were implemented in Castile and Leon in 2007, Galicia in 2011, Asturias in 2015 and the Balearic Islands in 2019. In Castile and Leon, the reform was a full ban on alcohol consumption for minors while before there was only a ban on hard liquors. In Galicia and Asturias, the MLDA increase was a full reform, banning consumption of all types of alcohol, when previously all consumption was permitted at 16. In the Balearic Islands, minors were not allowed to purchase alcohol until the age of 18 before 2019, but consumption was not explicitly prohibited.

The factors driving the timing and stringency of MLDA implementation across regions are unclear. Political ideology does not predict MLDA reform adoption: seven regions increased the MLDA under Socialist Party (PSOE) governments and seven under People's Party (PP) governments.[8] GDP per capita also appears unrelated. As shown in Table A2, regions that raised the MLDA after 2006 ('Treatment' group) and regions where the MLDA was already 18 ('Control' group) had statistically similar levels of GDP per capita in both 2006 and 2020. The severity of adolescent drinking also fails to explain the timing differences. While we cannot observe drinking levels from the early 1990s when the MLDA was universally 16, we can examine this factor by comparing regions in 2020, after all regions had raised the MLDA to 18, assuming no dynamic effects. Although late adopter regions had significantly higher teenage drinking rates in 2006, treated and control areas had converged by 2020. The only observable factor correlated with adoption timing is PISA performance, with pupils in regions that adopted later performing better. One potential explanation, although we lack direct evidence, is that policymakers in regions with better educational performance may have felt less urgency to adopt policy changes.

Regarding other policies, the legal smoking age is determined at the national level and increased nationwide from 16 to 18 in 2005. The consumption of other substances such as cannabis has been prohibited throughout the study period. Spain has no specific curfew times for minors. The only curfews implemented during our sample period were due to COVID-19 and affected all age groups equally.

amendments capturing the most recent reforms.

[8]The MLDA was increased under PSOE governments in Andalucia (1997), Aragon (2001), Asturias (2015), the Balearic Islands (2019), Castile-La Mancha (1995), Extremadura (1997), and Navarre (1991). The PP implemented similar reforms in Cantabria (1997), Castile and Leon (1994), Galicia (1996), La Rioja (2001), Madrid (2000), Murcia (1997), and the Valencian Community (1997). Regional parties were responsible for MLDA increases in three regions: the Canary Islands (1997), Catalonia (1991), and the Basque Country (1998).

3 Data

We use several publicly available sources: the High School Survey on Drug Use, the Program for International Student Assessment (PISA) and the 2021 census.

3.1 High School Survey on Drug Use

The High School Survey on Drug Use from the Spanish Observatory on Drugs and Addictions (*Encuesta sobre uso de drogas en Enseñanzas Secundarias* in Spanish, also known by its acronym ESTUDES) is conducted every two years among a random representative sample of Spanish students and mainly collects information on the consumption of alcohol and other drugs. The survey follows a two-stage cluster sampling process in which, first, a random sample of educational centres is selected and then, within each centre, questionnaires are provided to all students present in several randomly selected classes. The sampling is stratified by region, type of educational centre (public vs. private), and grade level to ensure representativeness across these dimensions. We use information from the waves conducted between 2004 and 2021 and focus on students aged 14 to 17, with a total sample size of about 255,000 students.[9] We describe the main variables of the database in Table A3 and we provide summary statistics in Table 1. The complete list of survey questions asked consistently across all waves between 2004 and 2021 is in Table A4.[10]

Similar to other European countries, teenage alcohol consumption is prevalent in Spain. In our sample of adolescents aged 14 to 17, 60% report having drunk in the last 30 days, 34% had 5 drinks or more (binge drank) at least once, and 24% got drunk at least once. When asked about their friends' drinking behaviour, 50% declare that most or all of them drank in the previous month, and 22% declare that they got drunk.

Drinking levels are very similar for males (25% got drunk in the last month) and females (24%). They are slightly lower for people with college-educated parents (24% got drunk in the last month) compared to non-college-educated (26%). For a subset of

[9]The survey also includes information on pupils aged 18 who are typically repeat students. We do not consider them in our analysis. We also exclude 341 observations corresponding to students in treated regions who were already 17 when the MLDA was increased to 18.

[10]To minimise potential reporting bias, we present results for all available variables in the paper, with only three exceptions: repetition, relationship with parents, going out in the afternoon and consumption of hard drugs. We find no significant impact of MLDA changes on either of these outcomes; detailed results are available upon request.

years, the survey also provides detailed information on behaviours connected to alcohol intake. Around 33% report having experienced a hangover in the last year, 19% could not remember the events of the preceding night, 15% could not focus in school the day after having consumed alcohol and 13% had driven under alcohol influence.

Most teenagers consider that having access to alcohol is very easy (66%) or easy (25%). Around one-third bought alcohol themselves and another third obtained alcohol through a friend who was 18 or older. Alcohol is mostly consumed in bars (41%) or at home and in parks (43%). The majority of teenagers (56%) acknowledge that heavy drinking (measured as 5 or more drinks each weekend) may be problematic. About 40% of pupils report that their parents allow them to consume alcohol.

The use of other substances, while lower, remains substantial. Although Spanish law prohibits tobacco sales to minors, 24% of the sample report smoking in the last 30 days, with 10% smoking daily. As for other drugs, 15% report using cannabis in the last 30 days. Other illegal drugs, such as cocaine, are very uncommon in the sample (<1%). Consistent with the findings of previous studies, we observe that the consumption of these substances has been declining during the last two decades (Leal-López et al. 2019, 2020).

While the survey does not collect direct information on mental health, it does track the use of anxiolytics and hypnosedatives –medications that slow brain activity to treat anxiety and insomnia – which can serve as an indirect indicator of mental health status. Approximately 5% of adolescents report having used these medications in the previous month (10% within the previous year).[11] When asked about their motivations, users cite improving sleep (63%), dealing with anxiety (49%), and feeling better (14%). Only 4% report using them alongside other drugs.[12] The use of these medications increased substantially during our study period, from 3.5% monthly users in 2006 to 7.3% in 2021. Consistent with previous research, we observe a strong correlation between consumption of these drugs and alcohol (Carrasco-Garrido et al. 2018), suggesting potential comorbidity between alcohol use and anxiety-related conditions.

[11]The survey question on the use of anxiolytics and hypnosedatives explicitly mentions several drugs: *hypnotics, benzos, trankimazin, rohipnol, tranxilium, diacepam, valium, barbitúricos, lexatin, orfidal, noctamid, benzodiacepinas, zolpidem* and *stilnox*. The survey does not include information on other medications such as anti-depressants or drugs that are commonly used to treat attention deficit hyperactivity disorder (ADHD).

[12]Source: High School Survey on Drug Use (ESTUDES), year 2004, question 46.

Some waves of the survey also include information on leisure activities. Teenagers in Spain go out frequently with their friends. The average respondent meets their friends 7 times monthly in the afternoons and goes out 4 times at night. The mean arrival time when going out at night is between 1 and 2AM.

Spanish teens also spend substantial time on the internet and social media. For instance, in 2021, around 35% reported playing videogames more than two hours daily. Sports are also popular; 70% exercise at least once a week and 18% almost every day.

3.2 Program for International Student Assessment (PISA)

To measure students' performance consistently, we use the information provided by the OECD's Program for International Student Assessment (PISA).[13] PISA assesses students' competencies in reading, mathematics, and science, and measures their ability to apply knowledge and skills to real-world problems (OECD 2024). As the test carries no explicit incentives, performance likely reflects both cognitive ability and motivation.

PISA is conducted every three years on a stratified random sample of schools, and participants within each school are randomly selected among students born 16 years before the calendar year of the test. Exams usually take place between April and May and, at the time of assessment, students are aged between 15 and 3 months and 16 years and 5 months. We use the seven PISA waves that were conducted between 2003 and 2022.[14]

The PISA sample size for Spain is exceptionally large, as most regions have opted to fund expanded samples to obtain statistically meaningful scores at the regional level.[15] Our sample includes information for approximately 143,000 students. We report the main summary statistics in Table 2 and detailed variable definitions in Table A5.

The scores provided by PISA are standardised to have a mean of 500 points and a standard deviation of 100 points across OECD countries.[16] The average performance of

[13]Unlike other countries, Spain does not conduct national standardised assessments of student performance. To enter university, students are required to take the Spanish University Admission Tests (*Evaluación de Bachillerato para Acceso a la Universidad* or E.B.A.U.) but the content and the assessment of these exams vary across regions and over time.

[14]We did not use the first PISA wave, in the year 2000, as it does not include information on the region where students are based.

[15]PISA reports the region where the school is located only for these expanded samples. There is information on location for 3 regions in the 2003 wave, for 10 regions in 2006, 15 regions in 2009, 14 regions in 2012, 17 regions in 2015, and 18 regions in 2018 and 2022.

[16]The exam lasts for 2 hours and each student is assessed on a booklet (from a pool of 7). From

Spanish students is 490, slightly below the OECD average. Around half of the students are women and 88% were born in Spain. Approximately one-third of parents have a college degree.

The OECD has raised concerns about the reliability of some of the assessments conducted in Spain in 2018 (OECD 2019). The problem appears to be related to unusual response patterns in the reading test. Some Spanish students responded in ways that were inconsistent with typical testing behaviours, most likely because some PISA exams were administered too close to high-stakes final exams. In our preferred specification, we exclude observations that may have been affected by this problem according to the OECD, which constitute around 2% of the overall sample.[17]

PISA also provides information on school characteristics. The average student in our sample attends a school with a student-to-teacher ratio of 12:1 and where there are two computers for every three students. Weekly instruction time per subject ranges between 3 and 4 hours, and students report spending approximately 9 hours per week on homework.

3.3 Census micro-data

We obtained information on educational attainment from the 2021 census from the Spanish Statistical Office (INE). We focus on the likelihood of completing upper secondary education and on the likelihood of attending university.

Since we study the reforms that took place between 2007 and 2019, we restrict our attention to individuals born between 1987 and 2002, which is the latest cohort for which there is information on college attendance. There are 610,207 individuals in the sample, with an average age of 26; 78% had completed upper secondary education and 42% were enrolled in college at the time of the census or had already graduated. Approximately 9% of individuals in the census live in a region different from their region of birth.

the questions answered, the OECD estimates an underlying distribution of each student's ability. PISA reports 5 plausible values (10 plausible values in the more recent waves) for each pupil in each examination category. In our analysis, we take the average of all the available plausible values.

[17] Following OECD guidelines, we consider as potentially problematic those PISA exams administered during weeks 7–10 in regions with early high-stakes exams. We identified these observations using a separate dataset provided by the OECD (OECD 2019).

4 Empirical analysis

We estimate a two-way fixed-effects regression model, exploiting the staggered timing of MLDA changes across regions in a difference-in-differences framework. We leverage variation from all the MLDA changes occurring between 2004 and 2021.

To assess the effects of these reforms on teenagers' drinking habits and educational performance we estimate the following equation:

$$Y_{i,r,c,t} = \alpha_r + \delta_c + \gamma_t + \beta MLDA18_{r,c,t} + X_{i,t}\boldsymbol{\theta} + \varepsilon_{i,r,c,t}, \tag{1}$$

where $Y_{i,r,c,t}$ is an outcome for individual i, living in region r, born in cohort c, and observed at year t. We include fixed effects for the region of residence, birth cohort, and for year of survey or exam.[18]

Our main variable of interest, *MLDA18*, takes value 1 when the MLDA in region r at time t is 18, and is 0 if the MLDA is 16. We control for individual characteristics in vector $X_{i,t}$, including parental education (father's and, separately, mother's), month of birth, year of birth and year of survey interacted, gender, age, country of birth, whether the individual attends a private school, and grade level at the time of the survey.[19] We estimate this equation using Ordinary Least Squares (OLS) and employ weights to account for stratified sampling, provided in the survey. Given the small number of regions (N=17), we use clustered wild bootstrap to compute confidence intervals and p-values. Alternative methods are discussed in the robustness section.

The consistency of our two-way fixed-effects estimates relies on three main assumptions (Roth et al. 2023). First, it requires the Stable Unit Treatment Value Assumption (SUTVA). While this assumption may be violated near regional borders, we expect violations to be limited given that most of the population lives far from regional boundaries and teenagers face relatively high costs for cross-regional travel. Second, we rely on the parallel trends assumption, which we validate using an event study analysis

[18]The inclusion of a set of fixed effects for cohort and another for year of survey only plays a role when we analyse data from the High School Survey on Drug Use, which takes place biannually and includes information each year for four cohorts. Instead, these two sets of fixed effects are co-linear when we use PISA data.

[19]In our estimates of educational performance using PISA data we further control for parental socio-economic status using the Index of Economic, Social and Cultural Status (ESCS), a composite measure developed by PISA designed to capture various aspects of a student's family and home background.

that compares the evolution of the main outcome variables in the treatment and control groups. Third, it assumes homogeneous treatment effects across regions and no dynamic effects over time. We present evidence in support of these assumptions in Section 5.

4.1 Impact of MLDA on access to alcohol

After the reforms, respondents were less likely to reply that accessing alcohol is easy (β=-11%, p-value=0.01), and became less likely to report purchasing or consuming alcohol at legal points of sale (see Table 3). Teenagers affected by the reforms were 5 percentage points (p.p.) less likely to buy or drink at a bar (a decline of around 10% over the counterfactual mean, p-value=0.05), and 12 p.p. less likely to report buying alcohol themselves (25%, p-value=0.05). However, some teenagers found alternative ways to access alcohol, with a 10 p.p. increase in the proportion reporting buying alcohol through someone above 18 (42%, p-value=0.05). There was no significant change in the proportion purchasing alcohol through another minor or reporting obtaining alcohol at a private house or park. Importantly, the high MLDA might affect youth's attitudes towards alcohol. Teenagers became 6% more likely to report that having 5 or more drinks on a weekend is a moderate to serious problem (p-value=0.05). There was no statistically significant change, though, on parents' leniency toward their offsprings' alcohol consumption.

4.2 Impact of MLDA on alcohol consumption

Alongside changing the channels through which teenagers obtained alcohol, the MLDA also affected net consumption. The DiD estimates, reported in Table 4, show that the impact of MLDA changes on teenage alcohol consumption in Spain was modest but non-negligible. Among adolescents aged 14–17, the probability of drinking alcohol in the previous month decreased by 4 percentage points (7%, p-value=0.05), the likelihood of getting drunk in the last month fell by 5 percentage points (17%, p-value=0.04), and binge drinking declined by 5 percentage points (14%, p-value=0.04). The reforms also affected the intensive margin of consumption: teenagers reported drinking on 0.34 fewer days per month (11% decrease, p-value=0.06), getting drunk on 0.11 fewer days (15% decrease, p-value=0.04), and binge drinking on 0.14 fewer days (12% decrease, p-value=0.06). An index indicator combining these drinking measures suggests the effects are not due to

multiple hypothesis testing. The joint measure shows declines in drinking of 0.09 standard deviations (p-value=0.04). The higher MLDA delayed both initial alcohol consumption and first intoxication: exposed adolescents reported starting to drink 1.3 months later (0.11 years, p-value=0.07) and experiencing their first intoxication 1.6 months later (0.13 years, p-value=0.12).

Our analysis of peer-reported drinking behaviours reinforces these findings. Following the reform, we observe significant reductions in teenagers reporting alcohol consumption among their friends, with decreases of 4 percentage points in reported drinking (8%, p-value=0.05) and drunkenness (17%, p-value=0.05) within the previous 30 days. These parallel declines in both self-reported and peer-reported drinking behaviours provide compelling evidence of the policy's effectiveness across social networks and suggest the effects are not merely due to changes in self-reporting behaviour.

Event study plots support the validity of the difference-in-differences strategy in this context. As shown in Figure 3, there are no significant differences in the evolution of drinking behaviour across treated and control regions before the policy changes.

4.2.1 Heterogeneity analyses

The change in the MLDA decreased the proportion of teenagers consuming alcohol – and particularly the proportion reporting high levels of consumption. We explore whether there are any differences in the magnitude of the effects depending on adolescents' age, gender, and parental education. As shown in Table A6, there is already a decrease at age 14, which becomes stronger at ages 15 and 16, and decreases slightly at age 17. For instance, the probability of getting drunk decreased by 2 percentage points at age 14, 3 percentage points at age 15, 6 percentage points at age 16, and 5.5 percentage points at age 17. The effects by age are qualitatively similar for other measures of alcohol consumption. While the decrease in alcohol consumption is very similar for boys and girls, reductions in drinking appear larger for pupils with more educated parents (Figure A2), though this difference is not statistically significant.

We also compare the impact of the different regional reforms depending on their characteristics (Table A9). Estimates on drinking outcomes are slightly larger in regions that experienced comprehensive reforms (Galicia and Asturias) compared to those with

partial reforms (Castile and Leon and the Balearic Islands), although the difference is not statistically significant. Furthermore, we report estimates separately by region in Table A8, finding consistent effects across all regions.

4.3 Impact on other drugs

We examine whether the increase in the minimum legal drinking age also impacted the consumption of other substances, which might affect educational performance either directly or through complementarity or substitutability patterns with alcohol. We do not find significant effects on cigarettes or cannabis consumption. As shown in Table 5 (columns 3–6), we observe a small reduction in cigarette use and a slight increase in cannabis consumption. Specifically, the share of smokers decreased by 1.4 percentage points (a 6% relative decline, p-value=0.12), while cannabis use increased by 0.3 percentage points (a 2% relative increase, p-value=0.80).

4.4 Impact on mental health

The MLDA changes might affect youth mental health through different channels. On the one hand, youth might not appreciate restrictions to alcohol intake if, for instance, alcohol is a coping and socialisation mechanism. On the other hand, a number of studies have found an association between alcohol consumption and anxiety-related disorders (Smith & Randall 2012, Kushner et al. 2000), with evidence suggesting a bidirectional relationship where excessive drinking can both trigger and exacerbate anxiety symptoms. Consistently with the latter, we find a significant decrease in anxiolytic and hypnosedatives use. The share of users declined by 0.4 percentage points (7%, p-value=0.03) in the previous month and by 1.1 percentage points (10%, p-value=0.05) in the previous year (Table 5, columns 1–2). While these effects are modest in magnitude and should be interpreted cautiously given multiple hypothesis testing, they are consistent with an overall improvement in mental health resulting from reduced alcohol consumption.

4.5 Educational performance

4.5.1 Impact of MLDA on PISA scores

Next, we assess the effects of the MLDA on educational performance using the information provided by PISA. These exams are completed by individuals aged between 15 years and 3 months and 16 years and 5 months, a group that experienced a significant decrease in alcohol consumption when the MLDA increased (see Table A6, column 5).

The event study plot confirms parallel pre-trends in PISA scores between treated and control regions before policy implementation, with a clear divergence occurring precisely when the MLDA increased to 18 years (see Figure 4). As shown in column 1 of Table 6, raising the MLDA caused a statistically significant improvement in overall test scores of 4.6% of a standard deviation (p=0.03). To address a key threat to validity —the possibility that simultaneous increases in educational resources at the regional level accompanied MLDA changes— we include controls in column 2 for changes in student-to-computer ratios, student-to-teacher ratios, and instructional hours. Our estimates remain robust to these controls. Finally, results persist when excluding observations flagged by the OECD as potentially unreliable due to atypical testing behaviour in the 2018 wave (approximately 2% of the overall sample, see column 3). The estimate in this restricted sample is 4.4% of a standard deviation (p=0.03).

Out of the three dimensions assessed in PISA, the impact is largest in Reading (7% st. dev., p-value=0.05) and Science (4% st. dev., p-value=0.03), and it is not statistically significant in Maths (1% st. dev., p-value=0.37), although none of these three estimates is significantly different from each other (see Table A7).

Given that the MLDA increase seemed to have a larger effect on drinking behaviour among children of more educated parents, we examine heterogeneity in educational impacts by parental education (see Table 6, columns 4 and 5). The effect is larger for children with at least one college-educated parent (β=0.09 st. dev., p-value=0.02) than for children of less educated parents (β=0.03 st. dev., p-value=0.05), although this difference is not statistically significant.

4.5.2 Impact of MLDA on educational attainment

Our PISA analysis shows improved performance among students aged 15–16. To examine whether this translates into longer-term educational attainment, we analyse individual-level data from the 2021 census using two measures: completion of upper secondary education and college enrolment. We estimate a similar equation to the above but redefine the treatment variable such that $MLDA$ takes the value of 1 if the individual would have only been allowed to drink at age 18 and 0 if the individual would have been allowed to drink at age 16. In addition to province of birth, we also include controls for gender, month of birth, and year of birth.

An event study analysis leveraging differences in the age of individuals at the time of the MLDA change supports the validity of our difference-in-differences strategy (see Figure 5). There are no significant differences in educational attainment between treatment and control groups for individuals who were 18 or older when the reform was implemented. For those affected by the reforms, we do not find significant changes in the completion of upper secondary education, the estimate is close to zero and not significant (Table 7, column 1). However, we observe a 2.1 percentage point increase (5% relative increase, p-value=0.09) in university attendance, although this estimate is only marginally significant (column 4).

In columns 2 and 5, we separately examine individuals affected by the MLDA increase before age 16 (*fully treated*) and those who were 16-17 when the reform was implemented (*partially treated*). As expected, the impact on college enrolment is larger for the fully treated group (2.4 vs. 1.4 percentage points), although these estimates are not significantly different from each other. In columns 3 and 6, we restrict the sample to individuals who still reside in their birth region at census time (91% of the sample). While this restriction appropriately addresses concerns about individuals who moved before age 16, it could introduce bias if mobility occurred later and was itself influenced by the improved educational outcomes. With this caveat in mind, the effect on college attendance is slightly larger in this restricted sample (3.4 percentage points, p-value=0.09).

4.6 Mechanisms

The increase in the MLDA might affect educational performance through direct and indirect channels. As we discuss below, the reform produced no detectable effects on study effort, socialising patterns, or other lifestyle factors, which suggests that the observed effects likely stem primarily from reduced alcohol consumption and perhaps improved mental health.

4.6.1 Direct cognitive effects

There is extensive medical literature linking alcohol intake to poorer cognitive ability, including impaired memory formation, executive processing, and attention. While we cannot directly measure cognitive ability, we posit that reduced alcohol consumption may have improved students' cognitive functioning, which would be consistent with the observed improvements in PISA scores.

4.6.2 Alternative behavioural channels

We examine whether the MLDA changes affected educational performance through changes in student effort or lifestyle rather than cognitive improvements. Using PISA data on weekly homework hours as a proxy for student effort, we find no substantial changes in time allocated to studying and can reject increases in homework dedication larger than 6% of a standard deviation (see Table 8). Similarly, the MLDA changes do not affect teenagers' nighttime activities or socialising patterns. As shown in Table 9, the frequency of going out is unchanged (β=0.2 days, p-value=0.75) and return times when going out are unaffected (β=0.1 hours, p-value=0.20). We also find no changes in screen time, videogame use, or sports participation, ruling out substantial substitution toward other activities as an alternative mechanism.

4.6.3 Mental health effects

As shown above, we find that the MLDA changes improved mental health, as evidenced by a decrease in anxiolytic and hypnosedative use in the previous month. This improvement, which is consistent with the medical literature documenting alcohol-induced anxiety, may have directly affected students' educational performance.

4.7 Impact of alcohol consumption on educational performance

The above estimates capture the impact of raising the MLDA. Calculating the impact of alcohol consumption itself using this policy-induced variation requires making additional assumptions. This calculation is complex, as the reform affects both whether teenagers drink (extensive margin) and how much they drink (intensive margin).

If we consider the sample of students that could have participated in the PISA assessment based on their age, the share of children in the control group who have never consumed alcohol – around 36% – reflects the share of *never takers* under the assumption of monotonicity (i.e., no individual would drink more due to an increase in the MLDA).[20] These teenagers were unaffected by the policy, as they would not have drunk even if the MLDA was 16. The remaining 64% were affected by the policy to some degree. On the extensive margin, we observe that the share that would have drunk if the MLDA was 16 is equal to 5%. Moreover, for the remaining 59%, there was a decrease in their intensity of drinking, particularly in terms of getting intoxicated and binge drinking.

To estimate the effect on students who actually changed their drinking behaviour due to the reform (rather than the average effect across all students), we can scale our estimates. If we assume that alcohol affects educational performance similarly at both extensive and intensive margins – and that the effects on education are driven solely by alcohol – then dividing by the share of teenagers who changed their drinking behaviour (0.64) suggests that compliers experienced an improvement in PISA results of approximately 8% of a standard deviation.

We can also cautiously extrapolate the potential impact of eliminating adolescent alcohol consumption entirely. Under the strong assumptions of linearity, homogeneity, and that binge drinking is the sole mechanism through which alcohol affects educational performance, a policy that reduced binge drinking to zero would increase PISA performance by approximately 36% of a standard deviation. However, the confidence intervals for this extrapolated "total effect on the treated" are wide, with a lower bound of 8%.[21]

[20] In Table A6 column 5 we show that the proportion of teenagers drinking in the PISA age group in treated regions, net of the impact of the policy, is 64%, hence, the share who would have never consumed alcohol is 36%.

[21] This calculation divides the reduced form estimate (4.4% st. dev.) by the first stage estimate of 12%

5 Robustness checks

5.1 Sensitivity to regions in sample

Our estimates leverage variation from MLDA changes which were implemented slightly differently across regions, as described in Section 2. However, we do not find significant differences in our results across regions, as shown in Table A8; nor differences across reform types (where we distinguish the full reforms in Galicia and Asturias from the partial reforms in Castile and Leon and the Balearic Islands) in Table A9. Furthermore, additional analyses leaving out one treated region at a time in Figure A1 show that, while excluding regions affects precision, the main estimate is not substantially altered.

5.2 Heterogeneous and dynamic effects over time

Recent methodological work on staggered difference-in-differences designs has shown that two-way fixed effects (TWFE) estimates can provide biased estimates of the average treatment effect on the treated (ATT) when treatment effects are heterogeneous across cohorts or over time (Roth et al. 2023, Callaway & Sant'Anna 2021).

The homogeneity assumption would fail in our context if the level of strictness in enforcement of the MLDA varies across regions or it changes over time depending on how long the policy has been implemented. We do not find that effects differ across regions as shown in Table A8, which suggests that implementation timing was not a major issue and that the homogeneity assumption might be plausible.

Some of the newly-proposed methods for consistent estimation in staggered settings involve using only as control group units that have not (yet) been treated to ensure the effects are not contaminated by potential dynamics. This is not feasible in our case, as most regions had already raised the MLDA to 18 in the past. Instead, as an additional test and in the spirit of Goodman-Bacon (2021), we calculate separately all the different 2x2 difference-in-differences estimates, and we examine whether their magnitude changes over time or across units. As shown in Figure A3, the majority of the pairwise estimates have negative values and there is no clear relationship between treatment timing and the size of the coefficient.

reduction in binge drinking (in Table A6 column 5).

Furthermore, we repeat our analysis using only regions where the MLDA had increased at least 5 years earlier as treated units. This approach relaxes the assumption of homogeneous effects over time, requiring only that MLDA impacts stabilise after 5 years. We implement this by creating a *stacked database* from our health survey and PISA data (Cengiz et al. 2019, Deshpande & Mueller-Smith 2022). Each *stack* pairs one of the four treated regions with regions where the MLDA change occurred more than 5 years before. For example, for Asturias (treated in 2015), the control group includes all regions treated before 2010. We include all controls from our main specification interacted by stack and compute standard errors using clustered wild bootstrap.

These supplementary estimates show similar magnitudes to our main findings for both drinking and PISA outcomes (see Tables A10 and A11). Event studies for these stacked regressions are reported in Figure A4 for drinking outcomes and A5 for PISA scores.

5.3 Non-linear models

We estimate additional models for our intensive margin drinking variables using non-linear methods to adapt to the count nature of the variables (number of days drinking, getting drunk and binge drinking). In Table A12 we present the estimated effects using Poisson Quasi Maximum Likelihood Estimation (PQMLE). We compute standard errors using clustered bootstrap.

The magnitudes estimated are qualitatively similar. For the number of days drinking, the non-linear model estimates a fall of 7% (p-value=0.12) compared to 11% in the linear model. For days getting drunk, we estimate a drop of 16% (p-value=0.06) in our non-linear model versus 15% in the linear regression. For the number of days binge drinking, the non-linear model yields a drop of 15% (p-value=0.00), similar to the 12% estimated in the linear model.

5.4 Inference

In our main results, we report confidence intervals using the wild clustered bootstrap. As a robustness check, we also computed standard errors clustered at the region-cohort level for our main outcomes: drinking and educational performance. The corresponding results are reported in the Appendix in Tables A13 and A14, respectively. The confidence

intervals obtained using clustered standard errors are smaller than those from the wild clustered bootstrap procedure.

5.5 Violations of parallel trends

We assess the robustness of our estimated effects on PISA to potential violations of the parallel trends assumption following the approach of Rambachan & Roth (2023). We implement this test in three steps. First, we identify the maximum pre-period deviation from our event study in Figure 4, which equals 0.018. Second, we shock the post-treatment control observations by proportional changes based on this maximum deviation. Third, we re-estimate the effects as in column 3 of Table 6 to obtain p-values under different magnitudes of parallel trends violations. Our results remain statistically significant at the 95% confidence level when allowing deviations up to 50% of the maximum deviation, and at the 90% confidence level when allowing deviations up to 75% of the maximum deviation. At the full maximum deviation, the p-value is 0.11. Figure A6 plots the p-values across different deviation magnitudes.

6 Conclusion

We provide the first empirical evidence of the impact of raising the MLDA from 16 to 18 on teenagers' academic performance. Analysing staggered reforms across Spanish regions, we find that these MLDA changes reduced teenage alcohol consumption by 8–17%, with stronger effects on heavy drinking. We also observe a decrease in the use of anxiolytics and hypnosedatives, consistent with improvements in mental health, but no detectable effect on the consumption of other illegal drugs or on leisure activities. These reforms led to significant improvements in educational outcomes, with PISA exam performance improving by 0.04 standard deviations.

According to OECD benchmarks, this effect corresponds to roughly two months of additional schooling.[22] For comparison, achieving similar gains through instructional time would require about 1.5 additional hours of weekly classes.[23] To provide a rough

[22]One standard deviation in our sample corresponds to about 80 PISA points. Since the OECD calculates that 20 PISA points is equivalent to one year of schooling (Schleicher 2023), our estimate of 0.04 standard deviations ($0.04 \times 80 = 3.2$ points) implies $3.2/20 = 0.16$ years—or approximately two months—of schooling.

[23]Estimates of the effect of instructional hours on PISA scores range from 0.014 to 0.058 standard

sense of the potential macroeconomic implications, this improvement could translate into approximately a 0.07 percentage point increase in annual GDP growth, based on the relationship between test scores and growth estimated by Hanushek & Woessmann (2010), though this extrapolation should be interpreted with considerable caution.[24]

In terms of mechanisms, given the lack of impact on leisure activities or the consumption of other substances, our preferred interpretation is that these effects reflect alcohol's direct impact on cognitive and psychological functioning (which we cannot directly measure), rather than indirect effects through changes in time use or other behaviours.

These results have important policy implications for European countries, where youth drinking remains prevalent, particularly in countries that still allow alcohol consumption at age 16 (see Figure A7). For instance, in countries like Germany and Denmark, where soft alcohol is allowed at age 16, the share of 15-16 year olds reporting binge drinking in the previous month is above 50%, compared to only 13% in the US. Drinking rates are also high in other European countries where the MLDA is 18, suggesting poor compliance. Our findings suggest that cognitive development and educational outcomes could be meaningfully improved through better MLDA enforcement in countries with existing age 18 restrictions, or by raising the MLDA to 18 years in countries where it remains at 16 (e.g., Austria, Belgium, Denmark, Germany and Switzerland). Given the relatively low implementation costs compared to educational interventions that might achieve similar results, MLDA policies represent a potentially cost-effective approach to improving youth cognitive outcomes.

deviations, with an average of 0.028 standard deviations (Rivkin & Schiman 2015, Lavy 2015, Bietenbeck & Collins 2023). Our 0.04 standard deviation improvement divided by 0.028 suggests roughly 1.4 additional hours of weekly instruction would be needed.

[24]Hanushek & Woessmann (2010) estimate that a 1 standard deviation increase in PISA scores translates to 1.74 percentage points higher growth. Our 0.04 standard deviation improvement thus implies $0.04 \times 1.74 = 0.07$ percentage points additional growth.

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Tables

Table 1: Summary statistics - High School Survey on Drug Use

	(1)	(2)	(3)	(4)	(5)
Variable	**Mean**	**SD**	**Min**	**Max**	**N**
Alcohol consumption					
Drink last 30 days (dummy)	0.60	0.49	0	1	240,803
Drink last 30 days (days)	3.09	4.80	0	24	240,803
Get drunk last 30 days (dummy)	0.24	0.43	0	1	242,416
Get drunk last 30 days (days)	0.66	2.03	0	24	242,416
Binge drink last 30 days (dummy)	0.34	0.48	0	1	214,376
Binge drink last 30 days (days)	1.20	3.01	0	24	214,376
Age first drank	13.80	1.31	10	17	176,458
Age first got drunk	14.52	1.20	10	17	103,070
Most friends drank last 30 days	0.50	0.50	0	1	250,993
Most friends got drunk last 30 days	0.22	0.41	0	1	250,347
Having 5 drinks each wkdn is a problem	0.56	0.50	0	1	221,797
Access to alcohol					
Very easy to access alcohol	0.66	0.47	0	1	147,893
Easy to access alcohol	0.25	0.43	0	1	147,893
Parents allow drinking	0.40	0.49	0	1	193,425
Obtained alcohol at bar/shop	0.49	0.50	0	1	212,264
Obtained alcohol at house/park	0.20	0.40	0	1	188,394
Acquired alcohol themselves	0.39	0.49	0	1	166,632
Acquired alcohol through minor friend	0.14	0.35	0	1	166,628
Acquired alcohol through adult friend	0.36	0.48	0	1	166,628
Drank alcohol at bar/shop	0.41	0.49	0	1	237,830
Drank alcohol at house/park	0.43	0.49	0	1	237,830
Problems related to alcohol					
Hangover after consuming	0.33	0.47	0	1	122,640
Could not remember last night	0.19	0.39	0	1	121,692
Could not focus after consuming	0.15	0.35	0	1	121,643
Drove under influence	0.13	0.34	0	1	218,286
Other drugs					
Cigarettes last 30 days	0.24	0.43	0	1	250,422
Smokes daily	0.10	0.30	0	1	250,422
Cannabis last 30 days	0.15	0.36	0	1	247,780
Cannabis last 30 days (index)	1.13	4.11	0	24	247,780
Tranquillisers/sleeping pills last 30 days	0.05	0.23	0	1	228,806
Tranquillisers/sleeping pills last 12 months	0.10	0.30	0	1	229,058
Leisure					
Goes out at night (index)	4.53	4.95	0	20	238,356
Arrival time when going out at night	2.35	2.24	0	8	252,250
Goes out afternoon/evening	7.36	5.84	0	20	145,857
Videogames	1.73	1.30	0	4	164,947
Internet daily	0.85	0.36	0	1	147,376
Sport	2.55	1.28	0	4	170,601
Individual controls					
Age	15.49	1.06	14	17	255,752
Female	0.51	0.50	0	1	255,752
Born in Spain	0.82	0.38	0	1	255,752
Attends private school	0.36	0.48	0	1	255,752

Notes: Summary statistics for selected variables from the High School Survey on Drug Use 2004–2021. The sample includes pupils aged 14 to 17 at the time of the survey. A description of the variables is in Table A3.

Table 2: Summary statistics - PISA and census

	(1)	(2)	(3)	(4)	(5)
Variable	**Mean**	**SD**	**Min**	**Max**	**N**
PISA					
Outcomes of interest					
Average score	491.92	80.01	27	849	180,668
Math score	491.77	82.71	21	870	180,668
Reading score	488.37	86.47	1	847	180,668
Science score	495.90	84.07	-175	913	180,668
Homework time	9.25	9.06	0	90	98,571
Individual controls					
Age	15.85	0.29	15.25	16.42	180,668
Female	0.50	0.50	0	1	180,667
Born in Spain	0.88	0.33	0	1	180,668
Father has college degree	0.31	0.46	0	1	170,531
Mother has college degree	0.35	0.48	0	1	174,141
PISA during finals period	0.02	0.14	0	1	180,668
School controls					
Student to teacher ratio	11.93	5.07	1	139	164,027
Computer to student ratio	0.66	0.59	0	7	166,082
Instruction time Math	3.56	1.38	0	72	156,692
Instruction time Science	3.25	2.00	0	66	112,957
Instruction time Reading	3.51	1.18	0	80	116,998
Census					
Upper secondary education	0.78	0.41	0	1	610,207
College	0.42	0.49	0	1	610,207
Age	26.57	4.69	19	34	610,207
Female	0.49	0.50	0	1	610,207
Mover	0.09	0.29	0	1	610,207

Notes: Summary statistics for selected variables from PISA 2003–2022, and the 2021 Census. The PISA sample includes all pupils in the assessment. The Census sample includes people born between 1987 and 2002. A description of the variables is in Table A5.

Table 3: Impact on alcohol access

	(1)	(2)	(3)	(4)	(5)
	Easy to access	Obtained alcohol at:		Drank at:	
	alcohol	Bar/Shop	House/Park	Bar	House/Park
MLDA 18	-0.108	-0.054	0.014	-0.054	-0.014
	[-0.19,-0.06]	[-0.33,0.00]	[-0.04,0.12]	[-0.42,0.02]	[-0.08,0.08]
Magnitude (%)		-9.96	8.26	-11.25	-3.42
Mean	0.13	0.54	0.17	0.48	0.40
p-value	0.01	0.05	0.36	0.06	0.57
N	221,998	211,258	187,388	236,818	236,818
	(6)	(7)	(8)	(9)	(10)
		Acquired alcohol:		Having 5 drinks each	Parents allow
	themselves	through minor friend	through adult friend	wknd is a problem	drinking
MLDA 18	-0.116	0.008	0.098	0.036	-0.001
	[-0.33,0.00]	[-0.28,0.15]	[-0.02,0.71]	[0.00,0.06]	[-0.10,0.04]
Magnitude (%)	-24.58	7.75	41.92	6.06	-0.24
Mean	0.47	0.10	0.23	0.59	0.39
p-value	0.05	0.69	0.05	0.05	0.95
N	165,734	165,730	165,730	220,929	192,562

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported variables related to alcohol access for individuals aged 14 to 17 from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Easy to access alcohol is a standardised index variable. The remaining dependent variables are binary indicators. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

Table 4: Impact on alcohol consumption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Index	Drinking alcohol		Getting drunk		Binge drinking		Age first		Friends	
	cols 2–7	last 30 days		last 30 days		last 30 days		last 30 days			
		dummy	days	dummy	days	dummy	days	drank	got drunk	drink (dummy)	get drunk (dummy)
MLDA 18	-0.091	-0.043	-0.342	-0.046	-0.108	-0.050	-0.145	0.110	0.132	-0.044	-0.044
	[-0.19,-0.02]	[-0.24,-0.01]	[-2.06,0.06]	[-0.10,-0.01]	[-0.32,-0.01]	[-0.10,-0.01]	[-0.34,0.01]	[0.07,0.15]	[0.07,0.19]	[-0.18,-0.00]	[-0.20,0.00]
Magnitude (%)		-6.74	-10.86	-17.13	-15.15	-13.87	-12.00			-8.32	-17.17
Mean	0.02	0.64	3.15	0.27	0.72	0.36	1.20	13.86	14.54	0.53	0.26
p-value	0.05	0.05	0.06	0.04	0.04	0.04	0.06	0.07	0.14	0.05	0.05
N	251,274	239,766	239,766	241,410	241,410	213,335	213,335	233,535	219,553	249,921	249,275

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures last month for individuals aged 14 to 17 from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Column 1 estimates an index variable that combines the measures in columns 2 to 7. Columns 1–7 and 10–11 estimate effects using OLS. The 95% confidence interval and p-values are calculated using wild bootstrap. Columns 8 and 9 estimate effects on age at first drinking using Tobit to account for right-censoring in the variable. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

Table 5: Impact on consumption of other substances

	(1)	(2)	(3)	(4)	(5)	(6)
	Anxiolytics and hypnosedatives		Cigarettes last 30 days		Cannabis last 30 days	
	last month	last year	at least once	daily	at least once	days
MLDA 18	-0.004	-0.011	-0.014	-0.005	0.003	0.064
	[-0.01,-0.00]	[-0.03,-0.00]	[-0.07,0.00]	[-0.02,0.01]	[-0.05,0.04]	[-0.56,0.45]
Magnitude (%)	-6.67	-9.52	-5.94	-5.98	2.18	8.37
Mean	0.06	0.11	0.23	0.08	0.12	0.77
p-value	0.03	0.05	0.12	0.36	0.80	0.52
N	227,717	227,968	249,321	249,321	246,721	246,721

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported smoking and other drug consumption measures for individuals aged 14 to 17 from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

Table 6: Impact on educational performance (PISA)

	(1)	(2)	(3)	(4)	(5)
	PISA score (standardised)				
MLDA 18	0.046	0.044	0.044	0.087	0.026
	[0.01,0.11]	[0.01,0.12]	[0.01,0.11]	[0.04,0.15]	[-0.00,0.12]
Sample	Full	Full	Restricted	College	Less educated
Indiv. controls	Yes	Yes	Yes	Yes	Yes
School controls	No	Yes	No	No	No
p-value	0.03	0.03	0.03	0.02	0.05
N	175,073	138,412	171,397	72,918	98,479

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on performance in the PISA exams from the OECD. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. The outcome variable *PISA score* is the average across all plausible values provided in the data for an individual's performance in Maths, Reading and Science, standardised to mean 0 and standard deviation 1. Controls include age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status. Column 2 also controls for school-level attributes (class size, computers per student, number of lectures per week). In column 1 the sample includes all students who participated in PISA exams in Spain between 2003 and 2022. In column 2 we include only observations with information on school characteristics. In column 3 we exclude around 3,000 students who participated in PISA in 2018 who have been flagged by the OECD due to concerns about the reliability of the data. In column 4 we consider children with at least one college-educated parent and, in column 5, children with less educated parents. Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

Table 7: Impact on educational attainment

	(1)	(2)	(3)	(4)	(5)	(6)
	Upper secondary			College		
MLDA 18	-0.010		-0.002	0.021		0.034
	[-0.20,0.11]		[-0.27,0.18]	[-0.06,0.16]		[-0.10,0.25]
	(0.486)		*(0.885)*	*(0.092)*		*(0.093)*
MDLA 18 full treat		-0.011			0.024	
		[-0.19,0.14]			[-0.04,0.20]	
		(0.506)			*(0.099)*	
MDLA 18 partial treat		-0.007			0.014	
		[-0.75,0.09]			[-0.35,0.13]	
		(0.805)			*(0.333)*	
Sample	Full	Full	Excl. movers	Full	Full	Excl. movers
Magnitude (%)	-1.28		-0.30	5.09		8.26
Mean	0.79	0.78	0.79	0.42	0.42	0.42
N	610,207	610,207	554,724	610,207	610,207	554,724

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on educational attainment from the 2021 Census from INE. The variable *MLDA 18* takes value one if the individual could not legally drink when they were 16, and is 0 if they could legally drink at 16. We proxy legal access based on the region of birth. In columns 1–3 the outcome variable is a binary indicator equal to 1 if individual completed upper secondary education. In columns 4–6 the outcome variable *college* is 1 if an individual pursued higher education. The sample comprises individuals aged 16 to 25 in the 2021 census. Columns 1, 2, 4 and 5 report estimates for the full sample. In columns 3 and 6 the sample excludes individuals who reside in a different province from which they were born. Controls include gender, year of birth and province of birth. The sample includes 10% of all individuals born between 1987 and 2002 in the 2021 census. 95% confidence intervals (in brackets) and p-values (in parentheses) have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

Table 8: Impact on student effort

	(1)	(2)	(3)
	Homework time		
MLDA 18	-0.086	-0.094	-0.086
	[-0.21,0.07]	[-0.23,0.07]	[-0.21,0.07]
Sample	Full	Full	Restricted
Indiv. controls	Yes	Yes	Yes
School controls	No	Yes	No
p-value	0.31	0.34	0.31
N	122,116	102,674	119,246

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported time devoted to homework for individuals in PISA. The variable *MLDA 18* takes value one when the MLDA in the region at the time of the exam is 18, and 0 if it is 16. The dependent variable is standardised to mean 0 and standard deviation 1 to account for changes in reporting over time. In column 1 the sample includes all students who participated in PISA exams in Spain between 2003 and 2022. In column two we consider only students with non-missing information on school characteristics. In column 3 we exclude around 3,000 students who participated in PISA in 2018 who have been flagged by the OECD due to concerns about the reliability of the data. In all columns controls include age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status. Column 2 also includes controls for school-level attributes (class size, computers per student, number of lectures per week). Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

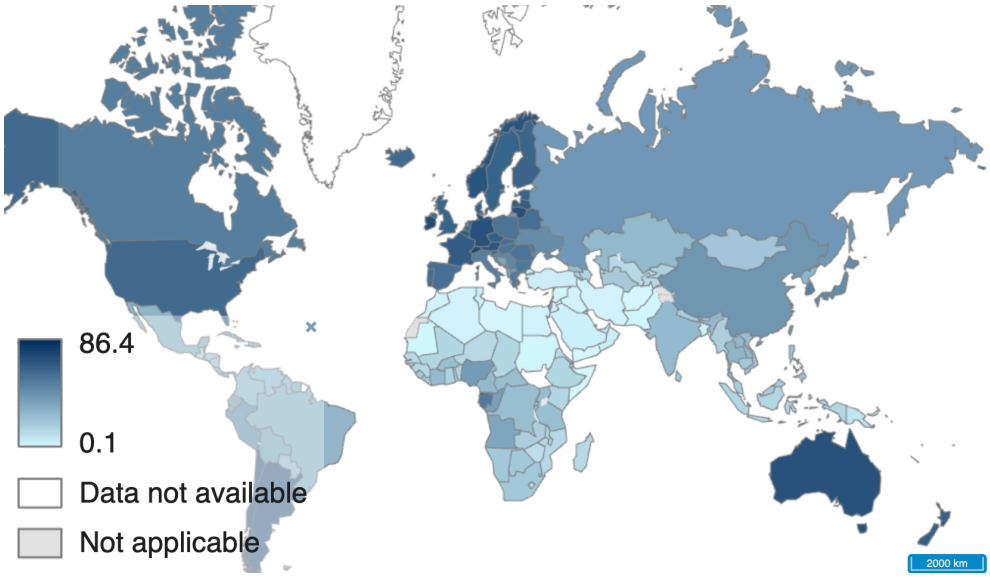
Table 9: Impact on leisure activities

	(1)	(2)	(3)	(4)	(5)
	Goes out at night		Internet	Videogames	Sport
	days per month	arrival time (index)	(daily)	(std)	(std)
MLDA 18	0.157	0.127	0.013	0.012	-0.037
	[-1.00,0.80]	[-0.18,0.42]	[-0.26,0.49]	[-0.06,0.13]	[-0.10,0.09]
Mean	3.20	2.26	0.82	0.00	0.06
p-value	0.75	0.20	0.21	0.65	0.34
N	237,287	251,146	146,603	164,202	169,825

Notes: Estimates of the MLDA increase on self-reported time use for individuals aged 14 to 17 from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the MLDA in the region at the time of the exam is 18, and 0 if it is 16. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

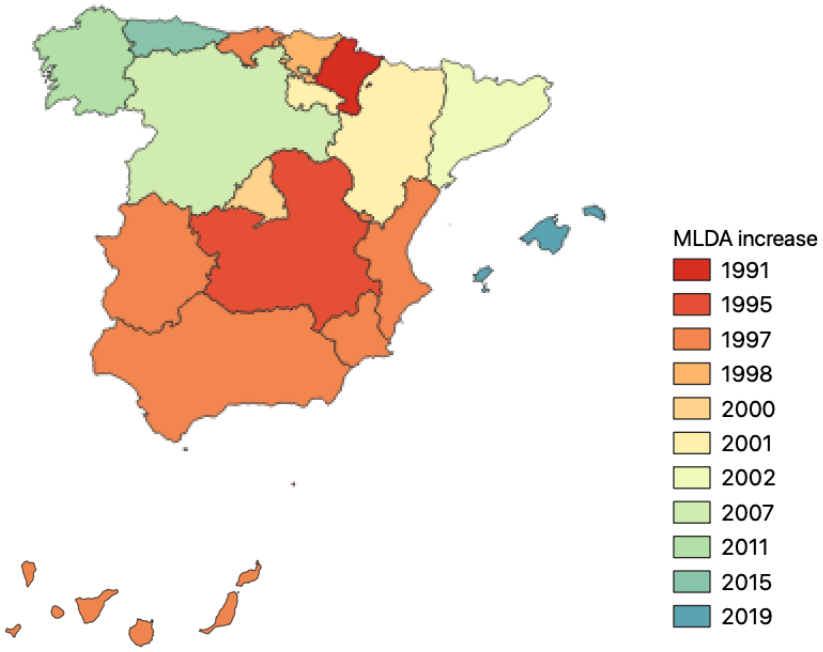
Figures

Figure 1: Alcohol consumption in past year (%), 15-19 years old, 2016



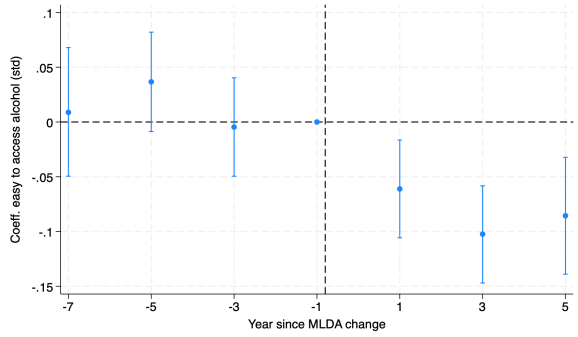
Notes: Prevalence of teenage consumption in the past month from WHO (2019).

Figure 2: MLDA increase across Spanish regions

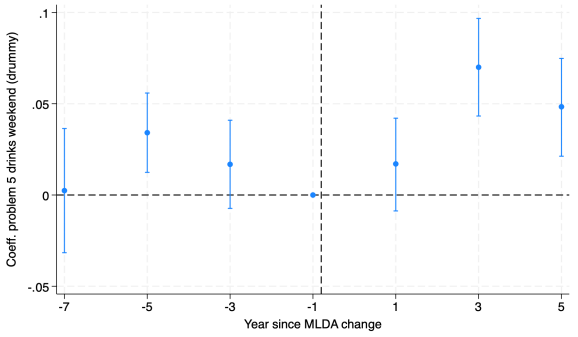


Notes: Map of Spanish regions and timing of MLDA reforms. Whenever a region experienced more than one regulatory change in the MLDA (one partial, one full) we code the year in which the full reform took place.

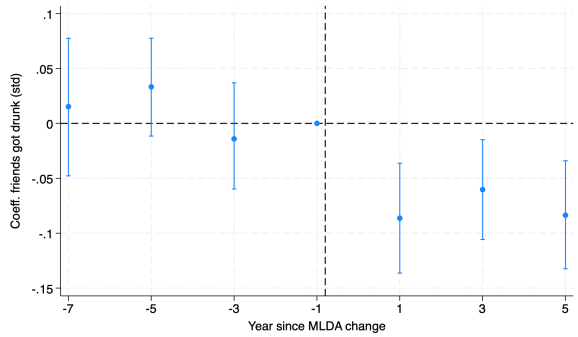
Figure 3: Event studies: Effect of MLDA on alcohol access and drinking measures



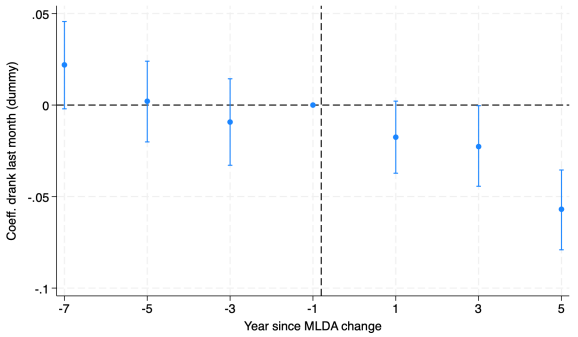
(a) *Easy to access alcohol (std)*



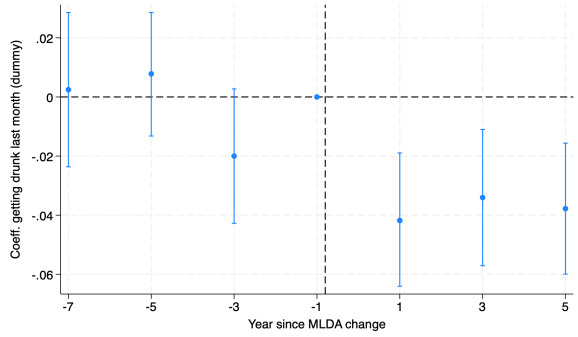
(b) *Problem 5 drinks weekend (dummy)*



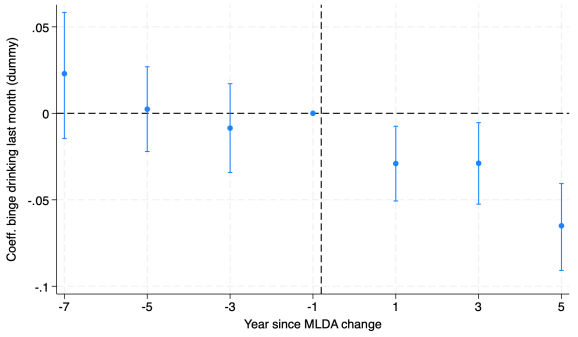
(c) *Friends got drunk (std)*



(d) *Drinking in last 30 days*



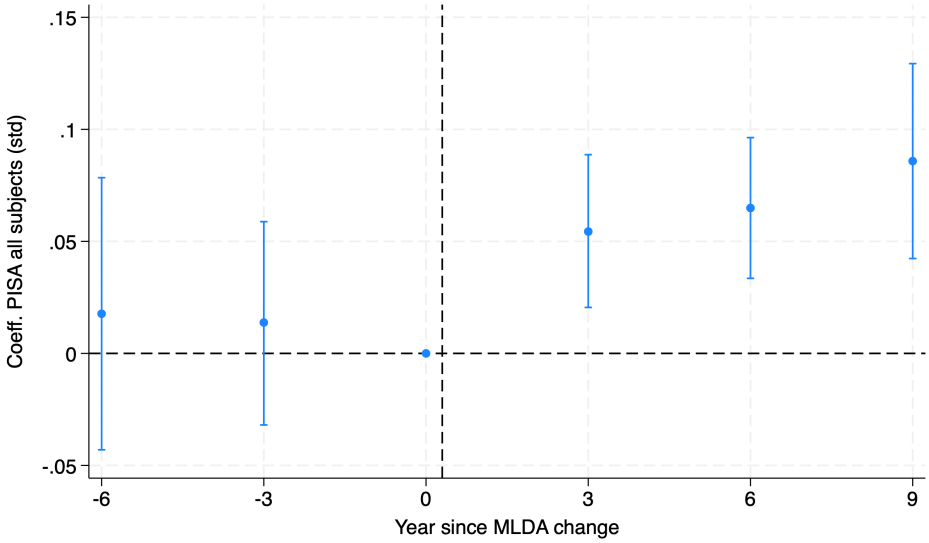
(e) *Get drunk in last 30 days*



(f) *Binge drink in last 30 days*

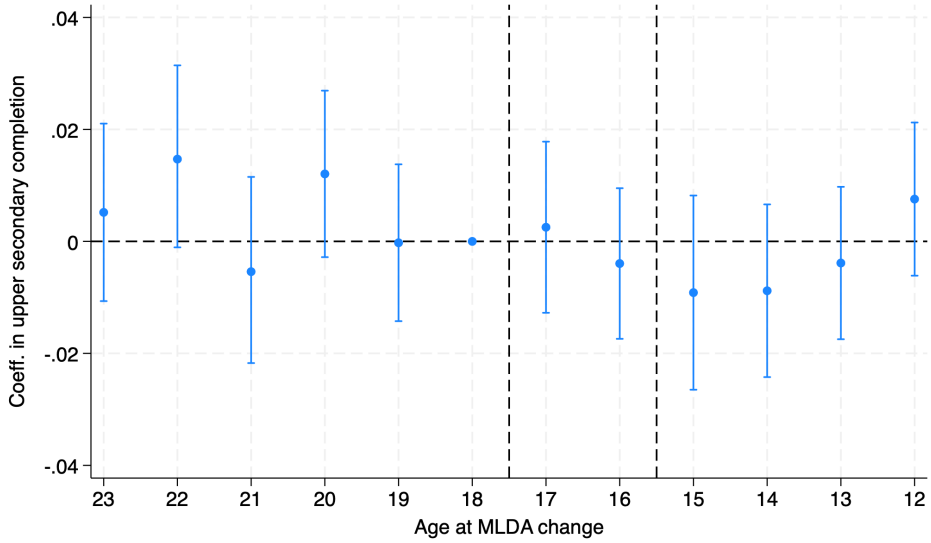
Notes: Event studies of the prevalence in alcohol access and drinking measures from the High School Survey on Drug Use. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. The base year is the year prior to the MLDA increase. 95% confidence intervals have been calculated using wild bootstrap.

Figure 4: Event study: Effect of MLDA on PISA test scores

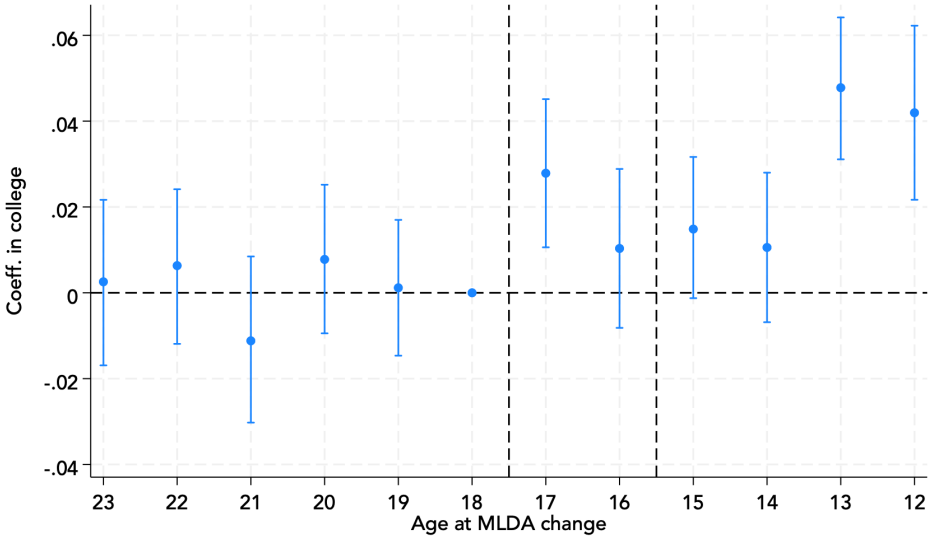


Notes: Event study of standardised test scores in PISA. Regions where PISA exams took place at the same time as final high school exams excluded. Controls include age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status. Weights applied. The base year is the year prior to the MLDA increase. 95% confidence intervals have been calculated using wild bootstrap.

Figure 5: Event study: Effect of MLDA on educational attainment



Completing upper secondary education



Going to college

Notes: Event study of the probability of graduating from upper secondary education and going to college, by age at the time of the MLDA reform in their region of birth. The sample includes 10% of all individuals born between 1987 and 2002 in the 2021 census. Controls include gender, year of birth and province of birth. The base age group are those aged 18 at the time of MLDA change. 95% confidence intervals have been calculated using wild bootstrap.

Online Appendix

Supplementary Tables

Table A1: Minimum Legal Drinking Age regulation, by region

Region	Effective from:	Alcohol permitted under 18	Regulation	Source
Andalucia	July 20th, 1997	None	Ley 4/1997, de 9 de julio, de Prevención y Asistencia en materia de Drogas.	BOE-A-1997-18301
Aragon	May 1st, 2001	None	Ley 3/2001, de 4 abril, de prevención, asistencia y reinserción social en materia de drogodependencias.	BOE-A-2001-9342
Asturias	May 20th, 2015	None	Ley 4/2015, de 6 de marzo, de atención integral en materia de drogas y bebidas alcohólicas.	BOE-A-2015-4847
Balearic Islands	February 28th, 2014	No sale or consumption allowed in public establishments	Ley 7/2013, de 26 de noviembre, de régimen jurídico de instalación, acceso y ejercicio de actividades en las Illes Balears.	BOE-A-2014-655
	May 19th, 2019	None	Ley 9/2019, de 19 de febrero, de la atención y los derechos de la infancia y la adolescencia de las Illes Balears.	BOE-A-2019-5578
Basque Country	July 15th, 1998	None	Ley 18/1998, de 25 de junio, sobre Prevención, Asistencia e Inserción en materia de Drogodependencias	B.O.P.V. - 14 de julio de 1998
Canary Islands	February 18th, 1997	None	Ley 1/1997, de 7 de febrero, de Atención Integral a los menores.	BOE-A-1997-5498
Cantabria	November 15th, 1997	None	Ley de Cantabria 5/1997, de 6 octubre, de Prevención, Asistencia e Incorporación Social en Materia de Drogodependencias.	Boletín Oficial de Cantabria núm. 205, de 14 de noviembre de 1997
Castile and Leon	April 7th, 1994	Moderate alcohol content (less than 18%) above 16 years	Ley 3/1994, de 29 de marzo, de Prevención, Asistencia e Integración Social de Drogodependientes de Castilla y León.	BOCL nm. 65, de 6 de abril de 1994
	June 14th, 2007	None	Ley 3/2007, de 7 de marzo, por la que se modifica la Ley 3/1994, de 29 de marzo, de prevención, asistencia e integración social de drogodependientes de Castilla y León.	BOCL nm. 52, de 14 de marzo de 2007
Castile-La Mancha	April 22nd, 1995	None	Ley 2/1995, de 2 de marzo, contra la Venta y Publicidad de Bebidas Alcohólicas a Menores.	Diario Oficial de Castilla-La Mancha núm. 19, de 21 de abril de 1995
Catalonia	June 7th, 1991	Moderate alcohol content (less than 23%) above 16 years	Ley 10/1991, de 10 de mayo, de modificación de la Ley 20/1985, de prevención y asistencia en materia de sustancias que pueden generar dependencia.	BOE-A-1991-14237
	April 8th, 2002	None	Ley 1/2002, de 11 de marzo, de tercera modificación de la Ley 20/1985, de 25 de julio, de Prevención y Asistencia en Materia de Sustancias que Pueden Generar Dependencia.	DOGC nm. 3598, de 19 de marzo de 2002
Extremadura	May 18th, 1997	None	Ley 4/1997, de 10 de abril, de Medidas de Prevención y Control de la Venta y Publicidad de Bebidas Alcohólicas para Menores de Edad.	Diario Oficial de Extremadura núm.57, de 17 de mayo de 1997
Galicia	July 22nd, 1996	Moderate alcohol content (less than 18%) above 16 years	Ley 2/1996, de 8 de mayo, de Galicia, sobre drogas.	BOE-A-1996-14650
	February 28th, 2011	None	Ley 11/2010, de 17 de diciembre, de prevención del consumo de bebidas alcohólicas en menores de edad.	BOE-A-2011-1647
La Rioja	February 18th, 2001	None	Ley 4/2000, de 25 de octubre, de Espectáculos Públicos y Actividades Recreativas de la Comunidad Autónoma de la Rioja.	BOE-A-2000-21563
Madrid	May 12th, 2000	None	Ley 5/2000, de 8 de mayo, por la que se eleva la edad mínima de acceso a las bebidas alcohólicas	BOE-A-2000-9793
Murcia	November 13th, 1997	None	Ley 6/1997, de 2 de octubre, sobre drogas para la prevención, asistencia e integración social.	BOE-A-1998-3169
Navarre	April 6th, 1991	None	Ley Foral 10/1991, de 16 de marzo, sobre prevención y limitación de consumo de bebidas alcohólicas por menores de edad.	BOE-A-1991-23614
Valencian Community	June 19th, 1997	Moderate alcohol content (less than 18%) above 16 years	Ley 3/1997, de 16 de junio, sobre drogodependencias y otros trastornos adictivos.	Diario Oficial de la Generalitat Valenciana núm. 3.016, de 18 de junio de 1997
	August 27th, 2002	None	Ley 4/2002, de 18 de junio, por la que se modifica la Ley 3/1997, de 16 de junio, sobre Drogodependencias y otros Trastornos Adictivos.	BOE-A-2002-14189

Notes: MLDA reforms across Spanish regions, 1991-2019.

Table A2: Comparison of treated and control regions, 2006 and 2020

	(1)	(2)	(3)	(4)	(5)	(6)
	Treated	Control	Diff	Treated	Control	Diff
	2006			2020		
Drink last 30 days	0.596	0.546	0.050	0.458	0.467	-0.009
			[-0.10,0.14]			[-0.09,0.12]
Get drunk last 30 days	0.283	0.228	0.055	0.204	0.223	-0.018
			[-0.04,0.11]			[-0.08,0.08]
Binge drink 30 days	0.417	0.363	0.054	0.240	0.268	-0.028
			[-0.06,0.13]			[-0.09,0.06]
GDP per capita	20,459	22,740	-2,281	22,046	23,663	-1,617
			[-6311.36,4801.86]			[-6947.03,3699.52]
PISA score	0.128	0.019	0.109	0.099	-0.100	0.200
			[-0.34,0.43]			[-0.07,0.39]

Notes: Summary statistics for treated regions in 2006 in Column 1 (i.e. Castile and Leon, Galicia, Asturias and the Balearic Islands) and in 2020 in column 4. Information for control regions for the year 2006 is in column 2 and for the year 2020 in column 5. Columns 3 and 6 show the difference in means between the treatment and control group in 2006 and 2020, respectively. 95% confidence intervals of the difference (in brackets) calculated using wild bootstrap. Teenage drinking variables come from the High School Survey on Drug Use and are binary indicators. PISA score shows the standardised test score across all topics assessed in PISA (Science, Maths and Reading). GDP figures are in euros in current (2024) prices from the Spanish Statistical Authority (INE).

Table A3: Variable definitions - High School Survey on Drug Use

Variable	Description
Outcomes of interest	
Alcohol consumption	
Drink last 30 days (dummy)	Binary indicator, 1 if individual reports having consumed alcohol in the last 30 days, 0 otherwise
Drink last 30 days (days)	Created from an index variable where an individual reports consuming 1–3, 4–5, 6–9, 10–19, or more than 20 days. We take the average number in each category to convert to days. For instance, if the individual reported consuming 10–19 days we code it as 14.5. The highest category is coded as 24.5
Get drunk last 30 days (dummy)	Binary indicator, 1 if individual reports having been drunk in the last 30 days, 0 otherwise
Get drunk last 30 days (days)	Created from an index variable coded similarly to *Drink last 30 days (days)*
Binge drink last 30 days (dummy)	Binary indicator, 1 if individual reports having had more than 5 drinks at least once in the last 30 days, 0 otherwise
Binge drink last 30 days (days)	Created from an index variable coded similarly to *Drink last 30 days (days)*
Age first drank	Age individual first consumed alcohol
Age first got drunk	Age individual first got drunk
Most friends drank last 30 days	Binary indicator, 1 if individual states that most or all of their friends drank last 30 days, 0 otherwise
Most friends got drunk last 30 days	Binary indicator, 1 if individual states that most or all of their friends got drunk last 30 days, 0 otherwise
Having 5 drinks each wkdn is a problem	Binary indicator, 1 if individual states that having 5 drinks each weekend is a problem, 0 otherwise
Access to alcohol	
Easy to access alcohol (index)	Categorical variable where individual states how easy it is to access alcohol. Prior to 2014 the variable had four possible categories, ranging from 'Very easy' to 'Almost impossible'. From 2014 the categorisation changed to two categories divided into 'Easy' or 'Difficult'. We standardise the variable in each year.
Parents allow drinking	Binary indicator, 1 if individual reports that their parents allow them to consume alcohol, 0 otherwise.
Obtained alcohol at bar/shop	Binary indicator, 1 if individual reports purchasing alcohol in a bar/disco or pub, 0 otherwise
Obtained alcohol at house/park	Binary indicator, 1 if individual reports purchasing alcohol at a house or at the park, 0 otherwise
Acquired alcohol themselves	Binary indicator, 1 if individual reports purchasing alcohol themselves, 0 otherwise
Acquired alcohol through adult friend	Binary indicator, 1 if individual reports purchasing alcohol through an adult friend, 0 otherwise
Drank alcohol at bar	Binary indicator, 1 if individual reports consuming alcohol in a bar/disco or pub, 0 otherwise
Drank alcohol at house/park	Binary indicator, 1 if individual reports consuming alcohol at a house or at the park, 0 otherwise
Problems related to alcohol	
Hangover after consuming	Binary indicator, 1 if individual reports having experienced hangover in the last 12 months, 0 otherwise
Could not remember last night	Binary indicator, 1 if individual reports not being able to remember the previous night after having drunk in the last 12 months, 0 otherwise
Could not focus after consuming	Binary indicator, 1 if individual reports not being able to focus after consuming alcohol in the last 12 months, 0 otherwise
Drove under influence	Binary indicator, 1 if individual reports having driven after drinking or been in a car where the driver had drunk in the last 12 months, 0 otherwise
Other drugs	
Cigarettes last 30 days	Binary indicator, 1 if individual reports having smoked cigarettes in the last 30 days, 0 otherwise
Smokes daily	Binary indicator, 1 if individual reports smoking daily, 0 otherwise
Cannabis last 30 days	Binary indicator, 1 if individual reports having consumed cannabis in the last 30 days, 0 otherwise
Cannabis last 30 days (index)	Created from an index variable where individual reports whether smoked cannabis at all, less than weekly, less than daily, or daily
Tranquillisers/sleeping pills last 30 days	Binary indicator, 1 if individual reports having consumed tranquillisers or sleeping pills in the last 30 days, 0 otherwise
Tranquillisers/sleeping pills last 12 months	Binary indicator, 1 if individual reports having consumed tranquillisers or sleeping pills in the last 12 months, 0 otherwise
Leisure	
Goes out at night (index)	Standardised index variable where individuals report the frequency of going out in the night. The categories are never, 1-3 nights, once a week, twice a week, 3-4 nights a week, or 4 nights or more
Arrival time when going out at night	Categorical variable ranging from "before midnight", from 0-1 AM, 1-2AM, 2-3AM, 3-4AM, 4-8AM, or "did not come back"
Goes out afternoon/evening	Standardised index variable where individuals report the frequency of going out in the afternoon-evening. The categories are never, 2 or 3 times a year, once or twice a 30 days, at least weekly, or every day
Videogames	Standardised index variable where an individual reports the frequency of playing videogames. For 2012 and 2014 we use a variable including the following categories: never, 2 or 3 times a year, once or twice a 30 days, at least weekly, or every day. For 2016 to 2020 we have more precise indicators with the number of hours that people play daily, from never, less than 30 minutes, 1 hour daily, 2-3 hours daily, and 4 or more. We standardise the values each year
Internet daily	Binary indicator, 1 if individual reports using the Internet every day, 0 otherwise
Sport	Standardised index variable where an individual reports the frequency of different sports or exercising. Categories are never, 2 or 3 times a year, once or twice a 30 days, at least weekly, or every day
Individual controls	
Education father	Categorical variable where individual reports father's education. The categories are no formal education, up to primary education, up to secondary education, vocational education, university education (degree), university education (master or above) or doesn't know. We code an additional category when the value was missing
Education mother	Categorical variable where individual reports mother's education. The categories are no formal education, up to primary education, up to secondary education, vocational education, university education (degree), university education (master or above) or doesn't know. We code an additional category when the value was missing
Country of birth	Categorical variable describing if individual was born in Spain or abroad. We code an additional category when the value was missing
Attends private school	Binary indicator, 1 if individual attends private school, 0 otherwise.

Notes: Variable definitions from the High School Survey on Drug Use, 2004–2021.

Table A4: List of questions that appear in all survey waves

Question	**Question number in 2004**
Sex	P1
Month and Year of Birth	P2
Parental labour status	P4
Parental occupation	P5
Parental studies	P6
Repetition	P9
Leisure activities	P12
Going out at night, days and time	P15-P16
Cigarette consumption	P21-P27
Alcohol consumption	P28-P40
Anxiolytics and hypnosedatives	P41-P46
Cannabis	P47-P53
Cocaine	P54-P58
Heroine	P59-P61
Speed	P62-P64
LSD	P65-P67
Volatile substances	P68-P70
Extasis	P71-P77
Opinion on drug use	P78-P84
Access to drugs	P85
Information on drugs	P86-P91
Drug and alcohol consumption by friends	P92
Relationship with parents	P94

Notes: List of questions available in all waves of the High School Survey on Drug Use and variable label in the 2004 edition. All the questionnaires can be accessed in the following link: `https://pnsd.sanidad.gob.es/profesionales/sistemasInformacion/sistemaInformacion/encuestas_ESTUDES.htm`

Table A5: Variable definitions - PISA and census

Variable	Description
PISA	
Outcomes of interest	
Average score	Average of all plausible values available per year for all subjects, in points
Math score	Average of all plausible values available per year for math, in points
Science score	Average of all plausible values available per year for science, in points
Reading score	Average of all plausible values available per year for reading, in points
Homework time	Total time spent on homework, standardised per year. Not available for 2009. For 2018 we use an index variable where individuals indicate when they last did homework. 2018 is omitted in the summary statistics.
Individual controls	
Education father	Categorical variable where individual reports father's education. The categories are no formal education, primary education, lower secondary education, upper secondary education, tertiary education, or missing
Education mother	Categorical variable where individual reports mother's education. The categories are no formal education, primary education, lower secondary education, upper secondary education, tertiary education, or missing
Country of birth	Categorical variable distinguishing native students, first-generation students, or non-native students.
Index ESCS	Index of Socio-Economic and Cultural Status. Composite score derived by PISA from three indicators related to family background: parents' highest education, in years, parents' highest occupational status, and home possessions
PISA during finals period	Binary indicator which is 1 in years and regions where the PISA exams coincided with high-stakes final examinations
School controls	
Student to teacher ratio	Total number of students divided by the total number of teachers in a school
Computer to student ratio	Total computers available for educational purposes over total student enrolment in the school
Instruction time Math	Total minutes of instructional time in Math. In years when total instruction time was not available, we took the average instructional time for English, Math, and Science. We standardise the variable each year
Instruction time Science	As above, for Science
Instruction time Reading	As above, for Reading
Census	
Upper secondary	Binary indicator, 1 if individual reports having attained upper secondary education (above mandatory education - *Educación Secundaria Obligatoria or ESO*), 0 otherwise
College	Binary indicator, 1 if individual has a higher education degree (bachelor's, master's, or above), 0 otherwise
Mover	Binary indicator, 1 if person resides in different region to which they were born in, 0 otherwise

Notes: Variable definitions from PISA 2003–2022.

Table A6: Impact on alcohol consumption, heterogeneity by age

	(1)	(2)	(3)	(4)	(5)
	Age at time of survey				
	14	15	16	17	PISA aged
	Drink last 30 days (dummy)				
MLDA 18	-0.015	-0.036	-0.069	-0.034	-0.052
	[-0.09,0.03]	[-0.13,0.00]	[-0.16,-0.01]	[-0.12,0.03]	[-0.19,-0.02]
Magnitude (%)	-3.92	-6.25	-9.11	-4.29	-8.12
Mean	0.37	0.57	0.76	0.80	0.64
p-value	0.33	0.05	0.05	0.10	0.028
N	52,706	67,245	68,063	52,789	84,367
	Get drunk last 30 days (dummy)				
MLDA 18	-0.019	-0.030	-0.062	-0.055	-0.038
	[-0.06,0.01]	[-0.08,0.01]	[-0.11,-0.01]	[-0.17,0.00]	[-0.22,-0.00]
Magnitude (%)	-17.84	-14.94	-17.87	-13.94	-15.38
Mean	0.11	0.20	0.35	0.40	0.25
p-value	0.11	0.07	0.03	0.06	0.044
N	53,857	67,771	68,134	52,654	84,939
	Binge drink last 30 days (dummy)				
MLDA 18	-0.018	-0.022	-0.083	-0.079	-0.040
	[-0.27,0.02]	[-0.08,0.04]	[-0.12,0.03]	[-0.37,0.04]	[-0.20,-0.01]
Magnitude (%)	-10.90	-7.85	-18.06	-14.98	-12.09
Mean	0.16	0.28	0.46	0.53	0.33
p-value	0.17	0.23	0.15	0.10	0.032
N	48,539	58,960	58,641	48,236	74,366

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures from the High School Survey on Drug Use by age of individual. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Columns 1–4 report estimates for individuals aged 14–17, respectively. Column 5 includes individuals eligible for PISA participation (i.e., aged between 15 years and 3 months and 16 years and 5 months). Age in months has been calculated based on the year and month of birth, and the median month in which the corresponding survey took place (for example, if the survey took place between February and April, we use March as the reference month). Dependent variables are binary indicators. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions minus the estimated effect of the MLDA.

Table A7: Impact on educational performance (PISA), by subject

	(1) Math	(2) Reading	(3) Science
MLDA 18	0.014	0.073	0.042
	[-0.03,0.10]	[-0.00,0.16]	[0.02,0.09]
Sample	Restricted	Restricted	Restricted
Indiv. controls	Yes	Yes	Yes
School controls	No	No	No
p-value	0.37	0.05	0.03
N	171,397	171,397	171,397

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on performance in the PISA exams from the OECD, by subject. The score is the average across all plausible values provided in the data standardised to mean 0 and standard deviation 1. We exclude around 3,000 students who participated in PISA in 2018 who have been flagged by the OECD due to concerns about the reliability of the data. All columns include controls for individual-level attributes (age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status). Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap.

Table A8: Impact on teenage drinking, by affected region

	Drinking alcohol		Getting drunk		Binge drinking	
	dummy	days	dummy	days	dummy	days
MLDA 18 - Castile and Leon	-0.032	-0.290	-0.039	-0.050	-0.066	-0.158
	[-0.55,0.33]	[-5.95,3.89]	[-0.51,0.44]	[-1.94,1.34]	[-0.93,0.40]	[-4.18,2.02]
MLDA 18 - Galicia	-0.042	-0.290	-0.046	-0.122	-0.047	-0.102
	[-0.51,0.28]	[-4.16,3.02]	[-0.40,0.39]	[-1.45,1.40]	[-0.50,0.31]	[-2.18,2.23]
MLDA 18 - Asturias	-0.063	-0.713	-0.059	-0.152	-0.060	-0.298
	[-1.25,0.89]	[-9.94,13.45]	[-1.08,1.05]	[-4.32,3.69]	[-1.19,1.14]	[-8.54,6.27]
MLDA 18 - Balearic Islands	-0.053	-0.038	-0.054	-0.174	-0.009	0.008
	[-1.98,1.03]	[-9.89,13.05]	[-1.19,0.78]	[-1.13,1.67]	[-1.09,1.01]	[-3.84,3.99]
Mean	0.64	3.15	0.27	0.72	0.36	1.20
N	22,068	22,068	22,721	22,721	23,051	23,051

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures by region from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions minus the estimated effect of the MLDA.

Table A9: Impact on key outcomes, full vs partial reforms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Drinking alcohol		Getting drunk		Binge drinking		PISA score
	dummy	days	dummy	days	dummy	days	(standardised)
MLDA 18 - full reform	-0.047	-0.393	-0.049	-0.130	-0.051	-0.158	0.043
	[-0.44,0.16]	[-4.66,1.51]	[-0.37,0.17]	[-1.08,0.37]	[-0.44,0.13]	[-3.19,0.84]	[-0.21,0.96]
MLDA 18 - partial reform	-0.036	-0.251	-0.041	-0.071	-0.049	-0.109	0.046
	[-0.62,0.25]	[-4.71,3.34]	[-0.48,0.34]	[-2.41,1.26]	[-0.60,0.85]	[-2.75,2.40]	[-0.12,0.49]
Mean	0.63	3.06	0.26	0.68	0.36	1.17	
N	239,766	239,766	241,410	241,410	213,335	213,335	171,397

Notes: Columns 1 to 6 present estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures by region from the High School Survey on Drug Use. Column 7 estimates effects on PISA exams from the OECD. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Full reforms took place in Galicia and Asturias, while partial took place in Castile and Leon and the Balearic Islands. Controls in columns 1–6 include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Controls in column 7 include age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status. In column 7 we exclude around 3,000 students who participated in PISA in 2018 who have been flagged by the OECD due to concerns about the reliability of the data. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions minus the estimated effect of the MLDA.

Table A10: Impact on alcohol consumption, restricted comparison group

	Drinking alcohol		Getting drunk		Binge drinking	
	dummy	days	dummy	days	dummy	days
MLDA 18	-0.038	-0.273	-0.052	-0.136	-0.064	-0.210
	[-0.09,0.02]	[-0.80,0.44]	[-0.11,0.01]	[-0.41,0.18]	[-0.13,0.03]	[-0.65,0.23]
Magnitude (%)	-5.77	-7.52	-16.99	-16.07	-15.20	-14.02
Mean	0.66	3.62	0.31	0.85	0.42	1.49
p-value	0.11	0.21	0.07	0.15	0.11	0.13
N	1,016,286	1,016,286	1,024,584	1,024,584	904,184	904,184

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Estimates on a stacked database where each treated region is compared to regions where the MLDA increase took place 5 years earlier or more. Weights applied. The dependent variables are binary indicators. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth and month of survey, all interacted with *stack*. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions minus the estimated effect of the MLDA.

Table A11: Impact on educational performance (PISA), restricted comparison group

	(1)	(2)	(3)
	PISA score (standardised)		
MLDA 18	0.043	0.037	0.042
	[0.00,0.14]	[-0.47,0.57]	[-0.47,0.57]
Sample	Full	Full	Restricted
Indiv. controls	Yes	Yes	Yes
School controls	No	Yes	No
p-value	0.04	0.27	0.05
N	692,017	222,736	673,637

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on performance in the PISA exams from the OECD. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Estimates on a stacked database where each treated region is compared to regions where the MLDA increase took place 5 years earlier or more. The outcome variable *PISA score* is the average across all plausible values provided in the data for an individual's performance in Maths, Reading and Science, standardised to mean 0 and standard deviation 1. Controls include age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status. Column 2 also controls for school-level attributes (class size, computers per student, number of lectures per week). In column 1 the sample includes all students who participated in PISA exams in Spain between 2003 and 2022. In column 2 we include only observations with information on school characteristics. In column 3 we exclude around 3,000 students who participated in PISA in 2018 who have been flagged by the OECD due to concerns about the reliability of the data. Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated using wild bootstrap. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

Table A12: Impact on alcohol consumption, count variables estimated using PQMLE

	Drinking alcohol days	Getting drunk days	Binge drinking days
MLDA 18	-0.07	-0.16	-0.15
	[-0.17,0.02]	[-0.32,0.01]	[-0.24,-0.05]
Mean	2.80	0.61	1.06
p-value	0.12	0.06	0.00
N	239,765	241,389	213,326

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. 95% confidence intervals (in brackets) and p-values have been calculated using bootstrap. PQMLE stands for Poisson Quasi Maximum Likelihood Estimation. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions minus the estimated effect of the MLDA.

Table A13: Impact on alcohol consumption, alternative inference method

	(1)	(2)	(3)	(4)	(5)	(6)
	Drinking alcohol last 30 days		Getting drunk last 30 days		Binge drinking last 30 days	
	dummy	days	dummy	days	dummy	days
MLDA 18	-0.043	-0.344	-0.047	-0.111	-0.051	-0.149
	[-0.06,-0.02]	[-0.56,-0.13]	[-0.06,-0.03]	[-0.20,-0.03]	[-0.07,-0.03]	[-0.27,-0.03]
Magnitude (%)	-6.80	-10.92	-17.26	-15.51	-14.05	-12.34
Mean	0.64	3.15	0.27	0.72	0.36	1.21
p-value	0.00	0.00	0.00	0.01	0.00	0.01
N	239,766	239,766	241,410	241,410	213,335	213,335

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures last month for individuals aged 14 to 17 from the High School Survey on Drug Use. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Columns 1 to 6 show different drinking measures, are estimated with OLS and the confidence interval is calculated using wild bootstrap. Controls include age, father's education, mother's education, gender, month of birth, country of birth, whether student attends a private school and grade level. Weights applied. 95% confidence intervals (in brackets) and p-values have been calculated clustering standard errors at the region-cohort level. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

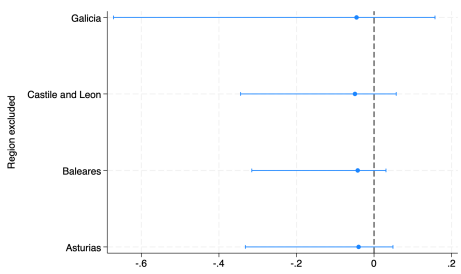
Table A14: Impact on educational performance (PISA), alternative inference method

	(1)	(2)	(3)
	PISA score (standardised)		
MLDA 18	0.046	0.044	0.044
	[0.02,0.08]	[0.01,0.08]	[0.01,0.07]
Sample	Full	Full	Restricted
Indiv. controls	Yes	Yes	Yes
School controls	No	Yes	No
p-value	0.00	0.01	0.00
N	175,073	138,412	171,397

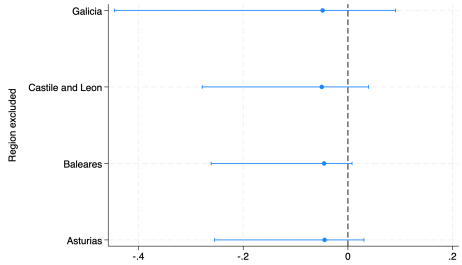
Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on performance in the PISA exams from the OECD. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. The outcome variable *PISA score* is the average across all plausible values provided in the data for an individual's performance in Maths, Reading and Science, standardised to mean 0 and standard deviation 1. All columns include controls for individual-level attributes (age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status). Column 2 also includes school-level attributes (class size, computers per student, number of lectures per week). In column 1 the sample includes all students who participated in PISA exams in Spain between 2003 and 2022. In column 2 we include only observations with information on school characteristics. In column 3 we exclude around 3,000 students who participated in PISA in 2018 who have been flagged by the OECD due to concerns about the reliability of the data. All regressions include Weights. 95% confidence intervals (in brackets) and p-values have been calculated clustering standard errors at the region-cohort level. *Mean* includes the counterfactual mean, calculated as the observed mean in treated regions after accounting for the estimated effect of the MLDA.

Supplementary Figures

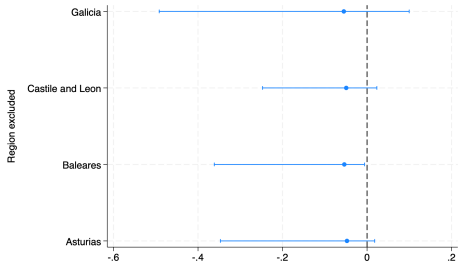
Figure A1: Impact on key outcomes, leaving out one treated region at a time



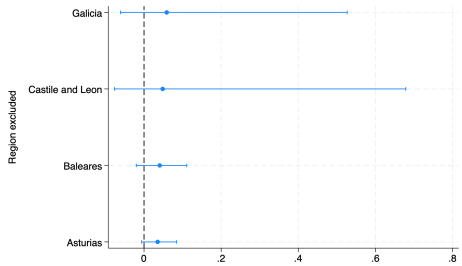
(a) Probability of drinking in the last 30 days



(b) Probability of getting drunk in the last 30 days



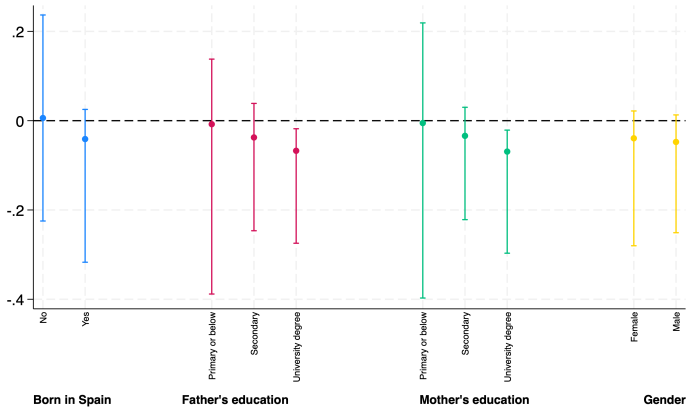
(c) Probability of binge drinking in the last 30 days



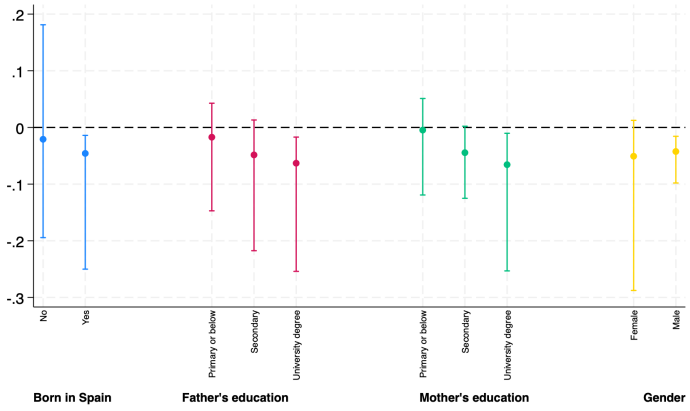
(d) PISA score (standardised)

Notes: Panels a to c present estimates of the MLDA increase on self-reported drinking measures for pupils aged 14 to 17 in the High School Survey on Drug Use by pupil attributes, excluding one treated region at a time. Panel d presents estimates on PISA exams from the OECD. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Dependent variables are binary indicators. Controls in panels a to c include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth and month of survey. Weights applied. Controls in panel d include age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status. 95% confidence intervals have been calculated using wild bootstrap.

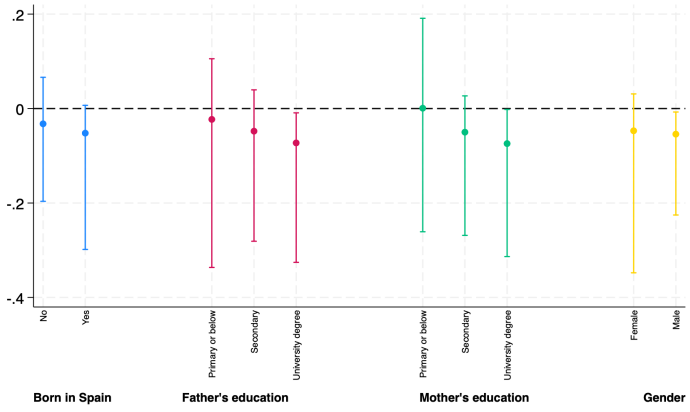
Figure A2: Impact on alcohol consumption, heterogeneity by gender and parental education



Drinking in last 30 days



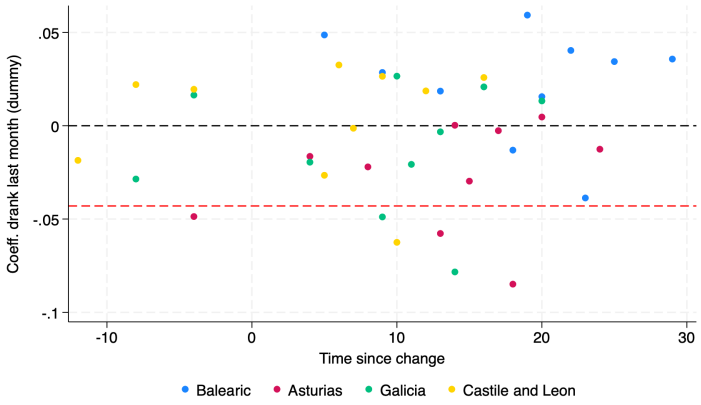
Get drunk in last 30 days



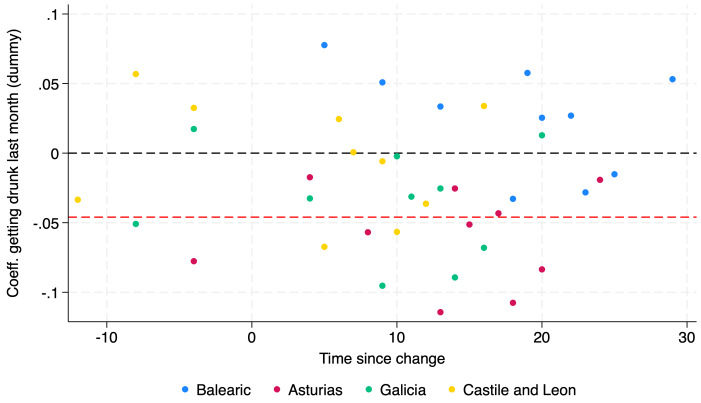
Binge drink in last 30 days

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures for pupils aged 14 to 17 in the High School Survey on Drug Use by pupil attributes. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. Dependent variables are binary indicators. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. 95% confidence intervals have been calculated using wild bootstrap.

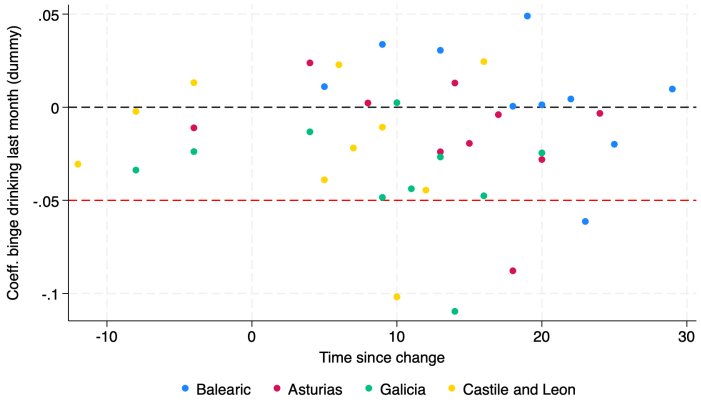
Figure A3: Impact on alcohol consumption, pairwise comparisons



Drinking in last 30 days



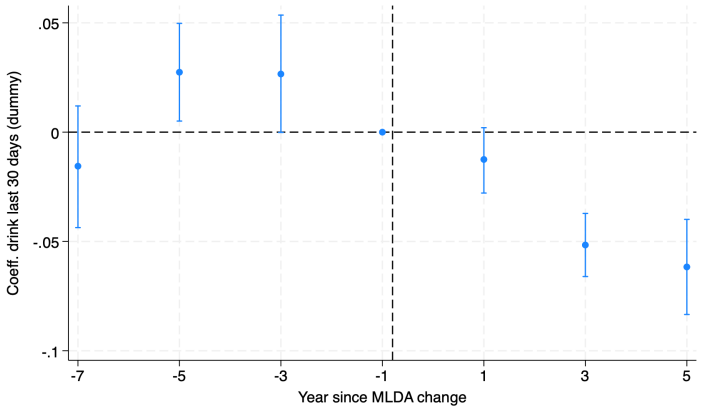
Get drunk in last 30 days



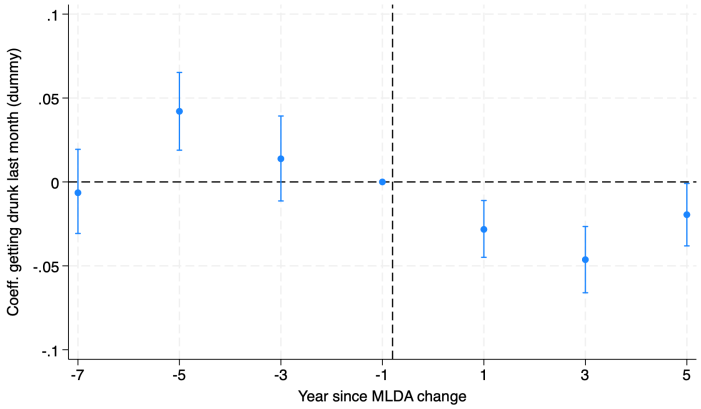
Binge drink in last 30 days

Notes: Estimates of the MLDA increase in Castile and Leon, Galicia, Asturias and the Balearic Islands on self-reported drinking measures for pupils aged 14 to 17 in the High School Survey on Drug Use by pupil attributes. Each point shows the coefficient relative to a given treatment cohort. The x-axis shows the distance between the MLDA increase in a treated region and the MLDA increase in a given control cohort set of regions. The variable *MLDA 18* takes value one when the minimum legal drinking age in the region at the time of the exam is 18, and 0 if it is 16. The dashed red line shows the ATT as estimated in TWFE in Table 4. Dependent variables are binary indicators. Controls include age, father's education, mother's education, gender, month of birth, country of birth, whether student attends a private school and grade level. Weights applied.

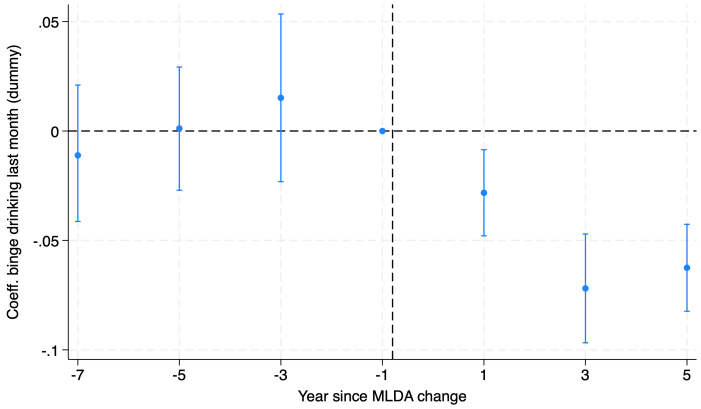
Figure A4: Event study: Effect of MLDA on various drinking measures, restricted comparison



Drinking in last 30 days



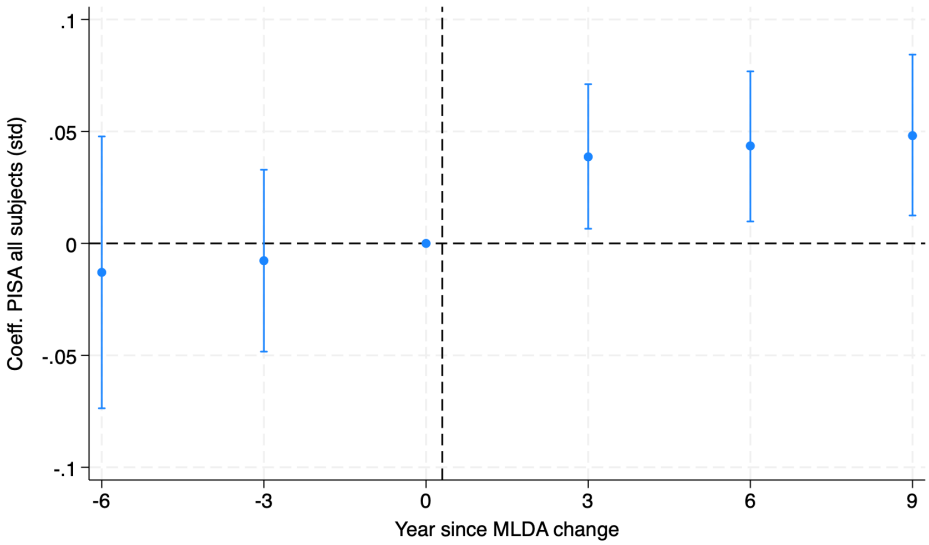
Get drunk in last 30 days



Binge drink in last 30 days

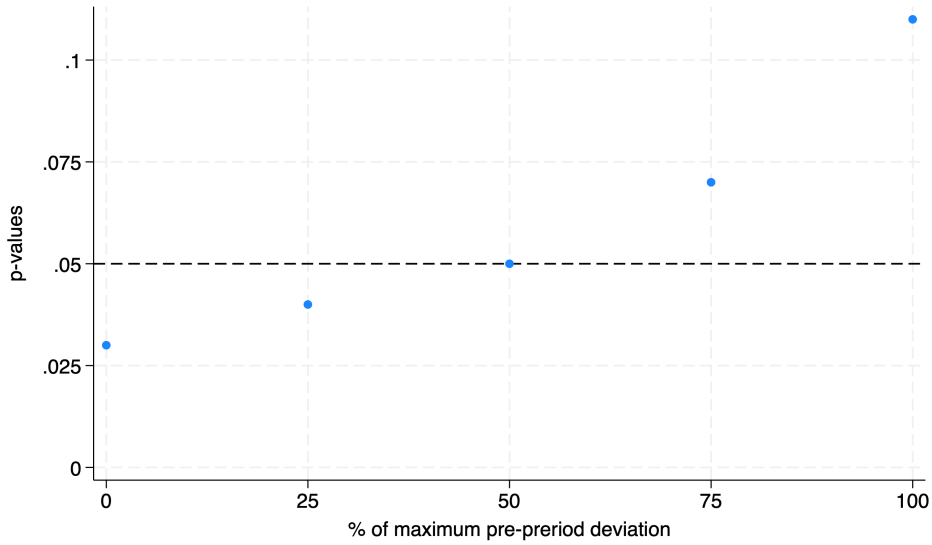
Notes: Event study of the prevalence in drinking measures from the High School Survey on Drug Use. Controls include age, father's education, mother's education, gender, month of birth, year of birth and year of survey interacted, country of birth, whether student attends a private school and grade level. Weights applied. Estimates on a stacked database where each treated region is compared to regions where the MLDA increase took place 5 years earlier or more. Weights applied. The base year is the year prior to the MLDA increase. 95% confidence intervals have been calculated using wild bootstrap.

Figure A5: Event study: Effect of MDLA on educational performance (PISA), restricted comparison



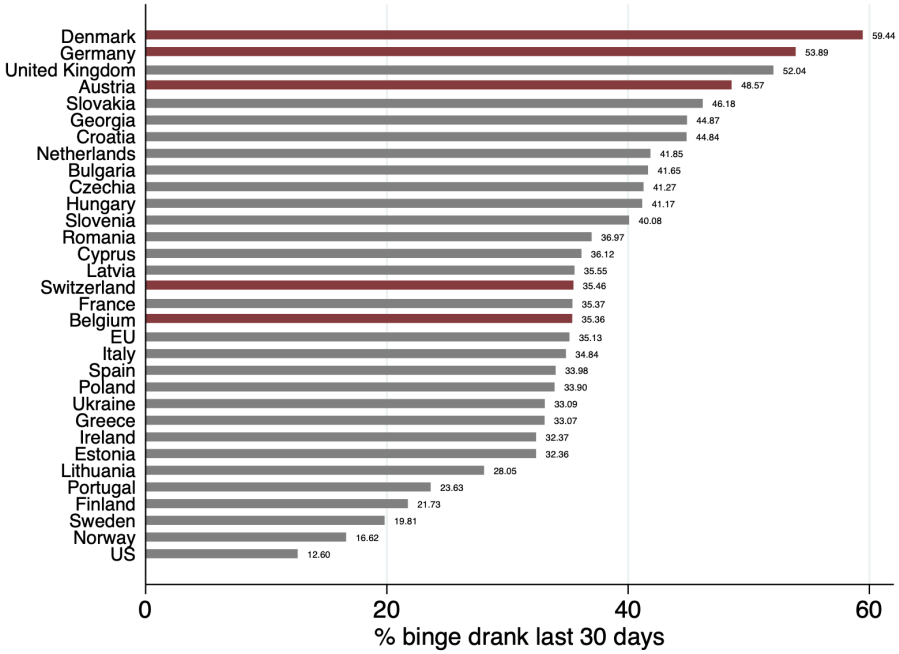
Notes: Event study of standardised test scores in PISA. Regions where PISA exams took place at the same time as final high school exams excluded. All columns include controls for individual-level attributes (age in months, father's education, mother's education, gender, month of birth, immigrant status and socioeconomic status), all interacted with stack. Column 2 also includes school-level attributes (class size, computers per student, number of lectures per week). In column 1 the sample includes all students who participated in PISA exams in Spain between 2003 and 2022. In column 2 we include only observations with information on school characteristics. In column 3 we exclude around 3,000 students who participated in PISA in 2018 who have been flagged by the OECD due to concerns about the reliability of the data. Estimates on a stacked database where each treated region is compared to regions where the MLDA increase took place 5 years earlier or more. Weights applied. The base year is the year prior to the MLDA increase. 95% confidence intervals have been calculated using wild bootstrap.

Figure A6: Violations of parallel trends assumptions and estimated effects on educational performance (PISA)



Notes: p-values of the estimated effect of MLDA reforms on PISA scores under different assumptions of parallel trends. Each point shows the p-value under the assumption that trends deviate by a proportion (0, 25, 50 or 100) of the maximum deviation observed in the pre-period.

Figure A7: Binge drinking rates among 15–16 year olds in selected countries



Notes: Binge drinking rates from the ESPAD survey (2023). Bars in dark red indicate countries where the MLDA is 16.