LANCASTER UNIVERSITY

DOCTORAL THESIS

Essays on the Economics of Alcohol and Risky Behaviours

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'Cause tramps like us, baby we
were born to run

Declaration of Authorship

I, Luke Wilson, declare that this thesis titled, "Essays on the Economics of Alcohol and Risky Behaviours" and the work presented in it are my own and has not been submitted in any other form for the award of a higher degree elsewhere. Chapter Three titled "Beauty and Adolescent Risky Behaviours" is a joint authored piece of work with myself, Colin P. Green and Anwen Zhang. A signed declaration of joint authorship can be found in Appendix D.

Luke Wilson

February 2019

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Abstract

Title: Essays on the Economics of Alcohol and Risky Behaviours

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This thesis contains three self-contained essays surrounding the theme of the effects of the availability, consumption, and overall misuse of alcohol, as well as the participation in other risky behaviours associated with alcohol consumption.

Chapter Two explores the effect of the minimum legal drinking age (MLDA) on alcohol consumption amongst young adults in the United Kingdom (UK). Excessive alcohol consumption among young people is a major public health concern. How alcohol availability influences individual decisions, whether it be the decision to start drinking, or the decision to increase the quantity consumed and the subsequent effect this has on individual health outcomes is highly policy relevant. This chapter examines one particular source of variation in availability, the minimum legal drinking age. Using the General Household Survey (1998-2007), we use a regression discontinuity design (RDD) to estimate the impact of the MLDA in the United Kingdom on alcohol consumption among young adults. There is a discrete jump of 7.3 percentage points in alcohol consumption at the minimum age cut-off across various model specifications. However, we find no evidence to suggest that the MLDA has an effect on binge drinking (the consumption of 8+ units in one period). This has important policy implications for the regulation of alcohol in both an on-premise and off-premise setting.

Chapter Three seeks to investigate how attractiveness influences alcohol consumption, binge drinking and a variety of other adolescent risky behaviours. We use linear probability modelling and mediation analysis to estimate the influence of "beauty", reported by the interviewer, on behaviours related to under-age drinking, smoking, and teenage sexual activity. Furthermore, we use information on popularity (self-defined friendship groups) to investigate its mediating effect with respect to attractiveness and risky behaviours. We find, that the relationship between popularity and attractiveness explains a large proportion of risky behaviour and attractiveness variation. This is particularly notable for girls.

In addition, we demonstrate marked effects of teenage attractiveness on these behaviours. More attractive individuals are more likely to engage in under-age drinking, but markedly less likely to smoke or to be sexually active. In a series of robustness checks we argue that these effects do not reflect potential con-founders such as the risky behaviour(s) of peer groups, personal grooming or the socio-economic background of the adolescent. Furthermore, we find that attractive individuals are more likely to have consumed alcohol, than those of modal attractiveness, and those teenagers deemed less attractive are less likely to have consumed alcohol.

We estimate that attractive respondents are 6.6 percentage points more likely to have consumed alcohol, than those who were described as unattractive. Throughout we reject concerns that interviewers either vary in their judgement of attractiveness and/ or they may receive a non-random selection of respondents in terms of attractiveness and propensity to engage in risky behaviour. We use school and interviewer fixed effects, as well as information on how respondents present themselves in the interview process through their appearance (personal grooming) and behaviour (self-esteem and personality) to test and verify our results. Our results provide intriguing evidence on the growing literature surrounding the effect of "attractiveness" on labour market outcomes. While attractiveness is associated with higher wages in later life through channels such as confidence, our evidence suggests that attractiveness is also related to earlier consequential life decisions.

Chapter Four examines changes in alcohol consumption across the life-course using a large number of waves of a cross-sectional survey, the Health Survey for England (HSE). The decomposition of trends in alcohol volume and heavy drinking measures into age, period, cohort and demographic effects offers an important perspective on the dynamics of change and has the potential for the prediction of problematic drinking and alcohol attributable disease. This study investigates the changing attitudes to drinking in the UK, focusing primarily on the rates of abstention, which have been increasing amongst young adults, as well as changes in heavy drinking episodes documented by the respondent.

In the UK, no study to date has documented patterns among cohorts of the late 1990s and 2000s, who are now in the primary age of risk for heavy episodic drinking and the development of alcohol use disorders. We therefore explore changes in abstention and heavy episodic drinking across the life course. We expand on the existing literature by researching a more recent period of time, in which there has been changing attitudes to drinking amongst young adults. Furthermore, we analyse this relationship further by including additional covariates such as price, which incorporates the Alcohol Duty Escalator (2008-2014) and Gross Domestic Product within the age-cohort analysis. We find evidence to suggest that young adults are more likely to identify as abstainers relative to young adults from previous cohorts. However, we find that amongst those who identify as drinkers drink more than their older counterparts. While increasing in abstention rates in the UK is a welcome result, policy makers need to be wary of the increase in heavy drinking.

This thesis provides compelling new evidence surrounding how behaviours and attitudes to alcohol have changed over time. It investigates how young adults respond to alcohol purchasing restrictions through the MLDA, how alcohol consumption, amongst other risk taking behaviours, is affected by attractiveness, and finally how consumption and attitudes to alcohol consumption has changed over time relative to their older counterparts.

Notes

This PhD has been funded by the Innovation Agency Academic Health Science Network for the North West Coast. This thesis was granted ethical approval by Lancaster University Research Ethics Committee, this declaration can be found in Appendix B.

This thesis does not have chapter dedicated to an overall review of the literature. Instead, each chapter has its own individual literature review which can be found after the introduction of each subsequent chapter. Additionally, this thesis uses a variety of econometric methods. I thereofre chose to explain these in great detail in each chapter, rather than in a dedicated methodology chapter.

References for each chapter are combined and placed at the end of the dissertation.

Chapter 3 titled "Beauty and Adolescent Risky Behaviours" is a joint authored piece of work by myself, Colin P. Green (NTNU), and Anwen Zhang (LSE). A signed declaration documenting my contribution can be found in Appendix C.

Chapter 2 has been presented at 12th European Conference on Health Economics (EuHEA) in Maastricht (2018). A preliminary version of the paper was presented at the 3rd EuHEA Student-Supervisor conference in Barcelona 2016 and the North West Doctoral Training Centre, University of Manchester (2017). A full version of the paper was presented at the Kettil Bruun Society for Social and Epidemiological Research on Alcohol in Sheffield (2017).

A preliminary version of Chapter 3 has been presented at the North West Social Science Doctoral Training Program Liverpool (May 2018). A full version including mediation analysis was presented at the 5th EuHEA Student-Supervisor conference in Sicily

(September 2018).

Finally, an early edition of Chapter 4 has been presented at the 4th EuHEA Student-Supervisor conference in Lausanne (September 2017).

Chapters 2 and 4 use data provided by the UK Data Service and the Office for National Statistics. Chapter 3 uses data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), a program project directed by Kathleen Mullan Harris at the University of North Carolina. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth).

These data distributors bear no responsibility for the analysis or its interpretation throughout this thesis.

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Chapter 1

Introduction

1.1 General Background

1.1.1 Overview

The topic of discussion throughout this thesis is alcohol, specifically the availability, consumption, and risky behaviours associated with alcohol. Alcohol is the common term given for ethanol or ethyl alcohol. It is produced by the natural fermentation of sugars sourced from foods rich in starch, such as maize, wheat, molasses, barley, and potatoes. Alcohol is classed as a "sedative hypnotic" drug, which acts as a depressant on the central nervous system at high doses. While at lower doses, alcohol acts as a stimulant, inducing feelings of euphoria and talkativeness (Kuhn, Swartzwelder, & Wilson, 2008).

Alcohol, in a variety of forms, has existed for thousands of years and today, in the vast majority of societies, the regular consumption of alcohol is widely accepted. The consumption of alcohol is associated with both culture and religion, with celebrations and festivities taking place worldwide. Annual beer festivals have occurred annually at Bergkirchweih in Erlangen since 1755, and the worlds largest beer festival Oktoberfest, sees on average 6.5 million people travel to Munich each year and drink approximately 6,900,000 litres of beer.

Additionally, national holidays are also closely linked with alcohol related celebrations. Historically on St Patrick's Day in Ireland, Christians were allowed to put aside their Lenten restrictions on food and alcohol. As a result, excessive drinking has become permanently linked to the celebration. Alcohol has also been severely restricted in particular societies, some countries even going so far as banning outright the production, importation, transportation, and sale of alcoholic beverages. Prohibition in the United States was a nationwide constitutional ban on alcohol from 1920 to 1933 supposedly due to alcoholism, family violence, and political corruption. Throughout history, alcohol has been portrayed as both a positive and negative commodity.

Western civilizations with long drinking traditions tend to drink the most, while abstainers are more often found in the Middle East and South-east Asia, where laws and traditions limit consumption. Figure 1.1 depicts the distribution of mean alcohol consumption in litres of pure alcohol per adult (aged 15+) by country within the Organisation for Economic Co-operation and Development (OECD). The United Kingdom is shaded in red, with a mean consumption of 9.5 litres of pure alcohol per capita per year in 2015. This is equivalent to 18.3 units[1] of alcohol per week. This exceeds the previous recommended weekly limits set by the UK government.[2] Figure 1.2 illustrates the change in alcohol consumption over time within the G7. The UK is in red. Overall the UK's alcohol consumption of pure alcohol per person has increased relative to the rest of the G7.

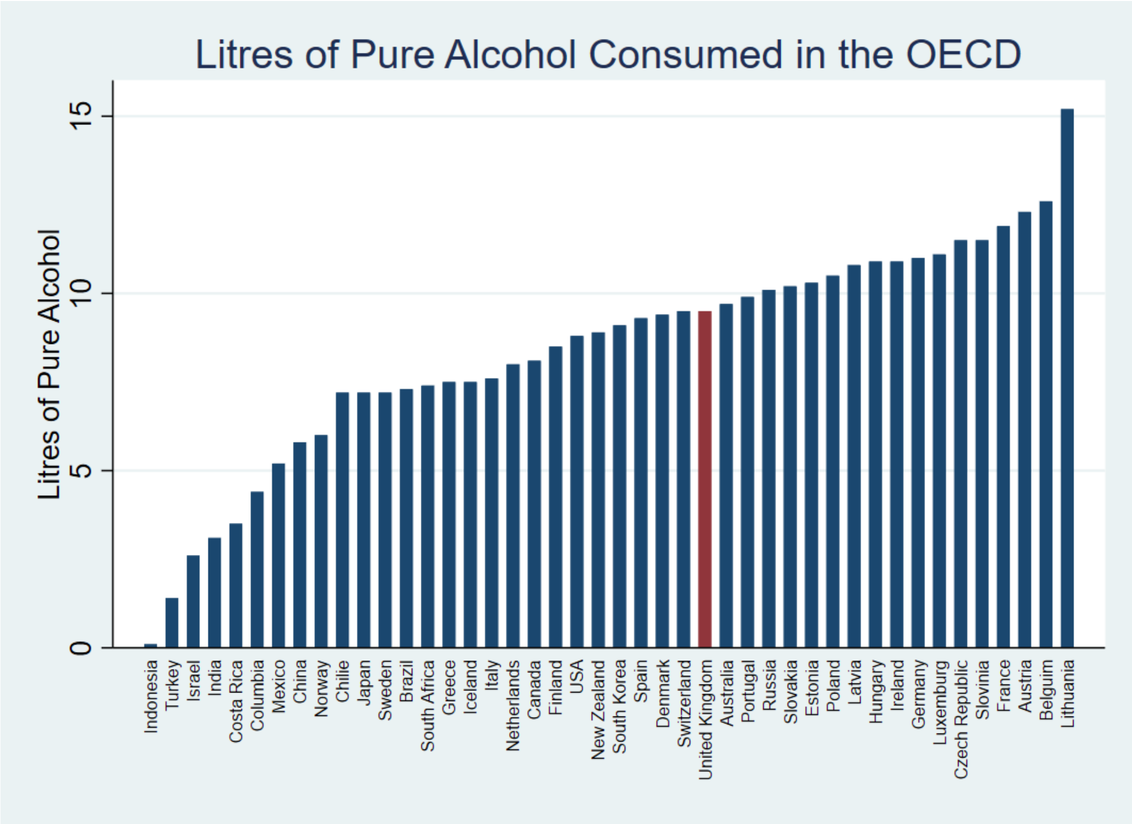
Beer, wine, and spirits all contain ethyl alcohol or ethanol in differing concentrations. Ethyl alcohol is formed when yeast ferments (breaks down without oxygen) the sugars in different foods. A standard drink consists of 1 pint (568.261 ml) of beer, 150ml of wine, or 25ml of spirits, all of which have roughly the same amount of pure alcohol, which is approximately 17ml.

According to data published by the British Beer and Pub Association (BBPA), recorded consumption of pure alcohol per head for those aged 15 years and over first hit double

[1] A unit of alcohol is 10ml (8g) of pure ethanol.

[2] The alcohol consumption guidelines were changed in January 2016 to 14 units for both men and women, spread evenly across the week. Prior to 2016, it was recommended that men should be limited to 21 units or less of alcohol per week, for women this has remained unchanged at 14 units.

FIGURE 1.1: Mean Alcohol Consumption by Nation within OECD

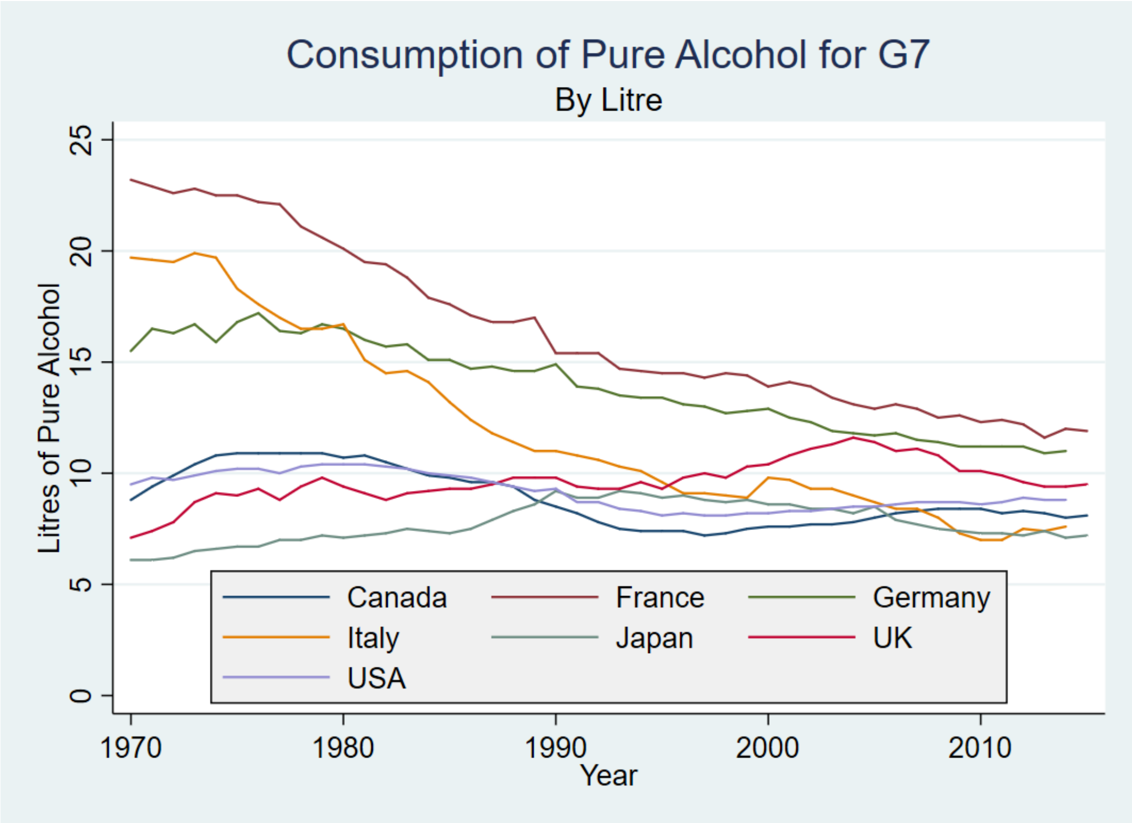


Source: OECD (2018)

digits in 1997. Consumption has been steadily increasing since 1982, peaking at 11.6 litres in 2004 and has continued to fall for the subsequent 10 years. In 2011 it was the first year in which recorded UK adult alcohol consumption fell below 10 litres per head since 1999. The latest published figures (2016) currently indicate consumption at 9.5 litres of pure alcohol per capita per year, these are the same as the OECD estimates documented from 2015.

However, one concern is that statistics on average consumption conceal the wide variation among individuals and hide a variety of trends in the distribution of alcohol consumption. For example, the decreases in alcohol consumption that the UK has witnessed post 2004 may be due to a population-wide fall in the consumption of alcohol as a result of our changing culture and behavioural norms, or it may in-fact be a result of dramatic

FIGURE 1.2: Change in Alcohol Consumption Over Time



Source: OECD (2018)

decreases amongst particular sub-groups of the population which in turn masks increases in other sub-groups of the population. Therefore, it is interesting, especially to policy makers, to examine why alcohol consumption patterns are changing over time and how they can alter these patterns. Can these changes be explained by changes in prices, taxes, or policies? Do these changes affect everybody or just a small group of individuals? Or are these changes a result of natural shifts in individual preferences? Understanding what exactly is driving this change is important when implementing alcohol control policies. If pricing and policy are driving significant changes in consumption, then it is imperative to know exactly *who* this is affecting and how this is benefiting/costing society. Is it that changing demographics are behind the differences in trends across countries or is it something more?

1.1.2 Why Does Alcohol Matter to Policy Makers?

Understanding the behaviours surrounding the consumption of alcohol, especially heavy alcohol consumption, remains a key policy area in society for a variety of reasons. Firstly, alcohol is a substantial source of tax revenue. Alcohol duty raised £11.6 billion in the United Kingdom in 2017[3] (HMRC, 2017). Furthermore, in 2016 the UK government raised £10.7bn in alcohol duty. This was fairly evenly shared between wine (£4.0bn), beer (£3.3bn) and spirits (£3.1bn). Cider raised relatively less duty (£0.3bn) due to its lower tax rate and smaller market share. Secondly, there is rising public concern about the harmful effects of alcohol which has led to an increased focus by policy makers. Long-term heavy alcohol consumption has been causally linked to several diseases such as alcoholic liver disease (cirrhosis), as well as the increased risk in a variety of cancers (Rehm et al., 2017). Acute intoxication has also been associated with negative externalities such as road traffic accidents, crime and assault (Levitt & Porter, 2001; Livingston, 2008).

The causal link between alcohol and health has been well-documented and scrutinized (Rehm et al., 2009; Rehm, Samokhvalov, & Shield, 2013; Rehm et al., 2017). Harmful alcohol consumption has been linked to cirrhosis (Gao & Bataller, 2011), cancer (Bagnardi et al., 2015), pancreatitis (Majumder & Chari, 2016), as well as a variety of other conditions. Moreover, there has also evidence to suggest that harmful drinking plays a causal role in the increased incidence of infectious diseases such as tuberculosis and HIV/AIDS (Rehm et al., 2009; Williams et al., 2016).

As well as the direct and indirect health effects associated with heavy alcohol consumption, the harmful use of alcohol extends beyond the various health related consequences to drinkers and places a significant burden on society through external costs or "spill-over effects" such as alcohol-related traffic collisions, violence, and criminal damage. Levitt and Porter (2001) found that "drivers with alcohol in their blood are seven times more

[3] These are the provisional estimates from HMRC. The full amount raised from the 2017-2018 tax year are yet to have been released at the time of writing.

likely to cause a fatal crash and drunk drivers above the legal limit (with a blood alcohol content (BAC) greater than 0.10 [4]) pose a risk 13 times greater than sober drivers". The most recent estimates for the UK show that there were 5,730 collisions where at least one driver was over the legal limit (DfT, 2017). Alcohol can also be attributable to crime and violence. In 2014/15 alcohol played a key role in 47% of violent offences in England and Wales and 54% of all offences in Scotland, which is roughly 704,000 individual incidences (ONS, 2016; Scottish Government, 2016). Overall, the Institute for Alcohol Studies estimate that alcohol costs society £21.5 billion, with £3.5 billion on health costs, crime costing £11 billion and lost productivity costing £7 billion (IAS, 2016).

The existence of negative externalities and spill-over effects that are imposed on society as a result of the private consumption of alcohol represent instances of market failure, which is clear justification for government intervention through a variety of alcohol related policies.

1.1.3 Health Effects of Alcohol

The consumption of alcohol presents both short and long term healths effects on the individual who consumes it. These vary in their severity to overall health and the duration in which they last. Alcohol is classed as a "sedative hypnotic" drug, which acts as a depressant on the central nervous system at high doses. While at lower doses, alcohol acts as a stimulant, inducing feelings of euphoria and talkativeness (Kuhn et al., 2008). Alcohol is difficult for the body to process, putting extra pressure on the liver, the digestive system, as well as the cardiovascular system.

Within minutes of consuming alcohol, it is absorbed into the bloodstream by blood vessels in the stomach lining and small intestine, this then travels to the brain. The first sign of intoxication is that a person may feel relaxed, uninhibited or giddy. As more alcohol is consumed in a small space of time a person may become more intoxicated. Other

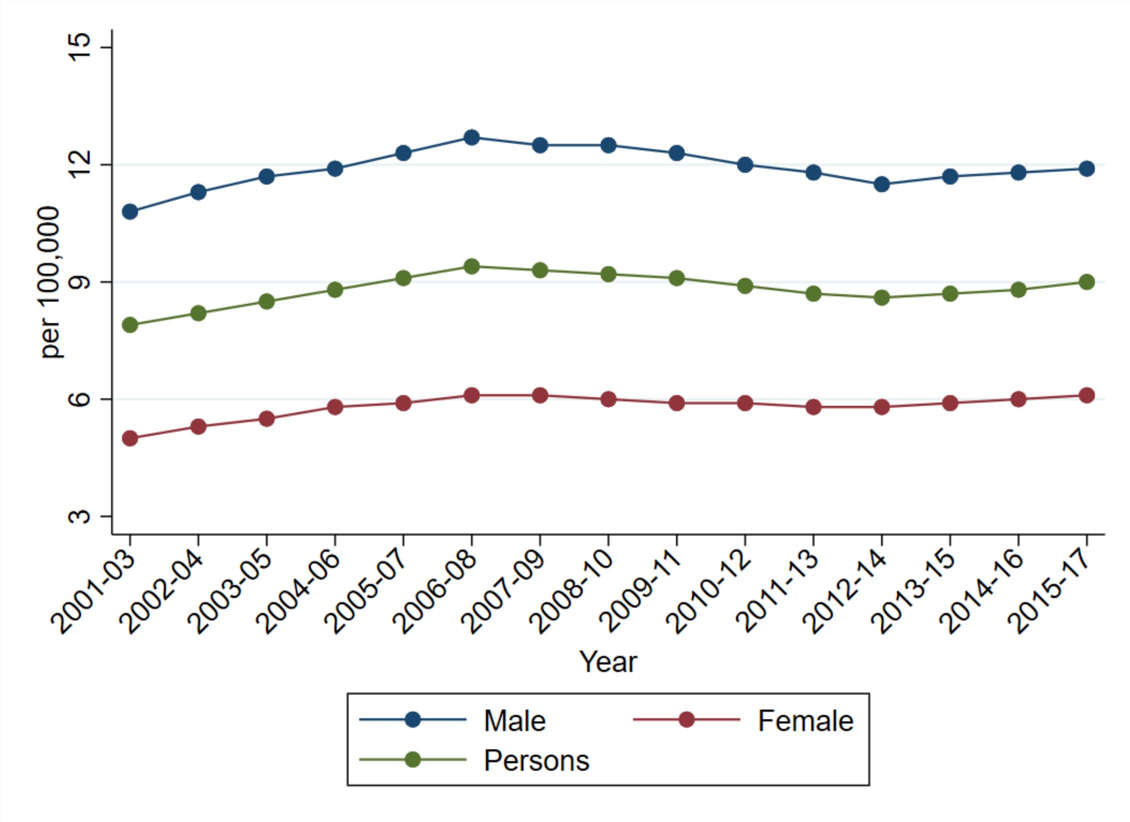
[4]The legal limit for England and Wales is 80 milligrams of alcohol for every 100 ml of blood in your body, or 0.1mg of alcohol per 1mg of blood. In December 2014, Scotland reduced their drink driving limit to 50 milligrams of alcohol for every 100 ml of blood

consequences of intoxication include slurred speech, clumsiness, drowsiness, vomiting, headaches, lapses of memory and a loss of consciousness (this list is not exhaustive, individuals may suffer from other effects). The severity of the effect is associated to the amount consumed in one drinking occasion. Consuming one to two drinks, the person feels relaxed, less inhibited, with a slower reaction time and reduced alertness. Three to four drinks is where reaction times and judgement is reduced, however motor skills are fine. Five to seven vision, perception are affected, the person may have an increased temper and become emotionally irrational. Consuming above eight drinks or more is closely (A BAC of 0.30 or higher) associated to increased probability of vomiting, loss of memory and loss of consciousness.

While the body absorbs alcohol fairly quickly, it takes the liver roughly one hour to process one drink. After drinking too much the night before, a person may continue to feel the effects listed above upon waking up. They may also suffer from what is commonly known as a hangover. This is because alcohol is toxic to the body, and the body is still working to get rid of the toxin. A hangover is also caused by dehydration in which a person may suffer from headaches, diarrhoea, nausea, fatigue to name a few. One of the most severe short term health consequences of alcohol misuse is alcohol poisoning. This is where the blood alcohol level is so high it is considered toxic. As a result, the person can become extremely confused, unresponsive, disoriented, have shallow breathing, and can even pass out or go into a coma. This often results in the person having to have their stomach pumped and fitting an intravenous drip, which goes directly into a vein, to top up their water, blood sugar and vitamin levels.

The sustained abuse of alcohol can cause a variety of long-term effects. Overall it is associated to over 200 diseases and injury related health conditions. Long-term alcohol misuse is associated with liver disease, pancreatitis, cardiomypathy, peripheral neuropathy, immune system dysfunction, mental health problems, cancer, osteoporosis (decrease in bone density) and in the most severe cases death. In England in 2017, the rate of mortality from alcoholic liver disease (liver cirrhosis) was 9.0 per 100,000 people aged under

FIGURE 1.3: Mortality Rate from Alcoholic Liver Disease, per 100,000 population aged under 75



Source: Public Health England (PHE) Liver Disease Profiles (2018)

75, a count of 12,812 deaths annually (ONS, 2017). Figure 1.3 illustrates the mortality rate from alcoholic liver disease, per 100,000 population aged under 75. Rates of premature alcoholic liver disease mortality are significantly higher in males (11.9 per 100,000 population) than for females (6.1 per 100,000 population).

1.1.4 Societal Costs of Drinking

Estimating the total cost of alcohol on society is a relatively unusual practice. However, a study by Lister, McVey, French, Stevens, and Merritt (2008) provides the most detailed analysis of the overall societal impact of behaviour choices to date. It finds that the total social cost of alcohol to England in 2006-07 was roughly £55.1 billion. £22.6 billion is associated to the costs to individuals and households. This includes crime and violence, private health and care costs, informal care costs, lost income due to unemployment, and unusually high spending on alcohol. £21.9 billion is described as "human values costs", these are the economic costs of pain and grief associated with illness disability and death. £3.2 billion of the total cost is the cost of public health and care services, while £5.0 billion of the costs is associated to other public services, such as social care, criminal justice and fire services. Finally £7.3 billion of costs is to employers due to lost productivity, absenteeism and accidents at work. However, it must be stressed that the majority of the literature today focuses on the external cost of alcohol, setting aside the private costs to the drinkers themselves. The external cost to alcohol in the UK is roughly £21.5 billion mentioned in the previous section.

The annual cost of alcohol related crime in the UK is roughly £11 billion (IAS, 2016). A substantial body of research has looked at the relationship between drinking alcohol and criminal behaviour. (Cook & Moore, 2002; ONS, 2016; Rehm et al., 2009). In 2014, a study conducted in England and Wales revealed that victims of crime believed the offender(s) to be under the influence of alcohol in over half (53%) of all violent incidents, this is equivalent to over 700,000 offences (ONS, 2016). Moreover, they find that at weekends, 70% of all violent incidents are alcohol-related compared to only 35% on weekdays. The five crimes in which alcohol intoxication played a role were homicide, physical assault, sexual assault, robbery, and burglary.

As well as the external crime related costs to alcohol, there is also the £7.3 billion associated to the effect of alcohol misuse in the workplace. Heavy drinking and alcohol misuse during the working week contributes to the overall prevalence of alcohol-related health problems among the working population. This in turn impacts upon the overall productivity of the firm. It is estimated that up to 17 million working days are lost each year because of alcohol-related sickness and as a result, the cost to employers of sick days due to alcohol is estimated at £1.7 billion (IAS, 2016). In 2007, a report found that a third of all employees admitted to having gone to work suffering with a hangover in the past year.

Moreover, 10% of workers reported having a hangover at work at least once a month and 5% admitted to having a having a hangover at least once a week. 15% of workers also reported to having been drunk at work at least once in the past year (Lister et al., 2008).

1.1.5 Alcohol Related Policies

Restricting the sale of alcohol is a prominent policy tool used in reducing alcohol consumption. One of the most common policies is restricting the sale of alcohol by age. Policy makers and health experts believe children and adolescents have not yet reached an age where they can handle alcohol responsibly, and as a result are more likely to harm themselves. Furthermore, there is a well-documented link between under-age alcohol use on neurocognitive deficits and brain damage, with implications on learning and intellectual development (Bava & Tapert, 2010; Squeglia, Jacobus, & Tapert, 2009; Zeigler et al., 2005). MLDA laws vary by country. For example in the United Kingdom and the United States, the minimum legal drinking age to purchase alcohol is set at 18 and 21 respectively for all types of alcohol, while the minimum legal drinking age around Europe varies markly. In countries such as Austria, Belgium, Germany, and Denmark, the MLDA is dependent on the type of alcohol consumed or purchased. For example, in Belgium and Germany there is a binding MLDA of 16 for beer and wine and an MLDA of 18 for spirits. This is consistent across both on and off premise. In Denmark, there are separate MLDAs depending on the strength or the Alcohol by Volume (ABV), 16 for drinks under 16.5% ABV and 18 for drinks over 16.5% ABV. On the other end of the spectrum, Scandinavian countries have a higher MLDA than the UK. Finland and Norway have an MLDA of 18 for drinks up to 22% ABV and an MLDA of 20 for drinks above 22% ABV, while Sweden has an MLDA of 18 for drinks up to 3.5% ABV and 20 for drinks above 3.5% ABV. Table 1.1 illustrates the MLDA of selected European countries by beverage type and purchase location (on-trade vs off-trade).

In the United States, previous research made use of changes in minimum legal drinking ages (MLDA) at the state-level that occurred in the 1970s and 1980s (Birckmayer &

TABLE 1.1: Minimum Legal Drinking Age in Select European Countries

	On-premise		Off-premise	
	B&W	**S**	**B&W**	**S**
Austria*	16	16-18	16	16-18
Belguim	16	18	16	18
Czechia	18	18	18	18
Denmark	18	18	16	18
Finland	18	18	18	20
France	18	18	18	18
Germany	16	18	16	18
Greece	18	18	18	18
Iceland	20	20	20	20
Ireland	18	18	18	18
Italy	18	18	18	18
Netherlands**	18	18	18	18
Norway	18	20	18	20
Portugal	16	16	16	16
Spain***	16	16	16	16
Sweden	18	18	20	20
Switzerland	16	18	16	18
UK	18	18	18	18

Notes: B=Beer, W=Wine and S=Spirits. *Alcohol laws vary by state: three states have an age minimum of 16 while six states have a minimum age of 18. **Law changed in January 2014. ***WHO lists the drinking age as 16; other sources say that the minimum age varies by region, that it is 18, or that minors may purchase alcohol if accompanied by their parents. Information Extracted from the WHO (2018).

Hemenway, 1999; Toomey, Rosenfeld, & Wagenaar, 1996; Voas, Tippetts, & Fell, 2003; Wagenaar & Toomey, 2002). Specifically, the majority of US states experimented with drinking ages of 18, 19, and 20 before federal legislation in 1984 required that all states adopt an MLDA of 21 years old, or have highway funding revoked. The majority of this literature focuses on drink-driving amongst young adults. However, the recurring issue within this empirical strategy is that this type of study fails to consider unobserved characteristics in the treatment and control groups, for example the underlying decision for each state to change their MLDA[5].

The sale of alcohol can also be restricted using a variety of licensing systems. These are

[5]Carpenter and Dobkin (2009) use RD design to address these concerns about policy endogeneity that have been raised as criticisms of the research designs used in much of the prior literature. This is discussed much further in Chapter 2.

often set and differ at, the local authority, province, state, and particularly country level. For example, in Sweden alcohol is sold only by the Systembolaget. The Systembolaget is a government owned chain of liquor stores and is the only retail store allowed to sell wine and spirits above 2.25% ABV and beer above 3.5% ABV. There is also a similar arrangement in Norway. The Vinmonopolet is the government owned monopoly, and are the only off-premise stores licensed to sell wine and spirits above 2.5% ABV and beer above 4.8% ABV. Moreover, other Nordic countries follow similar systems: Iceland (Vinbuo) and Finland (Alko) follow similar systems. These state-owned monopolies exist for one reason, to minimize alcohol-related problems. They do this by selling alcohol in a responsible way and without the motivation to make profit. These stores also have restricted weekday hours, they are open until 3pm on Saturdays, and are closed on Sundays and holidays. This is to reduce the number of *impulse* purchases that may occur during the time periods in which individuals are most likely to drink.

In the United Kingdom, businesses, organisations and individuals who want to sell, or supply alcohol must have an issued licence which is granted by the local council or a licensing authority. Premises may be licensed for the "on-trade", where the alcohol is consumed on the premises (such as pubs, bars and restaurants), or for "off-trade", where alcohol is consumed away from the place of sale (such as supermarkets or off-licences). Holders of a licence are required "to take responsibility" for the sale of alcohol by enforcing the universal age restriction of 18 using the *Think 25* policy[6], keeping order, and are not permitted to sell alcohol to intoxicated individuals. Licences can be revoked, and licence holders can be fined if any of the conditions of the licence are breached.

Another sales-related policy used to restrict the consumption of alcohol is licensing hours. This policy has two main intentions: to reduce binge drinking (especially among young people) and through this channel to reduce alcohol related violence and harm. In the UK, there exists different licensing hours depending on whether the alcohol purchased, took place in a public house or bar (on-premise) or in a supermarket, local store or petrol

[6]Customers in any premises licensed to sell alcohol, including pubs, clubs, restaurants, supermarkets and convenience stores may be asked to produce identification where they appear under the age of twenty five.

station (off-premise). Inter-temporal alcohol licensing also varies by country within the UK. The Licensing (Scotland) Act 2005 governs the hours in which licensed establishments are able to sell alcohol in Scotland. The act states that alcohol can only be sold in off-licences between the hours of 10am and 10pm. However, you can purchase alcohol in on-premise locations between 11am and 11pm, although these licences can be extended under application.

In England and Wales, there has been a fairly recent licensing change. Prior to the legislative change, on-licence premises were not allowed to stay open (and serve alcohol) after 11:00 pm. Following the Licensing Act of 2003, licensed venues could apply to remain open later, up to a maximum of 5:00 am. The policy change came into effect in England and Wales on the 24th of November 2005. Off-licences are often open throughout the day up until the mandatory closing time, usually 22:30 or 23:00. Evidence in the UK has found that eliminating early and uniform closing hours can be associated with decreases in traffic collisions (Green, Heywood, & Navarro, 2014), however extending bar opening hours led to a marked increase in alcohol consumption in the form of heavy drinking and an increase in absenteeism (Green & Navarro Paniagua, 2016).

1.1.6 Pricing and Taxation

While it is not a primary focus of this thesis another, commonly used, policy tool used in reducing alcohol consumption is pricing and taxation. Governments and policy makers can affect the price of alcohol using a variety of methods of taxation, or through the introduction of minimum price per unit (MUP). How the UK sets their alcohol taxation is currently limited by the European Union (EU) under two alcohol tax directives. These set out: the structures of excise duties on alcohol and alcoholic beverages and the minimum rates that must applied to each category of alcoholic beverage. EU legislation only sets harmonised minimum rates, meaning that EU countries are free to apply excise duty rates above the specified minimum, according to their own national needs. Taken from the UK Government website (GOV.UK, 2018), Table 1.2 illustrates the specific element of

TABLE 1.2: Alcohol Duty in Addition to VAT of 20%

Alcohol Type	**Strength (ABV)**	**Rate**
Beer	1.2% to 2.8%	8.42 p/ per litre for each 1% of alcohol
	2.8% to 7.5%	19.08 p/ per litre for each 1% of alcohol
	< 7.5%	24.77 p/ per litre for each 1% of alcohol
Cider (Still)	1.2% to 7.5%	40.38 p/litre
	7.5% to 8.5%	61.04 p/litre
Cider (Sparkling)	1.2% to 5.5%	40.38 p/litre
	5.5% to 8.5%	279.46 p/litre
Wine (Still)	1.2% to 4%	88.93 p/litre
	4% to 5.5%	122.30 p/litre
	5.5% to 15%	288.65 p/litre
	15% to 22%	384.82 p/litre
Wine (Sparkling)	5.5% to 8.5%	279.46 p/litre
	8.5% to 15%	369.72 p/litre
Fortified Wine	15% to 22%	396.72 p/litre
Spirits	N/A	2874 p/litre of pure alcohol

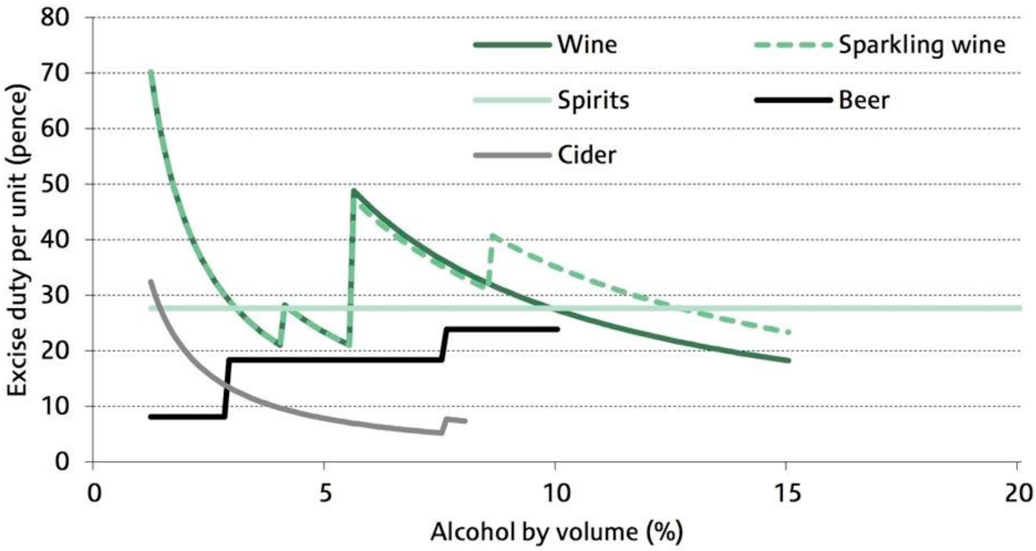
Notes: p/litre is the pence per litre of either product or pure alcohol depending on beverage type. Beer and Spirits are taxed by percentage of pure alcohol per (hecto)litre, Ciders and Wines are taxed by volume of product.

UK alcohol duty that is applied in addition to general VAT of 20%. To see how the duty element works, consider a pint of 5.0% strength beer. The Beer Duty paid is 19.08p x 5.0 = 95.40 pence per litre. This works out at 54 pence a pint (roughly 568ml). This is the added to the recommended retail price (or cost of production)and Value Added Tax is applied on top.

As well as alcohol excise taxation, the UK government introduced an "alcohol duty escalator" in 2008, which ensured an initial increase in alcohol duty of 6% as well as an annual 2% rise in the duty above inflation. The duty escalator was introduced as a four-year measure to address the rising affordability of alcohol. However, it was scrapped in 2013 for beer (Treasury, 2013), and 2014 for other drinks (Treasury, 2014). Since then a series of cuts and freezes have ensured that beer duty is 6% lower than in 2012, cider and spirits duty 3% higher and wine duty 10% higher. The effect of this by 2016, was that the UK alcohol prices were lower than would have been the case under the duty escalator.

Figure 1.4 illustrates the current UK duty rates by beverage type and how they evolve by alcohol by volume. These rates of tax have a number of controversial features. Firstly, in order to adhere to European Community Directive (92/84/EEC), beer and spirits are taxed in proportion to their alcohol content (ABV), while cider and wine are taxed according to the volume of liquid sold. As a result, on a per unit basis, higher strength wines and ciders attract less duty than lower strength wines and ciders (See Table 1.2 for further details). Secondly, there are significant differences in the level of tax between different types of drink, with wine, sparkling wine, and spirits attracting higher rates of duty on average than beer, and cider, which have a lower rate of excise duty. The current structure of alcohol duty in the UK allows some alcohol producers to beat the system by using "post-duty dilation". As ciders and wines are taxed by volume of product, rather than volume of pure alcohol some producers create a product at a ABV higher than the retailed product to which the duty is paid. Once this has occurred they dilute the product in the bottling process, lowering its strength and producing more product at a lower rate of duty. This however will be illegal in the UK in January 2020 following the November 2018 budget.

FIGURE 1.4: Excise Duty per Unit by Beverage Type



Notes: Figure assumes all cider is "still".)

Changes in consumer purchasing when prices change are a combination of the decision to purchase the product at all (participation), as well as how much of the good to purchase (quantity), these estimates of consumer responses to price changes are often measured by its *price elasticity of demand*. This is expressed as the percentage change in consumption of the good that results from a 1% increase or decrease in its price, *ceteris paribus*. Goods with a price elasticity greater than 1% are described as "relatively elastic", while those with a price elasticity of less than 1% are described as "relatively inelastic". Over the past several decades, there has been a growing literature on the estimation of this relationship between alcohol taxation and price on alcohol-related sales and consumption. Overall, evidence suggests that increasing the price of alcohol is effective at reducing total consumption, albeit the fall in consumption is proportionately smaller than the increase in price (Gallet, 2007; Meng, Brennan, et al., 2014; Wagenaar & Toomey, 2002).

Previous studies have focused on differential elasticities by beverage type. They find that beer, wine and spirits have different own-price elasticities, with beer appearing to be less elastic than wine and spirits. Gallet (2007) and Wagenaar and Toomey (2002) have attempted to summarise the overall price elasticity for alcohol across a variety of countries. Wagenaar and Toomey (2002) reviewed 112 studies of the impact of changes in alcohol taxes or prices on consumption and found on average a 1% increase in price leads to a 0.46% decrease in beer consumption. In a similar analysis, Gallet (2007) also found that demand for wine and spirits is more elastic than demand for beer, with a 0.70% and a -0.68% decrease in the consumption of wine and spirits respectively. Most studies of price elasticities of demand for alcohol have focused on own-price elasticity estimates, in the United Kingdom, Collis, Grayson, and Johal (2010), Meng, Brennan, et al. (2014) separate consumption into on- and off-trade. Both studies find that off-trade beer (-1.11% and -0.98%)is more responsive to price changes, however Meng, Brennan, et al. (2014) finds that off-trade spirits are the least responsive (-0.08%). These results are summarized in Table 1.3.

In recent years, another pricing policy – minimum unit pricing (MUP) – has attracted

TABLE 1.3: Estimates of Price Elasticities for Beer, Wine and Spirits

Author	**Time Period**	**Beer**	**Wine**	**Spirits**
Gallet (2007)	*Meta Analysis*	-0.36	-0.70	-0.68
Wagenaar (2012)	*Meta Analysis*	-0.46	-0.69	-0.80
Collis (2010)	2001-2006	-0.77*	-0.46*	-1.16*
		-1.11**	-0.54**	-0.90**
Meng (2014)	2001-2009	-0.79*	-0.87*	-0.89*
		-0.98**	-0.38**	-0.08**

Notes: * Refers to on-trade consumption only, ** Refers to off-trade consumption only. Collis (2010) and Meng (2014) are both UK based studies.

substantial attention (Angus, Holmes, Pryce, Meier, & Brennan, 2016; Brennan, Meng, Holmes, Hill-McManus, & Meier, 2014; Holmes et al., 2014; Stockwell & Thomas, 2013). MUP is not a tax, but rather a legally binding "price floor" in which retailers are not permitted to sell alcohol below a certain price. On the 1st of May 2018, the Alcohol (Minimum Pricing) (Scotland) Act 2012 was ratified. Scotland has become the first country in the world to implement minimum unit pricing in an attempt to reduce the significant harm of strong, low cost alcohol. The policy itself places a minimum price of 50p-per-unit. It is aimed at cheap lager, cider and spirits sold in supermarkets and off-licences. Prior to the legislation, super-strength cider and own-brand spirits could be bought for as little as 18p per unit. Under the new legislation, the cheapest bottle of Whisky (700ml at 40% ABV) will cost £14 and the cheapest bottle of Vodka (700ml at 37.5% ABV) will cost £13.13, both roughly £3 higher than before the policy was introduced. Table 1.4 provides an overview of the most popular alcoholic beverages that have affected by the introduction of MUP.

Though MUP and alcohol taxes both increase the base price of alcohol, they operate in particularly different ways. MUP focuses on a relatively narrow type of alcohol; the cheapest alcohol favoured by the heaviest drinkers. As a result, substantial tax increases would be required in order to replicate the estimated effects of MUP. Angus et al. (2016) found that duty would have to be increased by 28% to match the reduction in deaths that could be achieved by a 50p MUP in Scotland.

TABLE 1.4: Price of Alcohol in Scotland Before and After MUP

Alcohol	**Price Before (Average*)**	**Price After Introduction of MUP**
Vodka 700ml	£10.70	£13.13
Whisky 700ml	£11.90	£14
Gin 700ml	£10.70	£13.13
Wine (12.5%) 750ml	£4.15	£4.69
Beer (4%) 440ml**	£14.00	£17.60
Cider (5%) 2000ml	£2.05	£5
RTDs*** (4%)	£2.00	£1.40

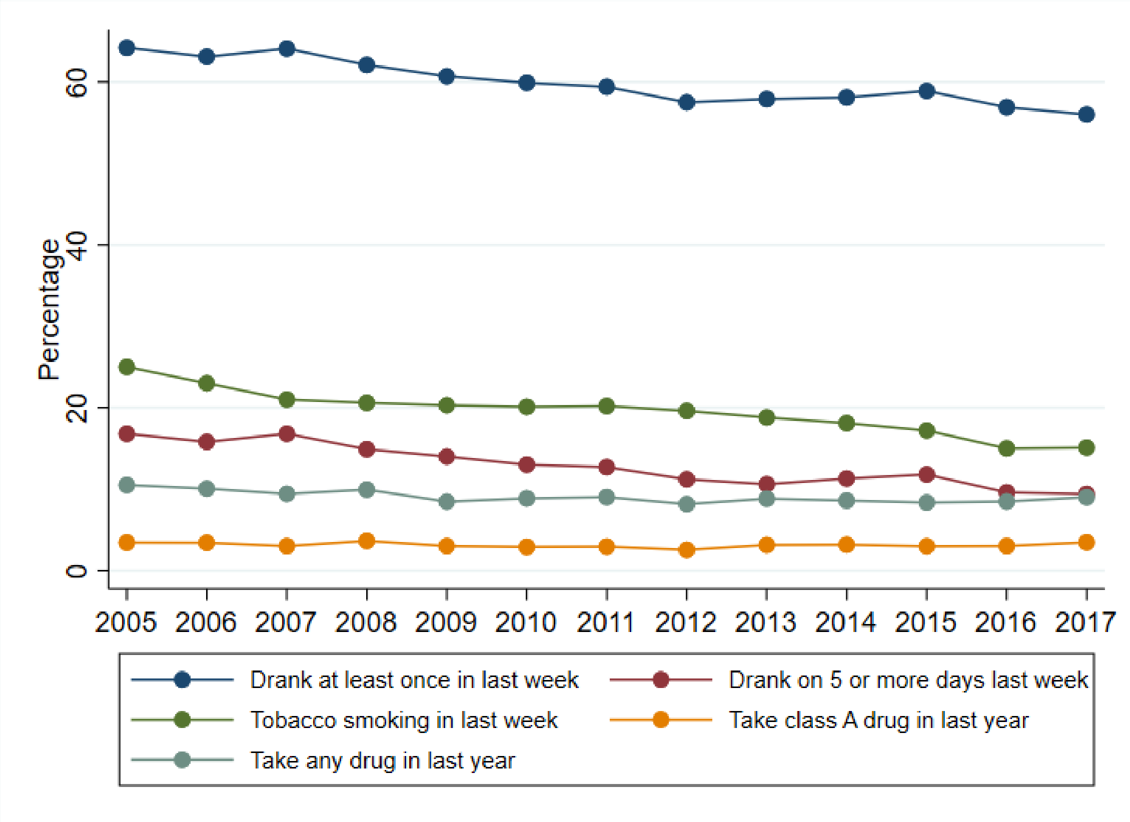
Notes: * Average across top 6 supermarkets in Scotland: Asda, Tesco, Morrisons, Aldi, Sainsbury's, and Lidl. ** Price refers to 18 440ml cans. ***RTDs refer to Ready to Drinks or Alcopops

As well as documenting the effects alcohol pricing and taxation has on society, one of the most important contributions the literature has made is the repeated demonstration that alcohol obeys the law of demand. The price level of alcoholic beverages influences per capita consumption levels of alcohol, as well as the incidence of alcohol abuse and its health-related consequences (Cook & Moore, 2002). However, just because alcohol-control measures are reliable at reducing alcohol abuse and heavy-drinking, does not in itself wholly justify its implementation. The majority of individuals who consume alcohol, drink in moderation. The price increases that arise as a result in increases in taxation or the introduction of a minimum price-per-unit will have a significant effect on the consumer surplus enjoyed by the majority, as it is only the harmful drinkers who are imposing significant external costs on society. The costs as well as benefits of taxation, price changes and control policies deserve attention.

1.1.7 Prevalence of Alcohol and other Risky Behaviours

According to the Opinions and Lifestyle Survey (OPN), in Great Britain, 57.0% of respondents aged 16 years and over in 2017 drank alcohol in the last week, which equates to 29.2 million people in the population. This is roughly a 7% decreased compared to 2005. Figure 1.5 illustrates the prevalence of drinking behaviours compared to other risky behaviours such as tobacco smoking and drug use. From the figure, it is clearly visible that the prevalence of the consumption of alcohol is the highest when compared to other behaviours.

FIGURE 1.5: Prevalence of Risky Behaviours in the United Kingdom Over Time



Notes: Data on alcohol and tobacco use is from the OPN while drug data is from the Home Office

While alcohol has the highest prevalence rates amongst tobacco, alcohol and drug use, it does not account for the highest number of preventable deaths in the UK associated to these behaviours. Instead tobacco accounts for the highest number of deaths standing at around 25,000 deaths in the UK and roughly 480,000 worldwide (WHO, 2018). Alcohol was accountable for 7,697 deaths in 2017 while there were 2,383 drug misuse deaths registered in England in 2016.

Additionally, due its highest prevalence as well as the short- and long-term problems associated to alcohol, the cost of alcohol on the NHS is higher than that of tobacco and drug misuse. It is widely estimated that the cost of alcohol to the NHS is roughly £3.5 billion annually. Most recent estimates find that the annual cost of tobacco is £2.6 billion and the annual cost of drug misuse is £500 million yearly. This provides further motivation for analysing the role alcohol plays in society as well as the measures used to control alcohol misuse.

1.2 Motivation and Aims

This thesis aims to extend the literature surrounding alcohol consumption in three distinct ways. Firstly, it examines the role of alcohol control policies, namely the MLDA and its effect on alcohol consumption amongst young adults. This provides vital information to policy makers as it helps untangle the effects alcohol control policies have on youth's decision to consume alcohol, as well as whether the sudden removal of alcohol purchasing restrictions cause an increase in binge or heavy drinking. Moreover, this thesis examines how the drinking distribution and heavy drinking has changed over the life course, across different periods, birth cohorts and ages. Finally, this thesis investigates the role alcohol plays among other risky behaviours such as tobacco and illicit drugs. Using a variety of teenage characteristics and popularity we provide a more detailed understanding as to why young adults consume alcohol. This thesis therefore provides a valuable contribution to the existing literature.

1.3 Structure of the Thesis

This thesis is presented as three individual empirical research chapters, however there exists a general overlapping theme; alcohol consumption. As well as chapter-specific conclusions, the thesis finishes with a general summary and discussion of the work presented of the work presented throughout.

1.3.1 Brief Overview of Chapter Two

Chapter Two uses a regression discontinuity design (RDD) approach to estimate the response of young adults at the sudden legal change in drinking restrictions at 18 years in the United Kingdom. The advantage of regression discontinuity design is that we are able to examine sharp differences in alcohol access for young adults on either side of age 18. That is, individuals slightly younger than 18 are subject to the drinking age law while those 18 or slightly older are not. As a result, observed and unobserved determinants of alcohol consumption and health outcomes are likely to trend consistently across the age "cut off" of 18, thus we can use evidence of discrete jumps in alcohol consumption at 18 years to identify the causal effect of the minimum legal drinking age restriction amongst young adults.

Overall, the analysis finds new evidence on the MLDA in the United Kingdom. The results throughout depict that MLDA restrictions in the UK are effective at influencing the individual decision to start drinking across various alcohol related characteristics. We find that once over the MLDA, the propensity to identify as a regular drinker increases and that the MLDA cut off at 18 creates an intensive decision among compliers to start drinking alcohol, more so, than the individual decision to increase alcohol consumption once restricted legal access has been lifted. Therefore, specifically in the UK, age-based restrictions to alcohol consumption reduce the frequency of those who drink but does not have a considerably large effect on the amount respondents drink.

1.3.2 Brief Overview of Chapter Three

Chapter Three uses several different methods including linear probability modelling and mediation analysis to estimate how physical attractiveness influences a range of risky behaviours such as under-age drinking, smoking, illicit substance use and under-age sexual activity. During the interview process, interviewers are asked to comment on a variety of characteristics relating respondent, this includes the physical attractiveness of the interviewee. This is rated on a 1 to 5 scale. We use this information to examine the relationship of beauty and teenage risky behaviours, and whether physical attractiveness influences these behaviours. For each behaviour we report the effect of being judged attractive and the effect of being judged unattractive, both relative to the base case. The results suggest that there is a substantial variation in a range of risky behaviours according to attractiveness. More attractive teens are less likely to smoke than both modal and less attractive teens. At the same time there appears to be an attractiveness gradient in alcohol consumption. We provide new evidence on pre-labour market behaviours associated to attractiveness. Our results provide new evidence in explaining adolescent behavioural decisions and social interactions, by expanding the literature to include physical attractiveness as a young adult. We demonstrate that these effects do not reflect potential con-founders such as risky behaviour of peer groups, personal grooming or the socio-economic background of the adolescent.

1.3.3 Brief Overview of Chapter Four

Chapter Four uses the Health Survey for England, a cross-sectional household survey, to examine age period and cohort effects to create synthetic cohorts. It is well understood from a single cross-section that alcohol consumption decreases with age, but the change in consumption across different birth cohorts is more interesting to policy-makers. Instead of collapsing consumption to the mean as is done in the majority of the literature, Chapter 4 examines the change in the distribution of drinking across cohorts. It also looks at whether price plays a role in determining differences across birth cohorts' alcohol consumption, since it might be expected that higher prices deter younger generations from drinking.

Chapter 2

The Effect of the Minimum Legal Drinking Age on Alcohol Consumption: Evidence from the United Kingdom.

2.1 Introduction

The detrimental effects of alcohol consumption on health and well-being constitutes a substantial economic burden worldwide (Griswold et al., 2018). Roughly 3.3 million deaths every year result from harmful use of alcohol, representing 5.9 percent of all deaths globally (WHO, 2018). While consuming moderate amounts of alcohol can be associated with better health and longer life (Mann, Smart, & Govoni, 2003; Peele & Brodsky, 2000; Rimm, Williams, Fosher, Criqui, & Stampfer, 1999), a large body of literature has documented the harmful impact of excessive alcohol consumption on the global burden of disease, injury and the contribution to risk factors (Cook & Moore, 2002; Murray & Lopez, 1997; Rehm et al., 2009). Furthermore, a recent study by Burton and Sheron (2018) finds that alcohol is a colossal global health issue and small reductions in health-related harms at low levels of alcohol intake, as explored by Mann et al. (2003), Peele and Brodsky (2000), Rimm et al. (1999), are outweighed by the increased risk of other health-related harms, including cancer. They therefore conclude that "there is no safe level of alcohol consumption".

In the United Kingdom (UK), excessive consumption of alcohol is a major public health concern. Alcohol misuse makes up 10 percent of the UK burden of disease and death, making alcohol the third largest lifestyle risk factor for disease and death in the UK (H. C. NHS, 2013). Understanding the causal relationship between youth drinking behaviour and mortality as well as other acute health outcomes is especially relevant for public policy in the United Kingdom as over half of young adults aged 16-24 consume alcohol regularly (Windsor-Shellard, 2017). Furthermore, roughly one-third of young adults partake in heavy episodic drinking (drink more than 8 units on one occasion in a given day[1]) (NHS, 2017).

A substantial body of literature has focused on the effects of alcohol consumption on alcohol related traffic collisions, criminal activity, illicit drug use as well as other risky behaviours (Carpenter & Dobkin, 2009, 2011; Crost & Guerrero, 2012; DeAngelo & Hansen, 2014; Deza, 2015). Given the negative direct and indirect effects of alcohol consumption on health and well-being, evaluating the effectiveness of policies regulating alcohol availability and consumption in a UK setting is of great concern to policy makers and health experts.

Using data from the General Household Survey (GHS), this chapter focuses on how youth drinking behaviour is affected by the presence of a minimum legal drinking age (MLDA). The United Kingdom has maintained a MLDA of 18 years since the 1923 Intoxicating Liquor Act. However, this form of alcohol availability has been subject to heated debate in the United States (US). Historically, many US states had a MLDA of 18 years until the introduction of the 1984 National Minimum Drinking Age Act which threatened to withdraw highway funding if states failed to comply with a new MLDA of 21. In the US, opponents of an MLDA of 21 argue that imposing such a high age limit encourages young adults under age 21 to consume alcohol in an irresponsible manner as alcohol related activities are not done in a "controlled environment" such as on licensed premises (Wechsler, Lee, Nelson, & Kuo, 2002). However, several US based studies suggest that

[1]For the purpose of this study, we define binge drinking as consuming 8 or more units in one drinking occasion. 8 units is the equivalent of 4 standard strength pints of lager (4% ABV).

the current policy restricting access to alcohol until 21 has substantial public health benefits for young adults, especially in relation to motor vehicle collisions (Carpenter, 2004; Carpenter & Dobkin, 2009, 2011; Birckmayer & Hemenway, 1999; Levitt & Porter, 2001).

Furthermore, minimum legal drinking ages around Europe vary considerably. In countries such as Austria, Belgium, Germany, and Denmark, the MLDA is dependent on the type of alcohol consumed or purchased. For example, in Belgium and Germany there is a binding MLDA of 16 for beer and wine and an MLDA of 18 for spirits. This is consistent across both on and off premise. In Denmark, there are separate MLDAs depending on the strength or the Alcohol by Volume (ABV), 16 for drinks under 16.5% ABV and 18 for drinks over 16.5% ABV. At the other end of the spectrum, Scandinavian countries have a higher MLDA than the UK. Finland and Norway have an MLDA of 18 for drinks up to 22% ABV and an MLDA of 20 for drinks above 22% ABV, while Sweden have an MLDA of 18 for drinks up to 3.5% ABV and 20 for drinks above 3.5% ABV. See Table 1.1 in Chapter 1 for more detailed analysis of the various MLDA laws in Europe.

This study adopts a regression discontinuity design (RDD) (Thistlethwaite & Campbell, 1960) that examines the sharp legal change in drinking restrictions at 18 years in the United Kingdom. Within this MLDA setting, the construction of a RDD model illustrates sharp differences in alcohol access for young adults on either side of age 18. Individuals slightly younger than 18 are subject to the drinking age law while those 18 or slightly older are not. As a result, observed and unobserved determinants of alcohol consumption and health outcomes are likely to trend consistently across the age "cut off" of 18, thus we can use evidence of discrete jumps in alcohol consumption at 18 years to identify the causal effect of the minimum legal drinking age restriction amongst young adults. This allows for a treatment and control setting in which discontinuous changes in acute health outcomes after the 18$^{\text{th}}$ birthday can be accredited to the drinking age.

The United Kingdom is particularly informative due to its lower minimum legal drinking age compared to the US. Furthermore, the UK has an "unorthodox" policy of allowing those aged 16-17 to consume a standard measure of either beer, cider or wine[2] on licensed premises during a meal when accompanied by a paying adult. However, the UK still maintains a strict legal purchasing age of 18. As a result, given that we tend to expect youths to become more responsible between the ages of 18 and 21, we might expect legal access to alcohol to have more severe effects at age 18 years thus, we may expect to find different results to that found in the US literature.

This chapter makes two main contributions to the existing literature. First, it provides the first UK estimates of the effect of the MLDA on alcohol consumption. Similar to previous studies in the US and Australia, our results suggest that legal access to alcohol at 18 leads to an increase in a variety of measures of alcohol consumption. We find that an MLDA of 18 is associated with a 7.3 percentage point increase in the probability of drinking, a 6.1 percentage point increase in the probability of drinking more than once a week as well as a 3.71 percentage increase in the probability of binge drinking.

The remainder of this chapter is structured as follows. In the next section, we will provide a review of the recent and relevant literature, further motivating our original contribution. Section 2.3 describes the General Household Survey 1998-2007. Section 2.4 sets out the different specifications of the empirical strategy. Section 2.5 and 2.6 presents our results and the robustness of the main findings respectively. Finally we conclude and provide a discussion of policy implications of our results.

2.2 Literature Review

There is an extensive body of literature that has documented the negative externalities associated with youth alcohol consumption and alcohol related outcomes (Hingson, Heeren, & Edwards, 2008; Warner & White, 2003; Whitehead & Wechsler, 1980). Wagenaar and Toomey (2002) provide a comprehensive review of all minimum drinking age studies between 1960 and 1999 in the United States. This review finds that alcohol related

[2] A standard measure is defined as 1 pint of beer or cider (568ml) or 1 glass of wine (175ml).

motor vehicle collisions have received the most attention due to their important policy implications related to public health and mortality as well as the availability of high quality outcome data in this field. Wagenaar and Toomey (2002) identified only six empirical studies that did not focus primarily on traffic fatalities. Instead, these studies focused on only one or two alcohol-related causes of death, such as acute alcohol poisoning and liver disease.

From this systematic review, there is historical evidence to suggest that youths exposed to lower MLDAs were more likely to drink and drink excessively (binge drink) when compared to similar youths who were exposed to a stricter MLDA. Furthermore, Carpenter, Kloska, O'Malley, and Johnston (2007) produced a comparative examination of the effect of an increase in the MLDA and the implementation of zero tolerance driving laws (ZT) on reducing youth alcohol use, specifically the change in drinking behaviour of high school seniors in the US. They conclude that increasing the MLDA in the 1970s was more effective at reducing the amount of alcohol consumed by high school students than the zero tolerance laws introduced in the 1990s and the doubling of the federal excise tax on beer in 1991. Miron and Tetelbaum (2009) use US state-level panel data from the previous 30 years to illustrate that the increase in the MLDA in 1984 failed to have the fatality-reducing effects that have been previously reported, instead they argue that these did not persist past the year of adoption and only have a minor impact on teen drinking. However, it could be argued that focusing on state-variation as a method for identification fails to consider unobserved differences at the state level that may be correlated with drinking behaviour, consequently one cannot retrieve a consistent estimate of the MLDA on drinking outcomes.

Laixuthai and Chaloupka (1993) examine the role of the MLDA and beer taxes in 1982 and 1989 on the change in frequency of youth drinking and heavy episodic drinking. They argue that, for both years, youth drinking is highly responsive to price changes resulting from increased excise taxes. However, they conclude that the price sensitivity of youth alcohol consumption fell after the US changed to a universal MLDA, this is statistically significant for both men and women. Therefore, the research indicates that increases in the full price of alcoholic beverages, either by raising excise taxes on alcohol or by increasing MLDAs will substantially reduce the frequency of drinking and heavy drinking by young adults. Moreover, Laixuthai and Chaloupka (1993) argue that increases in the full price of alcoholic beverages through a relatively large tax increase will have a more pronounced reduction in the frequency of youth alcohol consumption than an increase in the MLDA.

Although several studies have investigated the effect of the MLDA laws on alcohol consumption in the US, the majority of these have made use of state level variation in the MLDA that occurred in the 1970s and 1980s (Birckmayer & Hemenway, 1999; Miron & Tetelbaum, 2009; Toomey et al., 1996; Voas et al., 2003). However, the recurring issue within this empirical strategy is that this type of study fails to consider unobserved characteristics in the treatment and control groups.

For example, the studies do not consider, nor explain, the reasons why the change in the MLDA, for a given state, was introduced. If unobserved differences in the MLDA at the state level are associated with that states' drinking behaviours, one would find it difficult to estimate a consistent causal effect of the MLDA on alcohol consumption by purely using state level variation as the decision to impose the higher MLDA. Subsequently, these existing studies have faced various limitations, as listed above, resulting in questions regarding both their relevance and the validity of their instruments.

In order to address these concerns, recently a body of literature has developed that seeks to identify the causal effect of the MLDA and alcohol consumption on health outcomes using an alternative empirical strategy. The most prominent of these, is the work of Carpenter and Dobkin (2009, 2011) who focus on youth alcohol consumption and the MLDA. Carpenter and Dobkin (2009, 2011) adopt a regression discontinuity design (RDD) approach to analyse the effect of the MLDA on alcohol consumption and alcohol related mortalities, predominantly alcohol related traffic collisions. They find that once drinking restrictions are lifted at age 21, there is a large and immediate increase in measures of alcohol consumption, including a 21 percent increase in the number of days in which individuals drink. This increase in drinking "exposure" resulted in a discrete 9 percent increase in the mortality rate at 21, this is primarily due to motor vehicle collisions, alcohol-related deaths, and suicide. Moreover, they found that the observed mortality effects are not due entirely to "beginners", those without previous exposure to alcohol, but also those who have had previous experience. Furthermore, they find that the increase in mortality rates is due to an increase in the number of days on which individuals drink or drink heavily.

Lindo, Siminski, and Yerokhin (2015) use an age-based regression discontinuity design applied to the Household, Income and Labour Dynamics in Australia (HILDA) survey and CrashLink data to reveal the link between legal access to alcohol and motor vehicle collisions in New South Wales (NSW), Australia. This provides a particularly informative case study, as Australia has a minimum legal drinking age of 18, the same as that of the UK, as well as NSW being among the world leaders in their efforts against drunk driving (Lindo et al., 2015). They find that legal access to alcohol has significant effects on drinking behaviour in NSW. These results are suggestive of some gender heterogeneity in terms of drinking characteristics, they suggest that the MLDA has a considerably larger effect on female respondents on the "do you ever drink" variable. However, they find that the optimal point estimates are double for male respondents on "proportion of days drinking" and "binge drinking".

Furthermore, contrary to previous literature, Lindo et al. (2015) find that the estimated direct effects of legal access on motor vehicle collisions are routinely close to zero and there is very little heterogeneity by gender. However, their evidence does suggest that there are significant effects on hospitalisations due to alcohol poisoning and assault victimisation, implying that a year of legal access imposes additional hospital costs of $1 for intoxication per NSW youth and $3 for assault. The findings also show that there need not be a link between legal access to alcohol and motor vehicle collisions, but more work is needed to understand precisely how any such link can be broken. Moreover, they stress the importance in understanding the degree to which different alcohol-control policies can substitute and complement one another.

In Canada, Carpenter, Dobkin, and Warman (2016) use pooled cross-sectional data from the National Population Health Surveys (NPHS) and the Canadian Community Health Surveys (CCHS) 1994-2011, to analyse the effect of the MLDA on mortality rates and drinking behaviour. They find that total deaths increased significantly by 6 percent at Canada's MLDA, and argue that this is almost entirely attributable to a 17 percent increase in traffic collisions. Furthermore, Carpenter et al. (2016) find that the statistically significant increase in mortality is predominantly amongst men and statistically insignificant for women. Moreover, they also examine the effect of the MLDA on the distribution of drinking intensity. They again find stark gender differences: finding that the MLDA affects drinking among young women mainly in the range of one to five drinks consumed in a single day. At the higher end of the drinking distribution they find that the MLDA significantly affects the likelihood that men report having as many as 10 drinks in one day, thus matching the gender-specific mortality results. Taken together the authors argue that alcohol control policy should focus on moderating extreme drinking behaviour especially amongst young men.

B. K. Yörük and Yörük (2011) also use a regression discontinuity approach on data from the National Longitudinal Study of Youth, 1997 from the United States to demonstrate the impact of the MLDA on alcohol consumption, smoking and marijuana use among young adults. Focussing on both linear and quadratic specifications, they find that granting legal access to alcohol at age 21 leads to an increase in a plethora of measures of alcohol consumption such as a 10 percent increase in the probability of binge drinking, as well as an increase of 1.7 in the number of drinking days per week. However, contrary to other literature, B. K. Yörük and Yörük (2011) find that the probability of marijuana use among young adults tend to increase by around 7 percentage points. Crost and Rees (2013) come to different conclusions using the same dataset. They argue that the results of B. K. Yörük and Yörük (2011) are dependent upon restricting the sample to respondents who used marijuana since their last interview. Applying the same methodology, Crost and Rees (2013) find no evidence of a relationship between marijuana use and the MLDA at 21. In response to this argument, B. K. Yörük and Yörük (2013) re-examine their initial analysis using the full NLSY97 sample. In the extended sample, they find that respondents have the same, or increased their alcohol consumption (in comparison to the previous study) however they find that smoking and marijuana consumption becomes statistically insignificant.

Throughout the literature, there is far less evidence on the extent to which easier access to alcohol and the subsequent increased alcohol consumption affects the rate of non-fatal injuries among young adults. Carpenter and Dobkin (2017) seek to address these concerns, documenting that inpatient hospital admissions and accident and emergency (emergency department) visits increased by 71.3 and 8.4 per 10,000 person-years, respectively. However, there is no study outside the US that analyses the extent of ease of access of alcohol and consumption on the rate of non-fatal injuries. This is a serious gap, non-fatal injuries through alcohol consumption are more common than alcohol related deaths, in 2013, there were an estimated 325,870 admissions based on the narrow measure of alcohol, an increase of 37 percent across the last ten years.

2.3 Data

Our data on alcohol consumption comes from the Special Licence version of the General Household Survey (GHS) know formally known as the General Lifestyle Survey (GLF). The GHS is an annual cross-sectional household survey of approximately 20,000 individuals living in around 13,000 households in Great Britain conducted by the Office for National Statistics (ONS). From 1978 onwards, the GHS; now the General Lifestyle Survey (GLF), asked household members aged 18+ to complete the section on their drinking behaviours during face-to-face interviews. Furthermore, from 1988 onwards these questions were extended to 16 and 17 year olds who responded using a self-completion form.

The key feature of the Special Licence version of the dataset is that it contains the month and year of birth of each respondent as well as the exact date in which the survey took place. With this information, it is therefore possible to calculate the age in months for each respondent at the time of the interview. As the GHS is a nationwide study of the UK covering a wide variety of ages, we restrict the sample to those respondents who were surveyed between ages 16 and 20, inclusive. For the purpose of this study we analyse the effects of the MLDA from 1998 to 2007. The reason that our study ends in 2007 is that although the GHS and GLF are still being released today, the variables on either month and year of birth as well as the interview date have been omitted or withheld due to disclosure concerns. These variable are key to our analysis as they used in creating the running variable age in months in our RDD.

With respect to questions on drinking, the GHS is different to most social surveys. Instead of focussing on overall drinking, the GHS asks questions on both the maximum amount drunk on any one day in the previous seven days as well as average weekly alcohol consumption over a specified time period, thus allowing for two measures of alcohol consumption. Questions on drinking in the week before the interview have been included in the GHS from 1998 onwards, hence the start date of our analysis. These questions ask respondents about their drinking behaviour in the seven days prior to the interview. This is especially informative in our case as most social surveys report alcohol consumption as categorical variables such as "once or twice a week, two to three times, etc...". In the GHS however, respondents are asked on how many days they drank alcohol during the previous week. They are then asked how much of each of six different types of drink (normal strength beer, strong beer[3], wine, spirits, fortified wines, and RTDs[4]) they drank on their heaviest drinking day during the previous week. From this we can infer an individual's heaviest drinking day.

[3]Strong beer is defined as > 7.5% ABV.

[4]RTDs are "Ready to Drinks", also known as alcopops.

As well as questions on the heaviest drinking day, the GHS asks questions to establish average weekly alcohol consumption. These questions ask respondents about their drinking behaviour in the previous 12 months running up to the interview. This measure was developed by ONS in response to earlier medical guidelines, which recommends no more than of 21 units for men, and 14 units for women a given week. As of January 2016 , these guidelines have now been lowered to 14 units per week for both men and women, spread over 3 or more days in a seven day period.

The questions and responses on alcohol consumption we use from the GHS refer to a respondent's drinking behaviour in the week leading up to the interview. This is key to our analysis as by focusing on questions that refer to recent drinking behaviour we eliminate the possibility of respondents being part of both the control and treatment groups in the analysis: If a respondent has recently celebrated a birthday prior to the interview, then their answers to their yearly, or even monthly, alcohol consumption will be based upon the fact that they were below the MLDA for more time than they were over it. Hence they are in the control and treatment groups.

By using questions on weekly consumption, as well as applying a donut RDD approach[5] to our analysis we avoid this concern. Additionally, interviews in the GHS took place throughout the entire year of each cross-section. This is particularly important as responses are not biased through a seasonality effect; such as during the summer holidays, Easter or Christmas in which you may expect consumption to be higher than that of term time. This further strengthens the internal validity of our study.

One limitation of using the GHS is that it relies on self-reporting. Obtaining reliable evidence about drinking behaviour is difficult, moreover social surveys consistently record lower levels of consumption than would be expected from data on alcohol sales. This is partly because respondents may actively or subconsciously under-report how much alcohol they consume. Drinking at home is particularly likely to be underestimated because

[5] The donut RDD approach is explained in greater detail in Section 2.4.

the quantities consumed are not measured and are likely to be larger than legal measures dispensed in licensed premises. Furthermore, respondents who are under-aged drinkers may under-report their drinking behaviour due to the illegal nature of underage drinking. This is a limitation shared by all of the alcohol literature. However, due to the fact that the drinking questions were completed in a "self-completion" format by the respondent in their own time, one could argue that this may reduce potential social desirability bias compared with other survey administration methods. Appendix A1 depicts the summary statistics of all respondents and those within the 16 to 19 window.

2.4 Methodology

This chapter employs a regression discontinuity design (RDD) to estimate the effect of the MLDA laws on alcohol consumption among young adults. RDD is a non-experimental approach first introduced by Thistlethwaite and Campbell (1960) that is used to estimate a program or policy impact in which individuals are assigned to a treatment or control group based on whether their value for a "running" or "forcing" variable exceeds a designated threshold or cut off point. In our analysis, this approach takes advantage of the sudden legal change in alcohol access that occurs at age 18. Since the purchase and consumption of alcohol is legal according to this simple age cut off, it is possible to compare alcohol related outcomes across young adults who exhibit similar income, educational attainment, as well as other observable individual characteristics, but vary in their levels of alcohol use. As individuals do not differ significantly across the MLDA, observed and unobserved determinants of alcohol consumption and mortality are likely to trend smoothly across the age threshold. Thus, this allows for a treatment and control setting in which discrete changes in acute health outcomes after the 18th birthday can be accredited to the drinking age.

In order to construct an RDD, we assume that the respondents cannot manipulate, or control, the running variable. This is because our running variable, age in months, is naturally assigned therefore this meets our specific criteria. For our analysis we estimate various forms of the following equation:

$$Outcome_i = \beta_0 + \beta_1 X_i + \beta_2 MLDA_i + f(age_i) + \epsilon_i \tag{2.1}$$

Where $Outcome_i$ represents a particular measure of drinking behaviour.X_i represents the vector of observable characteristics of each respondent i such as gender, household income and race as well as the year the interview took place. *MLDA* is a dummy variable that takes a value of 1 if the respondent is aged 18 and older, and 0 otherwise. The parameter of interest with this framework is β_2, this measures the discrete change in a particular outcome when an individual turns 18. Within this framework our specified model of choice is an interacted local linear specification for $f(.)$. As we observe the month of birth and the date of the interview we can calculate the difference between the interview and the respondents' 18^{th} birthday, Thus, this local linear specification aims to adjust for age related changes in outcomes, therefore allowing the slope term to be versatile on each side of the MLDA.

Correctly modelling the polynomial is one of the main issues when implementing a regression discontinuity design. In order to address this concern we consider both non-parametric and parametric functions in age to explore the sensitivity of our results. Throughout our non-parametric analysis, we illustrate estimates for a range of bandwidths, as well as the recommended bandwidth selection procedures derived from Imbens and Kalyanaraman (2012), which argues that the optimal age bandwidths is between one and two (years). Furthermore, following from Lee and Card (2008) we cluster our errors on the running variable (age in months).

Following the literature's procedure for analysing the robustness and sensitivity of our regression discontinuity estimates, we construct various parametric specifications of our model. For our sensitivity estimates we consider linear, quadratic, and cubic models, thus allowing for these functions to vary on each side of the age cut off (age 18 or 216 months).

One of the key identifying assumptions regarding regression discontinuity design is that characteristics related to the outcomes of interest should vary smoothly through the treatment threshold. The fact that our study uses age as the variable that determines treatment (the forcing or running variable) helps to address the concern that this assumption may not hold. As individuals have no control over their age, manipulation of the running variable (age) is not possible (McCrary, 2008).

However, with all age-based studies there is the concern whether there might be additional treatments related to outcomes that are simultaneous with the treatment of interest (Lindo et al., 2015). The most obvious example in our case are birthday celebrations. Particularly, one may expect drinking outcomes to alter as a result of changes in activities and behaviours around a respondent's birthday. This particular additional treatment concern is typically addressed in the literature by estimating a "donut RDD" which omits observations that occur around a respondent's birthday. We essentially cut out the observations in which respondents were interviewed close to their birthday as these are the individuals that may cause the additional treatment effect. This systematic removal of observations in the immediate vicinity of their birthday, but within our chosen bandwidth will correctly capture the expected alcohol-related outcomes that would be observed at the treatment threshold in the absence of behavioural changes associated with having a birthday. This assumption implies that the pronounced birthday celebration effects that we would expect during a respondents' birthday does not exist outside of the specified donut.

Furthermore, one additional concern in our UK setting is the fact that at 18 years old, youths gain more individual rights and are no longer considered minors. In the UK, young adults can legally drive at 17, however are more likely to drive independently closer to 18 (after passing their driving test). Additionally, at 18 years old, young adults are often given more freedom from their parents, they may be able to go out more often and to stay out later at night. Moreover, individuals may leave home or go to university which may bias our results. Therefore, we might be concerned that our estimates of the effect of legal access to alcohol could be confounded by the "coming of age". This is a concern we need to address during our analysis by analysing the proportion of individuals living at home, being in sixth form, college or university, or being employed changes discontinuously across the treatment cut off.

2.5 Results

2.5.1 Descriptive Statistics

Table 2.1 illustrates basic demographic information about the sample of young adults from the GHS. The sample consists of 9,355 individuals who were aged between 16-19 years at the time they completed the GHS survey. The statistics presented in Table 2.1 reveal that the majority of the sample live at home and are split between work and education. The differences across gender are small with women less likely to be single and to live at home but more likely to be in school and higher education. In terms of alcohol characteristics, we find that 78 percent of young adults drink regularly and on average drink on 2.3 days a week. Amongst alcohol consumption, gender differences are more apparent with men more likely to consume more alcohol and on more occasions, on average drinking 2.5 days a week compared to women who on average drink on 1.5 days.

Furthermore, there is a similar story for heavy episodic drinking or "binge drinking". The sample includes 7,527 observations from repeated cross sections that include questions on "drinking on their heaviest day" in the previous week leading up to the survey. 21 percent of men reported that they consumed five or more drinks in one occasion, compared to 14 percent of women who reported consuming four or more standard measure drinks in one occasion. See Table A.1 in the appendix for a comparison of young adults sample to the entire sample of the GHS.

TABLE 2.1: Summary Statistics for GHS Survey 1998-2007 for Young Adults, by Gender

Variable Name	Young Adults	Male	Female
Control Variables			
Lives with Parents	0.8767	0.9110	0.8421
At School	0.6982	0.8467	0.5342
Higher Education	0.1776	0.1538	0.1930
Employed	0.5864	0.5930	0.5767
Single	0.7289	0.7322	0.7137
Annual Income (Household)	6786.01	7237.27	6332.17
White	0.8899	0.8956	0.8848
Black	0.0224	0.0195	0.0259
Asian	0.0481	0.0449	0.0496
Outcome Variables			
Drinks Regularly	0.7818	0.7960	0.7680
Drinking Days per Week	2.3358	2.5186	1.5505
Binge Drinks	0.1762	0.2117	0.1437
Number of Units per Week	14.5034	17.6102	11.5915
N	9,355	4,720	4,635

Notes: The sample is restricted to the analysis sample, which includes young adults interviewed when they are within two years of the minimum legal drinking age in the United Kingdom (16 to 20). Questions on binge drinking was answered by 7,527 respondents.

2.5.2 Validity of the Research Design

Before reporting the estimates of the effect of MLDA on the probability of alcohol consumption, we first test the possibility that there exists changes in observable characteristics of young adults at the age of 18 that could confound our results. In the United Kingdom, 18 is often considered the official age of adulthood, at 18, one can buy cigarettes, vote in national elections, and gamble. While we cannot rule out the possibility that this coming of age may have an effect on health outcomes, we can look at the extent to which turning 18 has effects on other major changes on young adults life by analysing other observable characteristics from within the GHS; whether they live with their parent or guardian, whether they are enrolled in secondary school or college (sixth form), whether they are employed, and their (household) income.

We first test the smoothness of all adulthood characteristics and control variables occurring at age 18. In Table 2.2 we estimate the smoothness of the individual covariates used in our analysis. The results reported in Table 2.2 suggests that for each control, the coefficient of the treatment variable is statistically insignificant, thus there is no evidence of a discontinuity in any of these variables at the cut off age of 18. These results reflect the changes we would be expect to see: as young adults get older they are less likely to live with their parents/guardians, less likely to be enrolled in school, and more likely to be employed. However, these major life changes events do not appear to be associated with turning 18 years, as these characteristics do not change discontinuously at the cut off. As a result, we can be confident that our estimated discontinuities with respect to alcohol consumption are in fact a result of a change in the legal availability of alcohol rather than a change in "coming of age effects" or income.

TABLE 2.2: Test of the Smoothness of the Control Variables Around the 18th Birthday

Outcome	**Estimate**	**Standard Error**
Single	0.0277	0.0338
Log Income	0.0173	0.1529
Parents	-0.0074	0.0289
Higher Education	0.0355	0.0435
Employed	0.0221	0.0213

Notes: The signs ***, **, *indicates the statistical significance at the 1, 5 and 10 percent significance level, respectively. Robust standard errors are clustered at the month of age is reported in parenthesis.

2.5.3 Results on the MLDA and Alcohol Consumption

In this section, we document how alcohol consumption responds to the MLDA. Figures 2.1a to 2.1d present discontinuity estimates for various measure of alcohol behaviours. Each figure shows the mean plots of each alcohol characteristic using two-month bins. We also superimpose a local-liner line over the two-month mean plot on each side of the cut off. These figures are for illustrative purposes as we further develop the model using a variety of specifications throughout the remainder of the chapter. The key estimates are also summarised in Table 2.3. These regressions are an interacted local linear specification, indexed in age fully interacted with a dummy variable that specifies age over 18 (years). The robust standard errors are clustered on month of age, and the bandwidth used are selected by the procedure described by Imbens and Kalyanaraman (2012). Figure 2.1a shows the results for "Ever drink alcohol", this plot reveals an increase in the proportion of those drinking as young adults grow older. More crucially this plot reveals a discontinuity at the age of 18, indicating that legal access to alcohol has a significant extensive effect on alcohol consumption. The estimate in Table 2.3 suggests a 5.8 percentage point increase, from our baseline model of 70.2 percent, in those who consume alcohol at the IK-optimal bandwidth of around 24 months each side of the cut off. Furthermore, estimates further predict, that at the cut off, young adults drink on average 1.14 more drinks on any one occasion and are 6 percentage points more likely to drink more than once a week (Figure 2.1b), these are both significant at the 1 percent level.

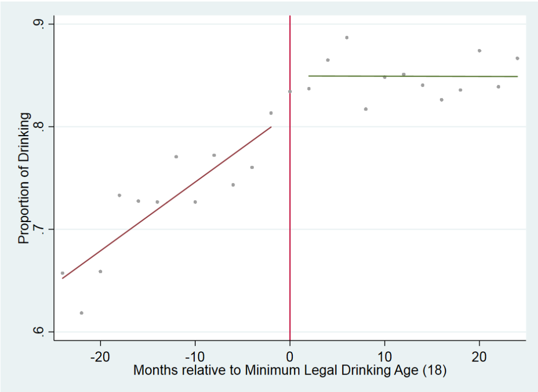
TABLE 2.3: Key Discontinuity Estimates

Outcome	**Estimate**	**Standard Error**	**IK Optimal Bandwidth**
Ever Drink Alcohol	0.0578***	0.01951	49
Drinking Days per Week	0.2016*	0.1199	52
Drinks More Than Once a Week	0.0611***	0.0231	56
Drinks on Heaviest Day	1.1429***	0.4620	57
Binge Drinking	0.0372*	0.0218	55
Binge Drinking More Than Once a Week	0.0299	0.0255	54

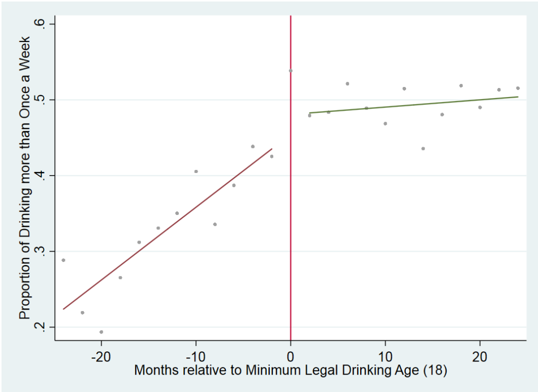
Notes: Table shows the key discontinuity estimates. Each outcome shows the estimated discontinuity, the robust standard errors are clustered on the month of age and the optimal bandwidth selected is described in Imbens and Kalyanaraman (IK) (2012). The signs ***, **, * indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively. Local linear regressions are estimated using a triangular kernel.

Estimated discontinuities for binge drinking are shown in Figure 2.1c and Figure 2.1d. 7,527 respondents were asked to document their drinking habits during their heaviest day of the week in terms of beverage type and cannister size, and whether they repeated this amount of drinking more than once in same week. From this, we define binge drinking using the Office of National Statistics definition as having over 8 units in a single session for men and over 6 units for women, which is roughly 5 or more standard measure drinks for men and 4 for women in one occasion. The estimates show that although

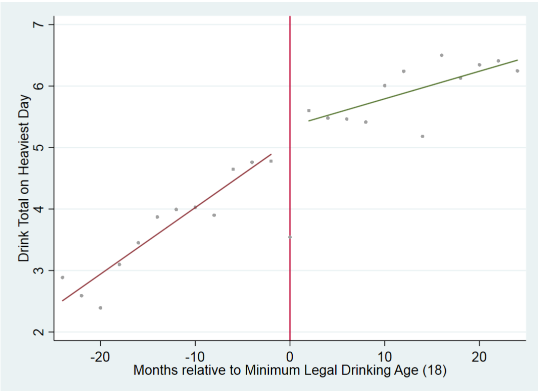
FIGURE 2.1: Illustrations of Discontinuities



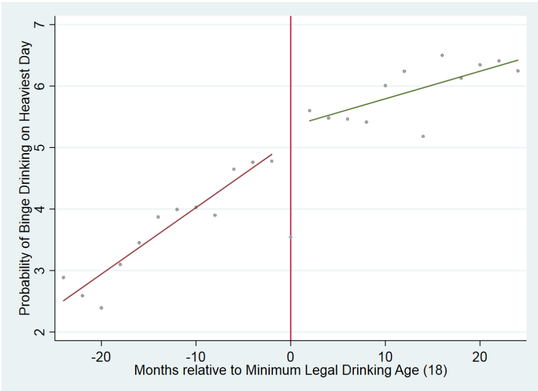
(A) Proportion of Drinkers



(B) Number of Drinking Days per Week



(C) Number of Drinks on Heaviest Day



(D) Proportion of Binge Drinking per Week the probability of binge drinking and binge drinking more than once a week increase after the 18th birthday, this effect is only significant at the 10 percent level for binge drinking and is statistically insignificant for repeated binging.

The results in Figures 2.1b to 2.1d reveal throughout, an increase in alcohol consumption as young adults grow older, however not all illustrate a significant discontinuity. The estimates suggest that MLDA restrictions in the United Kingdom are effective at influencing the individual decision to start drinking. At the cut off, the propensity to identify as a regular drinker increases much more than the amount consumed in a given period, whether that being a week or day. One can therefore argue that that the MLDA cut off drives more of an extensive decision among compliers to start consuming alcohol, than the individual decision to increase alcohol consumption. Age-based restrictions to alcohol consumption reduce the frequency of those who drink but not the amount respondents drink.

In order to better understand the driving characteristics behind our results we classify the respondents by month of birth to examine the heterogeneity within year groups. The Michaelmas term for school and college typically starts early September with the oldest students in the cohort born in September and the youngest born late August. We separate respondents into two groups with the older cohort consisting of those born between September and February and the younger cohort being made up of those born between March and August. Figures 2.2a to 2.2f depict the results. Each figure again shows the mean plots using a two-month bin. Figure 2.2a illustrates a comparatively higher discontinuity for "ever drinks alcohol" than the key discontinuity estimates. Those born later in the academic year are 8.1 percentage points more likely to identify as drinkers after the MLDA restrictions are removed, 0.6 percent higher than that of the whole sample (estimated using the IK-optimal bandwidth). Furthermore, the probability of drinking more than once a week increased by 8 percentage points after the cut off, 2 percentage points more than the whole sample. These results are also summarised in Table 2.4.

One of the most intriguing findings is the estimated discontinuities for binge drinking (shown in Figures 2.2e to 2.2f). The estimates are suggestive of discontinuities in binge drinking and in the frequency of binge drinking in a week. Both estimates illustrate a 5 percentage point increase at the age of 18 and are statistically significant. As well as depicting a larger discrete jump at the cut off, the probability of binge drinking and repeated binge drinking is higher than that of the regular sample. This is also evident, to a varying extent, among the other drinking characteristics. One possible explanation for this outcome is the relationship to their peer group. It is plausible that the older cohort are less likely to drink immediately at 18 as their academic peers are still below the legal drinking age. Furthermore, one could further argue that those born later in the academic year are more likely to have older peers within their academic group, therefore these older peers could initiate their friends into drinking through peer pressure, purchasing alcohol by proxy, making alcohol more readily available for the younger cohort.

TABLE 2.4: Key Discontinuity Estimates for Younger Cohort

Outcome	**Estimate**	**Standard Error**	**IK Optimal Bandwidth**
Ever Drink Alcohol	0.0819***	0.0321	53
Drinking Days per Week	0.3037	0.1374	55
Drinks More Than Once a Week	0.0824***	0.0318	54
Drinks on Heaviest Day	1.4926***	0.5333	59
Binge Drinking	0.0510*	0.0031	61
Binge Drinking More Than Once a Week	0.0492***	0.0204	61

Notes: The table shows the key discontinuity estimates. Each outcome shows the estimated discontinuity, the robust standard errors are clustered on the month of age and the optimal bandwidth selected is described in Imbens and Kalyanaraman (IK) (2012). A one month donut is applied around each birthday. The signs ***, **,* indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively. Local linear regressions are estimated using a triangular kernel. Analysis conducted using 1 month donut

Table 2.5 illustrates the key discontinuity estimates stratified by gender. These results are suggestive of some gender heterogeneity in the effects of alcohol consumption and behaviour. Specifically, they suggest that the relaxation of drinking restrictions has a more pronounced effect on males for all indicators, with the probability of males starting drinking increasing by 8 percentage points. Furthermore, the "binge drinking" indicator becomes statistically significant for males, illustrating a 7.8 percentage point increase in the probability of consuming 5 or more drinks in one occasion. However, it remains statistically insignificant for women. On the whole, there is evidence of MLDA discontinuities in drinking behaviour for both genders and a discontinuity in heavy episodic drinking for men.

TABLE 2.5: Key Discontinuity Estimates Split by Gender

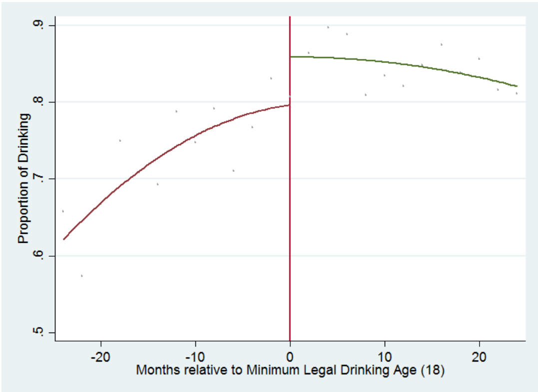
Outcome	Male	Female
Ever Drink Alcohol	0.0793***	0.0593***
	(0.0272)	(0.0274)
Drinking Days per Week	0.2060*	0.1801*
	(0.0624)	(0.0975)
Drinks More Than Once a Week	0.0753**	0.0669**
	(0.0310)	(0.0261)
Drinks on Heaviest Day	1.4420**	1.2773**
	(0.5775)	(0.3006)
Binge Drinking	0.0788**	-0.0278
	(0.0348)	(0.0270)
Binge Drinking More Than Once a Week	0.0356	0.0033
	(0.0473)	(0.0312)

Notes: The table shows the key discontinuity estimates. Each outcome shows the estimated discontinuity, the robust standard errors are clustered on the month of age and the optimal bandwidth selected is described in Imbens and Kalyanaraman (IK) (2012). The signs ***, **, * indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively. Local linear regressions are estimated using a triangular kernel.

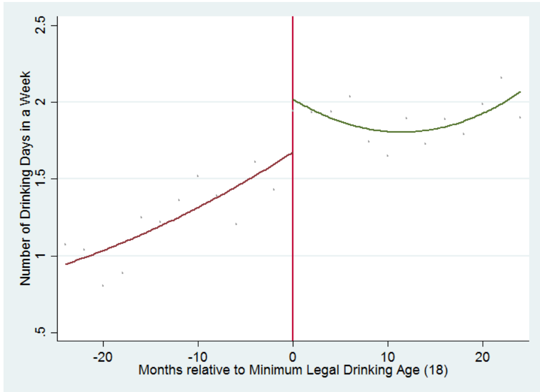
2.5.4 Minimum Legal Drinking Age and Health

As well as analysing the effect the MLDA has on alcohol consumption in the United Kingdom. We estimate the effect the MLDA has on a respondents self-assessed health. For all years of our analysis, the General Household Survey (1998-2007) respondents are asked to record their perceived level of health at the time of the interview. Here we have two measures of health. Firstly respondents were asked about their health on the whole in last 12 months. This is on a 3 point scale where 1 is not good, 2 is fairly good, and 3 is good. Secondly, respondents were asked about their health in general. This was rated on a 5-point scale 1 being very bad and 5 being very good. We use a multinomial logit model in our RDD analysis to estimate the effect of the MLDA on health. Figures 2.3a and 2.3b illustrate the impact of the MLDA on a respondents self-assessed health at aged 18. As evident from the figures, it is clear that although the self-assessed is decreasing over time (respondents are feeling less healthy with age) there in no significant discontinuity age

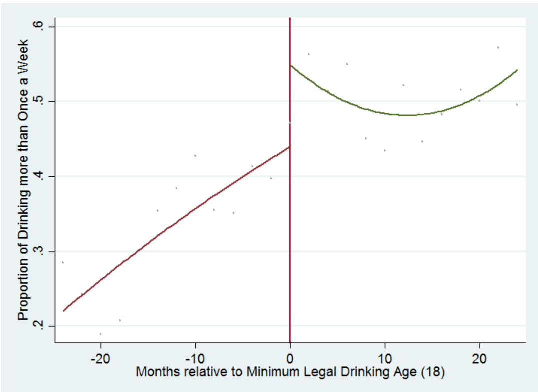
FIGURE 2.2: Illustrations of Discontinuities for Younger Cohort



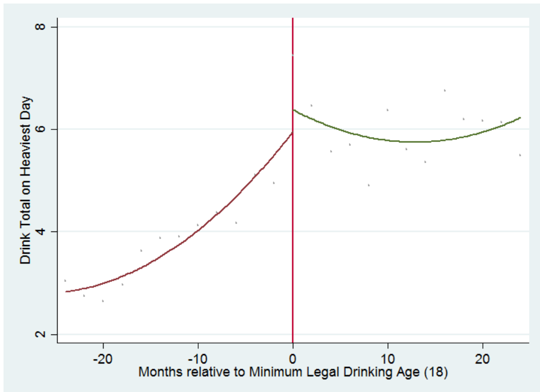
(A) Proportion of Drinkers (YC)



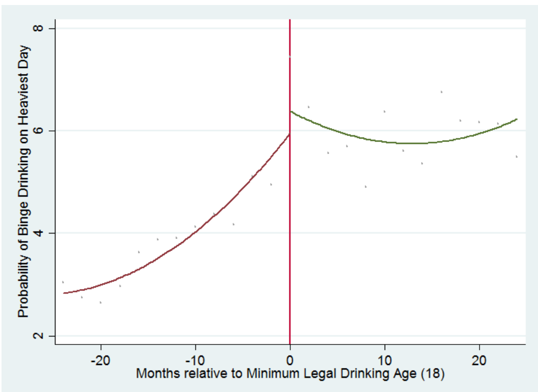
(B) Number of Drinking Days per Week (YC)



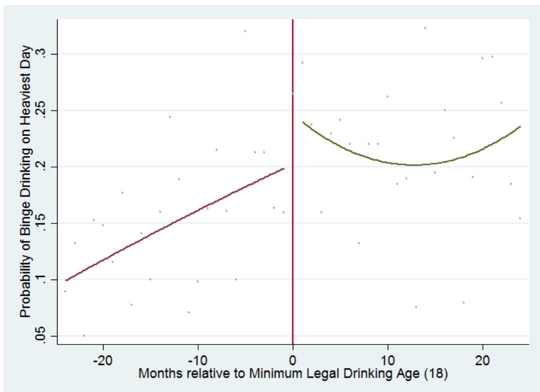
(C) Drinks Per Week (YC)



(D) Drinks on Heaviest Day (YC)

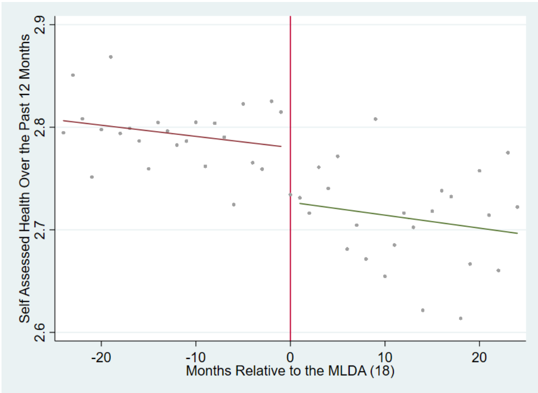


(E) Binge on Heaviest Day (YC)

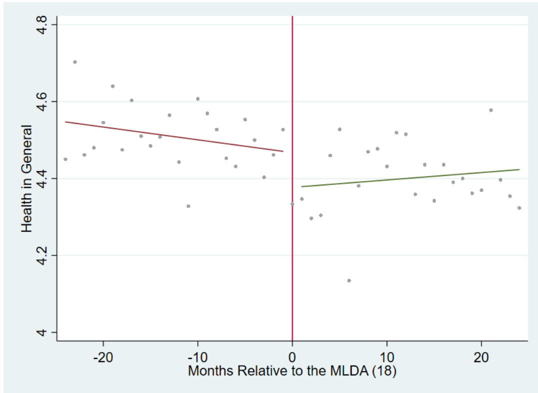


(F) Proportion of Binge Drinking per Week (YC)

FIGURE 2.3: Illustrations of Discontinuities for Self Assessed Health



(A) Health in the Past 12 Months



(B) Health in General

18. This is further evident in Table 2.6 which shows that the MLDA is associated with a -0.04 and -0.15 fall in self assessed health but neither are statistically significant.

TABLE 2.6: Estimates of Health Using Various Degrees of Polynomials, Parametric Analysis and Uniform Kernel Local Linear

Outcome	**Linear (1)**	**Quadratic (2)**	**Cubic (3)**	**Uniform Kernal (4)**	**Donut (5)**
Health in the Past 12 Months	-0.0369	-0.0461*	-0.0937***	-0.0763**	-0.0417
	(0.0330)	(0.0270)	(0.0341)	(0.0416)	(0.0523)
Health in General	-0.1503	-0.2502**	-0.3593***	-0.3835**	-0.1698
	(0.0982)	(0.1060)	(0.1230	(0.1696)	(0.0992)

Notes: Linear, Quadratic and Cubic refer to the degree of polynomial in our parametric analysis. Errors are clustered to the month of age. The signs ***,**,* indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively. Non-parametric Local linear model is specified as a uniform kernel.

2.6 Robustness Checks

With all Regression Discontinuity designs, it is important to consider whether there might be additional treatments related to outcomes that coincide with the treatment. Within our framework, it is possible that alcohol consumption may increase around the time of an individual's birthday because of abnormal activities and behaviours related to celebrating the occasion (birthday celebration effect). In order to address this problem, we estimate a "donut RDD" in which we omit observations that are in the immediate vicinity of the treatment threshold, in our case this is a respondent's 18th birthday. Furthermore, we apply the same size donut around other birthdays within the optimal IK bandwidth. We recover the estimate of the change in the drinking outcome at the threshold by projecting over the missing part of the age profile. This is equivalent to running a regression with an indicator variable that takes on a value 1 if the respondent is interviewed within their birthday month.

As the Special License version of the GHS only allows for us to calculate the age in months of each respondent we implement a one month donut around the treatment threshold and each birthday within the sample. These estimates are illustrated in Table 2.7. "Ever drinks alcohol" and "Drinks more than once a week" remains robust to the inclusion of a one month donut with the IK-optimal bandwidth point estimate illustrating a 7.3 percentage point increase in the probability of drinking and a 7.7 percentage point increase in the probability of drinking more than once a week, thus illustrating an increased discontinuity than the original estimates. Moreover, the drinking characteristics for the younger cohort remain robust to the one month donut. However, the estimates of "Drinking on heaviest day", "Binge drinking", and "Binge drinking more than one a week" are now insignificant with the inclusion of a one month donut. As a result, for these particular drinking outcomes, celebrations that occur around ones birthday drives these particular results. This is expected due to the nature of how the binge drinking questions were asked.

TABLE 2.7: Key Discontinuity Estimates with One-Month Donut

Outcome	**Estimate**	**Standard Error**	**IK Optimal Bandwidth**
Ever Drink Alcohol	0.0734***	0.0255	51
Drinking Days per Week	0.2654*	0.1496	50
Drinks More Than Once a Week	0.0765***	0.0377	49
Drinks on Heaviest Day	0.3844	0.3532	50
Binge Drinking	0.0201	0.0209	52
Binge Drinking More Than Once a Week	0.0100	0.0367	51

Notes: The table shows the key discontinuity estimates. Each outcome shows the estimated discontinuity, the robust standard errors are clustered on the month of age and the optimal bandwidth selected is described in Imbens and Kalyanaraman (IK) (2012). A one month donut is applied around each birthday. The signs ***, **,* indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively. Local linear regressions are estimated using a triangular kernel.

In order to test the sensitivity of our local linear specification model for the effect of the

MLDA on alcohol consumption we estimate our model using a variety of bandwidths. These are depicted in Table 2.8. The estimates from alternative bandwidths suggest that the relaxation of drinking restrictions has, on average, a 5.8 percentage point increase in the probability of drinking alcohol. As well as a 6.2 percentage point increase the probability of drinking more than once a week. Regardless of the specified bandwidth, our estimates for "Days Alcohol" suggest that the MLDA does not have an effect on the number of days young adults consumed alcohol in the last week. However, for each of our key drinking outcomes, these estimates remain significant and insensitive to changes in the bandwidth.

TABLE 2.8: Estimates of Non-Parametric Specification Using Various Bandwidths

Outcome	**Bandwidth**						
	48	42	36	30	24	18	12
Drink Alcohol	0.05836***	0.0645***	0.0674***	0.0668***	0.0576***	0.0466**	0.0485**
	(0.0196)	(0.0203)	(0.0207)	(0.0202)	(0.0194)	(0.0225)	(0.0232)
Days/ Week	0.2039*	0.2065*	0.2098	0.1908	0.1673	0.1377	0.1928
	(0.1127)	(0.1190)	(0.1280)	(0.1368)	(0.1442)	(0.1602)	(0.1788)
Drinks > Once a Week	0.0610**	0.0618**	0.0655**	0.0663**	0.0569	0.0482**	0.0825***
	(0.0250)	(0.0256)	(0.0266)	(0.0274)	(0.0278)	(0.0313)	(0.0321)
Drinks on Heaviest Day	0.7260**	0.8120**	0.9125***	0.9866***	0.9864**	1.1818***	1.6498***
	(0.3164)	(0.3290)	(0.3440)	(0.3639)	(0.3933)	(0.4373)	(0.0478)
Binge Drinking	0.0277	0.0342*	0.0379*	0.0383*	0.0364*	0.0547*	0.0991***
	(0.0201)	(0.0215)	(0.0235)	(0.0260)	(0.0296)	(0.0348)	(0.0336)
Binge Drinking> Once a Week	0.0225	0.0322	0.0385*	0.0439*	0.0490**	0.0699***	0.1161***
	(0.0257)	(0.0257)	(0.0260)	(0.0258)	(0.0246)	(0.0233)	(0.3334)

Notes: Errors are clustered to the month of age. The signs ***, **, * indicate the statistical significance at the 1,5, and 10 percent significance levels, respectively.

As well as estimating local linear regressions, we consider various parametric functions of age to explore the sensitivity of our results in a variety of functional forms. We focus on linear, quadratic and cubic models, allowing the slope of this functions to vary on each side of the treatment threshold. Overall, our results from the parametric models are robust to the degree of the polynomial specified. These results are depicted in Table 2.9. The estimates from alternative polynomials suggest that the probability of drinking among young adults increases from 5.6 to 7.7 percentage points at the MLDA.

Row 1 of Table 2.9 illustrates the various parametric specifications for the probability of drinking. This result is robust to all three parametric models to the 1 percent level. Row 4 shows that under the age 18 cut off is also associated with a 6.2 to 8.9 percentage point increase in probability of drinking more than once a week. Irrespective of the specified polynomial, our core results are not substantially different to our preferred model.

Throughout our non-parametric analysis we adopt a triangular kernel. The triangular kernel applies more weight to the observations closer to the cut off. In order to test the sensitivity of our kernel choice we estimate the same model as Table 2.3 using a uniform kernel. These are depicted in Column 4 of Table 2.9. For each of our key outcomes, the estimates remain significant and insensitive to changes in the kernel. However, the effect of the MLDA on the number of days in which young adults consume more than 8 units (binge drinking) remains insignificant.

TABLE 2.9: Estimates Using Various Degrees of Polynomials, Parametric Analysis and Uniform Kernel Local Linear

Outcome	Linear (1)	Quadratic (2)	Cubic (3)	Uniform Kernel (4)
Drink Alcohol	0.0564*** (0.0209)	0.0766*** (0.0280)	0.0659*** (0.0225)	0.0812*** (0.0250)
Days Alcohol	0.1907* (0.1125)	0.2356* (0.1596)	0.2089 (0.2178)	0.1813* (0.1144)
Drinks More Than Once a Week	0.0621** (0.0261)	0.0601** (0.0311)	0.0890*** (0.0324)	0.0689*** (0.0239)
Drinks on Heaviest Day	1.1447*** (0.2925)	0.9523*** (0.3668)	1.1924*** (0.3428)	0.7364** (0.3601)
Binge Drinking	0.0096 (0.0185)	0.4425* (0.0273)	0.0464* (0.0358)	0.0438 (0.0214)
Binge Drinking More Than Once a Week	0.0124 (0.0187)	0.0063 (0.0189)	0.0153 (0.0192)	0.0428 (0.0279)

Notes: Linear, Quadratic and Cubic refer to the degree of polynomial in our parametric analysis. Errors are clustered to the month of age. The signs ***,**,* indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively. Non-parametric Local linear model is specified as a uniform kernel.

Table 2.10 presents the sensitivity of our results subject to an artificial change in the cut off of the forcing variable. Columns 1 and 2 of Table 2.10 illustrate the cases when the cut off is changed to 17 and 19 respectively. When the MLDA is synthetically specified as 17 and 19 none of the estimates are statistically significant therefore we can argue that our model of choice does represent statistically significant changes in alcohol consumption when legal access to alcohol is no longer restricted.

On balance, the estimates depict that MLDA restrictions in the United Kingdom are effective at influencing the individual decision to start drinking. We have shown that our results are robust to a variety of different specifications in which we alter, the bandwidth in our local linear model, the polynomial in our parametric analysis as well as changes to the kernel and the cut off of our forcing variable. Overall, we find that at the age of 18, and at the relaxation of legal drinking restrictions, the propensity to identify as a regular drinker increases much more than the amount consumed in a given period, whether that is measured in a week or days.

TABLE 2.10: Estimates Using a Synthetic Cut Off

Outcome	**Age 17**		**Age 19**	
	Estimate	Standard Error	Estimate	Standard Error
Drink Alcohol	-0.0220	0.0369	-0.0196	0.0137
Drinking Days per Week	0.0501	0.1156	-0.0069	0.1726
Drinks More Than Once a Week	0.0369	0.0417	-0.0058	0.0482
Drinks on Heaviest Day	0.0707	0.3942	-0.1885	0.6077
Binge Drinking	-0.0035	0.0339	-0.0274	0.0487
Binge Drinking More Than Once a Week	-0.0241	0.0271	-0.0491	0.3300

Notes: Linear, Quadratic and Cubic refer to the degree of polynomial in our parametric analysis. Errors are clustered to the month of age. The signs ***, **, * indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively.

2.6.1 Siblings

Conclusions drawn from Fletcher (2014) find that once you control for siblings in peer effects models the estimated effects drop out. They argue that this is due to siblings acting as mediators and may facilitate or enable an individuals behaviour more than that of school friends or peers in general. As a result, we re-estimate our key local-linear specification controlling for whether the respondent has an older sibling who is above the MLDA and lives at home. These estimates can be found in Table 2.11. Here we find no significant difference to our key estimate from Table 2.3. Thus, we can argue that having an older sibling does not affect the individuals drinking habits either pre or post age 18.

TABLE 2.11: Key Discontinuity Estimates with Older Sibling

Outcome	Estimate	Standard Error	IK Optimal Bandwidth
Ever Drink Alcohol	0.0532***	0.0113	51
Drinking Days per Week	0.0991	0.2838	50
Drinks More Than Once a Week	0.0743***	0.0138	53
Drinks on Heaviest Day	1.641***	0.3901	56
Binge Drinking	0.0424*	0.0228	55
Binge Drinking More Than Once a Week	0.0124	0.0244	52

Notes: Table shows the key discontinuity estimates. Each outcome shows the estimated discontinuity, the robust standard errors are clustered on the month of age and the optimal bandwidth selected is described in Imbens and Kalyanaraman (IK) (2012). The signs ***, **, * indicate the statistical significance at the 1, 5, and 10 percent significance levels, respectively. Local linear regressions are estimated using a triangular kernel.

2.7 Conclusions and Discussion

This chapter investigates the effect of the minimum legal drinking age on alcohol consumption among young adults in the United Kingdom. We use the Special License Version of the GHS (1998-2007) which contains information on the month and year of birth of respondents as well as the interview date. With this information, we adopt an RDD approach with a clearly identifiable treatment and control group.

The UK provides an ideal setting due to its historic MLDA laws. While there have been many US based studies quantifying the effect of the MLDA on alcohol consumption and alcohol related outcomes, most of these existing studies have made use of the state level changes in the MLDA laws that occurred in the 1980's at the state level. However, the decision to adopt a lower MLDA may not be endogenous.

Using an RDD approach, our estimates suggest that the age 18 discontinuity is associated with up to a 7.3 percentage point increase in the probability of drinking on on base of 70.3

percent and a 7.3 percentage point increase in the probability of drinking more than once a week amongst young adults (baseline 68.3). Hence, we document that the MLDA is associated with a higher probability of individuals identifying as drinkers. Furthermore, we find that this effect is more pronounced among younger cohort members within a given school year who were born later in th academic year, illustrating an 8.2 percentage point increase at the cut off. This identifies the possibility of peer related alcohol consumption, which will need further analysis in the future.

Overall, our results provide new evidence on the MLDA in the United Kingdom. Our results throughout depict that MLDA restrictions in the UK are effective at influencing the individual decision to start drinking across various alcohol related characteristics. We find that once over the MLDA, the propensity to identify as a regular drinker increases by 7 percentage points.

Moreover, we have found that the MLDA cut off at 18 creates an intensive decision among compliers to start drinking alcohol, more so, than the individual decision to increase alcohol consumption once restricted legal access has been lifted. Therefore, specifically in the UK, age-based restrictions to alcohol consumption reduce the frequency of those who drink but does not have a considerably large effect on the amount respondents drink. Hence, further research is needed to investigate the effect of age based alcohol restrictions on other alcohol related outcomes such as morbidity, traffic accidents and mortality as well as the role of other alcohol related control policies such as inter-temporal licensing laws.

Chapter 3

Beauty and Adolescent Risky Behaviours

3.1 Introduction

There is a growing body of evidence demonstrating marked labour market benefits from physical attractiveness. For instance, Biddle and Hamermesh (1998) find substantial wage premia attached to beauty and show that this is largely invariant to occupational choice. In a similar vein, Fletcher (2009) finds large wage premia to beauty for young adults, and that this remains after attempts to control for ability. Recently, Stinebrickner, Stinebrickner, and Sullivan (2018) demonstrate that these premia are concentrated in jobs with substantial amounts of interpersonal interaction. This literature provides a compelling view that there are sizeable labour market returns to attractiveness.

What is not well understood is how physical attractiveness influences earlier, consequential, decisions. The previous literature seeks to provide, in essence, the effect of attractiveness on labour market outcomes conditional on individual characteristics, both demographic and 'pre-market'. Attractiveness is likely to change both the opportunities and costs of a variety of behaviours during adolescence. This includes a range of risky behaviours such as under-age drinking, smoking, illicit substance use and underage sexual activity that, in and of themselves, have implications for both labour market performance and important pre-market investments, most notably education (Carneiro, Crawford, & Goodman, 2007; J. J. Heckman & Rubinstein, 2001; J. J. Heckman, Stixrud, & Urzua, 2006).

We contribute to this literature by using rich survey data containing information on beauty to investigate how this influences adolescent risky behaviours. We use the restricted version of the National Longitudinal Study of Adolescent Health (Add Health) to estimate the influence of beauty on behaviours related to smoking, under-age drinking and teenage sexual activity. We demonstrate marked effects of teenage attractiveness on these behaviours. More attractive individuals are more likely to engage in under-age drinking, but markedly less likely to smoke or to be sexual active. In a series of robustness checks we demonstrate that these effects do not reflect potential con-founders such as risky behaviour of peer groups, personal grooming or the socio-economic background of the adolescent.

This raises the question of what mechanisms generate these effects. While, we are unable to be exhaustive in this regard we examine one particular channel that seems likely ex ante to be important, popularity. Moreover, previous research has demonstrated that retrospective measures of school friendship network size is related to both social skills and later life outcomes (Conti, Galeotti, Mueller, & Pudney, 2013).

We use similar, but contemporaneous, information on popularity to investigate its mediating effect with respect to attractiveness and risky behaviours. We demonstrate, that the relationship between popularity and attractiveness explains a large proportion of risky behaviour and attractiveness variation. This is particularly notable for girls. These results suggest that attractiveness in adolescence has a substantial influence on health behaviours and risk taking.

3.2 Literature Review

Initial research on the effects of beauty on adult outcomes considered this as part of a broader focus on non-cognitive traits and skills. The majority of this estimates the effect of these traits and skills on labour market outcomes (Hamermesh & Biddle, 1994; Biddle & Hamermesh, 1998; Mobius & Rosenblat, 2006). This research emphasises the importance of non-cognitive skills such as confidence in determining educational outcomes and labour market success, as well as the role of physical attributes in acquiring the necessary skills for success.

As part of this Hamermesh and Biddle (1994) examine the impact of *looks* on earnings. They use the Quality of Employment Survey (QES) along with the Quality of American Life Survey (QAL) and estimate the effect of interviewers' ratings of interviewees' physical appearance on interviewees' earnings. They demonstrate a sizeable beauty premium that is quite stable across occupations. They posit three possible reasons for the beauty premium; employer discrimination, customer discrimination, and occupational crowding.

The authors use three sets of household data to make inferences about the role of beauty in the labour market. They find evidence of a "plainness penalty", such that plain people earn less than average looking people, who in turn earn less than good looking people. Hamermesh and Biddle (1994) also provide evidence that suggests male looks have slightly larger effects on their earnings than those of women. They argue that this may be due to beauty ratings providing a noisier signal of women's physical appearance than for men. Finally, they find, better-looking people sort into occupations where beauty may be more productive due to consumer preferences. Despite this, the positive impact of individuals' looks on wages remains relatively stable across occupations.

In a similar vein, Fletcher (2009) uses data from the restricted version of the National Longitudinal Study of Adolescent Health (Add Health) to estimate the wage returns to attractiveness for young high school graduates (average age 22). He shows that the wage returns to attractiveness are large relative when compared to measured ability. For instance, while a one-standard deviation increase in ability is associated with a 3 to 6 percent higher wage, attractive or very attractive individuals earn 5 to 10 percent more than average-looking individuals. Similarly to Hamermesh and Biddle (1994) their results imply a 3 to 5 percent "plainness penalty" insofar as plain people earn less than average looking people, who earn less than good looking people. These results remain even after the introduction of controls for ability along with a range of usually unmeasured variables, including a personality rating, self-reports of attractiveness and self-confidence.

Scholz and Sicinski (2015) use data from the Wisconsin Longitudinal Survey (WLS), a one-third sample of all seniors in Wisconsin high schools in 1957, as well as yearbook photos and find a strong positive correlation between facial attractiveness of male high school graduates and their subsequent labour market earnings in their mid-thirties and their early fifties. They conclude that the attractiveness premium does not appear to result from greater cognitive ability, high school class rank, or greater educational attainment of attractive men. This leads them to argue that the beauty premium must result from employer and customer discrimination, or due to attractiveness being an intrinsically productive characteristic in the labour market.

Recently Stinebrickner et al. (2018) return to the issue of the wage beauty premia and in, particular, to its source. Rather than focusing on occupational variation in wage premia, they examine its relationship to within occupation variation in job tasks. They use unique data measuring the amount of interpersonal interaction on one's job and demonstrate marked variation in the beauty premium across jobs according to this.

Specifically, they find evidence of a beauty premium when "attractiveness is plausibly a productivity enhancing attribute—those that require substantial amounts of interpersonal interaction—a large beauty premium exists." They posit that "in jobs where attractiveness seems unlikely to truly enhance productivity—jobs that require working with information and data—there is no beauty premium." Thus, Stinebrickner et al. (2018) argue that the variation in the beauty premium across different types of jobs is inconsistent with the employer-based discrimination explanation for the beauty premium in Hamermesh and Biddle (1994) as this would predict that all job types will favour attractive workers. They conclude that individuals are more likely to sort into jobs where physical attractiveness is valued, rather than be discriminated against by employers (Hamermesh & Biddle, 1994; Scholz & Sicinski, 2015).

Mobius and Rosenblat (2006) decomposes the beauty premium in an experimental labour market using Argentinian university students. They identify three channels through which physical attractiveness raises an employer's estimate of a worker's ability. The confidence channel operates through workers' beliefs: they argue that physically-attractive workers are substantially more confident and as a result, worker confidence increases wages under oral interaction. Furthermore, the authors argue that, the visual and oral stereotype channels affect employers' beliefs, such that, employers expect good-looking workers to perform better than their less attractive counterparts under both visual and oral interaction even after controlling for individual worker characteristics and worker confidence.

Mobius and Rosenblat (2006) find a sizeable beauty premium that arises during the wage negotiation process between employer and worker. They find a significant beauty premium ranging from a 12 to 13 percent increase in wages for a one standard deviation increase in beauty in photograph (visual), telephone interview (oral), photograph and telephone (visual and oral) to a 17 percent increase in the face-to-face treatment. Decomposing across the treatment groups, Mobius and Rosenblat (2006) find that 15-20 percent of the beauty premium is transmitted through the confidence channel and about 40 percent each through the visual and oral interaction channels.

A related literature uses methods adopted from social network analysis to investigate the effect of popularity. The idea is to derive from observed school friendship networks sociometric measures of individuals' relational attributes and to analyse their determinants and their association with later-life outcomes. Along these lines Conti et al. (2013) use data from the WLS to estimate the relevance of social skills, namely popularity, for achieving economic success in later life. Popularity is measured from responses to the 1975 Telephone Questionnaire 23 years after the original survey, where respondents were asked to report the names of up to three same-sex best friends from their senior class in high school. Conti et al. (2013) estimate both the predictors of high school friendship nominations as well as the labour market returns to these nominations. Their results suggest that having one additional high school nomination increases labour market earnings by approximately 2 percent around age 35.

In response to this study, Fletcher (2014) replicates the findings by Conti et al. (2013) using Add Health. He demonstrates popularity effects similar to Conti et al. (2013), however questions whether the estimated effects of popularity on earnings reported are sensitive to controls for family-level heterogeneity. By using Add Health Fletcher (2014) overcomes the pitfalls found in Conti et al. (2013), as Add-Health allows for up to 10 friends in any year group is able to closely replicate the findings of Conti et al. (2013). The unique structure of Add Health also allows Fletcher (2014) to control for sibling fixed effects in an alternative version of the model. He finds that sibling comparisons eliminate any associations between popularity and earnings. This suggests that families, rather than friends, might be the cause of the association.

3.3 Potential Mechanisms

Recent research in adolescence (Clark & Loheac, 2007; Gardner & Steinberg, 2005) has mainly focussed on the presence of risk-taking behaviour by an individual caused by emotional and social factors, such as peer effects. While adolescents spend a substantial proportion of their time with their peers at school, thus are likely to be influenced by them, there is more to the decision-making process including factors such as their genetics (Anokhin, Golosheykin, Grant, & Heath, 2009). As a result we estimate the effect of physical attractiveness on a variety of risky behaviours. The health literature generally pins down determinants of risky behaviour to genetic, social environmental and personality factors. While we cannot provide a detailed explanation into the role genetics play, we can provide details on two potential mechanisms that attractiveness might effect risky behaviours, namely the social environmental and personality factors.

Firstly, we look at the role of social environmental. Beauty may effect the presence of risky behaviours with popularity as a potential mediator. For instance, a popular student may try to maintain their social status within the network by engaging in certain "cool" behaviours such as attending large social gatherings, or they are more likely to pick up certain behaviours through a larger social network. Here we argue that individuals who are more physically attractive than the base-level case may be more likely to be popular and as a result may be more likely to be invited or be part of more social events in which certain risky behaviours such as the consumption of alcohol or illicit drugs may take place. We test this theory in more detail in the mechanisms section later in the chapter.

Secondly, individuals who are more attractive may be more conditioned to take risks in general due to their personality. Individuals who are of the most attractive tend to be more outgoing and have high levels of self esteem than average. This outgoing nature is not necessarily related to popularity but in fact my lead the individual to try new things, these may include the risky behaviours that we use throughout this analysis. Overall we argue that attractiveness acts as a gateway to partaking in risky behaviours through popularity in which you may be more likely to be invited into occasions in which these behaviours take place as well as how the individuals personality in general may lead to risk taking irrespective of popularity.

3.4 Data

We use data from the restricted version of the National Longitudinal Study of Adolescent Health (Add Health). Add Health is a school-based longitudinal study of a nationally representative sample of adolescents in grades 7–12 in the United States during the 1994–95 school year. Add Health combines longitudinal survey data on respondents' social, economic, psychological and physical well-being with contextual data on the family, neighbourhood, community, school, friendships, peer groups, and romantic relationships. This provides unique opportunities to study how social environments and behaviours in adolescence are linked to health and achievement outcomes in young adulthood. The unique design of Add Health allows us to estimate the influence of beauty on risky behaviours such as smoking, under-age drinking and teenage sexual activity.

Initially, Add Health starts with an in-school questionnaire which collects data from adolescents, their fellow students, school administrators, parents, siblings, friends, and romantic partners in 1994–95. The study then follows up with a series of in-home interviews of the students approximately one year and then six years later.

The primary sampling frame for Add Health is a database collected by Quality Education Data. Initially the data collectors use systematic sampling methods and implicit stratification ensure that the initial 80 high schools selected are representative of US schools with respect to region of country, urbanicity, size, type, and ethnicity.

Estimates on beauty and risky behaviours are drawn from the in-home section of the survey. Students in each school were stratified by grade and sex. Roughly 17 students were randomly chosen from each year group so that a total of approximately 200 adolescents were selected from each of the 80 pairs of schools. A total core sample of roughly 12,100 adolescents were interviewed in each of the two initial waves (Wave I/II).

For the purpose of our study we focus on adolescence[1] and pool Waves I & II of the in-home surveys. Wave I in-home (September 1994-April 1995) is a follow up of the in-school survey and consists of 20,745 detailed interviews from adolescents who were in the initial study. Wave II in-home survey (April 1996-August) follows up those from Wave I and consists of 14,738 interviews. Although the in-home surveys have a panel structure, we do not follow an individual fixed effects approach, as beauty is primarily a fixed physical characteristic and there is little variation across the two waves. We pool

[1] Mean age is 16.235 for females and 16.350 for males. The youngest interviewed was 13.421, the oldest was 21.421.

the data cross-sectionally and as a result our baseline sample is 31,638 after dropping missing values.

We focus on six different types of risky behaviours (smoking, drinking, binge drinking, substance use, unprotected sex, and pregnancy[2]). Waves I and II of the in-home survey ask adolescents about both their engagement in and frequency of consumption of these activities where relevant. For topics on sexual behaviour, substance use, and illegal activities the respondents listened to recorded questions through headphones and entered their responses independently on the computer. The interviewer did not see or hear the questions, nor the responses of the interviewee. This interview method helps resolve the concern of under-reporting that is often present in studies that examines risky and illicit behaviour as the respondent has full anonymity during the questionnaire.

For our analysis, we focus on the engagement in (=1 if answer>0) and frequency of each risky behaviour. These are broken down as follows:

- *Smoking:* During the past 30 days, on how many days did you smoke cigarettes? (Responses range from 0 to 30 days)
- *Drinking:* During the past 12 months, on how many days did you drink alcohol? (Responses range from 0 = never, 1 = one or two days, 2 = once a month or less, to 6 = everyday or almost everyday)
- *Binge Drinking:* Over the past 12 months, on how many days did you drink five or more drinks in a row? (Responses range from 0 = never, 1 = one or two days, 2 = once a month or less, to 6 = everyday or almost everyday)
- *Substance Use:* During the past 30 days, how many times did you use marijuana/cocaine /inhalants/other drugs? (Responses range from 0 to 900)
- *Unprotected Sex:* Did you or your partner use any method of birth control when you had sexual intercourse most recently? What proportion of the time have you used birth control? (Responses range from 0 = none of the time, 1 = some of the time, to 5 = all of the time)
- *Pregnancy:* Have you ever been pregnant? How many times have you been pregnant? (Responses range from 0 to 9 times)

[2]To alleviate reverse causality issues, we dropped 75 observations who were in late pregnancy (7 to 9 months) at the time of the interview.

As a result, for all six behaviours, we have both a binary variable that represents engagement in the activity as well as continuous variable that illustrates the frequency of this behaviour. We provide estimates for both of these.

The key independent variable throughout our analysis is the physical attractiveness of the respondent. This variable is measured by the interviewer immediately after the interview. The interviewer is asked to describe the respondent, the neighbourhood, the circumstances, and the surroundings of the interview. With respect to the question on physical attractiveness, the interviewer is asked "How physically attractive is the respondent?" This is measured on a 1 to 5 scale, with 1 being "very unattractive" and 5 being "very attractive". The mean score on the 1–5 scale is 3.57, with a standard deviation of 0.84, where within-interviewer variation is 0.76 and between-interviewer variation is 0.47.

We use the information based on this question to derive a binary indicator, *Attractive*, which takes the value of 1 if the interviewer answered "very attractive" or "attractive", and 0 if "average looking", "unattractive", or "very unattractive".[3] A similar question is asked of the interviewer to rate the personality attractiveness of the respondent, which we will use for additional analysis. With respect to the survey design, we know limited information regarding the interviewers who conduct the surveys. We know, by design, that the all the interviewers in Waves I & II are female. This is to control for any gender bias that may have possibly occurred during the interview phase if there were different gendered interviewers. Moreover, we also know that in total there are 966 interviewers, roughly split equally across both Waves I & II. Therefore, each interviewer interviewed on average 32.8 respondents.

In addition to beauty, we use popularity to investigate its mediating effect with respect to attractiveness and risky behaviours. In order to measure popularity, we use information from self-defined friendship nominations. Each respondent was asked to nominate their

[3]For robustness checks, we also report results with both the 5-point scale and a 3-point scale in the appendix. The 3-point scale are based on these three regrouped categories: attractive or very attractive; average looking; unattractive or very unattractive.

top 5 male and top 5 female friends. From this we proxy popularity with the logarithm of in-degree, that is, the number of times the respondent has been nominated as a friend by their peers.

Table 3.12 presents summary statistics for the full sample stratified by gender. For the purpose of the study we use all respondents who answered the In-Home Waves I & II questionnaires. The sample consists of 16,152 female respondents and 15,486 male respondents. Add Health allows us to create a rich set of family background information which we later use as covariates. These include: the adolescent's race, age, whether mother is absent from home and mother's education levels, whether father is absent from home and father's education levels, and household income.[4]

3.5 Empirical Strategy

Our baseline model takes the form of the following fixed effects model

$$Y_{ivst} = \alpha_s + \alpha_v + \alpha_t + \beta Attractive_{ivst} + X_{ivst}\gamma + \varepsilon_{ivst}, \tag{3.1}$$

where Y_{ivst} denotes the risky behaviour outcome of interest for student i at school s interviewed by interviewer v at year t, α_s the school fixed effects, α_v the interviewer fixed effects, α_t the year effects, X_{ivst} a vector of individual characteristics, and ε_{ivst} the error term. $Attractive_{ivst}$ is a binary indicator which takes the value of 1 if individual i is "very attractive" or "attractive" in terms of physical attractiveness, and 0 otherwise.

A challenge for the identification of a beauty effect on risky behaviours is that beauty may proxy for a range of family background characteristics that are also correlated with risky behaviours. To tackle this issue, we start by including a rich set of socio-economic background characteristics in X_{ivst}, including the adolescent's race, age and its squared

[4]To avoid dropping those who have missing values for household income, a binary indicator of missing household income is included in the regression, and missing values are recoded to zero.

term, whether mother is absent from home and mother's education levels, whether father is absent from home and father's education levels, and household income. These covariates are also denoted in Table 3.12. Next, our inclusion of school fixed effects[5] α_s in the regression will reduce the influence of unobservable family socio-economic status if there is selection into school based on family background. Unless indicated otherwise, standard errors are clustered at the school level to allow for intra-school correlation of the error term.

Our key variable of interest, physical attractiveness, reflects judgements of the survey interviewers. This, naturally, leads to a range of concerns regarding the extent to which this measure may reflect other factors that are correlated with the propensity to undertake risky behaviours. For instance, interviewers may either vary in their judgement of attractiveness and/or they may receive a non-random selection of respondents in terms of attractiveness and propensity to engage in risky behaviour. Out of this concern, we introduce fixed effects for the 966 interviewers in the data.[6] The inclusion of interviewer fixed effects α_v will help deal with the case if interviewer ratings of the respondents' physical attractiveness and the respondents' self-reported risky behaviours are correlated in a systematic way. Hence our main estimates of interest now reflect within-interviewer variation in judgements of respondent attractiveness.

We check robustness of the results to a number of additional concerns. First, out of the concern that a third person present at the interview might bias the adolescent's reporting of risky behaviours, we check if the results are robust when excluding those who had interrupted interviews. We further provide a number of examinations that aim to establish whether any beauty effects reflect confounding influences of factors such as self-esteem and personality attractiveness.

To understand the underlying mechanism through which physical attractiveness might

[5]There are 145 schools in the data.

[6]There are 564 interviewers in Wave I, and 402 interviewers in Wave II. An average interviewer interviews 32.8 students.

lead to risky behaviours, we examine popularity as a potential mediator. Previous research demonstrate that friendships may be powerful influences for risky behaviours, particularly during adolescence. Attractive adolescents may find it easier to make friends in school. This popularity may influence both the propensity and opportunities to engage in risky behaviours. At the same time, less popular adolescents may be more likely to engage in certain risky behaviours to, for instance, to increase acceptance amongst their peers. Hence, in practice the effect of popularity on risky behaviours is an empirical question. Our approach is to use mediation analysis (Judd & Kenny, 1981; MacKinnon, Fairchild, & Fritz, 2007) to understand how much of the beauty effect on risky behaviours is explained by popularity, by running the following regression:

$$Y_{ivst} = \alpha'_s + \alpha'_v + \alpha'_t + \beta' Attractive_{ivst} + \delta Popularity_{ivst} + X_{ivst}\gamma' + \varepsilon'_{ivst}, \tag{3.2}$$

where $Popularity_{ivst}$ denotes the log number of students in school s who nominate i as a friend. We measure the total effect of beauty on risky behaviour with β_1, the direct effect of beauty on risky behaviour with β', and the indirect (mediated) effect through popularity with $\beta - \beta'$, and compare the sizes of indirect effect to the total effect to gauge the importance of popularity. Standard errors for these measures are obtained by bootstrapping.

3.6 Results

3.6.1 Baseline Results

Table 3.1 presents estimates of the effect of adolescent attractiveness on risky behaviours. We report all results separately for males and female.[7] The top two panels (A & B) provide estimates of the probability of engaging in one of six different risky behaviours for females and males respectively. The bottom two panels (C & D) provide corresponding

[7] Reported numbers of observations may be smaller due to no variation in the outcomes within the school or interviewer.

estimates for frequency of risky behaviours (at the intensive margin). Taken together, they provide estimates of the effects of beauty on adolescent risky behaviours at both the intensive and extensive margins. For simplicity the incidence models as estimated as linear probability models, while the frequency models are estimates by least squares.

These estimates show marked variation in both the incidence and frequency of risky behaviours according to interviewer reported beauty. These effects typically work in the same direction and are quite consistent across genders. More attractive adolescents are less likely to smoke, engage in substance use, and for girls, become pregnant. The estimates for unprotected sex are consistently negative although not significant. Moreover, these effects are of a substantial magnitude. Comparing the size of the estimated coefficients to the sample mean incidences reported at the bottom of each panel, these reductions are typically in the order of 5–10%. For ever pregnant the effect is even larger. Attractive adolescent girls are 15 percent less likely to have ever been pregnant by the time of interview (ages vary between 13 and 19). The one outlying behaviour is drinking alcohol. Attractive adolescents are more likely to have consumed alcohol over the past year, this effect is much larger for girls. The effect of attractiveness on binge drinking is positive but small and not statistically significant.

One issue might be that these models of incidence may hide important variation in the frequency of these risky behaviours. In turn, at least in some cases, this variation in the intensive margin may be the particular source of policy concern. To examine this, the bottom two panels report analogous results for the frequency of these risky behaviours. For teenage girls these results largely follow those for incidence. Likewise, for boys the estimated effects on frequency largely follow those for incidence, although the positive effects of attractiveness on drinking now becomes statistically insignificant, whereas the negative effects on substance use are now statistically significant. As a general point, these estimates are less precise. This may reflect our decision to estimate these models by OLS when count data models may be more appropriate. In the next section, we return to this point by estimating non-linear models to check for robustness.

Tables 3.2 and 3.3 report more results based on a 3-point and 5-point scale of attractiveness respectively, with average looking as the reference group. Table 3.2 shows that unattractive is only significant in two cases, where unattractive males are less likely to engage in drinking or binge drinking. Table 3.3 demonstrates that while there is an apparent gap between very attractive and attractive females, these differences are much smaller for males. These results highlight nuanced heterogeneous effects by gender.

An alternative, perhaps cleaner, identification strategy can exploit within-family between-sibling variation in attractiveness[8]. This design has the advantage of purging all family background influences by utilizing the idiosyncratic genetic variation in physical attractiveness between siblings. In practice, however, this comes at the cost of little identifying variation and smaller sample size, resulting in less precise estimates and smaller statistical power. We present the results for this sibling fixed effects model in Appendix Table A.2, combining males and females. Due to the aforementioned statistical issues, the estimates are noisy, with only one statistical coefficient for the incidence of smoking. Furthermore, due to the fact that only identical twins and fraternal twins were sampled with certainty and that full-sibling pairs are only entered into the sample by chance we are unable to disentangle this analysis any further due to the loss of all statistical power and the cell sizes not meeting the disclosure requirements outlined by the National Longitudinal Study of Adolescent to Adult Health Secure Licence Agreement.

3.6.2 Robustness

Table 3.4 reports alternative results using non-linear estimation strategies. Panels A & B report odds ratios following a logistic model for binary outcomes, and panels C & D report the coefficients from a Poisson model where frequencies of risky behaviours are the outcomes. Considering the difficulty of finding consistent estimators for dealing with fixed effects in non-linear models, we simplify by including the average outcome at the

[8]The in-home sample consists of pairs of siblings living in the same households. Identical twins and fraternal twins were sampled with certainty. In addition, non-related pairs, such as step-siblings, foster children, and adopted (non-related) siblings, were part of the sample. The majority of full-sibling pairs entered into the sample by chance (disproportionately drawn from the 16 saturation-school samples).

school and interviewer levels to take into account selection issues at these levels. The results are, in essence, consistent with those in Table 3.1, but with some expected improvement in precision. The only two cases where evidence becomes weaker in terms of statistical significant are the incidence of pregnancy for girls, and the frequency of substance use for boys. Two cases become borderline statistically significant with incidence of binge drinking for girls and frequency of drinking for boys.

In summary, our results generally hold under these estimation approaches, with only slight variation. We only see a little variation in the estimates of the effect of attractiveness on unprotected sex. While the sign is routinely negative the effect for male incidence is now statistically significant at a 10 percent level, and the negative effects for female incidence and frequency are no longer statistically significant.

Another concern relates to the self-report nature of the risky behaviours. Although the CAPI procedure helps with keeping the responses unobserved from the interviewer, interruption during the interview such as parents entering the room might still lead to some biased reporting. In Table 3.5, we rerun the estimation on a sub-sample which was interruption free during the interview process. We lose some precision, which is partly due to the smaller sample, but the results are similar to those obtained from the full sample.

A further concern is that, rather than picking up attractiveness per se, interviewers are responding to how interviewees present themselves. For instance, physical attractive individuals may be more confident or have higher self-esteem. This could either be considered as a transmission channel (Mobius & Rosenblat, 2006), or could represent endogeneity issues such as family background and socio-economic status not captured by the observables, and reverse causation. In the former case, separating the role of self-esteem would give an indication of the importance of this transmission channel. In the latter case, controlling for self-esteem would reduce the endogeneity bias. For these considerations, we next introduce variables about how interviewees present themselves into the model. Add health provides information on self-reported self-esteem by the respondent, and a scale of personality attractiveness, similar to physical attractiveness, reported by the interviewer. We separately control for self-esteem in Table 3.6 and personality attractiveness in Table 3.7. Both variables are consistently negatively associated with all risky behaviours we examine. As we cannot say for certain whether these reflect underlying channels or unobserved family background, we stress the potential for reverse causation and hence caution with interpreting these coefficients. That said, the effects of attractiveness, to differing degrees, point to a separate effect of physical attractiveness on certain risky behaviours. The remaining effect is strongest for alcohol consumption. Although this is not a perfect test due to the correlation between attractiveness and self-esteem/personality, the results point out that self-esteem or personality alone does not explain all the beauty effects.

Lastly, we investigate whether there are potential heterogeneities across racial or age groups. There exist large racial disparities in risky behaviours, as well as some small variation in attractiveness ratings across racial groups. Table 3.8 reports the results for racial heterogeneity by including an interaction term between attractive and non-white. A general finding is that the beauty effects on alcohol consumption is mainly driven by whites, except for female smoking. The effects for non-whites are much smaller and close to zero, particularly for males. On the age dimension, the variation in risky behaviours is much lower in younger age groups, which prompts us to investigate whether the beauty effects may vary across age. Results in Table 3.9 show that there is little to no heterogeneity across age groups, suggesting the beauty effect is common across high school ages.

3.7 Mechanisms

We now investigate the underlying mechanism through which beauty might affect risk behaviours. We run mediation analysis, considering popularity as a potential mediator. The results are presented in Table 3.10. Column (1) presents the effect of attractiveness on popularity. We find that attractiveness strongly increases popularity for both males and females. Having established this, we next consider whether the effect on risky behaviours is mediated through popularity, for instance a popular student may try to maintain their social status within the network by engaging in certain "cool" behaviours, or they are more likely to pick up certain behaviours through a larger social network. Columns (2)–(7) report the results for equation (3.2), where popularity is included in the model. The results show that popularity is strongly correlated with risky behaviours. Specifically, for females, popularity is positively correlated with smoking, drinking, binge drinking, and substance use, and negatively correlated with pregnancy. Unprotected sex is not significantly associated with popularity for females. For males, popularity is strongly associated with drinking, binge drinking, substance use, and unprotected sex, but not correlated with smoking.

To better understand the extent to which popularity explains the effect of attractiveness on risky behaviours, we decompose the total effect into direct effect (of beauty on risky behaviours) and indirect effect (mediated through popularity) in Table 3.11. For females, the indirect effect and direct effect go in the same direction on drinking and pregnancy, explaining about 40 percent of total effect for drinking, and about a quarter of the total effect on pregnancy. The direct and indirect effects take opposite signs for smoking, binge drinking, and substance use, cancelling out some of the negative direct effect. For males, the direct and indirect effects take the same signs for drinking, binge drinking, and unprotected, explaining about or over half of the total effect in each case, and take opposite signs for smoking and substance use.

3.8 Conclusion

This chapter makes several contributions to the literature on social interactions and risky behaviours amongst young adults. We use the Add Health Survey data to investigate how beauty influences adolescent risky behaviours in the United States. We focus on six different types of risky behaviours (Smoking, Drinking, Binge drinking, Substance Use, Unprotected Sex and Pregnancy).

The previous literature has provided evidence on the effect of attractiveness on labour market outcomes conditional on individual characteristics, both demographic and "pre-market". Attractiveness is likely to change both the opportunities and costs of a variety of behaviours during adolescence.

Overall our findings suggest substantial variation risky behaviours according to attractiveness reported by the interviewer. We find evidence to suggest that more attractive teens are less likely to smoke than both modal and less attractive teens. Additionally, there appears to be an attractiveness gradient in alcohol consumption, this however is different by gender. We find that attractive females are more likely to have consumed alcohol in the past twelve months than those of, or below "average" looking. These effects are large, attractive teenage girls are 4.2 percentage points more likely to have consumed alcohol, than girls of and below average looking.

Our results also provide suggestive evidence that attractive adolescent females are less likely to use illicit substances, engage in unprotected sex and become pregnant. Overall, the vast majority of the literature relating to physical attractiveness has focuses on later-life labour effects. We provide new evidence to this literature by examining the role of beauty at a younger age (adolescence). Our results provide new evidence in explaining adolescent behavioural decisions and social interactions, by expanding the literature to include physical attractiveness as a young adult. We demonstrate that these effects do not reflect potential con-founders such as risky behaviour of peer groups, personal grooming or the socio-economic background of the adolescent.

Throughout we performed a variety of robustness checks such as estimating logistic and count data versions of out preferred specification. Furthermore, we take into consider potential confounders such as differences in interviewer characteristics such as including interviewer fixed effects. We also control for whether the interviewer's perception on how well-groomed the respondents are, as well as how they rated the respondent's personality to see if it biases our results. Our results remain robust and significant throughout and provide compelling new evidence in the literature.

TABLE 3.1: Beauty and Risky behaviours

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Female subsample, dep. var. = engagement in risky behaviour						
Attractive	-0.021^{**}	0.046^{***}	0.011	-0.018^{***}	-0.009	-0.011^{**}
	(0.010)	(0.010)	(0.007)	(0.006)	(0.006)	(0.005)
Obs.	15,795	15,795	15,795	15,795	15,795	15,795
Dep. var. mean	0.279	0.458	0.241	0.151	0.119	0.071
Panel B: male subsample, dep. var. = engagement in risky behaviour						
Attractive	-0.026^{***}	0.024^{**}	0.014	-0.014	-0.006	
	(0.009)	(0.010)	(0.009)	(0.009)	(0.006)	
Obs.	15,093	15,093	15,093	15,093	15,093	
Dep. var. mean	0.288	0.454	0.295	0.183	0.107	
Panel C: female subsample, dep. var. = frequency of risky behaviour						
Attractive	-0.406^{**}	0.080^{**}	-0.007	-0.033^{***}	-0.010	-0.024^{***}
	(0.204)	(0.031)	(0.024)	(0.012)	(0.010)	(0.008)
Obs.	15,795	15,795	15,795	15,742	15,794	15,783
Dep. var. mean	4.527	0.998	0.538	0.263	0.134	0.085
Panel D: male subsample, dep. var. = frequency of risky behaviour						
Attractive	-0.504^{**}	0.054	0.001	-0.034^{*}	-0.014	
	(0.194)	(0.033)	(0.029)	(0.020)	(0.010)	
Obs.	15,093	15,093	15,093	15,018	15,093	
Dep. var. mean	4.622	1.152	0.799	0.369	0.109	

Notes: This table reports the effect of beauty on a number of risky behaviours. All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is participation in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no for panels *A* and *B*. Dependent variable is the frequency of the risky behaviour for panels *C* and *D*. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.2: Results Using 3-point Scale of Beauty

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Female subsample, dep. var. = participation in risky behaviour						
Attractive (3-point scale)	−0.019*	0.042***	0.010	−0.018***	−0.010	−0.011**
	(0.010)	(0.010)	(0.007)	(0.007)	(0.006)	(0.005)
Unattractive (3-point scale)	0.010	−0.025	−0.006	−0.003	−0.008	0.000
	(0.016)	(0.020)	(0.014)	(0.014)	(0.010)	(0.011)
Obs.	15,795	15,795	15,795	15,795	15,795	15,795
Dep. var. mean	0.279	0.458	0.241	0.151	0.119	0.071
Panel B: male subsample, dep. var. = participation in risky behaviour						
Attractive (3-point scale)	−0.025**	0.018*	0.008	−0.014	−0.004	
	(0.010)	(0.009)	(0.009)	(0.009)	(0.006)	
Unattractive (3-point scale)	0.011	−0.055***	−0.055***	−0.007	0.017	
	(0.018)	(0.020)	(0.018)	(0.013)	(0.011)	
Obs.	15,093	15,093	15,093	15,093	15,093	
Dep. var. mean	0.288	0.454	0.295	0.183	0.107	
Panel C: female subsample, dep. var. = frequency of risky behaviour						
Attractive (3-point scale)	−0.413**	0.074**	−0.013	−0.035***	−0.013	−0.024***
	(0.208)	(0.033)	(0.024)	(0.013)	(0.011)	(0.008)
Unattractive (3-point scale)	−0.054	−0.048	−0.049	−0.011	−0.024	−0.002
	(0.346)	(0.053)	(0.039)	(0.028)	(0.021)	(0.014)
Obs.	15,795	15,795	15,795	15,742	15,794	15,783
Dep. var. mean	0.279	0.458	0.241	0.148	0.119	0.070
Panel D: male subsample, dep. var. = frequency of risky behaviour						
Attractive (3-point scale)	−0.509**	0.040	−0.007	−0.037*	−0.016	
	(0.208)	(0.032)	(0.028)	(0.020)	(0.010)	
Unattractive (3-point scale)	−0.045	−0.120	−0.074	−0.028	−0.016	
	(0.381)	(0.074)	(0.068)	(0.035)	(0.020)	
Obs.	15,093	15,093	15,093	15,018	15,093	
Dep. var. mean	4.622	1.152	0.799	0.369	0.109	

Notes: This table reports the effect of beauty on a number of risky behaviours. All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is participation in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no for panels *A* and *B*. Dependent variable is the frequency of the risky behaviour for panels *C* and *D*. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.3: Results Using 5-point Scale of Beauty

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Female subsample, dep. var. = participation in risky behaviour						
Very attractive (5-point scale)	−0.025*	0.054***	0.023**	−0.020*	−0.019**	−0.016**
	(0.014)	(0.015)	(0.011)	(0.011)	(0.008)	(0.008)
Attractive (5-point scale)	−0.018*	0.038***	0.006	−0.017**	−0.007	−0.010*
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)	(0.005)
Unattractive (5-point scale)	0.028	−0.039*	−0.023	0.014	−0.004	0.006
	(0.021)	(0.023)	(0.016)	(0.015)	(0.012)	(0.012)
Very unattractive (5-point scale)	−0.034	0.011	0.038	−0.041*	−0.018	−0.015
	(0.026)	(0.031)	(0.028)	(0.024)	(0.021)	(0.016)
Obs.	15,795	15,795	15,795	15,795	15,795	15,795
Panel B: male subsample, dep. var. = participation in risky behaviour						
Very attractive (5-point scale)	−0.024	0.015	0.009	−0.016	−0.008	
	(0.016)	(0.018)	(0.014)	(0.014)	(0.010)	
Attractive (5-point scale)	−0.025***	0.019*	0.008	−0.014	−0.003	
	(0.010)	(0.010)	(0.010)	(0.010)	(0.006)	
Unattractive (5-point scale)	0.011	−0.071***	−0.070***	−0.012	0.016	
	(0.019)	(0.022)	(0.020)	(0.014)	(0.011)	
Very unattractive (5-point scale)	0.015	0.019	0.019	0.017	0.017	
	(0.039)	(0.041)	(0.036)	(0.029)	(0.021)	
Obs.	15,093	15,093	15,093	15,093	15,093	
Panel C: female subsample, dep. var. = frequency of risky behaviour						
Very attractive (5-point scale)	−0.700***	0.109**	0.027	−0.046**	−0.009	−0.029***
	(0.244)	(0.042)	(0.032)	(0.021)	(0.016)	(0.009)
Attractive (5-point scale)	−0.310	0.061*	−0.027	−0.031**	−0.014	−0.023***
	(0.225)	(0.034)	(0.025)	(0.013)	(0.011)	(0.008)
Unattractive (5-point scale)	0.272	−0.040	−0.065	0.025	−0.004	−0.003
	(0.440)	(0.061)	(0.043)	(0.029)	(0.022)	(0.015)
Very unattractive (5-point scale)	−0.876	−0.061	−0.003	−0.097*	−0.071**	0.000
	(0.580)	(0.094)	(0.080)	(0.049)	(0.035)	(0.034)
Obs.	15,795	15,795	15,795	15,742	15,794	15,783
Panel D: male subsample, dep. var. = frequency of risky behaviour						
Very attractive (5-point scale)	−0.425	0.067	0.001	−0.047	−0.007	
	(0.337)	(0.050)	(0.045)	(0.036)	(0.020)	
Attractive (5-point scale)	−0.529***	0.035	−0.008	−0.035	−0.018*	
	(0.201)	(0.033)	(0.029)	(0.022)	(0.009)	
Unattractive (5-point scale)	0.035	−0.162**	−0.113	−0.034	−0.011	
	(0.398)	(0.075)	(0.074)	(0.037)	(0.023)	
Very unattractive (5-point scale)	−0.414	0.087	0.116	0.001	−0.039	
	(0.801)	(0.133)	(0.108)	(0.069)	(0.028)	
Obs.	15,093	15,093	15,093	15,018	15,093	

Notes: This table reports the effect of beauty on a number of risky behaviours. All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is participation in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no for panels *A* and *B*. Dependent variable is the frequency of the risky behaviour for panels *C* and *D*. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.4: Nonlinear Model Results

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Female subsample, dep. var. = engagement in risky behaviour, logistic model, odds ratio reported						
Attractive	0.904**	1.176***	1.061*	0.873***	0.965	0.886
	(0.041)	(0.044)	(0.038)	(0.041)	(0.048)	(0.072)
Obs.	15,978	15,978	15,978	15,978	15,978	15,978
Dep. var. mean	0.280	0.458	0.241	0.151	0.119	0.071
Panel B: male subsample, dep. var. = engagement in risky behaviour, logistic model, odds ratio reported						
Attractive	0.892***	1.112***	1.084*	0.946	0.945	
	(0.037)	(0.041)	(0.046)	(0.050)	(0.055)	
Obs.	15,279	15,279	15,279	15,279	15,279	
Dep. var. mean	0.288	0.454	0.295	0.182	0.107	
Panel C: female subsample, dep. var. = frequency of risky behaviour, Poisson model						
Attractive	−0.057*	0.064***	−0.020	−0.113***	−0.020	−0.221***
	(0.035)	(0.024)	(0.034)	(0.043)	(0.058)	(0.077)
Obs.	15,978	15,978	15,978	15,925	15,977	15,966
Dep. var. mean	4.527	0.998	0.538	0.263	0.134	0.085
Panel D: male subsample, dep. var. = frequency of risky behaviour, Poisson model						
Attractive	−0.086**	0.042*	0.007	−0.070	−0.082	
	(0.035)	(0.025)	(0.030)	(0.049)	(0.083)	
Obs.	15,279	15,279	15,279	15,204	15,279	
Dep. var. mean	4.622	1.152	0.799	0.369	0.109	

Notes: This table reports the effect of beauty on a number of risky behaviours. All models control for observable characteristics, school and interviewer averages of the outcome. Panels *A* and *B* estimate a logistic model, where the dependent variable is engagement in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no. Panels *C* and *D* estimate a Possion model, where the dependent variable is the frequency of the risky behaviour. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Odds ratios are reported in panels *A* and *B*, whereas coefficients are reported in panels *C* and *D*. Standard errors clustered at the school level are in parentheses.

TABLE 3.5: Robustness Check on Interview Interruption

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Female subsample, dep. var. = engagement in risky behaviour						
Attractive	-0.013	0.049^{***}	0.010	-0.019^{**}	-0.010	-0.012^{*}
	(0.012)	(0.010)	(0.008)	(0.008)	(0.007)	(0.006)
Obs.	12,133	12,133	12,133	12,133	12,133	12,133
Panel B: male subsample, dep. var. = engagement in risky behaviour						
Attractive	-0.030^{***}	0.022^{**}	0.014	-0.014	-0.005	
	(0.011)	(0.011)	(0.010)	(0.010)	(0.007)	
Obs.	11,876	11,876	11,876	11,876	11,876	

Notes: This table reports the effect of beauty on a number of risky behaviours based on the subsample excluding those who had a third person present during the interview. Beauty is categorised as attractive, unattractive and average looking (base group). All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is engagement in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no for panels *A* and *B*. Dependent variable is the frequency of the risky behaviour for panels *C* and *D*. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.6: Beauty, Self-Esteem, and Risky behaviours

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: female						
Attractive	−0.014	0.053***	0.016**	−0.012*	−0.007	−0.010**
	(0.010)	(0.010)	(0.007)	(0.007)	(0.006)	(0.005)
Self-esteem	−0.024***	−0.026***	−0.020***	−0.018***	−0.008***	−0.003***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Obs.	15,760	15,760	15,760	15,760	15,760	15,760
Panel B: male						
Attractive	−0.021**	0.029***	0.018**	−0.010	−0.004	
	(0.009)	(0.010)	(0.009)	(0.009)	(0.006)	
Self-esteem	−0.022***	−0.021***	−0.017***	−0.016***	−0.006***	
	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	
Obs.	15,061	15,061	15,061	15,061	15,061	

Notes: All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is engagement in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.7: Beauty, Personality, and Risky behaviours

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: female						
Attractive	0.010	0.060***	0.028***	0.002	0.004	−0.005
	(0.011)	(0.010)	(0.008)	(0.008)	(0.007)	(0.005)
Personality attractive	−0.069***	−0.032***	−0.040***	−0.045***	−0.029***	−0.015***
	(0.008)	(0.009)	(0.009)	(0.007)	(0.007)	(0.006)
Obs.	15,794	15,794	15,794	15,794	15,794	15,794
Panel B: male						
Attractive	−0.005	0.036***	0.034***	0.002	0.004	
	(0.010)	(0.011)	(0.011)	(0.009)	(0.007)	
Personality attractive	−0.046***	−0.027**	−0.043***	−0.034***	−0.021***	
	(0.009)	(0.011)	(0.010)	(0.007)	(0.006)	
Obs.	15,093	15,093	15,093	15,093	15,093	

Notes: All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is engagement in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.8: Racial Heterogeneity in the Effect of Beauty on Risky Behaviours

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Female subsample, dep. var. = participation in risky behaviour						
Attractive	−0.005	0.065***	0.029***	−0.010	−0.008	−0.016***
	(0.012)	(0.011)	(0.010)	(0.010)	(0.008)	(0.006)
Attractive × non-white	−0.032*	−0.040**	−0.037**	−0.016	−0.002	0.010
	(0.018)	(0.018)	(0.015)	(0.015)	(0.012)	(0.011)
Obs.	15,795	15,795	15,795	15,795	15,795	15,795
Dep. var. mean	0.279	0.458	0.241	0.151	0.119	0.071
Panel B: male subsample, dep. var. = participation in risky behaviour						
Attractive	−0.030**	0.030**	0.031***	−0.029***	−0.014*	
	(0.013)	(0.012)	(0.011)	(0.011)	(0.008)	
Attractive × non-white	0.009	−0.013	−0.035*	0.032**	0.017	
	(0.016)	(0.021)	(0.018)	(0.014)	(0.010)	
Obs.	15,093	15,093	15,093	15,093	15,093	
Dep. var. mean	0.288	0.454	0.295	0.183	0.107	

Notes: This table reports the heterogenous effect of beauty on risky behaviours by race. All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is participation in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no for panels *A* and *B*. Dependent variable is the frequency of the risky behaviour for panels *C* and *D*. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.9: Age Heterogeneity in the Effect of Beauty on Risky Behaviours

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Female subsample, dep. var. = participation in risky behaviour						
Attractive	−0.021*	0.054***	0.014	−0.017*	−0.007	−0.010**
	(0.011)	(0.011)	(0.008)	(0.009)	(0.007)	(0.004)
Attractive × age above median	0.000	−0.018	−0.007	−0.003	−0.005	−0.003
	(0.013)	(0.014)	(0.011)	(0.010)	(0.009)	(0.008)
Obs.	15,795	15,795	15,795	15,795	15,795	15,795
Dep. var. mean	0.279	0.458	0.241	0.151	0.119	0.071
Panel B: male subsample, dep. var. = participation in risky behaviour						
Attractive	−0.021*	0.027**	0.009	−0.026***	−0.004	
	(0.012)	(0.012)	(0.010)	(0.008)	(0.007)	
Attractive × age above median	−0.011	−0.006	0.010	0.024*	−0.003	
	(0.013)	(0.012)	(0.014)	(0.012)	(0.010)	
Obs.	15,093	15,093	15,093	15,093	15,093	
Dep. var. mean	0.288	0.454	0.295	0.183	0.107	

Notes: This table reports the heterogenous effect of beauty on risky behaviours by age. All models control for observable characteristics, school and interviewer fixed effects. Dependent variable is participation in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no for panels *A* and *B*. Dependent variable is the frequency of the risky behaviour for panels *C* and *D*. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.10: Popularity as the Mechanism

		Risk behaviours					
	(1) Popularity	(2) Smoke	(3) Drink	(4) Binge drink	(5) Substance use	(6) Unprotected sex	(7) Pregnancy
Panel A: Female subsample							
Attractive	0.230***	−0.014	0.023**	−0.003	−0.021**	−0.004	−0.008
	(0.016)	(0.012)	(0.011)	(0.009)	(0.008)	(0.007)	(0.006)
Popularity		0.019**	0.070***	0.042***	0.020***	0.001	−0.013***
		(0.008)	(0.011)	(0.008)	(0.008)	(0.005)	(0.004)
Obs.	11,182	11,182	11,182	11,182	11,182	11,182	11,182
Panel B: male subsample							
Attractive	0.208***	−0.025**	0.031**	0.016	−0.013	0.003	
	(0.017)	(0.011)	(0.012)	(0.010)	(0.010)	(0.006)	
Popularity		0.009	0.048***	0.046***	0.024***	0.013***	
		(0.009)	(0.009)	(0.008)	(0.009)	(0.004)	
Obs.	10,451	10,451	10,451	10,451	10,451	10,451	

Notes: Beauty is categorised as attractive, unattractive and average looking (base group). All models control for observable characteristics, school and interviewer fixed effects. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the school level are in parentheses.

TABLE 3.11: Mediation Analysis Results with Popularity as the Mediatior

	Participation in risk behaviour						
	(1) Smoke	(2) Drink	(3) Binge	(4) Substance use	(5) Unprotected sex	(6) Pregnancy	
Panel A: Female							
Direct effect	−0.014	0.023**	−0.003	−0.021***	−0.004	−0.008	
	(0.009)	(0.010)	(0.009)	(0.007)	(0.007)	(0.005)	
Indirect effect (through popularity)	0.004***	0.016***	0.010***	0.005***	0.000	−0.003***	
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	
Total effect	−0.010	0.039***	0.007	−0.017**	−0.004	−0.011**	
	(0.009)	(0.010)	(0.009)	(0.007)	(0.007)	(0.005)	
Obs.	11,182	11,182	11,182	11,182	11,182	11,182	11,182
Panel B: male							
Direct effect	−0.025**	0.031***	0.016	−0.013	0.003		
	(0.010)	(0.011)	(0.010)	(0.008)	(0.007)		
Indirect effect (through popularity)	0.002	0.010***	0.010***	0.005***	0.003***		
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)		
Total effect	−0.023**	0.041***	0.025***	−0.009	0.006		
	(0.010)	(0.011)	(0.010)	(0.008)	(0.007)		
Obs.	10,451	10,451	10,451	10,451	10,451	10,451	

Notes: This table reports the results of a mediation analysis, with popularity as the mediator for the effect of beauty on risky behaviours. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors are obtained by bootstrapping.

TABLE 3.12: Summary Statistics by Sex

	Female (51.1%)		Male (48.9%)		Total	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Beauty						
Attractive	0.565	(0.496)	0.429	(0.495)	0.499	(0.500)
Attractive (3-point scale)	0.565	(0.496)	0.429	(0.495)	0.499	(0.500)
Average (3-point scale)	0.384	(0.486)	0.505	(0.500)	0.443	(0.497)
Unattractive (3-point scale)	0.051	(0.221)	0.066	(0.248)	0.059	(0.235)
Very attractive (5-point scale)	0.186	(0.389)	0.101	(0.302)	0.145	(0.352)
Attractive (5-point scale)	0.379	(0.485)	0.328	(0.470)	0.354	(0.478)
About average (5-point scale)	0.384	(0.486)	0.505	(0.500)	0.443	(0.497)
Unattractive (5-point scale)	0.036	(0.185)	0.054	(0.225)	0.044	(0.206)
Very unattractive (5-point scale)	0.016	(0.125)	0.012	(0.111)	0.014	(0.118)
Risky behaviour						
Smoking	0.280	(0.449)	0.288	(0.453)	0.284	(0.451)
Drinking	0.458	(0.498)	0.454	(0.498)	0.456	(0.498)
Binge drinking	0.241	(0.428)	0.294	(0.456)	0.267	(0.442)
Substance use	0.151	(0.358)	0.183	(0.387)	0.167	(0.373)
Unprotected sex	0.119	(0.324)	0.108	(0.310)	0.114	(0.317)
Ever pregnant	0.071	(0.257)			0.071	(0.257)
Smoking (frequency)	4.528	(9.795)	4.618	(9.837)	4.572	(9.816)
Drinking (frequency)	0.998	(1.371)	1.149	(1.578)	1.072	(1.478)
Binge drinking (frequency)	0.538	(1.159)	0.796	(1.472)	0.664	(1.328)
Substance use (frequency)	0.262	(0.748)	0.370	(0.951)	0.314	(0.855)
Unprotected sex (frequency)	0.134	(0.590)	0.109	(0.527)	0.122	(0.560)
Ever pregnant (frequency)	0.086	(0.348)			0.086	(0.348)
Covariates						
White	0.517	(0.500)	0.518	(0.500)	0.518	(0.500)
Black	0.210	(0.408)	0.194	(0.396)	0.202	(0.402)
Hispanic	0.161	(0.367)	0.168	(0.374)	0.164	(0.371)
Other ethnicity	0.112	(0.315)	0.119	(0.324)	0.115	(0.319)

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	Female (51.1%)		Male (48.9%)		Total	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Age	16.235	(1.537)	16.350	(1.521)	16.291	(1.530)
Age-sq./10	26.595	(4.946)	26.963	(4.913)	26.775	(4.933)
Mother not present	0.058	(0.234)	0.065	(0.247)	0.062	(0.240)
Mother no high school	0.149	(0.356)	0.131	(0.337)	0.140	(0.347)
Mother high school or some college	0.502	(0.500)	0.487	(0.500)	0.495	(0.500)
Mother degree and above	0.250	(0.433)	0.263	(0.441)	0.257	(0.437)
Mother education missing	0.040	(0.197)	0.053	(0.224)	0.047	(0.211)
Father not present	0.316	(0.465)	0.272	(0.445)	0.294	(0.456)
Father no high school	0.101	(0.301)	0.100	(0.301)	0.100	(0.301)
Father high school or some college	0.329	(0.470)	0.351	(0.477)	0.340	(0.474)
Father degree and above	0.210	(0.408)	0.231	(0.421)	0.220	(0.414)
Father education missing	0.045	(0.206)	0.046	(0.209)	0.045	(0.208)
Log HH income	7.787	(4.594)	7.987	(4.493)	7.885	(4.546)
HH income missing	0.254	(0.435)	0.236	(0.424)	0.245	(0.430)
Easy access to cigarettes	0.319	(0.466)	0.287	(0.452)	0.304	(0.460)
Easy access to alcohol	0.282	(0.450)	0.275	(0.447)	0.278	(0.448)
Easy access to drugs	0.026	(0.158)	0.033	(0.179)	0.029	(0.168)
Knowledge about birth control	4.606	(3.171)	4.661	(3.028)	4.633	(3.102)
Knowledge quiz missing	0.257	(0.437)	0.232	(0.422)	0.245	(0.430)
Additional variables						
Third person at interview	0.231	(0.422)	0.214	(0.410)	0.223	(0.416)
Personality attractive	0.558	(0.497)	0.448	(0.497)	0.504	(0.500)
Self-esteem	16.048	(2.656)	16.783	(2.372)	16.408	(2.548)
Popularity	1.535	(0.678)	1.392	(0.740)	1.466	(0.712)
N	16,152		15,486		31,638	

Notes: Reports the means and standard deviations of variables by sex. Standard deviations are in parentheses.

Chapter 4

Heavy Episodic Drinking and the Life Course

4.1 Introduction

The consumption of alcohol and its related negative health effects are a source of extensive policy debate across a range of countries as a result of its associated negative externalities and increasing cost to society (Cawley & Ruhm, 2011). In England in 2016, there were 5,507 alcohol-specific deaths and in the United Kingdom (UK) as a whole, there were approximately 9,000 deaths related to alcohol. This accounts for 4 percent of all deaths in the UK most of which are preventable (ONS, 2017). Long-term heavy alcohol use is associated with several diseases such as cirrhosis of the liver (prevalence has increased 400 percent since 1970), as well as increasing the risk of many partially attributable disorders such as cancer of the larynx, stomach, colon, and liver (Bagnardi et al., 2015).

A substantial body of literature has focused on the effects of alcohol consumption on alcohol related traffic collisions, criminal activity, illicit drug use and risky behaviours (Crost & Guerrero, 2012; DeAngelo & Hansen, 2014; Deza, 2015). Given the negative direct and indirect effects of alcohol consumption on health and well-being, understanding the complex and changing role alcohol plays in society is important when evaluating the effectiveness of policies regulating alcohol availability and consumption.

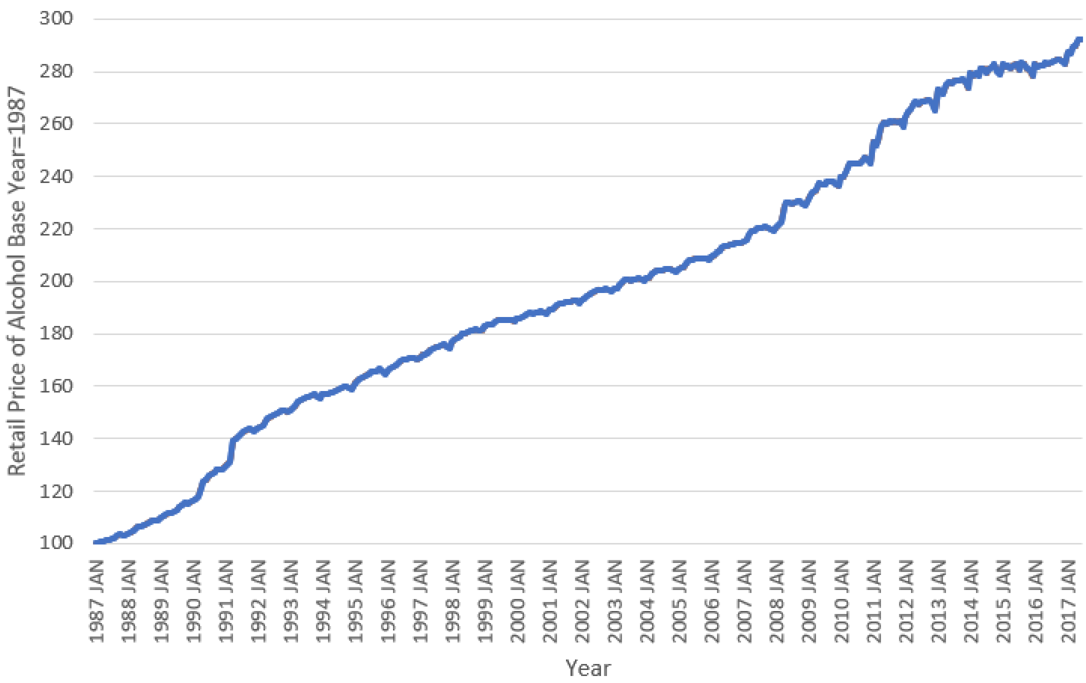
Behaviours surrounding the consumption of alcohol in the UK is changing. Since 2004, it has been estimated that there has been a decline in the prevalence of drinking in Great Britain as a whole, with the largest fall in drinking occurring amongst young adults (aged 16 to 24) (Windsor-Shellard, 2017). According to recent analysis by the Office for National Statistics (ONS), 56.9 percent of adults aged 16 years and above consumed alcohol, which equates to 29 million people in the population. Moreover, as well as a fall in drinkers (prevalence), there has also been a reduction in the number of those who drank on 5 days or more in a given week. In 2016, 9.6 percent of adults (roughly 4.9 million people in the population) drank alcohol on 5 or more days, compared in 2005, in which 22 percent of men and 13 percent of women had 5 or more drinking days in the past week (Windsor-Shellard, 2017).

Throughout the UK, rates of abstention as well as the number of "occasional[1]" drinkers has increased (Measham, 2008). Since 2005, there has roughly been a 2 percentage point increase in the number of individuals who stated that they do not consume alcohol. Moreover, in 2016 it was recorded that 20.9 percent of adults (around 10.6 million adults in the population) said that they did not drink alcohol (Windsor-Shellard, 2017). However, such statistics have several weaknesses. Firstly, they fail to capture the fact that an overall reduction in alcohol consumption may mask increases in some sub-sections of the population. For example, the number of abstainers has increased, but so may have the number of heavy drinkers, thus these statistics are counterbalanced by declines among other respondents. Moreover, there may also be changes in the patterns of drinking behaviour, specifically, individuals might drink on fewer occasions, however they may consume more in a single period such that individuals "stack" units over a couple of days or in a single drinking occasion. Although these individuals follow the government's recommended guidelines[2] , they are still consuming dangerous levels of alcohol.

[1]Occasional being defined as taking place from time to time; not frequent or regular

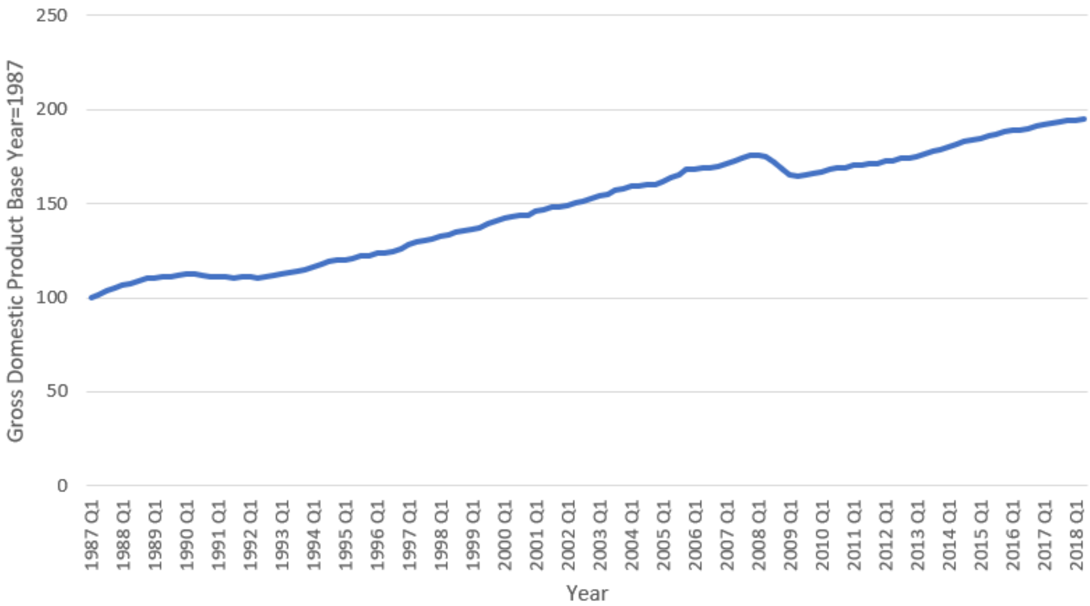
[2]Prior to 2016 and throughout our period of analysis the Chief Medical Officers' (CMO) guidelines for men was 21 units and 14 units for women. Since 2016 these has changed such that:To keep health risks from alcohol to a low level it is safest not to drink more than 14 units a week on a regular basis (for both men and women). If you regularly drink as much as 14 units per week, they argue that it is best to spread drinking evenly over three or more days.

FIGURE 4.1: Long Term Real Price of Alcohol



Using data from the Health Survey for England (HSE), we aim to shed more light on any potential changes and to do so examine the change in alcohol consumption over the life-course using repeated cross-sectional data. This chapter expands on the existing work which studies how alcohol consumption changes with age, and over separate birth cohorts, by researching a more recent period of time, endeavouring to control for a range of economic factors, as well as a variety of explanatory variables within our analysis. This chapter builds on previous research by conducting age-period-cohort (APC) analysis, using the real price of alcohol (as a function of RPI) and Gross domestic Product (GDP) in a repeated cross-sectional survey over a 24-year period. Figure 4.1 illustrates how the price of alcohol in real terms has increased over time, while Figure 4.2 shows the growth in Gross Domestic Product. In particular, we seek to identify whether APC analysis indicates attributions of the UK population trend to rising and falling youth consumption are justified and whether recent increases in abstention can be explained through changes in the demographic origins of the population. We focus primarily on the rates of abstention as well as heavy drinking episodes documented by the respondent. In the UK, no study to date has documented patterns among cohorts of the late 1990s and 2000s, who are now in the primary age of risk for heavy episodic drinking and the development of alcohol use disorders.

FIGURE 4.2: Gross Domestic Product



4.2 Literature Review

Kemm (2003) use data from the General Household Survey (GHS) from 1978 to 1998 to analyse the alcohol consumption over a twenty year period. They find that, after about age 20 years, both men and women become more likely to be non-drinkers or light drinkers with age. Moreover, men are also less likely to be heavy drinkers as they grow older, however for women these estimates are less precise than the estimates of men.

Kemm (2003) acknowledges that the questions regarding alcohol consumption were altered in 1986. Between 1978 to 1985 inclusive, the first two alcohol questions established if respondents drank at all. Those who had drunk even occasionally in the last year were then asked about their consumption of five types of alcohol of varying strengths: shandy, beer/cider, spirits, liqueur, and wine. First, respondents were asked how often they consumed each beverage in the last 12 months, and then asked them how much they "usually had drunk on any one occasion during the last 12 months". The product of frequency and quantity were used to derive quantity frequency (QF) ratings, that grouped drinkers into the five categories based on the frequency of drinking their main drink of choice and the quantity consumed. From 1986, drinkers were categorized on the basis of estimated total number of units of alcohol consumed per week into alcohol consumption (AC) ratings.

The main concern with this method of deriving quantity frequency is the possibility of measurement error. One can argue that measurement error might occur more often in infrequent drinkers, because their typical consumption is more difficult to define and capture in a snapshot questionnaire. In the GHS, prior to 1986, the optional responses for frequency for each respondent are: most days; 3-4 days per week; 1-2 per week; 1-2 per month; 1-2 per 6 months; 1-2 per year; or not at all. In 1990, the frequency categories were changed to almost every day, 5 or 6 days a week, 3 or 4 days a week, once or twice a week, once or twice a month, once every couple of months, once or twice a year and not at all in the last 12 months.

Kemm (2003) divides the sample into 5-year birth cohorts for males and females. Each cohort is then followed through a series up to 1998 or until they reach 83-87. Most 5-year age sex bands contained 500 or more individuals. The author splits their analysis into "non or very light drinkers"(less than one unit per week) and "heavy drinkers" (more than 21 units per week for men and 14 units per week for women). With respect to "non or very light drinkers", they find that "non or very light drinking" increases as respondents get older, however there is very little difference across cohorts, especially amongst men although the oldest birth cohorts of men appear to have much higher rates of low drinking compared to their younger counterparts. Women appear to have much clearer differences between cohorts, furthermore there is a more apparent age effect with older respondents more likely to be abstainers or very light drinkers.

With regards to heavy drinkers (over 21 and 14 units for men and women respectively)

Kemm (2003) finds that the percentage of heavy drinkers fall with age in both men and women. At the age of 25 years, 35 percent of men and 15 percent of women were classified as heavy drinkers, but by age 80 years, only about 10 percent of men and 2 percent of women were heavy drinkers, which may be as to be expected.

Although Kemm (2003) was the first to apply birth cohort analysis to the UK, there is one key limitation with his analysis. They only analyse changes in the proportions of the population who fall into each of the defined drinking groups i.e. the change in the number of respondents who are classified as heavy drinker by consuming over the recommended weekly amount. While this provides an interesting insight in the change in the prevalence of heavy or light drinkers, it does not show how consumption has changed within the specified group.

Meng, Holmes, Hill-McManus, Brennan, and Meier (2014) also uses the GHS and its later waves from the General Lifestyle Survey (GLF) to model age-period-cohort effects. Throughout, survey respondents are assigned into 19 5-year cohorts for birth, observation period (the year of the wave that the GHS/GLF took place), and age band. The study controls for household income, education, ethnicity, and country. The APC effects and the effects of other independent variables are estimated simultaneously and control for each other. All models are fitted separately for men and women to obtain gender-specific estimates.

The dependent variable in the consumption model is the drinker's average weekly consumption in units, which was calculated using the same questions used by Kemm (2003) as well as the updated definition of beverage alcohol content used to convert quantity measures into alcohol units (1 unit = 10 ml ethanol) which was introduced in 2006. Meng, Holmes, et al. (2014) model the incident rate ratio (IRR) of drinkers' average weekly alcohol consumption using a negative binomial regression model to account for the count nature of the dependent variable. This is an advance from the previous literature where alcohol consumption, rather than the proportion of heavy drinkers, is used as the explained variable, as this provides a more in depth picture of changes in the proportion of heavy episodic drinkers and whether consumption within heavy drinkers has also increased.

They find that average weekly units consumed peaks at age 18–24 with men consuming 25.1 units, and women consuming 11.9 on average. By the age 25, alcohol consumption falls by approximately 5 units per week, and remains fairly consistent until age 50, with further declines in later life (age 65). Overall, the results are consistent with Kemm (2003) with respect to the abstention analysis. Meng, Holmes, et al. (2014) find that abstention rates are increasing over age and period for both men and women by roughly 5 percent.

One shortcoming, as with all APC models, is that identification remains a challenge as birth cohort is a linear function of age and time period, such that $Cohort = Period - Age$. As a result, APC models suffer from multicollinearity. In order to address for this, Meng, Holmes, et al. (2014) use overlapping groups to avoid the problem of a mechanical relationship between age, period, and birth year. Therefore, while a separate effect can be estimated, its true effect cannot be identified.

Pryce (2014) also uses the GHS and adapts the methods used by Kemm (2003), Meng, Holmes, et al. (2014) to examine changes across the drinking distribution. He further extends their analysis to explore whether price plays a role in determining alcohol consumption. He does this in two ways: looking at the long-run price elasticity across cohorts, and whether the price of alcohol when the cohort begins drinking (assumed to be when they are aged 18) affects the cohort's alcohol consumption.

In line with the previous UK studies, Pryce (2014) finds that alcohol consumption has been increasing steadily across birth cohorts with younger birth cohorts tending to drink more than the preceding cohort at the same age. However, he finds that youngest cohorts (born 1986-1990) are beginning to drink less than their older peers with the youngest birth cohorts drinking on average 4 units per week compared to 7 for the older cohorts for men only.

Furthermore, Pryce (2014) estimates the quantile results from age-period-cohort modelling, finding age effects are not statistically significant for males, but are for females, meaning, holding all else constant, older women drink more than younger women. In addition, he finds a downward trend in consumption for both genders and all quantiles across time period. This means that *ceteris paribus* every type of drinker has decreased their consumption over time. Overall, Pryce (2014) finds that price does not have a significant effect on alcohol consumption in an APC setting.

In the United States (US), Kerr, Greenfield, Bond, Ye, and Rehm (2004) use data from the National Alcohol Survey, conducted for the Alcohol Research Group, between 1979 and 2000 inclusive. They estimate the influences of age, period and cohort on the consumption of beer, wine, and spirits separately.

The dependent variables used in this analysis are the monthly number of drinks of each beverage group; beer, wine, and spirits. The frequency of alcohol consumption is split into the number of drinks consumed in one occasion (where a drink is defined as 12g of ethanol) and how often this drinking pattern is repeated. This categorisation allows the calculation of both the volume of drinks per month consumed and the frequency of days in which five or more drinks were consumed for each of the beverages.

Instead of focusing on "heavy episodic drinking" or "binge drinking", Kerr et al. (2004) analyse APC effects for beer, spirits, and wine separately. They find that changing cohort demographics have significant effects on beverage-specific consumption, namely strong cohort effects for spirits, significant negative effects of age are found for beer and spirits consumption for men and strong period effects for men's beer and wine consumption and for women's spirits consumption. Overall, the results are consistent with evidence from the UK (Meng, Holmes, et al., 2014) such that changing cohort demographics are found to have substantial effects on alcohol consumption.

Kerr, Greenfield, Bond, Ye, and Rehm (2009) extends this analysis by modelling alcohol volume and heavy drinking days using data from six National Alcohol Surveys conducted over the 26-year period between 1979 and 2005, covering a 26 year period. Survey respondents were assigned either a 5 or 10-year age cohort and a 5-year birth cohort. The study also controls for income, ethnicity, geographic region, marital status, and educational attainment.

In order to conduct their analysis, the two main dependent variables they use are the monthly number of drinks consumed and the number of days in the past year on which five or more drinks were consumed (their definition of binge drinking). In the United States a standard drink is defined as having about 14 g of ethanol (in their earlier study a drink was defined as 12g of ethanol).

Kerr et al. (2009) find that while the mean values of drinking measures have continued to decline over time for those aged 26 and older, there has been a substantial increase in both alcohol volume and binge episodes among those aged 18–25 years. Specifically, they find that the more recent birth cohorts in the United States partake in more heavy drinking episodes of consuming 5 or more drinks in one occasion (and 8 or more drinks for men).

Similar to the earlier UK literature the effects are only shown at the mean for each age band, period, and birth cohort. Kerr et al. (2009) use 6 different surveys with alter the mode of interview, sampling procedures, and the general weighting of alcohol variables. As a result, comparisons across age, birth cohort and period may be biased through individuals potentially effecting their attitudes in their responses.

Keyes and Miech (2013) uses age-period-cohort effects (APC) to analyse heavy episodic drinking from the National Household Survey on Drug Use and Health 1985-2009 (NHSDUH). The authors find that heavy episodic drinking is decreasing in the US among adolescents and young adults. Moreover, they find that the younger cohorts born in the 1990s are at a lower risk of binge drinking than their older counterparts dating back to at least 1950–54.

Contrary to the results found in the UK, Keyes and Miech (2013) find similar trends for both males and females across the life course, with cohorts born in the 1960s, 1970s and 1980s at highest risk, and those born in the 1990s at lower risk of binge drinking. One difference that they found was that adolescent/young women have a higher probability of heavy episodic drinking compared to the mean of all women, while there was no statistically significant difference for men. This means that men are more likely to drink heavily across the life course than women, which is consistent with the literature (Kemm, 2003; Meng, Holmes, et al., 2014)

Throughout Keyes and Miech (2013), heavy episodic drinking was defined as any instance of consuming five or more drinks in one occasion, in the month leading up to the interview. The authors note that while most studies now define a lower threshold of drinks for women, the answers from the respondents in the survey made it difficult to disentangle a more robust definition of heavy episodic drinking.

There are a few notable limitations to Keyes' study. Firstly there are a few methodological changes that occurred throughout the course of the study. Prior to 1999 survey information was collected via chapter and pencil questionnaires, in 1999 the survey was administered using computer assisted software. Evidence suggests that reporting of substance use and alcohol consumption increased when the responses were collected via computer-aided software (Barker, Gfroerer, Caspar, & J, 1998). Secondly, in 2002 respondents were offered financial incentives to participate in the survey. Although this policy increased response rates, prevalence of substance use increased. These methodological changes may cause the estimates to be biased and limit inferential ability about the period effects that were estimated throughout this study.

Furthermore, there was no information in the study on the frequency of binge drinking within the population. One can expect problem drinkers to engage in weekly or daily heavy drinking while some individuals may have had a single episode of binge drinking. These two individuals are analysed with the same weight. Consequently, Keyes and Miech (2013) only considers the proportions of the population who fall into the defined drinking category, rather than the prevalence of binge episodes.

4.3 Data

Data from the Health Survey for England (HSE). The HSE is a repeated cross-sectional health interview survey of roughly 15,000 respondents conducted in England annually since 1991 by the National Centre for Social Research (NatCen). The HSE covers all of England and is a nationally representative sample of those residing at private residential addresses. The HSE collects detailed information on mental and physical health, health-related behaviour, and objective physical and biological measures in relation to demographic and socio-economic characteristics of people aged 16 years and over (Mindell et al., 2012). The survey design is formed of two sections an interview with each eligible individual and a nurse visits. The interview includes a set of core questions on general health as well as social indicators; smoking, alcohol, demographic and socio-economic indicators.

While there are a range of alcohol consumption measures available in the HSE, our main focus throughout this study is alcohol abstention and heavy episodic drinking. Our abstention dependent variable is drawn from the questions: "Do you drink alcohol?" and "Whether you drink nowadays?"[3]. From these, we can determine the drinking status of the respondent, and how long they have held this status. Furthermore, our other variable of interest is heavy drinking, this is derived from "How many units of alcohol you consumed on your heaviest day of drinking in the last 7 days?"[4] . We use this question as it provides a measure of heavy episodic drinking; the effect of which is of great significance due to the impact of heavy drinking on an individual's health (Griswold et al., 2018).

One shortfall of the HSE is that the question "How many units of alcohol you consumed on your heaviest day of drinking in the last 7 days?" was first introduced in the 1998 wave of the HSE. However, this still leaves us with 18 years of repeated cross-sections for this section of our analysis (1998-2014). Prior to 1998, the HSE asked respondents to document

[3] These questions are available in all waves of the HSE for our period of analysis (1991-2014).

[4] Questions on heavy drinking days are available from 1998. Prior to 1998 respondents were asked about weekly alcohol consumption rather than their heaviest day.

their weekly alcohol consumption rather than their heaviest drinking day[5]. Given this change in questioning, the years 1991-1997 are omitted from our heavy drinking analysis as the consistency of the data may introduce issues with consistency to our analysis. The change in the questions and the coding of such responses may pick up inaccurate period effects. Although this is not a perfect measure, as it may understate binge drinking insofar as heavy drinkers may be more likely to have numerous days of heavy drinking in the week, we test whether there is correlation between number of drinks consumed on their heaviest day and number of days alcohol is consumed and find little evidence of this. For our analysis on abstention we use the full sample 1991 to 2014. Finally, the HSE collects data on alcohol consumption from aged 16 years, however for the purpose of our study we keep only those aged between 16 and 90 years. Age is capped at 90 years as this is the capped age limit in the 2012, 2013, and 2014 waves of the HSE.

The HSE obtains information on alcohol consumption using two techniques. Individuals aged 16-24 years are asked to record their responses using either a computer-aided interview or a self completion questionnaire. Respondents aged over 25 years use only the computer-aided interview. The HSE asks questions regarding both frequency (whether an individual drank in past 12 months or the last week as well as the number of drinking days in the past week) and level (number of alcohol units drunk on the heaviest drinking day in the past week). Furthermore, the HSE depicts whether a respondent took part in binge drinking (whether men or women had drunk more than eight or six units, respectively, on their heaviest drinking day in the past 7 days). This definition of binge drinking is in line with UK guidelines.

As well as focusing on the rate of abstention and heavy episodic drinking across the life course, we apply our APC methodology to five health measures that can be found in the Health Survey for England. For the purpose of this study we focus on five outcomes that have been attributed to dangerous alcohol consumption (Burton & Sheron, 2018; Griswold et al., 2018; Lieber, Seitz, Garro, & Worner, 1979). We focus on high blood pressure

[5]Prior to 1998, respondents were asked to document their drinking from the question: "In the last week how many times did you consume alcohol?" Respondents could respond "1 to 2 times", "3 to 4 times", etc.

(hypertension), cardiovascular disease or heart problems, respiratory problems, mental health issues such as depression or anxiety and finally self-assessed health. The health measures we use in the HSE relating to hypertension, cardiovascular disease, respiratory problems and mental health are all derived from binary questions "Have you ever suffered from or currently suffering from *health outcome*" and "Do you take medication for *health outcome*". We use these answers to calculate the proportion of respondents who suffer from these health issues as well as the odds ratio in the results section later in the chapter. Finally, we also use information relating to general health. Respondents were asked to record their perceived level of health at the time of the interview. They were asked about their health in general. This was rated on a 5-point scale 1 being very good and 5 being very bad. The Incidence rate ratios to which are presented in Section 4.6.

Similarly to the GHS and Add Health, one limitation of the HSE is that it relies on self-reporting. Obtaining reliable evidence about drinking behaviour is difficult, moreover social surveys consistently record lower levels of consumption than would be expected from data on alcohol sales. This is partly because respondents may actively or unconsciously under-report how much alcohol they consume. Drinking at home is particularly likely to be underestimated because the quantities consumed are not measured and are likely to be larger than legal measures dispensed in licensed premises. However, this is a limitation shared by the majority of the alcohol literature that measures the purchasing and/or consumption of alcohol. Furthermore, information on alcohol is collected using either a "computed-aided personal interview" for those aged 25 years and over and in a paper "self-completion" format by the respondents aged 16-24 years in their own time. One could argue that this may reduce potential social desirability bias compared with other survey administration methods such as face-to-face interviews as responses are kept secret and remain anonymous throughout the entire interview and subsequent analysis.

4.4 Methodology

For this study, each respondent in the 24 waves of the HSE is assigned a 5-year birth cohort, except for the 1996-1998 birth cohort,these are listed in Table 4.1. One concern is the small sample problem for the 1901-1905 and 1996-1998 cohorts which only appear in their respective waves only once thus we drop them from the analysis. Age bands too are assigned a 5-year analysis period and are constructed as defined in Table 4.2.

TABLE 4.1: Birth Cohort Definitions

Birth Cohort	Min	Max	Observations
1	1901	1905	665
2	1906	1910	2,128
3	1911	1915	4,366
4	1916	1920	7,028
5	1921	1925	10,812
6	1926	1930	13,308
7	1931	1935	14,979
8	1936	1940	16,497
9	1941	1945	18,184
10	1946	1950	21,831
11	1951	1955	20,177
12	1956	1960	22,363
13	1961	1965	24,791
14	1966	1970	23,194
15	1971	1975	19,553
16	1976	1980	16,053
17	1981	1985	11,362
18	1986	1990	5,789
19	1991	1995	2,380
20	1996	1998	318

Throughout this analysis we have two variables of interest. The dependent variable in our abstention analysis is a binary indicator that takes the value 1 if the respondent did not drink at all in the 12 months leading up to the interview and 0 otherwise. Furthermore, the dependent variable in our heavy drinking is the number of units consumed by the individual on their heaviest drinking day.

As well as the categorical variables used to derive the age, period and cohort (depicted

TABLE 4.2: Age Band Definitions

Age Band	**Min**	**Max**	**Observations**
1	16	20	18,096
2	21	25	18,087
3	26	30	20,637
4	31	35	22,994
5	36	40	23,329
6	41	45	22,401
7	46	50	21,261
8	51	55	19,297
9	56	60	17,923
10	61	65	17,441
11	66	70	16,611
12	71	75	14,317
13	76	80	10,993
14	81	85	7,289
15	86	90	3,777

above) we use an extensive set of control variables such as household income (less than £15,000, median income, and top 10%), education (degree and above, A level to degree, A levels, below A levels, and no qualifications), ethnicity (White, Black, Dual Heritage, Asian, and Other), smoking status (never smoked, ex-smoker, and smoker) and government office region.

For our abstention analysis we use a logistic regression model to estimate the odds ratio (OR) and for our heavy episodic drinking analysis we model the incident rate ratio (IRR) of drinkers' number of units consumed on their heaviest day using a negative binomial regression model. We estimate variants of the following equation:

$$Outcome_{cgt} = \alpha + \beta_1 AgeBand_c gt + \beta_2 TimePeriod_c gt + \beta_3 BirthCohort_c gt + \epsilon_{cgt} \quad (4.1)$$

Where $Outcome_{cgt}$ is whether the respondent identifies as an abstainer or it is the number of units drunk on the respondent's heaviest drinking day prior to the interview, where the subscripts refer to birth cohort c, gender g, and time t.

We estimate the models separately for men and women to obtain gender specific estimates. This is for a variety of reasons. Firstly, up until 2016, the UK government guidelines for "safe" alcohol consumption differed by gender[6]. Secondly, it can be argued that genders will have heterogeneous alcohol consumption over the life course such as, Age effects - the consumption of alcohol should be lower for women during fertility periods, Cohort effects - consistently with the cigarette epidemics, the increase in alcohol consumption should be more recent among women than among men and period effects - differential changes in social norms.

To avoid perfect collinearity due to the mechanical relationship between age period and birth year ($Period = BirthYear + Age$), we first model our analysis similar to that of Meng, Holmes, et al. (2014) by using age bins which are smaller or larger than the period and cohort bins, and by having them overlap.

Furthermore, as a sensitivity analysis, we use an alternative to imposing restrictions on the bins by modelling the period effect using a variable that varies by period but does not have the "adding up" problem that leads to perfect collinearity that has been identified within APC analysis (J. Heckman & Robb, 1985). For this we use price (the real price of alcohol) and Gross Domestic Product.

4.4.1 Methodological Limitations

One concern with using this methodology is that respondents who are heavy drinkers are likely to die sooner than their non-drinking or moderate drinking counterparts. Whilst it is impossible to adjust for in this study, this must be taken into consideration when interpreting the results. If heavier drinkers are more likely to die prematurely, then the older waves of cohorts are likely to feature fewer heavy drinkers and as a result the estimated weekly unit consumption will be downward biased. An ideal remedy to this

[6] Prior to 2016, it was recommended that men should be limited to 21 units or less of alcohol per week, for women this has remained unchanged at 14 units. See previous footnote for more detail.

concern is to ideally have a large UK panel dataset in which one could match the observed rate of attrition from within the data with the corresponding rate of mortality.

4.5 Results

4.5.1 Descriptive Statistics

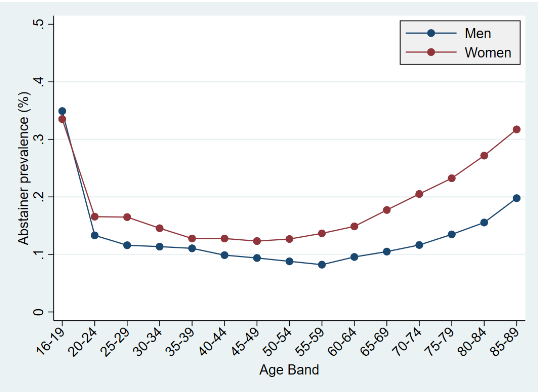
The weighted means of the proportions of abstainers and average unit consumption on heaviest drinking day by gender and APC are presented in Figures 4.3a to 4.4c. By age, abstention rates are decreasing consistently from age 18 to age 55, at their lowest point they are 9 percent for men and 12 percent for women. These then increase steadily from age 56 onwards. By period, abstention rates do not change dramatically over the period of analysis and remain fairly consistent for both genders. By cohort, male abstention rates fall from 26 percent in the 1901-1905 cohort to 9-10 percent in the 1941-65 cohort followed by a fairly sharp increase in the proportion of abstainers in the post 1981 birth cohorts. We also observe similar trends for women.

In terms of heaviest drinking episode in the last week, drinkers' highest daily unit consumption peaks at age 18–25 (13 for men, 8 for women), falls by approximately 4 units and steadily declines into later life. Again, for interview year (period) there is little change in the number of units consumed on the heaviest drinking day, this remains constant at roughly 7 units for men and 4 units for women. By cohort, we identify increasing consumption trends for male (from 2 units to 12 units) and female (from 1.8 units to 8 units units) cohorts of drinkers up to those born in 1985 and 1991 respectively.

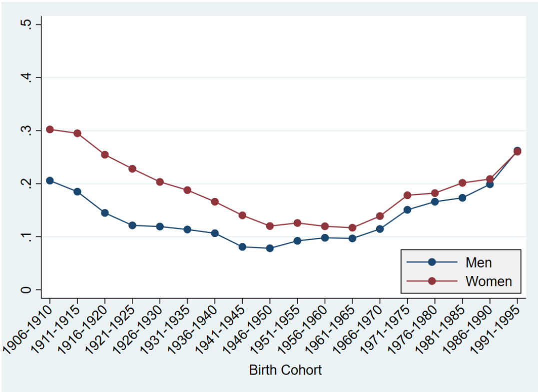
4.5.2 Drinking Characteristics by Age by Birth Cohort

In Figure 4.5 we illustrate the proportion of abstainers by age group defined by their particular birth cohort. For ease of interpretation, we plot each 5-year birth cohort in

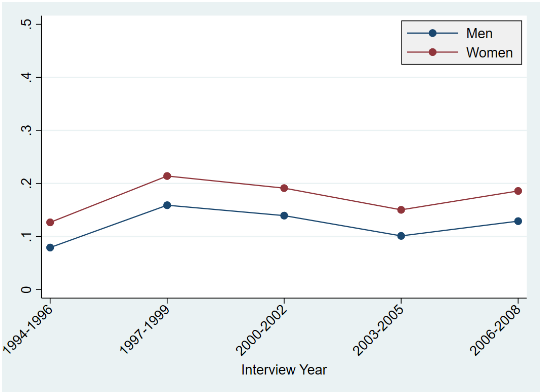
FIGURE 4.3: Proportion of Abstainers



(A) Prevalence of Abstainers by Age

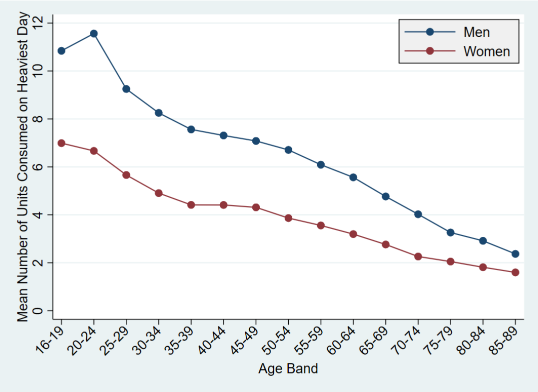


(B) Prevalence of Abstainers by Birth Cohort

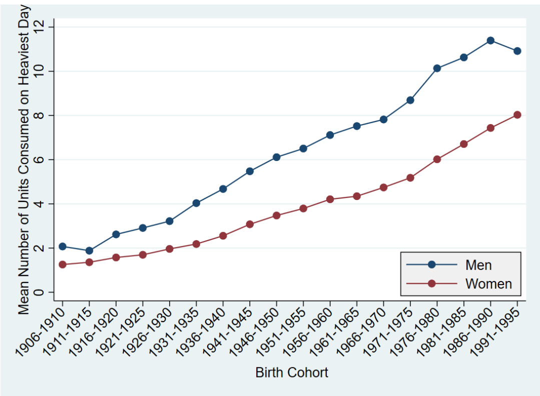


(C) Prevalence of Abstainers by Period

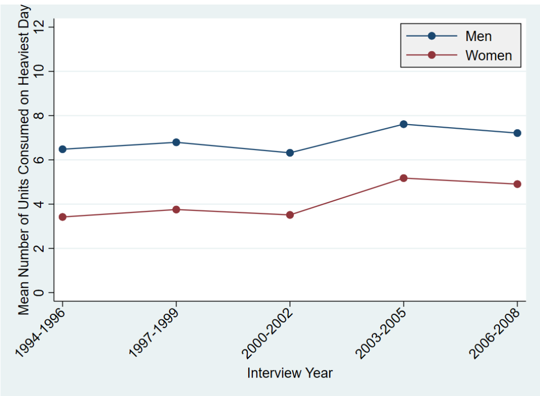
FIGURE 4.4: Proportion of Heavy Drinkers



(A) Number of Units Consumed on Heaviest Day by Age



(B) Number of Units Consumed on Heaviest Day by Birth Cohort

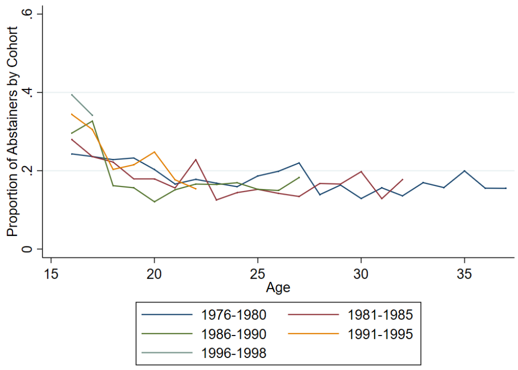


(C) Number of Units Consumed on Heaviest Day by Period groups of five.[7] However, these graphs can be overlapped by age to show the change in abstention rates by cohort and age over the cohorts. Figure 4.5a depicts the youngest 5 cohorts. Those who are the youngest individuals (born 1991 to 1998) aged 16 to 8 have the highest proportion of abstainers. This is most likely due to the fact the minimum legal drinking age in the UK is aged 18. In Figure 4.5a, as age increases, for all five cohorts the proportion of abstainers fall. Similarly, we observe a similar pattern in Figure 4.5b which is the 1951-1975 cohort. We find that the older cohort has a smaller number of abstainers relative to their younger counterparts. In Figure 4.5c and Figure 4.5d we find that as age goes up, for all cohorts, the rate of abstainers increases. The two possible reasons for this is that respondents may quit drinking in later life due to various health reasons. Additionally, the proportion of abstainers in older cohorts may be higher due to a "Survivorship Bias". This means that those who are more likely to drink and more likely to drink heavily may die prematurely, thus not appear in national representative house/health surveys. We explain this in more detail in the Survivorship Bias section later in this chapter.

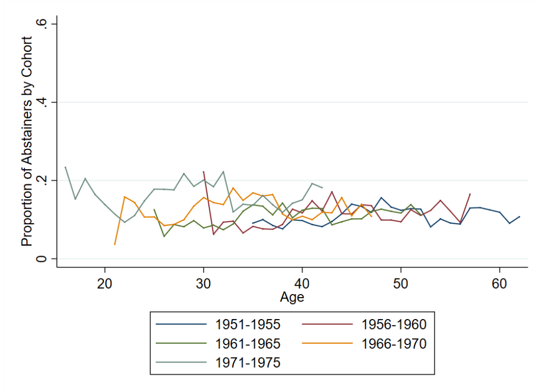
In Figure 4.6 we present the number of units consumed on the respondent's heaviest drinking day by age group defined by the birth cohort. In Panel 4.6a it is evident that the youngest cohorts are the heaviest drinkers. Except for 16 year olds from 1976 to 1980, those from the younger cohort drink more than their same aged counterparts. Furthermore, this relationship continues throughout the remaining three panels, while the number of units consumed on the heaviest day is also falling as cohort birth year increases. Overall, when observing Figures 4.5 and 4.6 as a whole, we find that while the rate of abstention is highest in 4.5a when we discard those over the 90 years of age, the youngest individuals are also the heavier drinkers.

[7] See Appendix 2 Figures B.1 to B.4 for the 10-year moving cohort versions for both abstainers and number of units consumed.

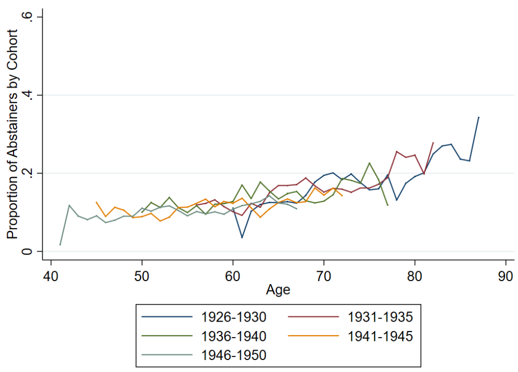
FIGURE 4.5: Proportion of Abstainers by Cohort



(A) 1976-1998



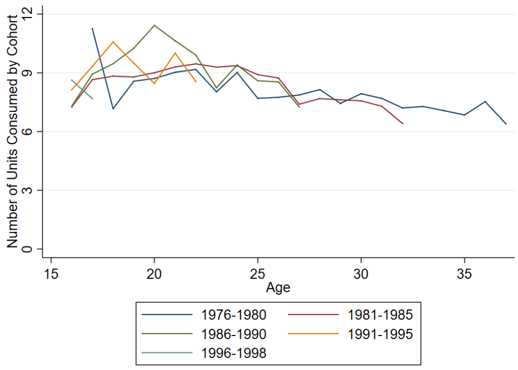
(B) 1951-1975



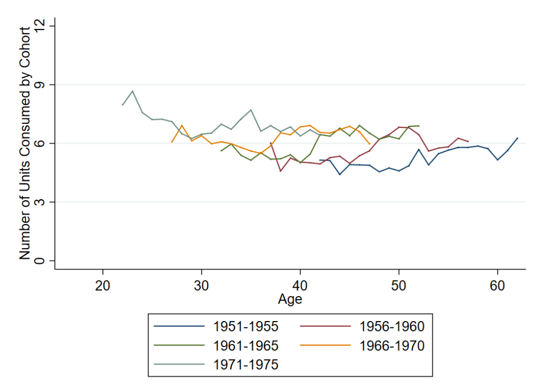
(C) 1926-1950

(D) 1900-1925

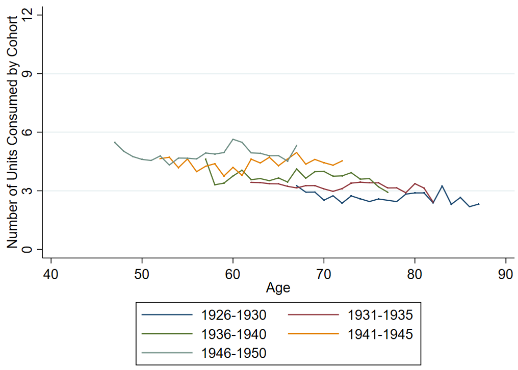
FIGURE 4.6: Number of Units Consumed by Cohort



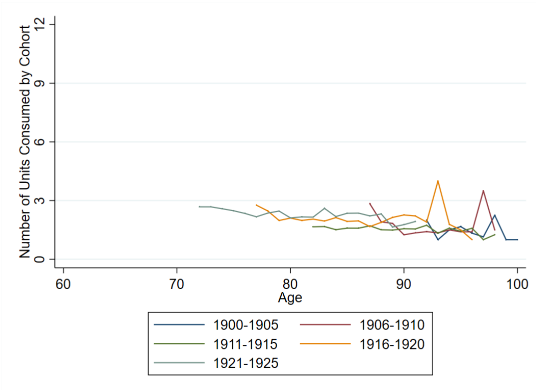
(A) 1976-1998



(B) 1951-1975



(C) 1926-1950



(D) 1900-1925

4.5.3 Modelling Alcohol Abstention

The results from the logistic models are shown in Figure 4.7 and Tables 4.4 to 4.9. For our analysis we estimate two versions of our APC models. The first model does not use control variables, instead preferring to see how alcohol consumption has changed unconditional on other variables. The second iteration of our APC model incorporates a full set of demographic variables which are outlined in Section 4.4 and in Table 4.3, the results to which are presented in Tables 4.5, 4.7 and 4.9.

In our baseline model, compared with our reference age group (46–50 year olds), men aged 16-20 and women aged 16-20 or 66+ are significantly more likely to be abstainers. Men aged 21–65 and women aged 21–45 are significantly less likely to be abstainers. The probability of alcohol abstention for men and women both decrease as people move from the 16-20 to the 20–25 year age group and increase over their later life times.

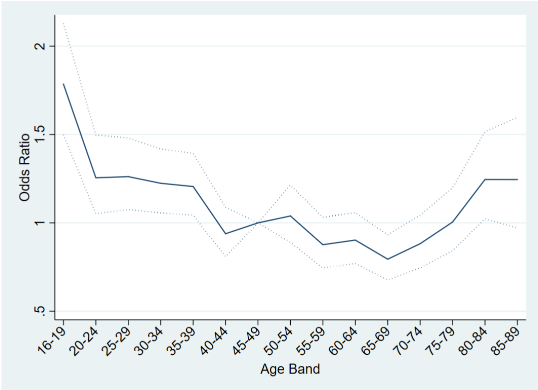
Figures 4.7a and 4.7b illustrate our logistic results with demographics for the age coefficients. With respect to our reference group, similar to our baseline results, we find that respondents aged 21-65 are less likely to be abstainers, with the Odds Ratio (OR) varying between 0.67 and 0.97 for men and 0.86 and 0.96 for women. These are also in table for in Table 4.5. In Figures 4.7c and 4.7d and Tables 4.8 and 4.9 we present our baseline and fully specified model for birth cohorts stratified by gender. We find evidence of U-shaped curves for cohort effects on abstention. Both men and women in the early birth cohorts (born before 1930) have significantly higher odds of abstention compared with the reference 1960–65 cohort. For those born after 1930, the odds of abstention compared with the reference cohort are significantly higher for men born between 1970 and 1974 (OR = 1.24) and, more markedly, between 1986 and 1990 (OR = 2.04–2.23) and for women born between 1991 and 1995 (OR = 1.32).

4.5.4 Modelling Heavy Episodic Drinking

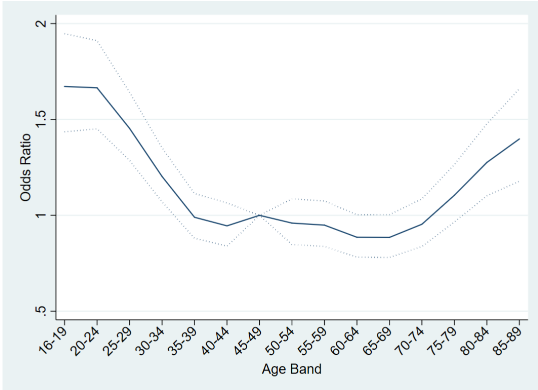
Similarly to our estimations of abstention, for our analysis of heavy episodic drinking we estimate our preferred specification both with and without controls. Figure 4.8 and Table 4.10 to Table 4.15 show the results from age-period-cohort modelling on the heaviest drinking day in the last week. This drinking measure aims to capture binge drinking or heavy episodic drinking in one drinking occasion. Previous studies have analysed APC effects on weekly unit consumption and from that infer "heavy drinking". However, these measures fail to pick exactly how many drinks are consumed in one period. We find that for both our baseline and fully specified model, there are significant age effects for both males and females. Consumption peaks for both men and women between ages 18–24 then starts to decrease, thus *ceteris paribus*, compared with the 46–50 age group, both male and female drinkers aged 18–24 drink significantly more. Birth cohort appears to have the strongest trend, in that every birth cohort appears to have consumed more than their older counterpart did at the same age. Table 4.3 depicts the estimated effects for our independent variables. We find that, compared to our reference group of *Median income*[8], those who have less than £15,000 in disposable income are more likely to abstain (OR=1.6447 for men and OR=1.431 for women). Conversely, those in the top 10% are less like to abstain and more likely to partake in heavy drinking.

[8]Median Income is defined as disposable income and is £27,000 per household

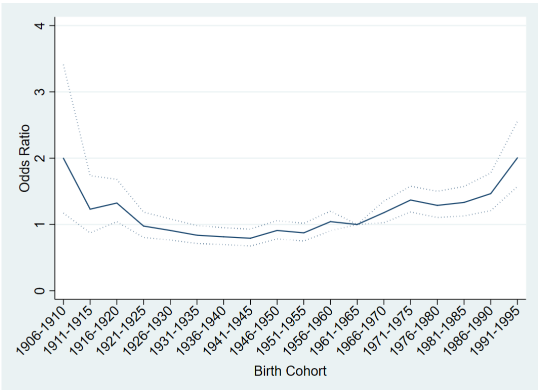
FIGURE 4.7: Illustrations APC Effects for Abstention by Gender



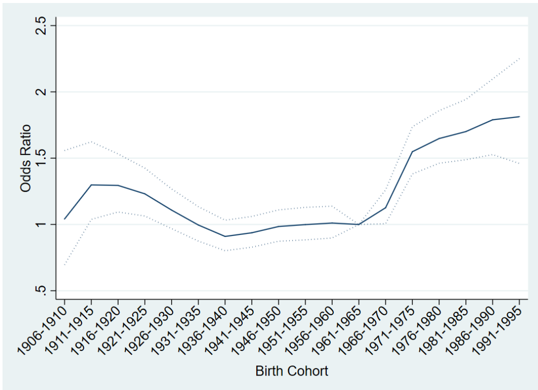
(A) Proportion of Abstainers by Age (Male)



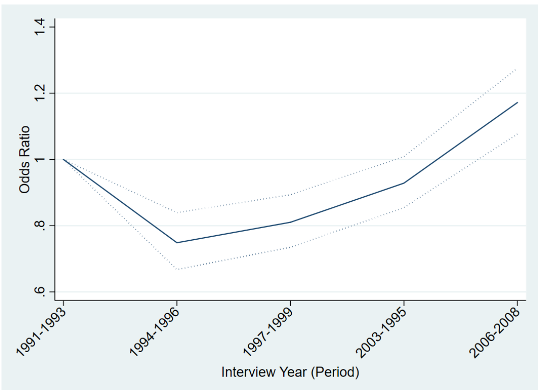
(B) Proportion of Abstainers by Age (Female)



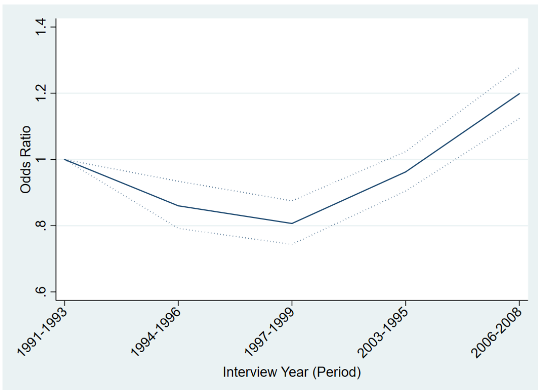
(C) Proportion of Abstainers by Cohort (Male)



(D) Proportion of Abstainers by Cohort (Female)



(E) Proportion of Abstainers by Period (Male)



(F) Proportion of Abstainers by Period (Female)

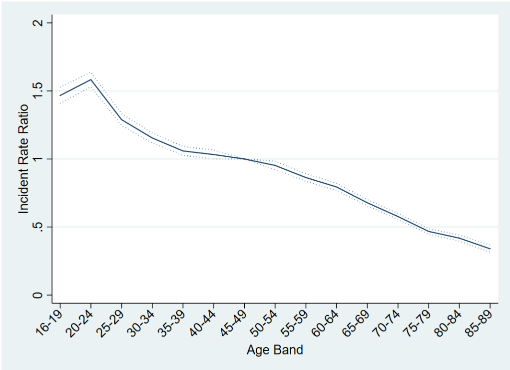
4.6 Related Health Outcomes

In this section we apply our APC methodology to five health outcomes that may be related to dangerous levels of alcohol consumption; self assessed health, cardiovascular disease / heart problems, high blood pressure (Hypertension), respiratory problems, and diagnosed mental health problems (such as depression and anxiety). These are depicted in Figures 4.14 to 4.12. In contrast to our analysis on drinking behaviours, for our analysis on health outcomes, we only estimate the APC model that incorporates the full set of demographic variables which are outlined in Table 4.3. Additionally, we also include the drinking characteristics of the respondents as covariates to see relationship between the heavy episodic drinking and health outcomes.

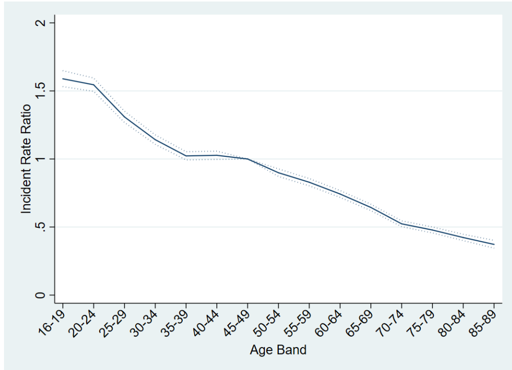
For all of the health measures presented our reference group is 46–50 year olds (Age), interviews recorded in 2001 to 2002 (Period) and individuals born in 1961-1965 (Cohort). Figure 4.10 presents the estimates of alcohol related cardiovascular disease. For both men and women, heart problems are more prominent in older individuals (OR=4.142) when both men and women reach age 60 and above. This is consistent with the previous medical literature (Mukamal & Lazo, 2017; Smyth et al., 2015) which find that prolonged heavy drinking can cause cardiomyopathy which weakens the heart muscle, or cause the heart to swell, thicken or become rigid, which means the heart can't pump blood as efficiently. Age well as age effects, we find evidence that those in the older cohorts are more likely to suffer from cardiovascular disease (OR=19.417). Chronic heart problems such as cardiomyopathy, angina or strokes are usually can be attributed to long-term heavy drinking, hence why the odds ratio is higher in the older individuals and cohorts.

Another long-term heart related heath outcome is high blood pressure also known as hypertension. These are presented in Figure 4.11. Similarly to other cardiovascular related issues we find that the incidence of high blood pressure is higher in older individuals by both age and cohort (OR=3.016) for women and men (OR=2.365) respectively. High blood pressure is more prominent among older women but is more common in men in earlier cohorts.

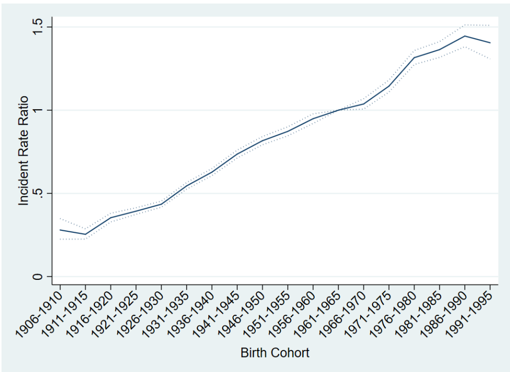
FIGURE 4.8: Illustrations APC Effects for Heavy Episodic Drinking by Gender



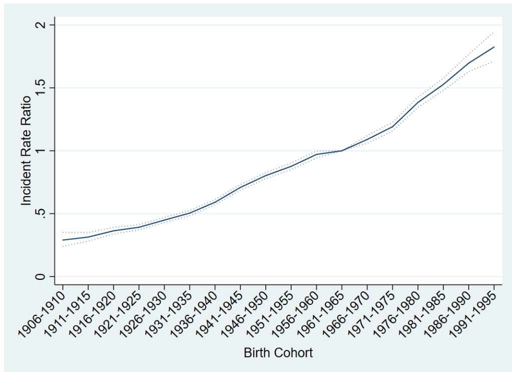
(A) Number of Units Consumed by Age (Male)



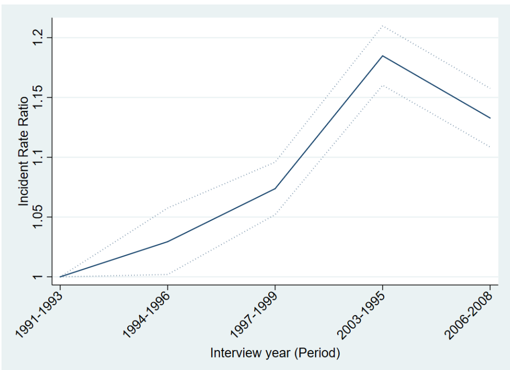
(B) Number of Units Consumed by Age (Female)



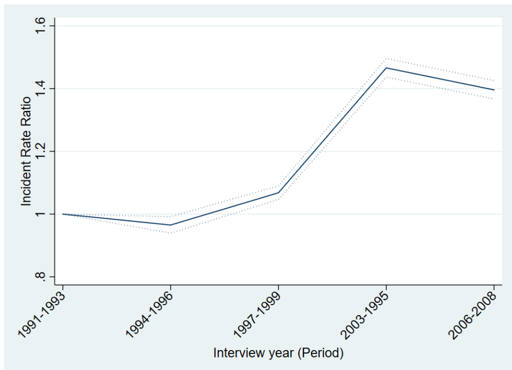
(C) Number of Units Consumed by Cohort (Male)



(D) Number of Units Consumed by Cohort (Female)



(E) Number of Units Consumed by Period (Male)



(F) Number of Units Consumed by Period (Female)

Holiday Heart Syndrome tends to come on after episodes of heavy drinking and leads to episodes of breathlessness and irregular heart beat. Therefore we measure the Odds Radio of a respondent having a respiratory problem or record suffering from being short of breath. Cohort effects illustrate that the younger cohorts are less likely to report breathing issues this is consistent with the increase in abstention rates in the same cohorts. However, age effects for men depicted in Figure 4.12a illustrates that the youngest individuals may be more likely to have a higher prevalence of respiratory problems which is consistent with the increased rate of high episodic drinking in young males.

As alcohol is classed as a "sedative hypnotic" drug, which can act as both a depressant on the central nervous system at high doses and act as a stimulant, inducing feelings of euphoria and talkativeness at lower does Kuhn et al. (2008) we estimate the relationship between alcohol use and acknowledged mental health problems such as depression and anxiety. These are portrayed in Figure 4.13. We find that the proportion of those who suffer from mental health problems is highest in mid-life at the reference group (age 46-50) however is more prominent amongst men in cohorts born post 1970. While slightly surprising to find this slight discrepancy between the age and cohort effects it is consistent with the literature and evidence suggesting that the mental health problems are more likely to be diagnosed than in previous years. This is also evident in the year effects in Figures 4.13e and 4.13f.

Finally, we observe the incidence rate ratio of self assessed health where respondents record their current health level where 1 is very good and 5 is very bad. Similarly to the long-term illnesses such as cardiovascular problems and hypertension we find respondents who are older either by age or cohort are more likely to report alcohol related poor health in later life. This is consistent with the evidence that prolonged alcohol use above the guidelines is detrimental to overall health after we control for a variety of socio-economic variables, time and cohort fixed effects.

4.7 Sensitivity Analysis

The main methodological issue with respect to age period cohort analysis is the identification problem due to the perfect linear dependency among age, period and cohort. Several strategies exist in order to solve this collinearity problem such as the non-linear transformation approach, in which, variables can be introduced in group dummies or in a parametric non linear functional form. Constrained coefficients GLIM model: this assumes that some categories of age groups, cohorts or time periods have the same effects on the dependent variables.

An alternative method having restrictions on the bin sizes in an APC model is to estimate the model using proxies in place of either age, period or cohort. In this analysis we use the RPI of alcohol over time in place of the period effect. The results of which are depicted in Table 4.16. The results suggest that the price of alcohol is not very strongly related to the amount respondents drink, either in the decision to drink (abstention) and in the amount consumed on their heaviest drinking day.

As well as estimating the model using the RPI of alcohol instead of the period, we also replicate the analysis using the GDP of the UK. These results can be found in Table 4.17. Similar to that of price, we find little evidence to suggest GDP plays a significant role in the change in participation of alcohol consumption and amount consumed. In fact, GDP has a precise 0 estimate for men.

In order to test the sensitivity of our results we re-estimate our abstention analysis using alternative definition of abstinence. We classify the respondents who drink very occasionally as abstainers, however our results did not differ significantly from the baseline model and our covariate model. Furthermore, we include gender dummies and their interactions between APC groups and find that these do not differ substantively from the base case model.

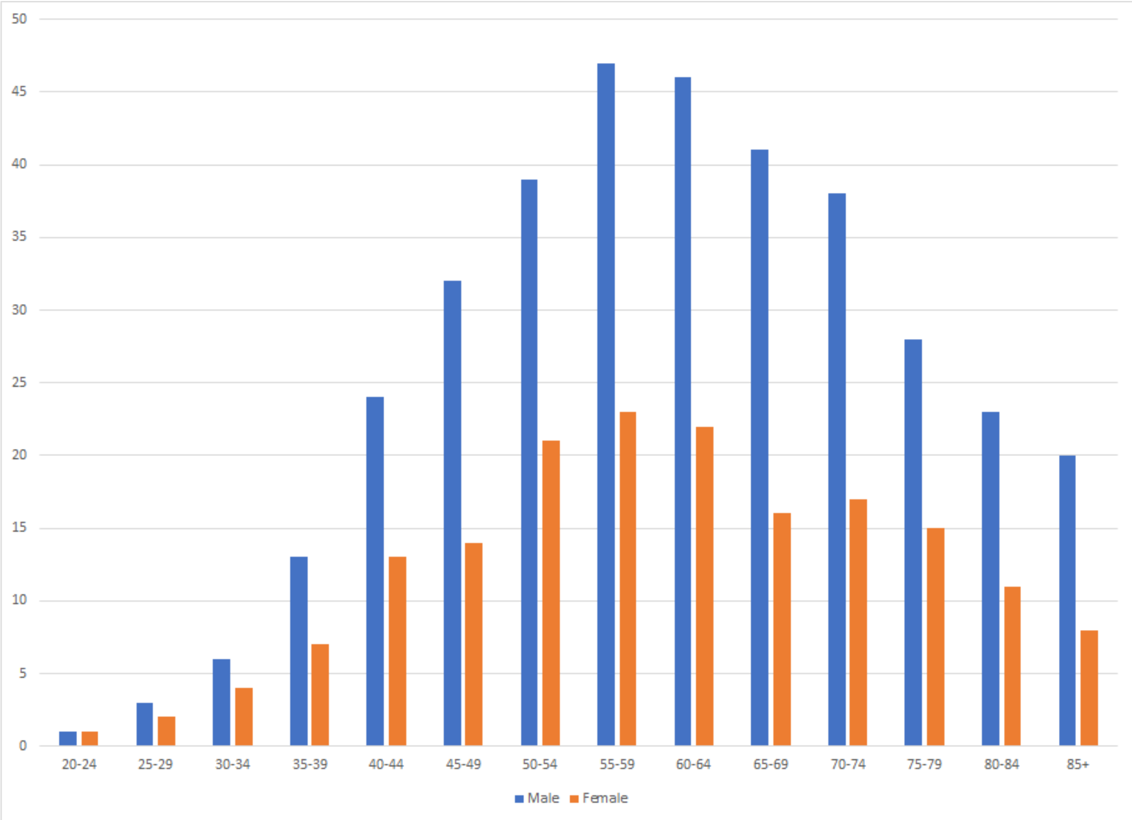
4.8 Survivorship Bias

One limitation to consider when using Age Period and Cohort analysis is the possibility of mortality or "survivorship bias". Survivorship bias occurs in this analysis where respondents who have high, or damaging levels of alcohol consumption may die earlier than those who consume alcohol at a safe level drinking at or under the recommended guidelines. As a result, if the more heavy drinkers die earlier than their light drinking counterparts, this then biases our estimates of the life course trajectory downwards. To fully understand this in detail, you would need a panel dataset rather than a repeated cross-section. However, we can use data from the ONS alcohol-related deaths bulletin 2017 presented in Figure 4.9 to show that the majority of alcohol related deaths occur around age 55 to 64 for both men and women. While we cannot provide estimates of the average alcohol consumption patterns of individuals who have died prematurely, we can so the in 2017 there were a total of 533,253 recorded deaths (ONS, 2017) and there were 5,507 alcohol-specific deaths (ONS, 2017) which equates to roughly 1% of all deaths. Therefore, the largest consumers of alcohol who consume fatal levels of alcohol would only account for a small proportion of the sample. While we cannot infer the drinking levels of individuals who my have died prematurely from smoking for example we have tried to explain the survivorship bias associated to APC modelling with respect to alcohol.

4.9 Conclusion

This chapter examined changes in abstention and heavy episodic drinking in the United Kingdom using age, period, and cohort estimation. We find evidence that within younger age cohorts, there is an increase in the proportion of abstainers for both men and women. However, when we consider the individuals who do drink, young adults have tended to drink more than their older counterparts, although this trend appears to have stopped with the youngest few cohorts.

FIGURE 4.9: Alcohol Related Deaths by Age



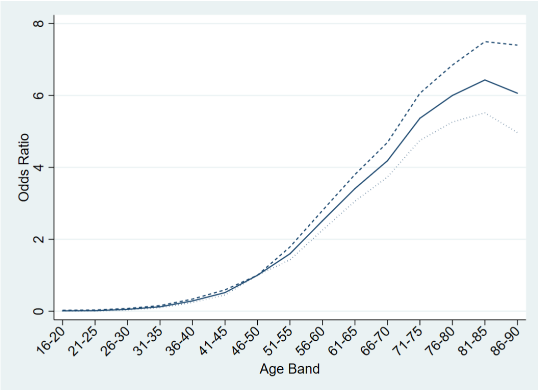
Source: ONS Alcohol-related Deaths Bulletin (2017)

Moreover, there is also a different age effect by cohort, with women born in the 1950s expected to drink more as they age compared to women born in 1970 who are expected to drink less as they age. This chapter has expanded on the existing work by researching a more recent period of time where there has been a documented change in alcohol consumption, as well as including the price of alcohol, which has been increasing due to the alcohol duty escalator (2008-2014) and Gross Domestic Product (GDP) as well as a variety of explanatory variables within our analysis. Additionally, the recently reported increases in abstinence, both here and in the literature, come against a backdrop of historically high levels of alcohol consumption.

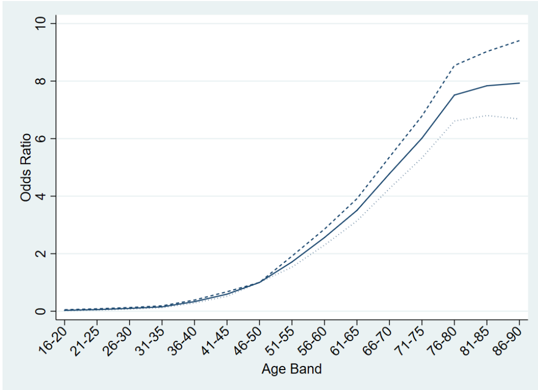
The purpose of this chapter was to examine the changes in drinking behaviour amongst individuals in England over time when we control for a variety of demographic variables as well as economic factors such as price of alcohol and GDP. Our results suggest that there is an overall increase in the rate of abstention within younger cohorts when we compare them to their older counterparts.

Our analysis provides intriguing results for policy makers, namely that the price of alcohol as well as the recent recession has played little part in the change in behaviours surrounding alcohol consumption. While the growing rate of abstention amongst young adults is a welcome result for policy makers, what needs attention are the individuals who are consuming large quantities of alcohol in one drinking occasion, as these are the individuals who are most likely to cause the unwanted externalities associated with heavy alcohol use. As a result, further research could focus on trying to further unravel the reason for the observed increases in abstention amongst young adults.

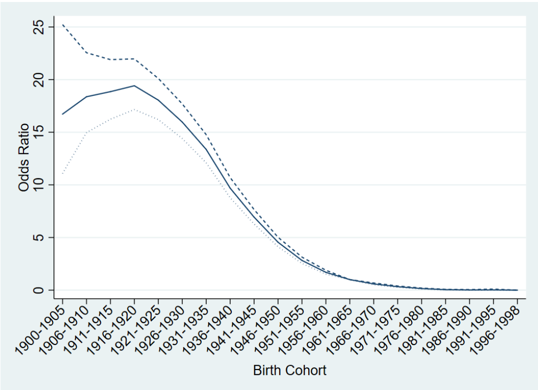
FIGURE 4.10: Illustrations APC Effects for Proportion of Cardiovascular Disease by Gender



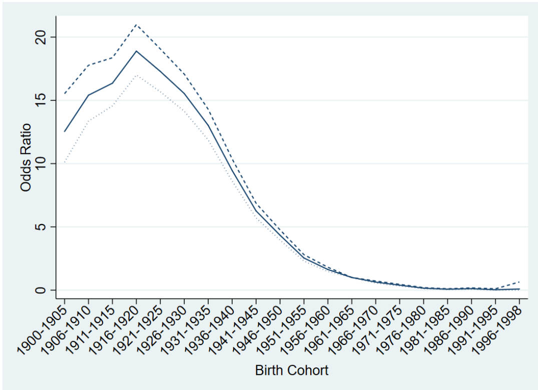
(A) Cardiovascular Disease by Age (Male)



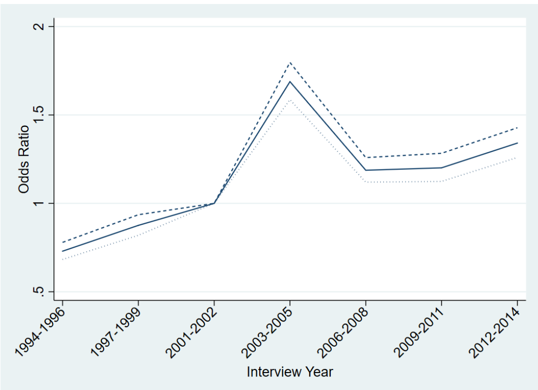
(B) Cardiovascular Disease by Age (Female)



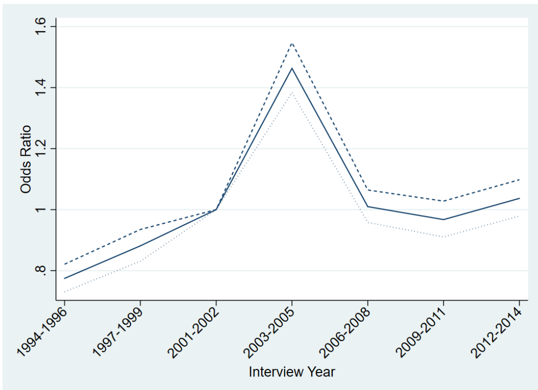
(C) Cardiovascular Disease by Cohort (Male)



(D) Cardiovascular Disease by Cohort (Female)

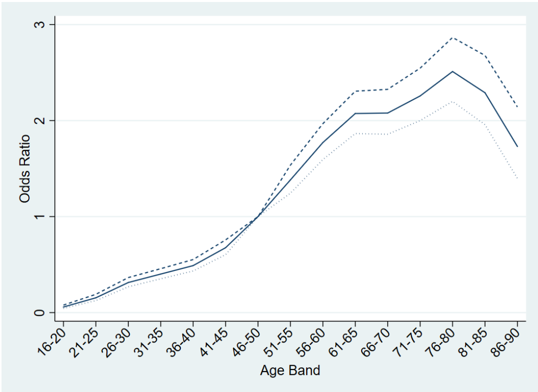


(E) Cardiovascular Disease by Period (Male)

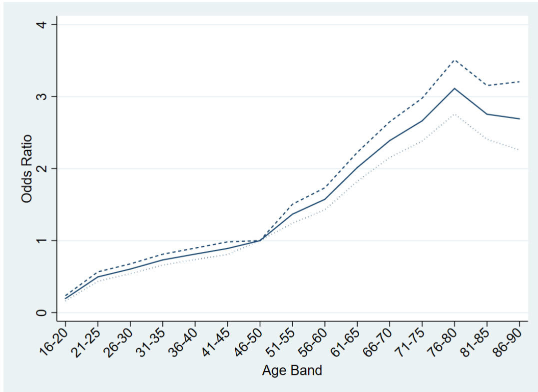


(F) Cardiovascular Disease by Period (Female)

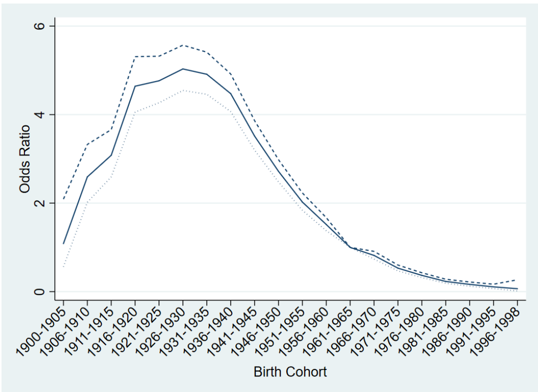
FIGURE 4.11: Illustrations APC Effects for Proportion of Hypertension by Gender



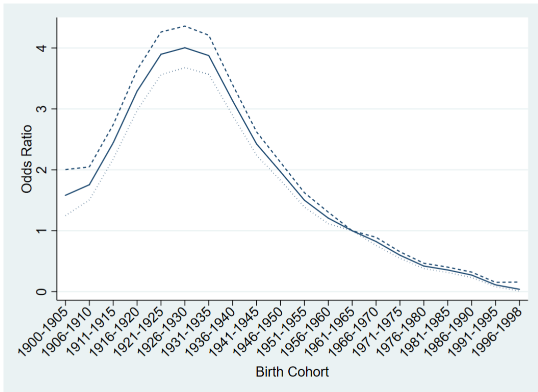
(A) High Blood Pressure by Age (Male)



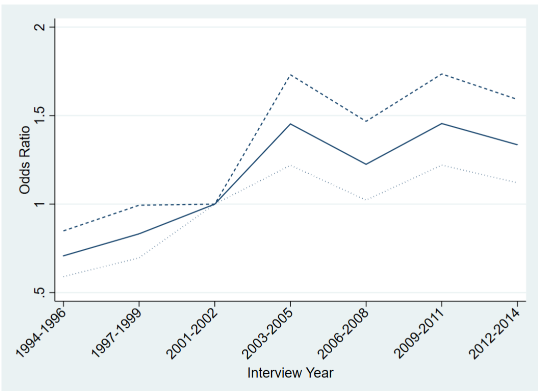
(B) High Blood Pressure by Age (Female)



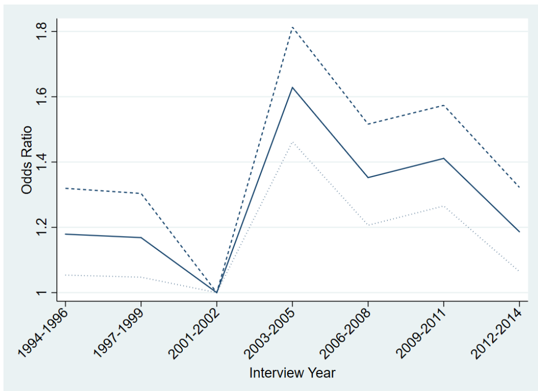
(C) High Blood Pressure by Cohort (Male)



(D) High Blood Pressure by Cohort (Female)

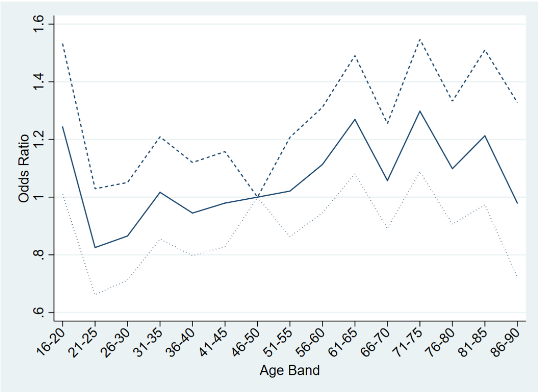


(E) High Blood Pressure by Period (Male)

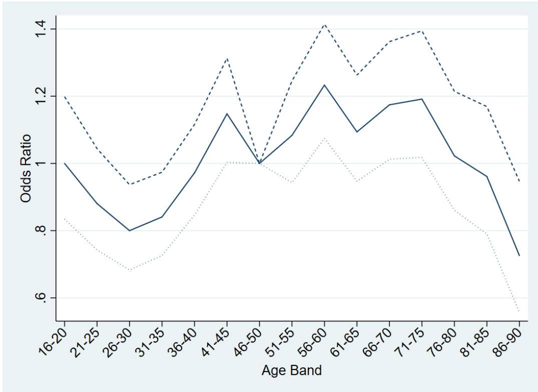


(F) High Blood Pressure by Period (Female)

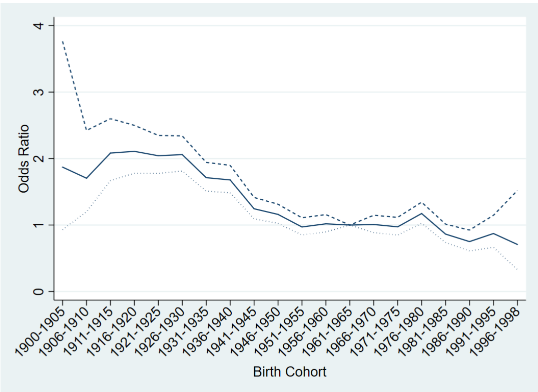
FIGURE 4.12: Illustrations APC Effects for Respiratory Problems by Gender



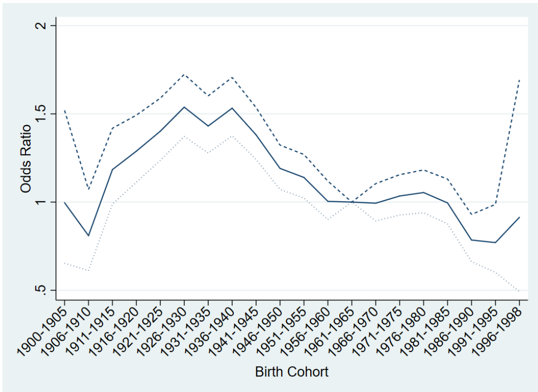
(A) Proportion of Respiratory Problems by Age (Male)



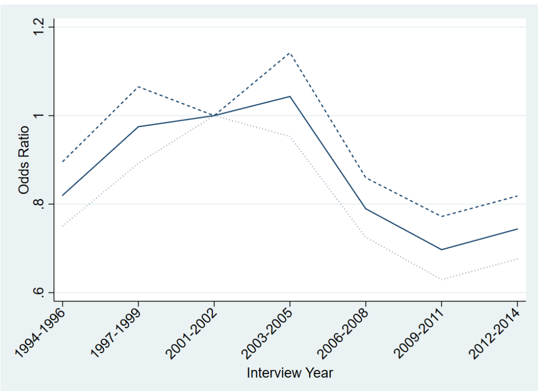
(B) Proportion of Respiratory Problems by Age (Female)



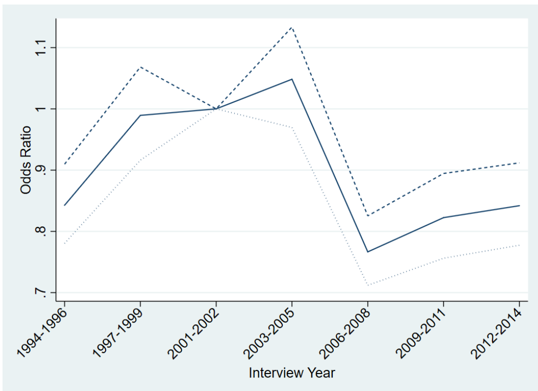
(C) Proportion of Respiratory Problems by Cohort (Male)



(D) Proportion of Respiratory Problems by Cohort (Female)

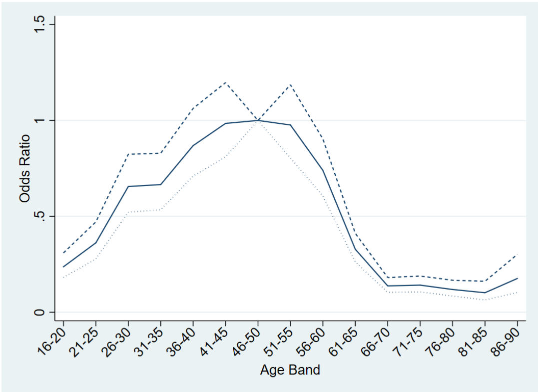


(E) Proportion of Respiratory Problems by Period (Male)

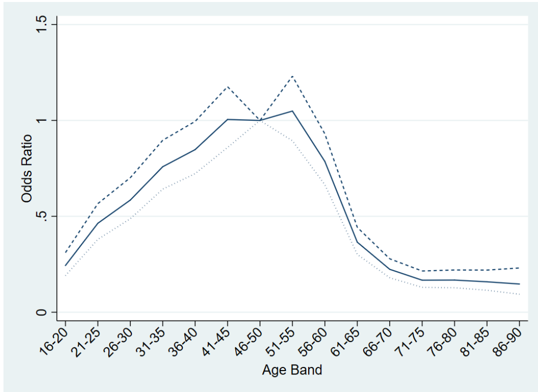


(F) Proportion of Respiratory Problems by Period (Female)

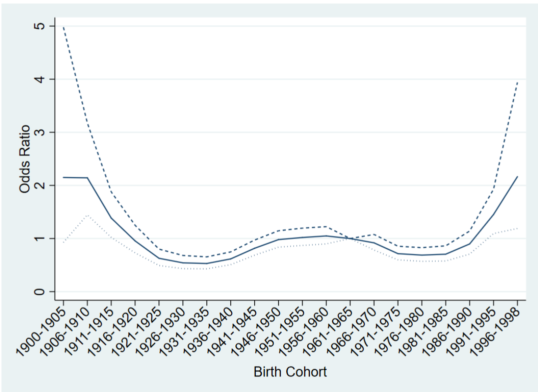
FIGURE 4.13: Illustrations APC Effects for Mental Health by Gender



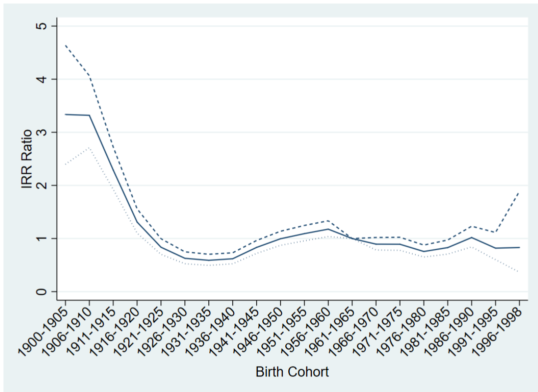
(A) Proportion of Mental Health by Age (Male)



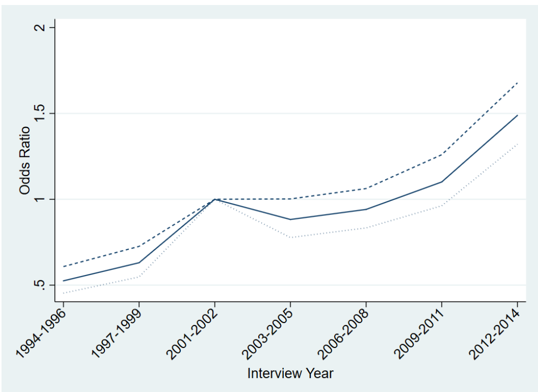
(B) Proportion of Mental Health by Age (Female)



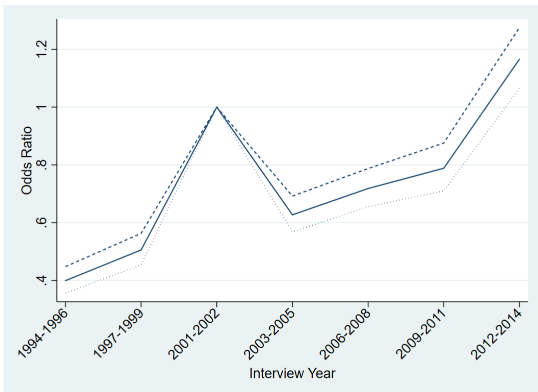
(C) Proportion of Mental Health by Cohort (Male)



(D) Proportion of Mental Health by Cohort (Female)

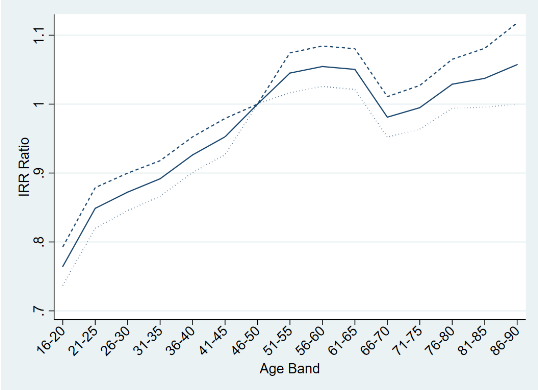


(E) Proportion of Mental Health by Period (Male)

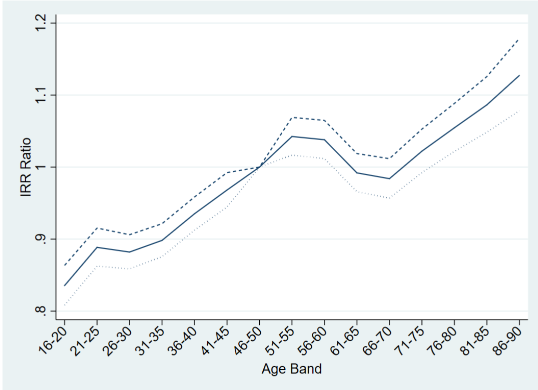


(F) Proportion of Mental Health by Period (Female)

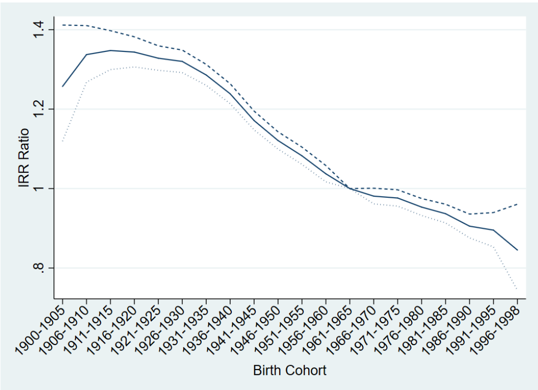
FIGURE 4.14: Illustrations APC Effects for SAH by Gender



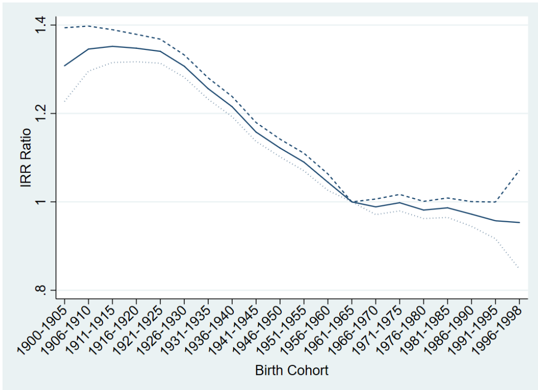
(A) Self Assessed Health by Age (Male)



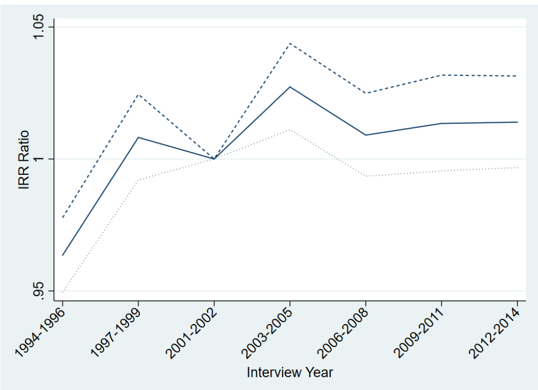
(B) Self Assessed Health by Age (Female)



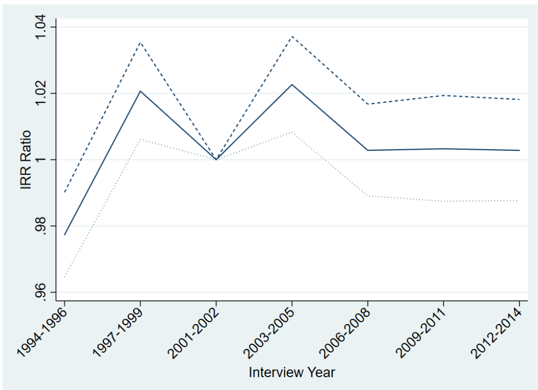
(C) Self Assessed Health by Cohort (Male)



(D) Self Assessed Health by Cohort (Female)



(E) Self Assessed Health by Period (Male)



(F) Self Assessed Health by Period (Female)

TABLE 4.3: Estimated effects of demographic variables

	Male		Female	
	Abstention (OR)	Heavy Drinking (IRR)	Abstention (OR)	Heavy Drinking (IRR)
Household Income				
≤ £15,000	1.6447*** (0.0526)	0.9372*** (0.0106)	1.431*** (0.0338)	0.0867*** (0.0103)
Median			Reference	
Top 10%	0.5273*** (0.0435)	1.0808*** (0.0147)	0.6083*** (0.0389)	1.0672*** (0.0141)
Education				
Degree	0.8464*** (0.0451)	0.8876*** (0.0107)	0.7902*** (0.0344)	0.9415*** (0.0106)
Above A level	0.7873*** (0.0497)	0.9742*** (0.0127)	0.6759*** (0.0440)	0.9543*** (0.0127)
A level			Reference	
Below A level	1.6599*** (0.2101)	1.0238*** (0.0181)	1.2745*** (0.0841)	0.9996*** (0.0121)
No Qualification	1.9674*** (0.0915)	1.0237*** (0.0129)	2.1859*** (0.7668)	0.9813*** (0.0119)
Ethnicity				
White			Reference	
Black	8.5174*** (0.4193)	0.6690*** (0.0156)	6.0637*** (0.2788)	0.5671*** (0.0175)
Dual	2.7777*** (0.3464)	0.7872*** (0.0338)	1.993*** (0.2021)	0.7693*** (0.0274)
Asian	87.0237*** (1.0709)	0.6835*** (0.0180)	122.7783*** (1.0138)	0.4537*** (0.0274)
Other	5.6930*** (0.5397)	0.6037*** (0.0299)	6.5834*** (0.3602)	0.5925*** (0.0341)
Government Region				
North East	0.9327*** (0.0986)	1.2529*** (0.0238)	0.9922*** (0.0694)	1.2073*** (0.0217)
North West	0.8497*** (0.0903)	1.1173*** (0.0176)	0.9745*** (0.0525)	1.1208*** (0.0173)
Yorkshire	1.3041*** (0.0891)	1.1041*** (0.0187)	1.1253** (0.0584)	1.0692*** (0.0176)
East Midlands	0.9662 (0.6657)	1.0254*** (0.0174)	1.0289 (0.0546)	0.9791*** (0.0164)
West Midlands			Reference	
Eastern	1.0973*** (0.7523)	0.9427*** (0.0156)	1.0546** (0.0487)	0.9499*** (0.0168)
London	1.3648*** (0.0799)	0.9285*** (0.0158)	1.2280*** (0.0576)	0.9380*** (0.0159)
South East	1.1367*** (0.0760)	0.9385*** (0.0149)	0.9747* (0.0487)	0.9496*** (0.0146)
South West	1.1147*** (0.0807)	0.9257*** (0.0153)	0.9884 (0.052)	0.9286*** (0.0150)
Smoking Status				
Never Smoked			Reference	
Ex-Smoker	0.6225*** (0.0237)	1.1539*** (0.0106)	0.5811*** (0.0174)	1.1909*** (0.0105)
Smoker	0.6573*** (0.0261)	1.3681*** (0.0139)	0.6140*** (0.0075)	1.4589*** (0.0141)

Notes: OR: Odds ratio, IRR: Incidence Reserve Ratio, Standard errors in parentheses. Median income is defined as £27,000 of disposable income. Abstention: Observations 115,053 (male) 140,871 (female) Heavy Drinking: Observations 77,428 (male) 96,789 (female) *p < 00.0, ** p < 00.5, ***p < 0.01.

TABLE 4.4: Logistic Results – Age Coefficients

Age Band	Male	Female
16-20	1.7198*** (0.1381)	1.9728*** (0.0862)
21-25	0.6287*** (0.0814)	0.8517*** (0.0688)
26-30	0.6285*** (0.0801)	0.8612*** (0.0706)
31-35	0.7327*** (0.0725)	0.83192*** (0.0575)
36-40	0.71604*** (0.0637)	0.8728*** (0.0460)
41-45	0.9318 (0.0581)	0.9586*** (0.0466)
51-55	0.9349*** (0.0503)	1.0299*** (0.0452)
56-60	0.9531*** (0.0505)	1.3183*** (0.0497)
61-65	0.9713*** (0.0577)	1.3227*** (0.0571)
66-70	1.0876*** (0.0605)	1.3567*** (0.0675)
71-75	1.1981*** (0.0731)	1.7662*** (0.0809)
76-80	1.2554 *** (0.0870)	2.1366*** (0.1011)
81-85	1.6681*** (0.1214)	2.5187*** (0.1270)
86-90	2.0971*** (0.1888)	3.0525*** (0.1768)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 115,053 (male) 140,871 (female) *p < 0.10, ** p < 0.05, ***p < 0.01.

TABLE 4.5: Logistic Results with Controls– Age Coefficients

Age Band	Male	Female
16-20	1.6651*** (0.1439)	1.6504*** (0.1229)
21-25	0.6723*** (0.1036)	0.8665*** (0.1139)
26-30	0.6361*** (0.0975)	0.8399*** (0.0866)
31-35	0.7309*** (0.0841)	0.8191*** (0.0713)
36-40	0.7042*** (0.0770)	0.8973*** (0.0587)
41-45	0.9237*** (0.0694)	0.9647*** (0.0579)
51-55	0.9293*** (0.0746)	1.0204*** (0.0616)
56-60	0.9708*** (0.0709)	1.3249*** (0.0585)
61-65	0.9717*** (0.0659)	1.3342*** (0.0572)
66-70	1.0799*** (0.0651)	1.3762*** (0.0583)
71-75	1.1851*** (0.0712)	1.8162*** (0.0828)
76-80	1.1522*** (0.0903)	2.1866*** (0.0668)
81-85	1.6141*** (0.1277)	2.4531*** (0.1019)
86-90	2.3217*** (0.1683)	2.5525*** (0.1253)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 115,053 (male) 140,871 (female) *p < 0.10, ** p < 0.05, ***p < 0.01.

TABLE 4.6: Logistic Results – Period Coefficients

Interview Band	Male	Female
1997-1999	2.1825*** (0.0794)	1.6280*** (0.0460)
2003-2005	1.6691*** (0.0584)	1.3663*** (0.0358)
2006-2008	1.0134*** (0.0377)	0.8686*** (0.0239)
2009-2011	1.0945*** (0.0461)	1.0096*** (0.0312)
2012-2014	1.3941*** (0.0534)	1.1923*** (0.0341)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 115,053 (male) 140,871 (female) *$p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

TABLE 4.7: Logistic Results – Period Coefficients with Controls

Interview Band	Male	Female
1997-1999	1.1018*** (0.0861)	1.0670*** (0.0636)
2003-2005	1.4238*** (0.0108)	1.2923*** (0.0736)
2006-2008	1.2766*** (0.0978)	1.1868*** (0.0677)
2009-2011	1.3058*** (0.1069)	1.3157*** (0.0797)
2012-2014	1.6848*** (0.1347)	1.5476*** (0.0926)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 115,053 (male) 140,871 (female) *p < 0.10, ** p < 0.05, ***p < 0.01.

TABLE 4.8: Logistic Results – Birth Coefficients

Birth Cohort	Male	Female
1906-1910	2.5441*** (0.4537)	2.0670*** (0.2899)
1911-1915	2.3851*** (0.2548)	1.9976*** (0.2302)
1916-1920	1.7447*** (0.1497)	1.8623*** (0.1577)
1921-1925	1.4217*** (0.0970)	1.7286*** (0.1152)
1926-1930	1.3191*** (0.0810)	1.4013*** (0.0952)
1931-1935	1.0478*** (0.0717)	1.1838*** (0.0836)
1936-1940	0.9844*** (0.0620)	1.0985*** (0.0695)
1941-1945	0.8832*** (0.0475)	1.0755*** (0.0565)
1946-1950	0.8960*** (0.0430)	0.9603*** (0.0481)
1951-1955	0.9304*** (0.0530)	0.9574*** (0.0504)
1956-1960	0.9967*** (0.0563)	0.9972*** (0.0479)
1966-1970	1.0396*** (0.0644)	1.0213*** (0.0517)
1971-1975	1.2426*** (0.0756)	1.0886*** (0.0672)
1976-1980	1.3065*** (0.0761)	1.0611*** (0.0709)
1981-1985	1.3255*** (0.0909)	0.9672*** (0.0741)
1986-1990	2.0430*** (0.1266)	1.0477*** (0.0933)
1991-1995	2.2305*** (0.2285)	1.3282*** (0.1655)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 115,053 (male) 140,871 (female) *p < 0.10, ** p < 0.05, ***p < 0.01.

TABLE 4.9: Logistic Results – Birth Coefficients with Controls

Birth Cohort	Male	Female
1906-1910	2.4988*** (0.5448)	2.0414*** (0.2139)
1911-1915	2.2305*** (0.2157)	1.9983*** (0.1481)
1916-1920	1.7234*** (0.1616)	1.8947*** (0.1112)
1921-1925	1.4765*** (0.0971)	1.6913*** (0.0919)
1926-1930	1.3193*** (0.0804)	1.4085*** (0.0761)
1931-1935	1.0376*** (0.0687)	1.1961*** (0.0660)
1936-1940	0.9814*** (0.0647)	1.0996*** (0.0586)
1941-1945	0.8921*** (0.0643)	1.0793*** (0.0590)
1946-1950	0.9099*** (0.6980)	0.9647*** (0.0601)
1951-1955	0.9738*** (0.0676)	0.9641*** (0.0624)
1956-1960	0.9928*** (0.0755)	0.9909*** (0.0611)
1966-1970	1.0484*** (0.0825)	1.0263*** (0.0650)
1971-1975	1.2690*** (0.0989)	1.0786*** (0.0906)
1976-1980	1.3177*** (0.1006)	1.0641*** (0.1009)
1981-1985	1.3232*** (0.1129)	0.9605*** (0.1156)
1986-1990	2.0652*** (0.1441)	1.0494*** (0.1448)
1991-1995	2.2047*** (0.2483)	1.4127*** (0.2001)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 115,053 (male) 140,871 (female) *$p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

TABLE 4.10: Negative Binomial Results – Age Coefficients

Age Band	Male	Female
16-20	1.5243*** (0.0287)	1.5986*** (0.0276)
21-25	1.5530*** (0.0268)	1.5144*** (0.0246)
26-30	1.2844*** (0.0218)	1.2629*** (0.0202)
31-35	1.1526*** (0.0188)	1.1073*** (0.0171)
36-40	1.0565*** (0.0169)	1.0148 (0.0152)
41-45	1.0501*** (0.0168)	1.0221 (0.0155)
51-55	0.9545*** (0.0156)	0.8815*** (0.0140)
56-60	0.8660*** (0.0144)	0.8056*** (0.0134)
61-65	0.7729*** (0.0132)	0.7241*** (0.0126)
66-70	0.6771*** (0.0119)	0.6184*** (0.0117)
71-75	0.5636*** (0.0110)	0.5112*** (0.0109)
76-80	0.4587*** (0.0102)	0.4676*** (0.0113)
81-85	0.4111*** (0.0121)	0.4160*** (0.0122)
86-90	0.3321*** (0.0147)	0.3609*** (0.0152)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 77,428 (male) 96,789 (female) *p < 0:10, ** p < 0:05, ***p < 0:01.

TABLE 4.11: Negative Binomial Results – Age Coefficients with Controls

Age Band	Male	Female
16-20	1.2471*** (0.0345)	1.2680*** (0.0328)
21-25	1.3334*** (0.0320)	1.2604*** (0.0281)
26-30	1.2158*** (0.0254)	1.1407*** (0.0223)
31-35	1.1364*** (0.0218)	1.0505*** (0.0193)
36-40	1.0555*** (0.0196)	1.0002* (0.0177)
41-45	1.0390*** (0.0192)	1.0192* (0.0181)
51-55	0.9378*** (0.0181)	0.9113*** (0.0174)
56-60	0.8894*** (0.0174)	0.8487*** (0.0169)
61-65	0.7985*** (0.0166)	0.7574*** (0.0166)
66-70	0.7016*** (0.0162)	0.6627*** (0.0164)
71-75	0.5916*** (0.0154)	0.5639*** (0.0163)
76-80	0.4757*** (0.0143)	0.5080*** (0.0171)
81-85	0.4159*** (0.0165)	0.4655*** (0.0196)
86-90	0.3273*** (0.0198)	0.4186*** (0.0258)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 77,428 (male) 96,789 (female) *$p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

TABLE 4.12: Negative Binomial Results – Period Coefficients

Interview Band	Male	Female
1998-2000	0.9356*** (0.0124)	0.8827*** (0.1177)
2001-2003	0.9258*** (0.0109)	0.9198*** (0.0175)
2004-2006	1.0210*** (0.0114)	1.1930*** (0.0129)
2007-2009	1.0795*** (0.0139)	1.3306*** (0.0166)
2010-2014	1.0341*** (0.0131)	1.2790*** (0.0155)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 77,428 (male) 96,789 (female) *$p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

TABLE 4.13: Negative Binomial Results – Period Coefficients with Controls

Interview Band	Male	Female
1998-2000	1.0318*** (0.0206)	0.9946*** (0.0201)
2001-2003	1.0417*** (0.0197)	1.0328*** (0.0198)
2004-2006	1.1270*** (0.0209)	1.3257*** (0.0248)
2007-2009	1.2178*** (0.0244)	1.5192*** (0.0302)
2010-2014	1.1947*** (0.0242)	1.4673*** (0.0294)

Notes: Exponentiated coefficients; Standard errors in parentheses. *p < 0.10, ** p < 0.05, ***p < 0.01.

TABLE 4.14: Negative Binomial Results – Birth Coefficients

Birth Cohort	Male	Female
1906-1910	0.2799*** (0.0314)	0.2902*** (0.0281)
1911-1915	0.2543*** (0.0157)	0.3141*** (0.3141)
1916-1920	0.3538*** (0.0133)	0.3639*** (0.0133)
1921-1925	0.3933*** (0.0101)	0.3920*** (0.3920)
1926-1930	0.4348*** (0.0093)	0.4487*** (0.0103)
1931-1935	0.5450*** (0.0101)	0.5045*** (0.0104)
1936-1940	0.6278*** (0.0108)	0.5908*** (0.0109)
1941-1945	0.7363*** (0.0120)	0.7087*** (0.0117)
1946-1950	0.8168*** (0.0126)	0.8027*** (0.0121)
1951-1955	0.8726*** (0.0139)	0.8760*** (0.0133)
1956-1960	0.9489*** (0.0147)	0.9707** (0.0141)
1966-1970	1.0375*** (0.0159)	1.0899*** (0.0154)
1971-1975	1.1446*** (0.0184)	1.1913*** (0.0177)
1976-1980	1.3158*** (0.0215)	1.3842*** (0.0208)
1981-1985	1.3640*** (0.0241)	1.5271*** (0.0244)
1986-1990	1.4456*** (0.0334)	1.6964*** (0.0352)
1991-1995	1.0254*** (0.0515)	1.0082*** (0.0592)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 77,428 (male) 96,789 (female) *p < 0.10, ** p < 0.05, ***p < 0.01.

TABLE 4.15: Negative Binomial Results – Birth Coefficients with Controls

Birth Cohort	Male	Female
1906-1910	0.2878*** (0.0475)	0.2798*** (0.0498)
1911-1915	0.2442*** (0.0215)	0.3221*** (0.0258)
1916-1920	0.3551*** (0.0185)	0.3610*** (0.0191)
1921-1925	0.4032*** (0.0142)	0.3883*** (0.0155)
1926-1930	0.4507*** (0.0131)	0.4541*** (0.0147)
1931-1935	0.5569*** (0.0137)	0.5035*** (0.0141)
1936-1940	0.6516*** (0.0145)	0.5929*** (0.0143)
1941-1945	0.7435*** (0.0149)	0.7118*** (0.0149)
1946-1950	0.8168*** (0.0150)	0.8016*** (0.0148)
1951-1955	0.8695*** (0.0163)	0.8833*** (0.0160)
1956-1960	0.9549*** (0.0172)	0.9605*** (0.0164)
1966-1970	1.0406*** (0.0184)	1.0562*** (0.0174)
1971-1975	1.1044*** (0.0210)	1.1331*** (0.0198)
1976-1980	1.1864*** (0.0245)	1.2263*** (0.0233)
1981-1985	1.2048*** (0.0288)	1.3356*** (0.0286)
1986-1990	1.2253*** (0.0358)	1.4628*** (0.0383)
1991-1995	1.0214*** (0.0546)	1.00462*** (0.0643)

Notes: Exponentiated coefficients; Standard errors in parentheses. Observations 77,428 (male) 96,789 (female) *p < 0.10, ** p < 0.05, ***p < 0.01.

TABLE 4.16: Age-Price-Cohort Regression Results

	Abstain		Heavy Drinking	
	Male	**Female**	**Male**	**Female**
Age 16-19	1.038***	0.854***	0.285***	0.0557
	(0.134)	(0.107)	(0.0531)	(0.0499)
Age 20-24	-0.282**	-0.144	0.342***	0.0493
	(0.118)	(0.0935)	(0.0454)	(0.0429)
Age 25-29	-0.363***	-0.0786	0.131***	-0.0676*
	(0.0999)	(0.0790)	(0.0380)	(0.0359)
Age 30-34	-0.282***	-0.142**	0.0333	-0.133***
	(0.0815)	(0.0650)	(0.0306)	(0.0290)
Age 35-39	-0.149**	-0.146***	-0.0313	-0.151***
	(0.0655)	(0.0530)	(0.0240)	(0.0223)
Age 40-44	-0.113**	-0.0357	-0.0224	-0.0692***
	(0.0537)	(0.0433)	(0.0185)	(0.0172)
Age 50-54	0.0218	0.0440	0.0165	0.0190
	(0.0562)	(0.0448)	(0.0188)	(0.0180)
Age 55-59	-0.0114	0.109**	-0.0114	0.0619***
	(0.0708)	(0.0551)	(0.0246)	(0.0239)
Age 60-64	0.189**	0.176***	-0.0277	0.0768**
	(0.0862)	(0.0676)	(0.0313)	(0.0310)
Age 65-69	0.308***	0.346***	-0.0973**	0.0818**
	(0.104)	(0.0810)	(0.0387)	(0.0387)
Age 70-74	0.447***	0.486***	-0.155***	0.0370
	(0.123)	(0.0955)	(0.0469)	(0.0473)
Age 75-79	0.633***	0.609***	-0.269***	0.0861
	(0.142)	(0.110)	(0.0556)	(0.0562)
Age 80-84	0.803***	0.777***	-0.313***	0.0594

	(0.163)	(0.125)	(0.0654)	(0.0664)
Age 85-89	1.098***	0.972***	-0.441***	0.00307
	(0.188)	(0.141)	(0.0805)	(0.0811)
Birth Cohort 1906-1910	-0.420	0.143	-0.632***	-0.943***
	(0.261)	(0.194)	(0.239)	(0.211)
Birth Cohort 1911-1915	-0.304	0.297*	-0.937***	-1.182***
	(0.224)	(0.171)	(0.111)	(0.106)
Birth Cohort 1916-1920	-0.454**	0.175	-0.693***	-1.088***
	(0.201)	(0.155)	(0.0843)	(0.0838)
Birth Cohort 1921-1925	-0.533***	0.112	-0.639***	-1.038***
	(0.180)	(0.140)	(0.0713)	(0.0717)
Birth Cohort 1926-1930	-0.415***	0.0808	-0.617***	-0.922***
	(0.160)	(0.125)	(0.0620)	(0.0620)
Birth Cohort 1931-1935	-0.332**	0.107	-0.465***	-0.811***
	(0.141)	(0.110)	(0.0535)	(0.0532)
Birth Cohort 1936-1940	-0.269**	0.0587	-0.389***	-0.665***
	(0.121)	(0.0958)	(0.0458)	(0.0452)
Birth Cohort 1941-1945	-0.480***	-0.0339	-0.278***	-0.486***
	(0.103)	(0.0809)	(0.0381)	(0.0371)
Birth Cohort 1946-1950	-0.440***	-0.135**	-0.206***	-0.345***
	(0.0839)	(0.0667)	(0.0309)	(0.0298)
Birth Cohort 1951-1955	-0.186***	-0.0127	-0.151***	-0.230***
	(0.0662)	(0.0536)	(0.0243)	(0.0231)
Birth Cohort 1956-1960	-0.0645	-0.0107	-0.0607***	-0.0802***
	(0.0517)	(0.0428)	(0.0182)	(0.0169)
Birth Cohort 1966-1970	0.259***	0.212***	0.0182	0.119***
	(0.0501)	(0.0410)	(0.0178)	(0.0166)
Birth Cohort 1971-1975	0.452***	0.443***	0.0549**	0.202***

	(0.0634)	(0.0512)	(0.0240)	(0.0226)
Birth Cohort 1976-1980	0.867***	0.869***	0.0705**	0.291***
	(0.0787)	(0.0631)	(0.0313)	(0.0296)
Birth Cohort 1981-1985	0.126	0.236***	0.0382	0.332***
	(0.0998)	(0.0800)	(0.0385)	(0.0363)
Birth Cohort 1986-1990	0.168	0.145	0.0360	0.363***
	(0.120)	(0.0974)	(0.0474)	(0.0445)
Birth Cohort 1991-1995	0.276*	0.127	-0.0220	0.363***
	(0.151)	(0.125)	(0.0631)	(0.0578)
Price of Alcohol	-0.089*	0.087**	0.066***	0.166***
	(0.049)	(0.031)	(0.017)	(0.016)
Observations	114,513	139,299	52,271	51,673

Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

TABLE 4.17: Age-GDP-Cohort Regression Results

	Abstain		**Heavy Drinking**	
	Male	**Female**	**Male**	**Female**
Age 16-19	0.838***	0.719***	0.212***	-0.0387
	(0.122)	(0.0967)	(0.0470)	(0.0439)
Age 20-24	-0.452***	-0.257***	0.281***	-0.0267
	(0.109)	(0.0856)	(0.0406)	(0.0381)
Age 25-29	-0.496***	-0.170**	0.0837**	-0.127***
	(0.0923)	(0.0727)	(0.0346)	(0.0324)
Age 30-34	-0.382***	-0.209***	-0.00252	-0.177***
	(0.0765)	(0.0610)	(0.0282)	(0.0265)
Age 35-39	-0.216***	-0.192***	-0.0557**	-0.182***
	(0.0627)	(0.0507)	(0.0225)	(0.0209)
Age 40-44	-0.146***	-0.0585	-0.0357**	-0.0873***
	(0.0528)	(0.0426)	(0.0179)	(0.0166)
Age 50-54	0.0556	0.0664	0.0289	0.0350**
	(0.0554)	(0.0442)	(0.0183)	(0.0175)
Age 55-59	0.0547	0.154***	0.0124	0.0903***
	(0.0681)	(0.0533)	(0.0232)	(0.0227)
Age 60-64	0.288***	0.244***	0.00985	0.123***
	(0.0812)	(0.0640)	(0.0286)	(0.0286)
Age 65-69	0.444***	0.435***	-0.0467	0.147***
	(0.0970)	(0.0759)	(0.0347)	(0.0351)
Age 70-74	0.616***	0.598***	-0.0920**	0.120***
	(0.114)	(0.0887)	(0.0417)	(0.0427)
Age 75-79	0.837***	0.741***	-0.194***	0.182***
	(0.132)	(0.102)	(0.0494)	(0.0508)
Age 80-84	1.043***	0.930***	-0.228***	0.167***

	(0.152)	(0.116)	(0.0586)	(0.0605)
Age 85-89	1.376***	1.143***	-0.344***	0.115
	(0.176)	(0.133)	(0.0737)	(0.0756)
Birth Cohort 1906-1910	-0.812***	-0.0916	-0.749***	-1.059***
	(0.247)	(0.184)	(0.236)	(0.208)
Birth Cohort 1911-1915	-0.653***	0.0788	-1.053***	-1.309***
	(0.208)	(0.159)	(0.104)	(0.101)
Birth Cohort 1916-1920	-0.759***	-0.0248	-0.803***	-1.225***
	(0.184)	(0.141)	(0.0757)	(0.0762)
Birth Cohort 1921-1925	-0.803***	-0.0671	-0.739***	-1.167***
	(0.164)	(0.127)	(0.0625)	(0.0641)
Birth Cohort 1926-1930	-0.649***	-0.0761	-0.706***	-1.037***
	(0.146)	(0.114)	(0.0540)	(0.0550)
Birth Cohort 1931-1935	-0.532***	-0.0287	-0.542***	-0.912***
	(0.128)	(0.101)	(0.0466)	(0.0471)
Birth Cohort 1936-1940	-0.434***	-0.0546	-0.454***	-0.749***
	(0.111)	(0.0882)	(0.0402)	(0.0402)
Birth Cohort 1941-1945	-0.614***	-0.124	-0.328***	-0.549***
	(0.0962)	(0.0754)	(0.0341)	(0.0335)
Birth Cohort 1946-1950	-0.542***	-0.202***	-0.243***	-0.392***
	(0.0792)	(0.0630)	(0.0282)	(0.0273)
Birth Cohort 1951-1955	-0.254***	-0.0579	-0.175***	-0.261***
	(0.0635)	(0.0515)	(0.0228)	(0.0217)
Birth Cohort 1956-1960	-0.0982*	-0.0333	-0.0729***	-0.0964***
	(0.0509)	(0.0421)	(0.0177)	(0.0165)
Birth Cohort 1966-1970	0.293***	0.234***	0.0297*	0.135***
	(0.0493)	(0.0402)	(0.0174)	(0.0161)
Birth Cohort 1971-1975	0.518***	0.488***	0.0779***	0.232***

	(0.0604)	(0.0487)	(0.0227)	(0.0212)
Birth Cohort 1976-1980	0.968***	0.936***	0.106***	0.335***
	(0.0739)	(0.0592)	(0.0290)	(0.0273)
Birth Cohort 1981-1985	0.275***	0.325***	0.0841**	0.388***
	(0.0960)	(0.0755)	(0.0354)	(0.0331)
Birth Cohort 1986-1990	0.357***	0.253***	0.0950**	0.434***
	(0.116)	(0.0922)	(0.0432)	(0.0404)
Birth Cohort 1991-1995	0.452***	0.275**	0.0640	0.483***
	(0.133)	(0.110)	(0.0555)	(0.0508)
GDP	-4.41e-07***	6.89e-08	1.28e-07***	4.57e-07***
	(1.11e-07)	(8.70e-08)	(4.79e-08)	(4.70e-08)
Observations	114,513	139,299	52,271	51,673

Notes: Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Chapter 5

Conclusion

This thesis contributes significant new knowledge to the research and evaluation of alcohol consumption and other risky behaviours in the United Kingdom and United States. This thesis has presented three distinct chapters analysing alcohol consumption in society. It has examined the effect of the MLDA on young adults in a UK setting. It examines the role alcohol consumption plays, as well as a variety of other risky behaviours, with respect to physical attractiveness in adolescence. Finally, it has provided new evidence to the growing literature on the change in alcohol consumption across the life-course, answering the questions: Is the increase in young adult abstention rates masking heavy drinking? And how has alcohol consumption changed within particular sun-groups over time.

Chapter Two used a Regression Discontinuity Design to explore the effect of the minimum legal drinking age (MLDA) on alcohol consumption amongst young adults in the United Kingdom (UK). It found evidence of a discrete jump of 7.3 percentage points in alcohol consumption at the minimum age cut-off across various model specifications. However, it found no evidence to suggest that the MLDA has an effect on binge drinking (the consumption of 8+ units in one period) amongst young adults. This has extended the literature by examining such policies in a UK setting. A country that has a minimum legal drinking age of 18 (lower than that of the US), as well as more relaxed consumption laws such as drinking in a restaurant or at home. Overall, it has shown that such control policies affect the decision to consume alcohol however, has less of an effect the quantity consumed by young adults overall or in one drinking occasion.

Chapter Three investigated how attractiveness influences alcohol consumption, binge drinking and a variety of other adolescent risky behaviours. To do this it used linear probability modelling and mediation analysis to estimate the influence of "beauty", reported by the interviewer, on behaviours related to smoking, under-age drinking and teenage sexual activity. It found marked effects of teenage attractiveness on the various behaviours, such that, more attractive individuals are more likely to engage in under-age drinking, but markedly less likely to smoke or to be sexual active. The results are robust throughout a series of sensitivity checks and do not reflect potential confounders such as risky behaviour of peer groups, personal grooming, individual's self esteem or the socio-economic background of the adolescent.

In addition, it found that attractive individuals are more likely to have consumed alcohol, than those of modal attractiveness, and unattractive teenagers are less likely to have consumed alcohol. The chapter found that attractive respondents are 6.6 percentage points more likely to have consumed alcohol, than those who were described as unattractive. It provides new evidence to the growing literature surrounding the pre-labour market outcomes conditional on individual characteristics. While attractiveness can be closely associated with increased wages in adulthood, through channels such as confidence and consumer discrimination (Mobius & Rosenblat, 2006; Stinebrickner et al., 2018) we find that while they work hard, they may play a little too hard.

Chapter Four examined changes in alcohol consumption across the life-course using a large number of waves of a cross-sectional survey, the Health Survey for England. The decomposition of trends in alcohol volume and heavy drinking measures into age, period, cohort and demographic effects offers an important perspective on the dynamics of change and has the potential for the prediction of problematic drinking and alcohol attributable disease. It found that there were significant differences in alcohol consumption across age, period and cohort, however found that the decision to drink as well as the amount consumed is not responsive to the change in price of alcohol or GDP over time.

Overall, the thesis has extended the literature in a variety of ways. It provides a detailed analysis of the change in behaviours related to youth alcohol consumption when the drinking age restrictions are removed at age 18 in the UK in Chapter 2. Chapter 3 uses a novel dataset from the United States to research how beauty affects early life decisions and risky behaviours. We conclude that attractiveness is likely to change both the opportunities and costs of a variety of behaviours during adolescence. This is an extension of the previous literature that has previously focused primarily on the wage premia and consumer based discrimination. Chapter 4 tracks life course drinking in the UK over age period and birth cohorts to analyse the change in individual behaviours surrounding alcohol consumption. It found that abstention is increasing amongst young adults and over time, whilst heavy consumption is increasing. Moreover, this chapter examines the role of economic variable and concludes that consumption is non-responsive to price changes or GDP. In policy terms overall, these are potentially significant findings.

5.1 Future Research

Chapter Two examines how the MLDA affects the individual decisions to drink as well as how much they drink. Ideally, the next step would be to examine how the removal of the minimum legal drinking age restrictions affect mortality and morbidity at age 18. Ideally, you would need information on all alcohol related admissions, either as a primary or secondary cause in England or the UK, one such dataset could be Hospital Episode Statistics (HES) in which you could link age of the patient with the ICD-10 code.

Furthermore, it would be interesting to examine how the role of peers or friendship networks affect the respondent's decision to drink alcohol. If the respondent has older peers who are no longer restricted by the MLDA, would the peers purchase alcohol for their friends, or would they wait until their younger friends are at the legal drinking age?

Additionally, an extension of Chapter Three could also be to examine the role of peers and the attractiveness of peers on adolescent risky behaviours. However, one of the prominent complications attributed to estimating peer effects is what Manski (1993, 2000) refers to as the "reflection problem", which argues that the researcher cannot unravel whether the average behaviour in some group influences the behaviour of the individuals that comprise the group or vice versa. Therefore, while peers' outcome affects the individual's decision, the individual's decision could influence the peers' outcome. One solution could be to use information on friends of friends and estimate two-stage instrumental variable analysis.

Finally in Chapter Four, future research could focus on trying to further unravel the reason for the observed increases in abstention amongst young adults. While we examine whether price of alcohol or GDP plays a significant role in the change in behaviour and attitudes to drinking, we find little evidence to suggest that they do. Another extension would be to examine how mortality has affected APC modelling. If the more heavy drinkers die earlier than their light drinking counterparts, this then biases our estimates of the life course trajectory downwards. To fully understand this in detail, you would need a panel dataset rather than a repeated cross-section.

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Appendix A

Additional Tables

TABLE A.1: Summary Statistics GHS 1998-2007

Variable Name	**All Participants**		**Young Adults**	
	Mean	SD	Mean	SD
Control Variables				
Female	0.5164	0.4997	0.4939	0.4999
Lives with Parents	-	-	0.8767	0.2361
At School	0.3908	0.1938	0.4982	0.5000
Higher Education	0.0930	0.2905	0.1776	0.0711
Employed	0.7345	0.4416	0.5864	0.4979
Single	0.1659	0.3720	0.7289	0.4333
Annual Income (Household)	30274.84	60239.45	6786.01	11240.61
White	0.9182	0.2741	0.8899	0.3130
Black	0.0183	0.340	0.0224	0.1481
Asian	0.0336	0.1803	0.0481	0.2138
Outcome Variables				
Drinks Regularly	0.8315	0.3743	0.7818	0.4130
Drinking Days per Week	3.2117	2.1504	2.3358	1.5267
Binge Drinking	0.2133	0.2606	0.1762	0.2864
Number of Units per Week	11.1026	18.9862	14.5034	25.4513
N	200,048		9,355	

Notes: Questions on binge drinking was answered by 7,527 respondents.

TABLE A.2: Results for the Sibling Fixed Effects Model

	Risk behaviours					
	(1) Smoke	(2) Drink	(3) Binge drink	(4) Substance use	(5) Unprotected sex	(6) Pregnancy
Panel A: Dep. var. = participation in risky behaviour						
Attractive	−0.074**	0.020	0.001	−0.019	0.002	−0.007
	(0.031)	(0.034)	(0.031)	(0.025)	(0.022)	(0.026)
Obs.	2,409	2,409	2,409	2,409	2,409	1,236
Dep. var. mean	0.310	0.451	0.281	0.154	0.094	0.054
Panel B: Dep. var. = frequency of risky behaviour						
Attractive	−0.848	0.036	−0.032	−0.001	0.035	−0.006
	(0.646)	(0.092)	(0.082)	(0.048)	(0.043)	(0.026)
Obs.	2,409	2,409	2,409	2,400	2,409	1,235
Dep. var. mean	4.790	1.039	0.676	0.295	0.110	0.060

Notes: This table reports the effect of beauty on a number of risky behaviours based on the sibling subsample. All models control for observable characteristics, sibling, school, and interviewer fixed effects. Dependent variable is participation in a certain behaviour as indicated in the column heading, with 1 = yes and 0 = no for panel *A*. Dependent variable is the frequency of the risky behaviour for panel *B*. ***, **, and * denote statistical significance at 0.01, 0.05, and 0.10 levels respectively. Standard errors clustered at the sibling pair level are in parentheses.

Appendix B

Additional Figures

FIGURE B.1: Proportion of Abstainers by Cohort 1951-1998

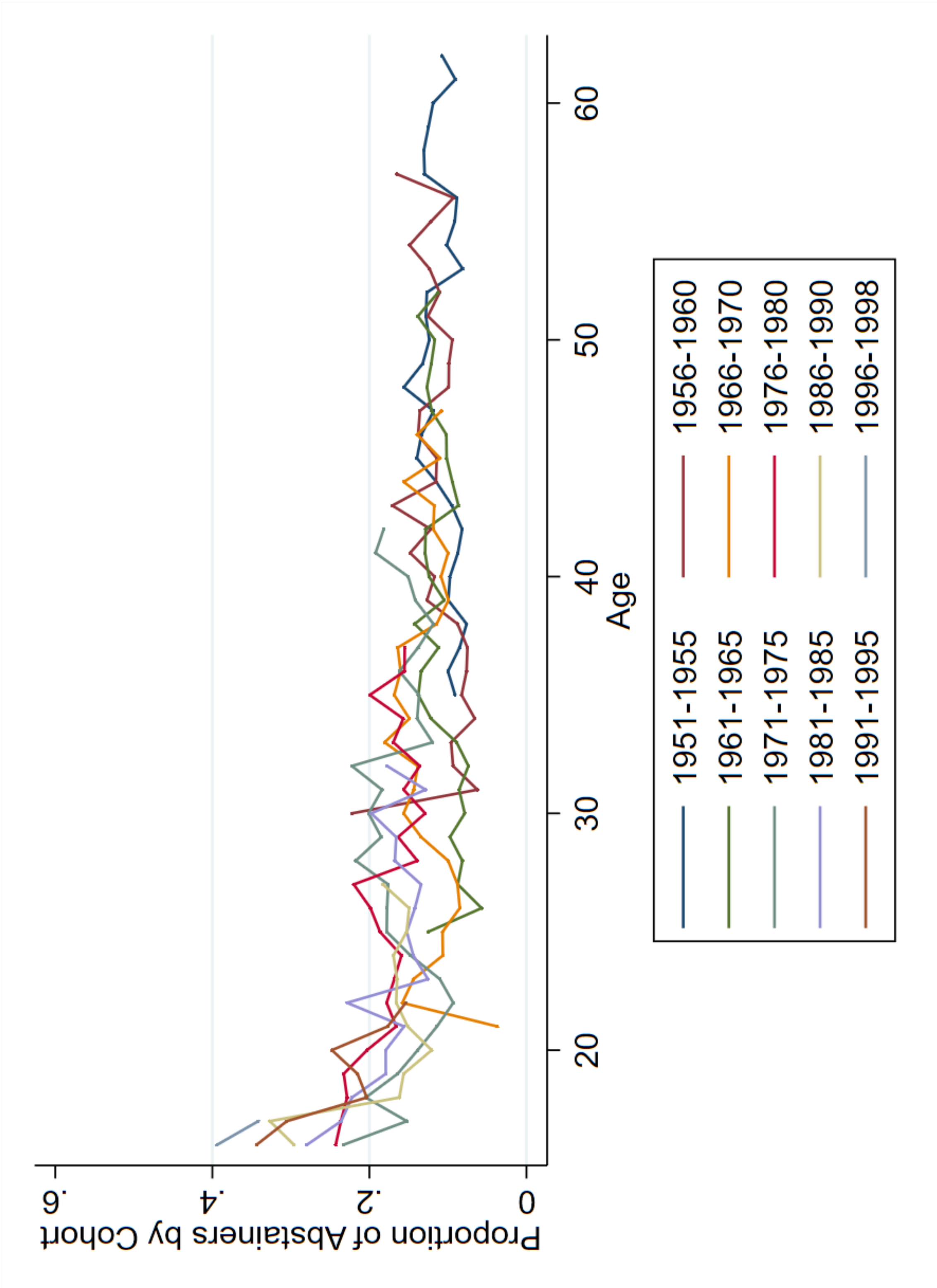


FIGURE B.2: Proportion of Abstainers by Cohort 1900-1950

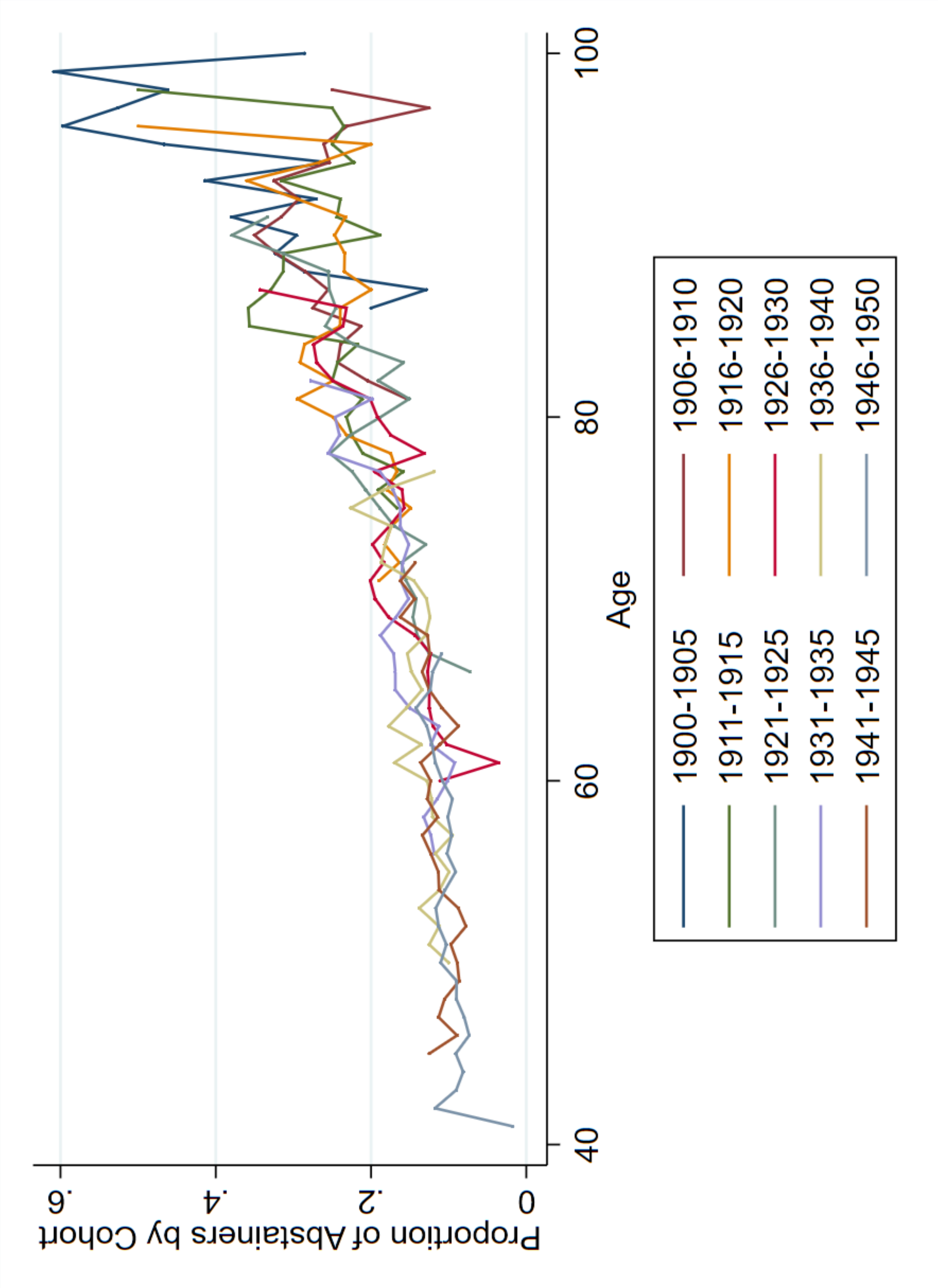


FIGURE B.3: Proportion of Units by Cohort 1951-1998

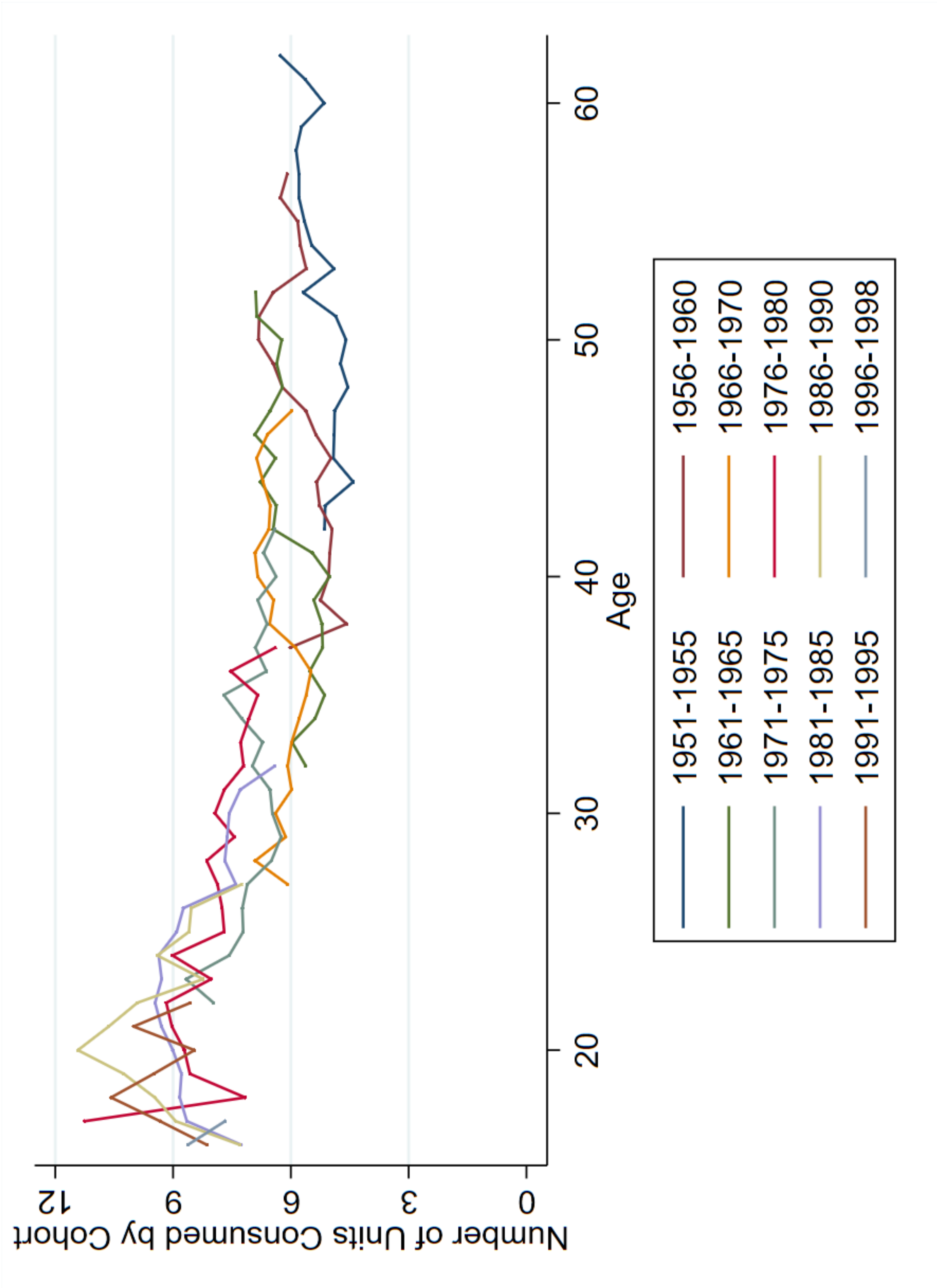
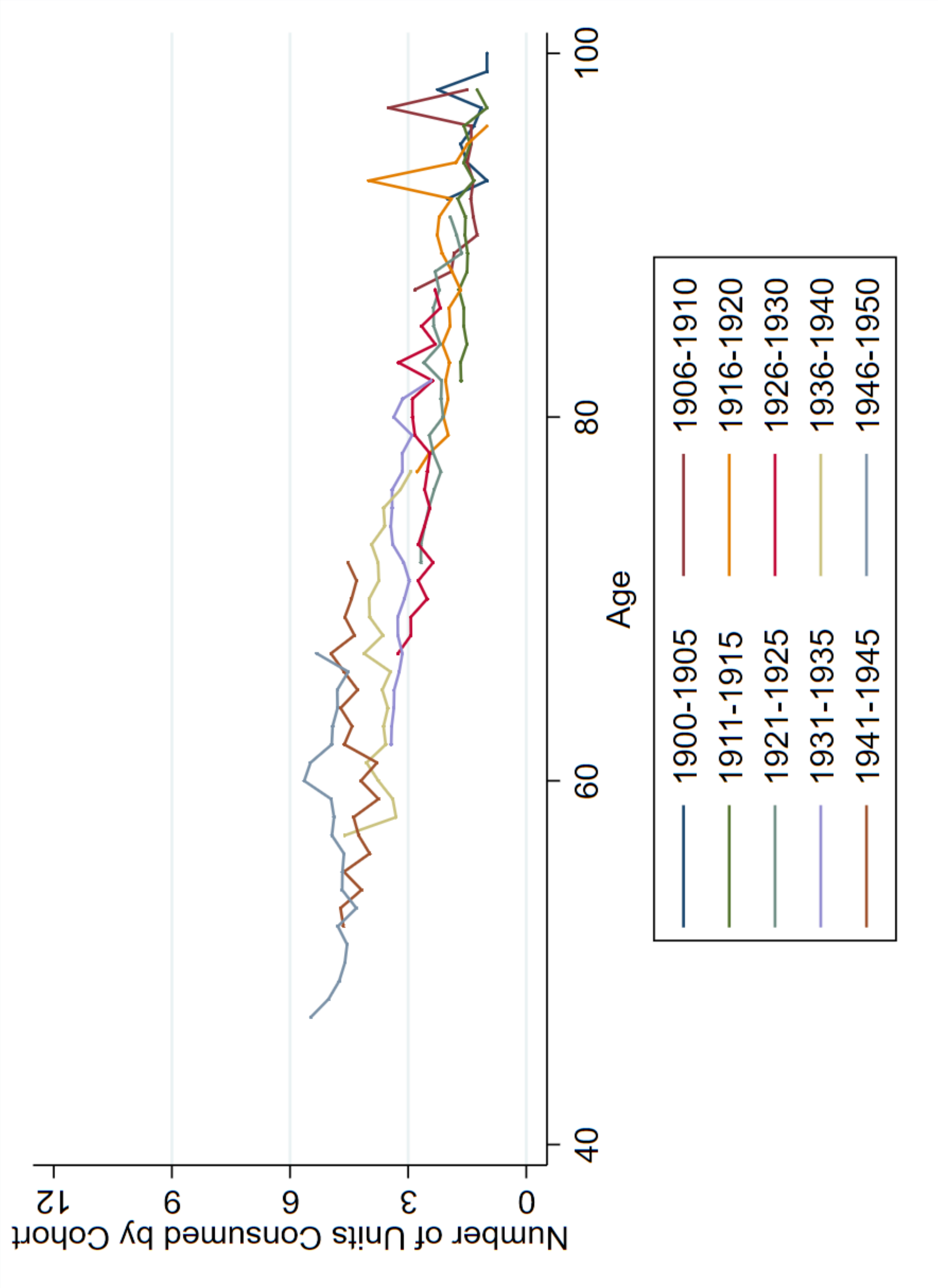


FIGURE B.4: Proportion of Units by Cohort 1900-1950



Appendix C

Ethics Approval

Date: 17th May 2016

Dear Luke

Thank you for submitting your completed stage 1 self-assessment form for **Essays on the Economics of Alcohol and Risky Behaviours.** The Part B information has been reviewed by members of the University Research Ethics Committee and I can confirm that approval has been granted for this project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress) to the Research Ethics Officer;
- submitting details of proposed substantive amendments to the protocol to the Research Ethics Officer for approval.

Please contact the Research Ethics Officer, Debbie Knight (ethics@lancaster.ac.uk 01542 592605 if you have any queries or require further information.

Kind regards,

Debbie

Debbie Knight | Research Ethics Officer | Email: ethics@lancaster.ac.uk | Phone (01524) 592605 | Research Support Office, B58 Bowland Main, Lancaster University, LA1 4YT
Web: Ethical Research at Lancaster: http://www.lancaster.ac.uk/depts/research/ethics.html

www.lancaster.ac.uk/50

Appendix D

Joint Authorship

We certify that Luke Wilson was involved in the conception and design of the work in Chapter 3 titled: “Beauty and Adolescent Risky Behaviours”. He has contributed significantly to the data analysis and its interpretation. He is the main contributor to the drafting the chapter, the critical revision of the chapter, and the final approval of the article version set to be sent for publication.

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Colin P. Green

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Anwen Zhang