Alcohol and Crime: Effects of the Minimum Legal Drinking Age in Australia

A thesis submitted in partial fulfilment of the requirements of the award of the degree:

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By

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Certificate of Originality

I, Daniel Thomason, declare that this thesis, submitted in partial fulfilment of the requirements for the award of Bachelor of Commerce (Honours), in the School of Accounting, Economics and Finance, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The work contained in this thesis has not been previously submitted for a degree or other qualification at any other higher education institution. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made.

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Dedication

"We must get beyond textbooks, go out into the bypaths... and tell the world the glories of our journey." – John Hope Franklin

The journey I have been on for the last year has not always been glorious, but it has certainly had its moments. I'm not sure about blood or tears, but the temperamental air conditioning in the computer lab has certainly contributed to some sweat helping to grease the thesis production wheels, and no doubt there is a fair bit less printer ink remaining in the world than when I started. I'd like to hope the people who have been so important during my honours year and throughout my university career already know how much I appreciate them, but just in case they don't (and for posterity's sake), here are those to whom I dedicate this thesis.

First, my supervisors, Peter and Oleg. Peter, if you hadn't offered me that research assistant job, responded warmly to all of my clueless emails through the years, and generally guided me through the process of becoming a passable economist, I would not be where I am today. Thank you for being an outstanding mentor and teacher. I still have your reply to the email I sent you begging to be spared the agony of attending tutorials in which you gently declined my request based on your position as a welfare-optimising social planner – it remains the best 'no' I have ever received! Oleg, the depth of your knowledge about any and every topic under the sun is an inspiration; I hope someday to become as much of a polymath as you are. Thank you for your ubiquitous words of wisdom, always delivered in no-nonsense phrases ("This reads like you spent ten minutes on it!") but with a smile. I'm warning you, though – eventually I'm going to become a strong enough chess player to beat you consistently![1]

Next, thank you to Lena. You've been a sounding board for ideas, a one-woman cheer squad, a nurse, a proofreader, an editor, and generally a wonderful partner in madness. You and I are pretty good evidence for assortative matching – I'm lucky to have found someone who appreciates the romance to be found in an optimisation problem or econometric model.

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Lastly, to my fellow Honours students and EFSOC executive members – thanks for sharing this year with me and tolerating my general loudness and over-enthusiasm. Your friendship has been one of the best parts of my university experience.

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[1] Well, if not you, then certainly your daughter.
At least, definitely before she's mastered motor control.
And maybe if she plays blindfolded…

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List of Abbreviations

ABS – Australian Bureau of Statistics

AIC – Australian Institute of Criminology

BOCSAR – Bureau of Crime Statistics and Reporting

COPS – Computerised Operational Policing System

D-in-D – Difference-in-Difference

HILDA – Household, Income and Labour Dynamics in Australia Survey

IV – Instrumental Variables

LHS – Left-Hand Side

MLDA – Minimum Legal Drinking Age

MVA – Motor Vehicle Accident

NSW – New South Wales

OLS – Ordinary Least Squares

PQ – Person Questionnaire

QLD – Queensland

RD – Regression Discontinuity

RHS – Right-Hand Side

SCQ – Self-completion Questionnaire

US – United States

Abstract

This thesis studies the effects of minimum legal drinking age policies on crime, examining theoretical and empirical aspects. Economic theories of crime began with Becker's (1968) rational crime model, and recently some work has been done to include psychological insights into these models, such as Card & Dahl's (2011) model of violent crime which incorporates the effect of emotional cues. There have been minimal attempts to reconcile these theories with alcohol consumption. The primary theoretical contribution of this thesis is extending existing theories to incorporate the effects of alcohol. On the empirical side, this thesis will identify causal effects of legal access to alcohol in Australia using a regression discontinuity (RD) design. This methodology exploits the change in legal access to alcohol at the minimum legal drinking age (MLDA) to identify the induced change in alcohol consumption and crime. Passing the MLDA is estimated to cause 11.6- and 14.6-percentage-point increases in the proportion of individuals who have ever drunk alcohol in QLD and NSW respectively, and 14.7- and 22.9-percentage-point increases in the proportion of individuals who drink alcohol at least weekly. Passing the MLDA is also estimated to cause (per 10,000 person years) an increase of 24 assaults & 268 public order offences in QLD and 27 assaults & 72 disorderly conduct offences in NSW. Implications of these results for public policy and directions for future research are considered.

1 Introduction

"Economics is extremely useful as a form of employment for economists." – John Kenneth Galbraith

1.1 Background, Motivation and Objectives

Although there are many addictive and possibly dangerous substances available, few are legally sanctioned for public consumption. Of these, alcohol has perhaps the highest potential for adverse consequences due to its widespread use. In 2007, 88 per cent of Australians aged over 18 reported having consumed alcohol at some point in their lives (Australian Bureau of Statistics 2012a). Additionally, in a survey-based study, 70 per cent of Australians reported having been negatively affected by someone else' alcohol use in the past year, and the costs to society were estimated at $20.58 billion per year (Laslett et al. 2010).

Many countries have a minimum legal drinking age (MLDA) policy to limit the damage from youth alcohol consumption. There is still debate, however, over whether this is an effective policy and over what constitutes the best age for this legislative threshold. Jones and Lachman (2011) argue that exposing adolescents to alcohol earlier will increase awareness of its effects and encourage responsible consumption. Other research finds that alcohol consumption is correlated with antisocial behaviour, and thus allowing more people access to alcohol will increase negative outcomes (e.g. Fitzpatrick et al. 2012; Lindo et al. 2013; Saylor 2011). This thesis will contribute to such policy discussions by providing novel empirical evidence on the issue.

Crime is one of the most salient negative outcomes associated with alcohol consumption. A report by the Australian Institute of Criminology (2012) found almost a third of all suspects detained by police reported that alcohol contributed to their current offence – a higher proportion than for all illegal drugs combined. Ireland & Thommeny (1993) suggest that over 40 per cent of serious assaults and around 60 per cent of offensive behaviour incidents are alcohol related.

Economic models of crime began with Becker's (1968) rational crime theory. This theory is based on the idea that criminal behaviour arises from individuals making cost/benefit calculations about the gains from crime and maximising their utility. Although Becker's model has sparked numerous studies since, there has been almost no attempt to incorporate alcohol into a crime commission framework. Given the volume of evidence demonstrating strong links between alcohol and crime, this is an important gap in the theoretical literature. The first objective of this thesis is to extend existing models to account for the effect of alcohol on crime. This will be achieved by augmenting the rational crime model with known effects of alcohol on its existing parameters, and by developing a new model based on an individual's loss of control provoking criminal action.

Apart from the studies mentioned above, many others highlight the correlation between alcohol and crime, but do not establish a causal link. Some third factor increasing both alcohol consumption and illegal activity may be responsible for part or all of the relationship. The challenge for researchers, therefore, is to identify how much additional crime is truly *caused* by alcohol. The major problem facing studies attempting to identify causal effects of alcohol on outcomes is accounting for the effect of unobserved heterogeneity (Carpenter & Dobkin 2011). This problem is known as omitted variable bias, and arises when variables that are correlated with both the outcome variable (crime, in this case) and the explanatory variable (alcohol consumption) are unaccounted for (see Rashad & Kaestner (2004) for a discussion in the context of alcohol and risky sexual behaviour).

A regression discontinuity (RD) design provides a method for eliminating unobserved heterogeneity, using a variable with some arbitrary threshold that determines whether an individual is 'treated' (i.e. increases their alcohol consumption, in this context). The identification requirement for this methodology is that only the independent variable for which causal effects are being estimated changes discontinuously at the threshold.

The MLDA provides a threshold for use in an RD study, but it cannot be used to identify the effects of alcohol consumption, as there is another factor that changes discontinuously at this age apart

from legal access to alcohol: legal access to alcohol-serving venues. Hence, any change in crime at the MLDA may be due either to changed alcohol consumption or to changed attendance at locations such as bars and nightclubs. RD estimates can be made for the effect of the MLDA, however, since this encompasses both changes.

Carpenter & Dobkin (2010; 2013) use an RD methodology to estimate the effect of the MLDA on crimes in the US. The validity of RD estimates is limited to the specific location of the discontinuity – estimates are local average treatment effects (Imbens & Lemieux 2008). Thus the results from RD studies in the US cannot be directly extrapolated to Australia since the US has a different threshold for alcohol access (i.e. 21 rather than 18). Also, although the two countries are quite similar in many respects, cultural factors and institutions such as attitudes towards drinking and perceptions of different types of crime vary considerably. For example, Van Kesteren (2009) found that in 2005, 47 per cent of US citizens favoured imprisonment over community service for punishing a repeat burglary offender as opposed to just 33 per cent of Australians. Stockley (2007) highlights that although in both countries minors cannot purchase or possess alcohol, Australian official bodies (e.g. the Australian Institute of Health and Welfare) offer advice on moderating underage consumption of alcohol, while the official stance in the US is that underage individuals should not be consuming alcohol at all. Beyers et al. (2004) also assert the difference between the two countries, arguing that the US policy towards substance control is focused on reducing total consumption, whereas the Australian policy targets harm minimisation. The second objective of this thesis is to provide the first estimates of the effect of legal access to alcohol on crime in Australia, using an RD methodology on the MLDA.

Apart from providing valuable insights for policy, the empirical results obtained in this thesis may also be used to test theoretical predictions. The rational crime model, discussed above, does not account for alcohol but may be augmented by inferring alcohol's effects on the model's parameters. This will provide hypotheses arising from this model on the effects of the MLDA on crime. The new loss of control theory directly accounting for alcohol's influence on crime will also

generate testable hypotheses. The final objective of this thesis is to test hypotheses from the existing and new theories against the empirical results obtained.

1.2 Thesis Structure

This thesis is arranged as follows. Chapter 2 reviews existing economic and sociological theories of crime, focusing on the rational crime model developed by Becker (1968) and the recent emotional cue theory of domestic violence from Card and Dahl (2011). Following this, Chapter 3 develops a new theory of crime incorporating the influence of alcohol, based on Card and Dahl's (2011) loss of control model. Chapter 4 outlines the hypotheses that emerge from the theories in the previous two chapters. Chapter 5 examines the four methodologies typically used to estimate the effects of alcohol consumption and reviews the empirical literature. Chapter 6 describes the data used in the empirical section of the thesis: the HILDA survey, QLD court records and NSW police records. Finally, Chapter 7 presents the empirical results with a discussion of the implications for the hypotheses and Chapter 8 concludes with a summary of the findings and outcomes from this thesis and suggestions for future research.

2 Theory

"My definition of an expert in any field is a person who knows enough about what's really going on to be scared." – P. J. Plauger

Pure economic theories of crime began with Becker's (1968) rational crime model, which demonstrated that criminal activity was consistent with a utility-maximising framework. This chapter discusses the foundations of this model and the subsequent extensions developed. Using insights from the psychological literature, a novel, augmented version of this model accounting for the effects of alcohol consumption is considered. More recently, Card & Dahl (2011) investigated the probability of domestic violence incidents occurring using a loss of control model, the findings of which are also discussed.

This chapter concludes with a discussion of the relevant sociological theories of crime, which provide further evidence for the mechanisms through which criminal tendency manifests.

2.1 Rational Crime Model

Becker's (1968) major contribution to the criminology literature was to depart from the treatment of criminal action as stemming from some defect, whether in the individual or in society. Instead he assumed that criminals are no different to any other agent: they are utility-maximising and respond to incentives. His analysis was targeted towards ascertaining the optimal method of crime control for a society, but one particular element of his overall model is most relevant: the supply of crime. Becker (1968, p.176) claimed that his was an improvement on existing theories of criminal behaviour as it did not require "ad hoc" sociological or psychological concepts and also did not "assume perfect knowledge, lightening-fast calculation, or any of the other caricatures of economic theory."

An individual's supply of offences was supposed to be related to the probability of conviction, the severity of punishment, and other influences including alternative sources of income, individual criminal propensity, and frequency of arrests:

$$O_j = O_j(p_j, f_j, u_j)$$

where *O* is individual *j*'s supply of offences in a given period, *p* is the probability of punishment per offence, *f* is the punishment per offence, and *u* is composed of all other influences. The supply of offences is negatively related to the probability of conviction and the punishment:

$$\frac{dO_j}{dp_j} < 0$$

$$\frac{dO_j}{df_j} < 0$$

The relationship between the supply of offences and the variables comprising *u* is not formally outlined, but the author discusses that it can be anticipated in many cases. For example, an increase in legal income would be expected to decrease the supply of crime, as would an exogenous decrease in the willingness to engage in criminal behaviour (due to, for example, a change in social attitudes).

Underlying this is an expected utility framework, where an individual will commit offences if the expected utility of doing so exceeds the expected utility of the next best alternative (e.g. legal occupation). The individual's expected utility is expressed as:

$$E(U_j) = p_j U_j(Y_j - f_j) + (1 - p_j) U_j(Y_j)$$

where *U* is the individual's utility function, *p* and *f* are as above, and *Y* is the income from committing an offence (monetary plus psychic gain). Factors such as private protection attempts and individual criminal propensity operate through *Y* – greater attempts at defence against crime will lower the expected monetary gain, and a decreased willingness to commit crime will lower the psychic gain. The model also indicates that punishment severity and probability of apprehension

are substitutes in deterrence: the effects on crime supply of a decrease in one can be completely offset by increasing the other.

Ehrlich (1973) extended these foundations by developing a model of time allocation under uncertainty. An individual chooses a mix of legal and illegal activities in order to maximise her utility, where illegal activities contribute positively to her utility (either through material or psychic gain), but carry the risk of a loss in utility from conviction and punishment. Legal activities, on the other hand, are riskless. The individual gains utility from her wealth (assets, earnings, and the monetary equivalent of intangible gains: X) and also time spent on non-market activity (i.e. leisure: t_c):

$$U_s = U(X_s, t_c)$$

where the subscript s indicates that the individual's wealth (and therefore total utility) is state-dependent. The two states are: being caught and punished (a), which occurs with known probability p; or getting away with the crimes (b), which occurs with probability $(1 - p)$. Wealth in each state of the world is therefore:

$$X_b = W' + W_i(t_i) + W_l(t_l)$$

$$X_a = W' + W_i(t_i) - F_i(t_i) + W_l(t_l)$$

where W' is the market value of the individual's assets, W_i is the wealth generated from illegal activities – a function of t_i, the time spent on illegal activities, and W_l is the wealth generated from legal activities – a function of t_l, the time spent on legal activities. F_i is the reduction in the returns from illegal activity due to being caught and punished.

The main conclusion from the model concerned the interaction between crime and appetite for risk: the degree of risk aversion is negatively related to the amount of crime an individual commits. The relative impact on the crime rate of an increase in the probability of apprehension versus an

equivalent increase in the severity of punishment also depends on the individual's risk aversion. A risk-loving individual will reduce their crime commission by more in response to an increase in apprehension probability than to an increase in punishment severity, and vice versa for a risk-averse individual.

The author provides empirical support for the theoretical model's validity using state-level data from the US. In line with the theory's predictions, the regression results show that crime rates are positively related to the estimated gains from criminal activity and negatively related to the estimated costs. Interestingly, the empirical results indicate that variables related to income have a smaller (and, in many cases, insignificant) effect on rates of violent crime than on property crime. This suggests that individuals committing violent crimes (which involve no direct monetary compensation themselves, although they may be accompanied by others that do, such as theft) are not as well represented by this theory, and thus violent crimes and property crimes may be better modelled separately with different underlying incentives.

2.1.1 Extensions

Since its beginnings with Becker and Ehrlich, the rational crime theory has been extended in a variety of ways. Several extensions are discussed below.

Buck et al. (1985) developed an interesting model to support the notion of a natural rate of crime, analogous to the natural rate of unemployment. They argue that increases in deterrence efforts will only have short-term effects, as criminals will find ways to circumvent the additional efforts made as time passes, and thus the crime rate will rise to its previous level. They conclude that the only means by which criminal activity can be permanently reduced is through the opportunity cost mechanism – that is, by raising the benefits from legal activity.

Davis (1988) constructed an inter-temporal model to account for the timing differences between reward from crime and potential punishment. He finds that under his model, individuals with

higher discount rates (i.e. who are more impatient) will commit more crimes. This challenges Becker's (1968) assertion that risk appetite is the mediating factor for individual criminal propensity. Foreman-Peck & Moore (2010) provide evidence for the hypothesis that criminals are more impatient than the general population, but also find that criminals have greater appetite for risk. It seems, therefore, that both risk preference and discount rates influence criminal probabilities.

Highlighting an extra dimension to the understanding of penalties imposed on criminals, Rasmusen (1996) identified the concept of stigma as an important deterrent mechanism. Two types of stigma are discussed: economic stigma, which leads to lower potential for pecuniary gain in the future; and social stigma, which leads to disadvantage in non-market activities such as marriage. The author concludes that stigma as an aspect of total punishment has the advantage of being costly for all potential offenders (as opposed to a large fine, which will be unpayable for offenders with few assets), but loses efficacy for repeat offenders, who are already suffering the effects.

2.1.2 Alcohol-Augmented Rational Crime Model

Although the rational crime model makes no provision for substance consumption, it may be altered to incorporate alcohol. Insights from the psychological literature will provide assumptions about how alcohol consumption affects the parameters built into the model. For example, alcohol may: decrease risk aversion; decrease the expected probability of punishment; or increase the perceived benefits of crime and/or decrease the perceived costs of crime. The effects of these possible changes on crime are discussed below.

Risk aversion

Risk aversion relates to von Neumann and Morgenstern's (1944) utility theory, indicating the behaviour of an individual's marginal utility of wealth (i.e. the curvature of the utility function with respect to wealth). Risk averse individuals have diminishing marginal utility of wealth, and

therefore prefer to receive a given amount with certainty rather than accept a gamble with an equivalent expected value. For risk preferring individuals,[2] the opposite is true, while risk neutral individuals are indifferent between the two.

Dave & Saffer (2008) use US survey data containing a measure of risk aversion to show that risk preference is positively related to alcohol consumption – that is, individuals who drink more alcohol tend to prefer risk more. Nasrallah et al. (2009) conducted experiments on the effects of alcohol on adolescent rats, and found that those exposed to alcohol demonstrated higher risk preference than control animals, with this behaviour persisting for some time after the alcohol exposure was discontinued.

Ehrlich (1973) assumes an individual has two choices of income-producing activity: legal work, involving a certain return; and illegal pursuits, which are equivalent to taking a gamble on the probability of being punished and hence losing wealth. *Ceteris paribus*, an individual with a higher risk preference will allocate more time to the risky pursuit – criminal activity. Thus if alcohol increases individuals' risk preference, it will also increase crime in general.

Subjective punishment probability

The expected probability of punishment may be diminished due to an impaired ability to accurately assess risk resulting from alcohol consumption. Lundborg & Lindgren (2002) found that individuals who consumed more alcohol estimated lower risks from alcohol consumption than individuals who had consumed less or no alcohol.

A decrease in the probability of punishment will result in a higher relative weight being placed on the gains in the 'good state' (i.e. not being punished), causing the expected utility from committing illegal activity to rise. Relative to an alcohol-free state, an individual's optimal amount of crime

[2] Also called 'risk loving' individuals.

will be higher when they are consuming alcohol if doing so causes them to assess the probability of apprehension and punishment lower.[3]

Costs and benefits of crime

Alcohol consumption may plausibly affect the perceived costs and benefits of criminal activity. Psychic aspects in particular are likely to be altered, including shame from public exposure of criminal behaviour, status gains among peers from rebellion, and so on. Lanza-Kaduce et al. (1997) demonstrated that as individuals consumed more alcohol, their perception of the moral censure associated with criminal activity decreased, and their perception of the benefits of crime increased.

An increase in the benefits or a decrease in the costs of a given option will make it more attractive, and therefore more time will be allocated to that option. Thus in the rational crime model, increased benefits or decreased costs of crime due to alcohol consumption would be predicted to increase crime.

2.1.3 Empirical Studies

A large body of empirical research exists examining various aspects of the rational crime model. Trumbull (1989) used both aggregate- and individual-level data from the US, and found that deterrent effects emerge from both law enforcement and also labour market improvement. Paternoster & Simpson (1996) examined the context of white collar crime, and found that severity and expected probability of consequences both decreased criminal behaviour. Interestingly, they point out that morality was an important mediator of deterrence strength of consequences – the higher the moral inhibitions, the less of a disincentive consequences were. This suggests that emotions and other sub-conscious processes are likely to play an important role in crime

[3] This mechanism runs counter to a standard assumption made in economic theory: rational expectations. Under rational expectations, individuals do not make systematic errors such as are postulated here.

determination. Tittle et al. (2010) confirm this, finding that although expected utility (benefits minus expected costs, as per Becker's framework) had the expected positive effect on criminal probability, the effect of morality was larger in magnitude. Also, expected utility influenced property crimes far more than violent crimes, indicating that the former are better described by the rational crime model than the latter.

2.2 Loss of Control Model

Card & Dahl (2011) developed a loss of control model to examine determinants of domestic violence rates. The model is based on an emotionally salient shock altering the probability of a violent incident. The authors use the results from American Football team home games in order to identify emotional shocks – the *a priori* expected outcome of the game is measured using betting market point spreads, with games grouped into expected wins, expected losses, and expected close games. An individual's probability of losing control (h) in a conflictual interaction (and therefore committing a violent act) is:

$$h = h_0 - \mu(y - p)$$

where y is the outcome of the game (1 for a win, 0 for a loss), p is the pre-game expected probability of home team victory, and μ is the impact of the difference in outcome to what was expected. $\mu = \alpha$ if $y - p < 0$ (i.e. for a home team loss) and $\mu = \beta$ if $y - p > 0$ (i.e. a home team win). They assume $\alpha > \beta$ due to loss aversion, which is the notion that losses cause a greater decrease in utility than the increase in utility from gains of the same magnitude (Tversky & Kahneman 1992).

In a working paper on the same topic, Card & Dahl (2009) also model the choice over whether or not to watch the game in the first place. They assume that an individual rationally anticipates the effect of watching the game on his probability of committing a violent act. Each individual is supposed to have some probability q of a conflictual interaction occurring in each period, with q

distributed across the population with distribution function F(q). They model an individual's utility as:

$$u^j - qh^j v$$

for j = 0 (not watching the game), W (watching a home team win) and L (watching a home team loss). v is the utility loss associated with a violent incident, and u^j is the utility gained from each state of the world. They assume $u^W \geq u^0 \geq u^L$ and $u^W > u^L$ such that watching a win is always preferred to watching a loss. An individual will choose to watch the game if the expected utility gain from doing so is positive (relative to not watching). The expected gain from watching the game, from combining the probability of losing control in each state of the world with the utility expression, is:

$$G(p;q) = pu^W + (1-p)u^L - u^0 - (\alpha - \beta)p(1-p)qv$$

This in turn implies that as the expected probability of a home team victory (p) increases, individuals with a higher risk of domestic conflict (higher q) will choose to watch the game. The increase in the probability of violence is therefore increasing in p for two reasons: loss aversion – upset losses are predicted to cause a greater increase in violence than the decrease from upset wins; and greater audience – in particular, as the expected probability of a home team win increases, the audience will have a higher proportion of men prone to conflict interactions.

The model predicts that upset losses should cause an increase in violent incidents and upset wins should cause a decrease. The authors tested the model using data from the 1990s and 2000s on US states that have a single associated football team and adequate crime data, examining Sunday games falling in the regular season. These selection criteria left six football teams and 886 games for analysis. The results showed an approximately 10% increase in the probability of domestic violence as a result of an upset loss (a loss when the home team was predicted to win by four or more points), but a statistically insignificant effect from an upset win or from either result in a game predicted to be close. The effects of an upset loss were also found to be stronger for more salient games (defined as games against a rival, games played when the team were still in

contention for the playoffs, or frustrating games based on technical characteristics), confirming that more salient situations will have greater emotional effects.

The effect of a home team loss on violence probability seems to be ephemeral. The upturn in violence rates occurs in the three hours immediately following the game's conclusion, and disappears after that. This suggests that the cause can be attributed to the temporary emotional shock of unexpected home team loss, indicating that anything altering emotional control or increasing the likelihood of emotional upset is likely to increase the probability of violence.

2.3 Sociological Theories

Sociological theories of crime proceed from the concept of deviance, which encompasses a broad range of behaviour, from mere transgressions against social norms to criminal acts. In their review of the topic, Downes & Rock (2011) mention three main schools of thought: radical criminology; control theory; and functionalism. Each of these is discussed below.

Bohm (1982, p570) argues that radical criminology places class relations at the heart of deviant behaviour, claiming that it is the conflict between "those who own and control the means of production and distribution and those who do not that is at the source of all crime in capitalist societies". In particular, the author highlights the pursuit of individual economic goals as motivating criminal action. Acknowledging that this only offers an explanation of property crimes (i.e. those involving some material gain), he also claims that violent crime results from individuals lashing out at the oppressive condition of capitalist society. In summary, property crimes are a calculated attempt to gain more economic power, whereas violent crimes are an emotional reaction to perceived injustice.

Control theory stands starkly opposed to radical criminology, viewing the containment and direction of individuals' behaviour as necessary for a civilized and healthy society (Downes & Rock 2011). According to Hirschi (1969), individuals are less likely to commit deviant acts if they

have strong ties to the community. That is, emotions of loyalty or shame will regulate behaviour towards other members of society. Lanza-Kaduce et al. (1997) found that greater alcohol consumption was associated with less moral condemnation of criminal behaviour and a higher value placed on deviance. This suggests that the suppression mechanism for crime suggested by control theory – social stigma – is diminished by alcohol consumption and that therefore drinking should cause more crime.

Lastly, functionalism provides the viewpoint that fits best with the Beckerian view of the existence of some optimal (non-zero) amount of crime. One of the chief proponents of the functionalist paradigm, Émile Durkheim (1982, pp97-104), argued that since crime exists in all societies it must therefore serve some purpose and thus constitutes an element of normal existence. The main functionalist argument is that deviance serves to strengthen society by helping to more sharply define correct behaviour, thus reinforcing group norms. Crime may not serve positive social ends, however, if it emerges from a breakdown of social norms – what Durkheim (1952, p.214) called "anomie". This echoes the control theory perspective on negative social outcomes from crime. Again, therefore, insofar as alcohol contributes to a weakening of social norms, functionalist theory suggests that more alcohol consumption will cause more crime.

3 Emotional Shock Theory

"Ah, sweet alcohol. Like a true friend, you replace the anger with better, louder anger." – Randy K. Milholland

This chapter presents a new theory accounting for the influence of alcohol on the probability of violent or nuisance crime. It is based on the model developed by Card & Dahl (2009, p33), who state: "we suspect that the same framework may prove useful in other settings where economists are trying to model the effect of visceral influences on observed behavior."

Some attempts have previously been made to incorporate the influence of alcohol on crime (Markowitz & Grossman 1998; Gyimah-Brempong 2001). These studies proceed by assuming that alcohol consumption increases criminal behaviour, without expanding on the mechanism. To date, there have been no studies incorporating an intermediary between alcohol consumption and crime.[4] The current framework models alcohol's effects on crime through a heightened reaction to emotional shocks.

The first section of this chapter describes the effect on the probability of violence of an emotional shock with and without alcohol consumption. The second section investigates an agent's choices of whether to consume alcohol at the beginning of the period and where to locate themselves during the period.

3.1 Probability of Crime

Consider an individual who each period has some probability of being placed in a situation with the potential for criminal action involving no long-term gain, merely a temporary relief of tension (e.g. assault, vandalism, etc.) – crimes of passion. With some probability $h \geq 0$ the individual commits a crime in this situation. His probability of committing a crime is influenced by a baseline probability

[4] To the best of the author's knowledge.

plus the influence of some negative shock, *s*.[5] Shocks may be driven by contact with others, such as being bumped by someone else or verbally abused, but may also be independent of current social context, such as a sporting team losing or the arrival of an upsetting text message. The probability of committing a crime of passion is:

$$h = h_0 + \gamma\alpha s \qquad (1)$$

where α converts a negative shock into the effect on the probability of crime, and γ is a parameter multiplying the effect of shocks, which is influenced by the consumption of cognition-affecting substances.[6] It is assumed that the probability of a negative event is known and chosen by the individual: s = 1 with probability *p* and s = 0 with probability (1 - *p*). Normalising γ = 1 if no substances are consumed:

$$h(D = 0) = h_0 + \alpha p$$

$$h(D = 1) = h_0 + \gamma\alpha p$$

where D is a binary variable indicating substance consumption choice. This theory could be applied to any drug – for example, marijuana causes individuals to react more slowly to stimuli, giving γ < 1. Here, we assume that alcohol causes an inflated reaction to negative events: γ > 1. This reflects the well-documented finding that a moderate amount of alcohol consumption causes fewer inhibitions (e.g. Australian Drug Foundation 2010).[7] Currently alcohol is modelled as a binary variable (drink/not drink), but this could be extended to make γ a function of the quantity of alcohol consumed.

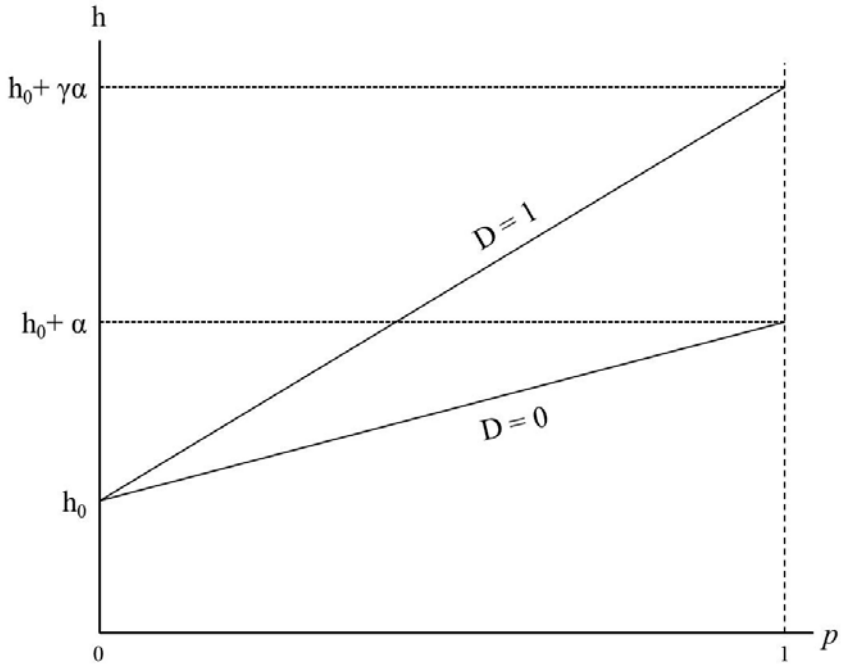
[5] This framework could also be extended to incorporate the influence of positive shocks and account for loss aversion (see Card & Dahl 2011).

[6] Alcohol consumption will also increase the risk of other negative outcomes such as adverse health effects and falling victim to crime, but the current model only accounts for the impact on crime commission.

[7] Another potential avenue through which alcohol may heighten reaction to negative shocks is through an altered interpretation of social cues. For example, alcohol has been shown to affect accuracy when judging whether a face is looking at or away from an individual (Penton-Voak et al. 2012).

Figure 3.1 shows the crime probabilities for all values of *p* (probability of a negative event occurring) with and without alcohol consumption. Alcohol consumption leads to a higher probability of crime for all values of *p*, but the effect is increasing in *p*.

Figure 3.1



Interestingly, alcohol consumption may also influence *p*. For example, a choice between staying home and drinking at a bar not only involves a change from the D=0 to the D=1 crime probability curve, but also an increased *p* due to the higher chance of a negative event occurring in a location such as a bar. This dual choice of D and *p* is examined further in the next section.

3.2 Alcohol and Location

3.2.1 Alcohol

Suppose an individual has some base level of utility (derived from their income, say), and derives utility from consumption of alcohol but loses utility from committing crime. The individual faces a choice of location during the period, which translates into a choice of *p*. It is assumed that locations

the individual enjoys more also have an inherently higher risk of negative events.[8] For example, it is more fun to go to a bar than to stay home, and to go to a nightclub than to go to a bar, but each time the level of risk increases. We also assume that the level of utility from alcohol increases in riskier locations. This can be modelled:

$$U = U_0 + R(p) + D(A - P + K(p)) - I(C)$$

where, again, D is a binary variable indicating consumption (D=1) or no consumption (D=0) of the substance, A is the utility gain from consumption of the substance, P is the cost of the substance translated into utility terms, R is the utility gain from location choice, K is the utility gain from location choice while consuming alcohol, and C is the utility loss from committing a crime.

We assume:

$$\frac{dR}{dp} > 0, \frac{d^2R}{dp^2} < 0$$

$$\frac{dK}{dp} > 0, \frac{d^2K}{dp^2} < 0$$

The expected utility of the individual is therefore:

$$E(U) = U_0 + R(p) + D(A - P + K(p)) - hC$$

$$E(U|D = 0) = U_0 + R(p_0) - (h_0 + \alpha p_0)C$$

$$E(U|D = 1) = U_0 + R(p_1) + A - P + K(p_1) - (h_0 + \gamma\alpha p_1)C$$

where p_1 and p_0 are the choice of p when drinking and not drinking, respectively.[9]

The expected utility gain from consuming the substance is:

$$E(U|D = 1) - E(U|D = 0) = A - P + R(p_1) - R(p_0) + K(p_1) - (h_0 + \gamma\alpha p_1)C + (h_0 + \alpha p_0)C$$

[8] This is well supported by the empirical data. For example, Teece & Williams (2000) found that for survey respondents who reported experiencing alcohol-related violent incidents, the most common location was a pub. Briscoe & Donnelly (2001) found that although nightclubs constitute only 2.7 per cent of all licenced premises in inner Sydney, they accounted for 5.7 per cent of all assaults occurring at licenced premises. Lang et al. (1995) found that the likelihood of harm was higher for individuals drinking at a nightclub or bar than at other locations.

[9] That is, $p_0 = p|D=0$ and $p_1 = p|D=1$.

$$= A - P + R(p_1) - R(p_0) + K(p_1) - (\gamma\alpha p_1 - \alpha p_0)C$$

$$= A - P + R(p_1) - R(p_0) + K(p_1) - [\alpha(\gamma p_1 - p_0)]C$$

Therefore the individual will choose to consume the substance if:

$$A + K(p_1) + [R(p_1) - R(p_0)] > P + [\alpha(\gamma p_1 - p_0)]C \qquad (2)$$

That is, the individual will drink alcohol if the utility gain from alcohol plus the change in utility from consuming alcohol given the choice of location[10] is greater than the direct utility cost of alcohol (through the price) plus the additional probability of crime due to alcohol consumption multiplied by the utility cost of committing a crime.

In addition, consider two groups of individuals: those below and those above 18 years old. Both groups must pay the monetary cost of alcohol, but individuals in the former group face a higher P due to the added cost imposed by avoidance of legal restrictions on their purchase and consumption.[11]

It is likely that each other parameter in (2) is distributed across the population as a function of age. For example, the costs of crime (C) will certainly be higher on average for older individuals due to a higher reputation loss and greater opportunity cost of foregone wages if incarcerated. It is assumed, however, that A is distributed identically for individuals just either side of 18 years old (e.g. 17-year-olds and 18-year-olds). Therefore the model predicts that a higher proportion of 18-year-olds will consume alcohol than 17-year-olds.

[10] Utility gained from alcohol consumption given location is a combination of the direct utility from doing so (K) and also the extra utility from changed location choice when drinking [R(p_1) – R(p_0)], where the latter can be positive or negative.

[11] This same analysis could be applied to other subsets of the population facing differing non-monetary costs of alcohol attainment – for example, individuals who live further from alcohol vendors face a higher cost in terms of time and effort, and so would be predicted to consume less alcohol and therefore commit fewer crimes. Halonen et al. (2012) provide empirical evidence to support this conclusion, finding that individuals who live within 1km of a bar are more likely to drink alcohol heavily.

3.2.2 Location

First order conditions for the optimal choice of *p* with and without alcohol are:

$$\frac{dE(U|D=0)}{\partial p} = R'(p_0^*) - \alpha C = 0 \qquad (3)$$

$$\frac{dE(U|D=1)}{\partial p} = R'(p_1^*) + K'(p_1^*) - \gamma\alpha C = 0 \qquad (4)$$

Rearranging equations (3) and (4):

$$R'(p_0^*) = \alpha C \qquad (5)$$

$$R'(p_1^*) + K'(p_1^*) = \gamma\alpha C \qquad (6)$$

Since:

$$\frac{dR}{dp} > 0, \frac{d^2R}{dp^2} < 0, \frac{dK}{dp} > 0, \frac{d^2K}{dp^2} < 0$$

$R'(p) + K'(p)$ is a strictly decreasing function.

$\therefore p_1^* > p_0^*$ when:

$$R'(p_0^*) + K'(p_0^*) > R'(p_1^*) + K'(p_1^*)$$

Substitute (5) and (6):

$$\alpha C + K'(p_0^*) > \gamma\alpha C$$

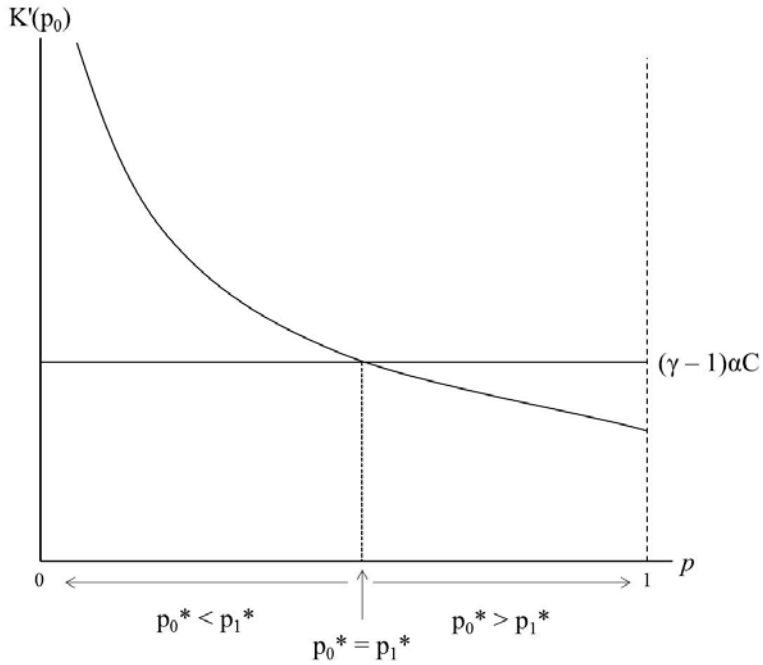
$$K'(p_0^*) > \gamma\alpha C - \alpha C$$

$$K'(p_0^*) > (\gamma - 1)\alpha C \qquad (7)$$

That is, the individual will choose a higher *p* when drinking than otherwise when the marginal cost of increasing *p* when consuming alcohol due to increased risk of committing a crime (RHS of equation 7) is less than the marginal utility gain from doing so (LHS of equation 7). The marginal cost and benefit are both relative to p_0^*. Since K is decreasing in *p*, there will be some value of p_0

below which $p_0^* < p_1^*$ and above which $p_0^* > p_1^*$. Figure 3.2 illustrates this. Individuals who choose a high value of p_0^* will compensate for the additional risk of committing crime from drinking by choosing a safer location. Individuals who choose relatively safe locations when not drinking will increase their level of risk when consuming alcohol due to a high marginal utility from increasing *p*.

Figure 3.2



Considering again individuals aged just above and just below 18 years old, the latter group have a truncated choice of *p*. Individuals who have not passed the MLDA are prohibited from attending bars, nightclubs, etc. – locations where *p* will be highest. That is, their choice of *p* has some upper limit *U* where $U < 1$. This increases the likelihood that individuals aged under 18 will locate themselves in a relatively safe location when they are not drinking, in the range where $p_0^* < p_1^*$. If preferences over p_0^* persist as individuals pass the MLDA, then the increased alcohol consumption will be accompanied by riskier location choice. Thus passing the MLDA will cause an increase in crime from alcohol compounded by location choice.

For all individuals, altered location choice can serve to either mitigate or reinforce the additional probability of crime due to alcohol consumption. Empirical evidence, however, supports the notion

that a majority of individuals select a risker location (i.e. higher *p*) when drinking than otherwise. In a study of New Zealand university students, Kypri et al. (2007) found that the majority of alcohol consumption was in pubs, bars and nightclubs (instead of houses or residential halls). Weiss & Moore (1994) found that the pub is the most preferred location choice for Israeli youth when drinking. O'Callaghan & Callan (1992) conclude that Australian youth view drinking as a social activity and overwhelmingly prefer being in a group when consuming alcohol. Wei et al. (2010) found that when college students attended (riskier) alcohol-serving parties they had higher blood alcohol content (measured at the conclusion of the night) than when they attended alcohol-free parties. *p* is certainly increasing with group size due to the higher likelihood of a negative social interaction. This therefore provides good evidence for the assertion that at least for the majority of individuals, the marginal benefit of selecting a higher *p* when drinking than otherwise outweighs the perceived marginal costs.[12]

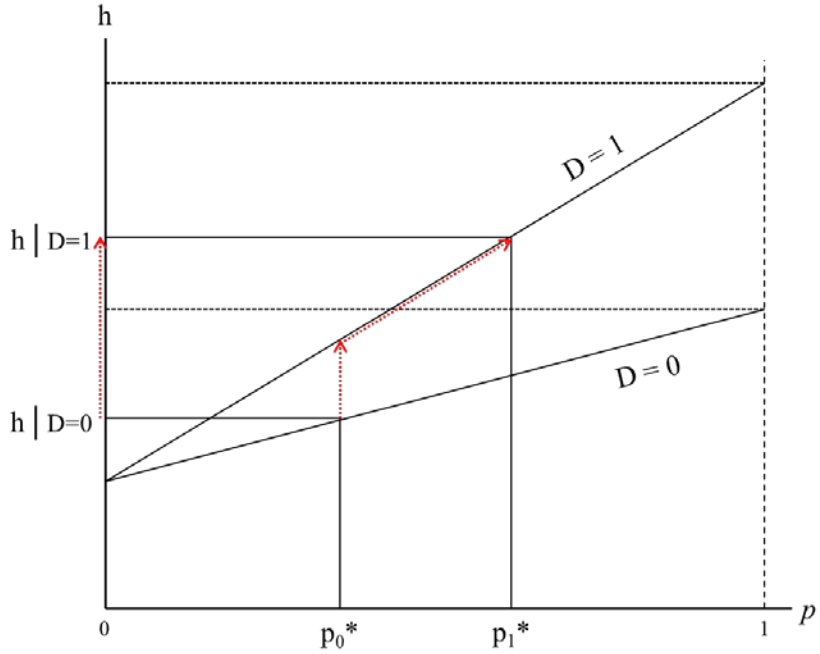
Overall, the model suggests that crime will be affected through two interdependent mechanisms: alcohol consumption and location choice. *Ceteris paribus*, consuming alcohol causes a higher probability of crime commission, but location choice is conditional upon alcohol consumption and may therefore either reinforce or mitigate the positive effect on crime rates. Empirical evidence suggests that individuals choose to attend risker locations when consuming alcohol; at the population level the cumulative effect of alcohol and location should be greater than the effect of alcohol alone. A relevant consideration for alcohol research emerges from this: how much of the change in the outcome is due to alcohol consumption *per se* and how much to the accompanying shift in location?

Figure 3.3 demonstrates the compounded increase in crime leading to the identification problem. Consider an individual who chooses a low p_0^* when not consuming alcohol. When the individual switches to consuming alcohol instead, this will cause a movement onto the D = 1 crime

[12] One potential limitation of these studies is that the participants are largely from their late teens or early 20s. This is a valid issue, and it is probable that age influences the decision-making process – intuitively increased age is likely to decrease the utility gained from risky location choice and also raise the costs of committing a crime, perhaps due to higher opportunity cost of incarceration or reputation loss. This extension is a possible avenue for future research.

probability trajectory. The decision to consume alcohol also affects the location choice, however, causing the individual to move to a higher p (p_1^*). These movements are shown by the red arrows in Figure 1; their combined effect is an increase in the individual's probability of committing a violent or nuisance crime from $h|D=0$ to $h|D=1$. Since typically only the change in h is observed, it is difficult to identify the relative impact of the two mechanisms.[13]

Figure 3.3



The model developed in this chapter formally demonstrates the identification problem inherent in estimating the negative outcomes from alcohol. Studies on the effects of the MLDA (e.g. using an RD methodology) will not suffer from this problem, as the estimates will be for the cumulative effects of all mechanisms affected by the policy. A large amount of research attempts to isolate the effects of alcohol consumption, and the empirical results obtained should therefore be interpreted with caution. Further research should supplement the findings before policies are developed based on their results. For example, the Allen Consulting Group (2011) cite empirical studies estimating the magnitude of social harm caused by alcohol as evidence for the need to increase alcohol taxes. Increasing the tax on alcohol may not be an optimal solution, however, if the *location* in which

[13] For example, the same change in h could occur for an individual who does not change their location at all between D = 0 and D = 1, but for whom the effects of alcohol are greater.

individuals choose to consume alcohol is partially responsible for the overall effects – vending restrictions may reduce the problem equally while causing a smaller loss in social welfare.[14] The theory presented in this chapter specifically models crime as the outcome, but the same interrelationship between alcohol consumption and location choice is also likely to affect others, particularly infrequent but high-impact outcomes such as mortality.

[14] That is, social welfare defined as the benefits accruing to society from the production (i.e. producer surplus) and consumption (i.e. consumer surplus) of a good or service (e.g. alcohol).

4 Hypotheses

"An economist's guess is liable to be as good as anybody else's." – Will Rogers

The theories presented in the previous chapters suggest hypotheses about the effects of legal alcohol access on crime. These will be tested using the results from the empirical study, presented in Chapter 7.

First a hypothesis about the effect of the minimum legal drinking age on alcohol consumption is discussed, then the predictions from the rational crime model and new emotional shock model are considered. The chapter concludes with an enumeration of the hypotheses.

4.1 Alcohol Consumption Hypotheses

The previous chapter discussed the idea that the minimum legal drinking age imposes an extra cost in obtaining alcohol on those aged below 18. According to the law of demand, if the price of a good decreases, quantity demanded will rise (Mankiw 2011, p.67). Therefore it is predicted that passing the minimum legal drinking age will lead to increased alcohol consumption.

Moreover, the increase will be greater for subsets of the population with higher implicit costs involved in obtaining alcohol while underage, as this subset will experience a greater price decrease after passing the minimum legal drinking age. Since the crime data are from two Australian states, these are convenient subpopulations to consider. If there is a difference between the implicit costs of underage alcohol access in NSW and QLD, then this should be reflected in the observed increase in alcohol consumption at the MLDA.

There is reasonable evidence to suggest that minors' costs of alcohol access are higher in NSW than in QLD. In NSW, individuals face not only a substantial fine but also the threat of imprisonment for up to 12 months for supplying alcohol to an underage individual, whereas in QLD the fine is lower (except for licensees) and there is no risk of imprisonment (NSW Liquor Act

2007, QLD Liquor Act 1992). NSW imposes large fines on licensees who allow minors to enter or remain in licensed premises, but QLD does not. Both states have similar penalties for minors who access alcohol in licensed premises, although the fine for minors consuming alcohol in a public place is higher in QLD.[15] There is a greater focus on public awareness of underage drinking as a social problem in NSW. The NSW Police Force (2010) runs a campaign called 'Supply means supply', aimed at discouraging provision of alcohol to minors, whereas no campaign targeting underage drinking exists in QLD. All of these points indicate that more disincentives exist in NSW than in QLD to discourage supplying alcohol to individuals under 18 years old. It is hypothesised, then, that NSW will exhibit a greater increase in alcohol consumption at the MLDA than QLD.

4.2 Rational Crime Model Hypotheses

The rational crime model predicts that an increase in the probability of apprehension and conviction or an increase in the severity of punishment should lead to a decrease in crime, since both of these elements increase the expected costs of criminal action. Becker (1968) and Ehrlich (1973) both discuss different magnitudes of response to a change in punishment or a change in apprehension, but the assumption is always that crime will decrease in response to an increase in either. Therefore one prediction arising from the rational crime model is that crime will fall when individuals start being treated as adults in the justice system, as once this occurs both the probability of punishment and the punishment severity increase dramatically.[16] This is an important point for research on the MLDA, as many countries (Australia included) have drinking ages that coincide with the change in justice system. The simultaneous changes could confound estimates,

[15] In NSW, licensees face a fine of $11,000 and/or 12 months imprisonment for sale of alcohol to a minor and a fine $5,500 for allowing a minor to enter or remain on licensed premises without a responsible adult. Individuals face a fine of $11,000 and/or 12 months imprisonment for supplying alcohol to a minor. Minors who consume alcohol at licensed premises, attempt to do so, or carry alcohol away from licensed premises face a $2,200 maximum penalty, minors possessing or consuming alcohol in a public place face a $20 maximum fine. In QLD, for supplying liquor to or allowing consumption of alcohol by a minor, licensees face a fine of $27,500, individuals face a fine of $2,750 and bar attendant face a $8,800 maximum fine or an infringement notice of $1,100. Minors who have or consume alcohol in a public place face a $247 on-the-spot fine or up to $2750 if prosecuted, and minors on a licensed premises other than exempt minors face a $330 on-the-spot fine or up to $2750 if prosecuted.

[16] See Chapter 6 for a discussion of the changes accompanying movement from the juvenile to the adult justice system.

since it will be uncertain to what extent each institution is responsible for the change in crime; in fact, the two effects may cancel each other out. In Australia, however, a valuable opportunity for avoiding this issue is available: since in QLD individuals become adults in the justice system at age 17, any change in crime at 18 will be free from this influence.

Using the alcohol-augmented rational crime model developed in section 2.1.2 yields the following hypotheses. Since all of the considered psychological mechanisms indicate that alcohol should increase crime, gaining legal access to alcohol will lead to increases in all crime categories. For QLD, this effect should be unambiguous at the MLDA, but for NSW the change in all crime categories will also be affected by the change in justice system.

4.3 Emotional Shock Model Hypotheses

The novel emotional shock model developed in Chapter 3 predicts several outcomes for the empirical study. First, it echoes the hypothesis discussed above that alcohol consumption will increase at the minimum legal drinking age due to the decrease in implicit costs of access. Second, the model predicts that although increased alcohol consumption will lead to more *violent and nuisance crimes*, this effect may be either amplified or dampened by the interrelated choice of location (i.e. choice of p, the probability of a bad event occurring).

Crimes other than violent and nuisance offences are not included in the model, as other types of crime, particularly property crimes, will be uninfluenced by emotional shocks. For example, although it is easy to conceive someone flying into a rage and causing a public disturbance after a fight with their partner, it seems strange to imagine the same stimulus causing the aggrieved party to commit a burglary. Hipp et al. (2004) provide evidence for this assertion: using variation in US crime rates, the authors found that property crimes are motivated by opportunity rather than emotion, whereas violent crimes are influence by both. Since crimes other than violent or nuisance crimes are unaffected by emotional impact, they are predicted to be unchanged by alcohol

consumption or location choice and thus unaffected by change in legal alcohol access at the MLDA.

Therefore in aggregate, it is hypothesised that passing the MLDA will result in higher violent and nuisance crime rates both through higher alcohol consumption and riskier location choice, and that other crimes will be unaffected.

4.4 Summary

Standard economic theory leads to an uncontroversial hypothesis regarding the effect of the minimum legal drinking age on alcohol consumption: the decrease in implicit costs of access at this age will lead to increased consumption. Evidence suggesting that NSW imposes higher implicit costs on underage alcohol access than QLD provides an extension to this hypothesis. Thus:

Hypothesis 1: Alcohol consumption will increase at the minimum legal drinking age.

Hypothesis 1a: The increase in alcohol consumption at the minimum legal drinking age will be greater for NSW than for QLD due to the higher additional implicit costs of underage alcohol access in NSW.

The rational crime model predicts a fall in crime at the age individuals become adults in the justice system due to the accompanying increases in the costs of crime. In QLD this occurs at age 17; therefore the change in justice system and MLDA occur at two different thresholds, permitting unconfounded estimation of the latter. In NSW, however, individuals become adults in the eyes of the law at 18, the same age they gain legal access to alcohol. The alcohol-augmented rational crime model predicts that increased alcohol consumption will unambiguously lead to more of every type of crime. Combining this with the hypothesis that alcohol consumption will increase at the MLDA yields hypotheses about the effects of legal access to alcohol on crime. In summary, then, three main hypotheses for the current research emerge from alcohol-augmented rational crime model:

Hypothesis 2: All crimes will increase in QLD at the minimum legal drinking age (18). [Alcohol-Augmented Rational Crime Model]

Hypothesis 3a: All crimes will increase in NSW at the minimum legal drinking age (18) due to the alcohol consumption effect dominating the deterrence effect. [Alcohol-Augmented Rational Crime Model]

Hypothesis 3b: All crimes will decrease in NSW at the minimum legal drinking age (18) due to the deterrence effect dominating the alcohol consumption effect. [Alcohol-Augmented Rational Crime Model]

The emotional shock model reaffirmed hypotheses 1 and 1a above, and also predicted the following:

Hypothesis 4: Violent and nuisance crimes will increase in QLD and NSW at the minimum legal drinking age due to a combination of greater alcohol consumption and riskier location choice, on average. [Emotional Shock Model]

These hypotheses will be tested using the empirical results presented in Chapter 7.

5 Methodologies & Literature Review

"Art and science have their meeting point in method." – Edward Bulwer-Lytton

Although this thesis specifically addresses the MLDA, most research in this area has focused on estimating the effects of alcohol more broadly. Therefore, this chapter reviews the methodologies used to study alcohol consumption and alcohol policies in general. It opens with an acknowledgment of the empirical issues underlying identification of causal effects. Next, the methodology used in the current study, regression discontinuity design, is explained and reasons for its specific strengths in the MLDA context are provided. Following this, three methodologies highly prevalent in the literature are discussed: instrumental variables, fixed effects, and difference-in-difference. For all four methodologies discussed, key articles from the literature on alcohol are considered. Finally a summary of the methodology review is presented and the research gap located.

5.1 Empirical Issues

Although there are a wealth of studies demonstrating association between alcohol use and myriad outcomes, researchers and policy makers must go beyond this to identify *causal* effects of alcohol consumption. The difficulty in doing so lies in the problem of endogeneity – that is, correlation between one or more of the independent variables and the error term (Wooldridge 2002, p.50).

Specifically in the context of alcohol, this is attributable to omitted variable bias – correlation between the explanatory variable for which a causal estimate is sought and a variable affecting the outcome but which is not included in the model. For example, risk appetite will influence both alcohol consumption and outcomes such as crime, but will be difficult to accurately measure. Many other such factors could be identified, and it will be challenging, if not impossible, to obtain

measures for all of them. Omitted variable bias therefore makes using ordinary least squares estimation inadequate, and necessitates the use of more sophisticated techniques.

5.2 Regression Discontinuity Designs

The effects of MLDA laws have been estimated using an RD methodology for a number of outcomes, including: mortality (Carpenter & Dobkin 2009); university achievement (Carrell et al. 2011); smoking (Yörük & Yörük 2011); marijuana use (Crost & Guerrero 2012; Yörük & Yörük 2011); morbidity (Callaghan et al. 2013); and crime (Carpenter & Dobkin 2013). Thistlewaite and Campbell (1960) pioneered the use of RD in an educational psychology study on the effects of receiving merit scholarships on students' academic outcomes. The authors exploited an arbitrary threshold in Preliminary Scholastic Aptitude Test scores used to determine which students received scholarships. After this, RD designs passed in and out of fashion in a number of disciplines, but as Cook (2008) points out in his review of the topic, their repeated rediscovery and use is evidence for their validity and strength as an empirical strategy.

This methodology exploits a natural experiment: some policy that divides individuals into treatment and control groups in a process emulating randomisation (DiNardo 2008). Specifically for RD designs, this involves using a variable with a threshold that determines whether an individual is treated or not. For example, in the two-party voting system in the US, the candidate who receives a higher share of the votes is elected. Lee (2008) used this threshold to estimate the causal effect of an individual winning a given election on the probability of them winning the following election. The relevant threshold occurs when the candidate has exactly the same proportion of the vote as their rival – below this point the candidate will not be elected, and above this point they will.

One of the key assumptions underlying this methodology is individuals do not have *precise* control over where they lie in the threshold variable (also known as the forcing variable or running variable). For the example above, this assumption holds because although each candidate will

evidently attempt to capture as high a share of the vote as possible, they will be unable to control this with any degree of precision. That is, a candidate may be able to target with reasonable accuracy a certain range of the vote share (between +/- 2 per cent, for example), but cannot narrow this range any further. This assumption is important because it means that individuals fall either side of the threshold (and are therefore sorted into treatment and control groups) in a random manner – Lee and Lemieux (2010) refer to this as 'local random assignment'. In the context of alcohol, the MLDA offers an appealing target for research; since the running variable for being 'treated' with legal access to alcohol is age, individuals clearly have no control at all over where they lie in the distribution.

A second key assumption for RD is that only the treatment variable is discontinuous at the threshold. Other relevant variables are not required to be constant at this point; they must only display no sudden jump (i.e. a discontinuity). In Australia, the MLDA is 18 years old. This is also the age at which individuals are 'treated' with the legal right and obligation to vote, but it seems improbable that voting rights could influence alcohol consumption or crime.[17] In all Australian states and territories except for QLD, 18 is also the age individuals are considered adults in the justice system, which is likely to influence crime, and may also influence alcohol consumption. Another variable that changes discontinuously at age 18 in many Australian states (including NSW and QLD) is access to the second tier of provisional drivers' licences (P2 licences). Since progressing to a P2 licence involves only a minor easing of some of the restrictions imposed on provisional drivers, this is unlikely to affect crime or alcohol consumption.[18] In particular, P2 drivers are still restricted to zero blood alcohol content, meaning that this potential incentive to

[17] Although this does suggest an interesting research topic, combining the current study with Lee (2008) – do crime rates and alcohol consumption rise immediately following an election, particularly if the election was close?

[18] In NSW, P2 licence holders are limited to 100km/h (up from 90km/h for P1), gain three additional demerit points (P2 = 7 points, P1 = 4 points), and are no longer have the restriction of carrying only one passenger aged under 21 who is not an immediate family member between 11pm and 5am, which applies to P1 drivers under 25 years old (NSW Roads and Maritime Services 2013). In QLD, P2 licence holders no longer have restrictions placed on their hands-free mobile phone use (P1 drivers in QLD are not allowed to have any sort of mobile phone conversation while driving, even one in which the phone is on loudspeaker and operated by a passenger) or passenger transport (which are the same as for NSW P1 drivers), but there are no changes to speed limits or demerit points (QLD Department of Transport and Main Roads 2013).

increase their alcohol consumption does not change at 18 (NSW Roads and Maritime Services 2013; QLD Department of Transport and Main Roads 2013).

The main difference between RD and a full experiment is that there is no value of the running variable for which there are both treated and untreated individuals. Instead, individuals very close to the threshold are treated as randomly assigned to treatment or control. This means that treatment effects should be estimated by comparing the outcomes for individuals just either side of the threshold. In practice, however, observations some distance from the threshold must be included in order to fit a conditional mean function to the data. Thus increased precision comes at the cost of decreased validity, since points further and further from the threshold will be included.

Angrist and Pischke (2009, p253) point out that the nature of RD also means that the choice of functional form is pivotal. The authors claim that ideally a non-parametric specification should be used but concede that parametric work remains standard. Two validity checks are suggested for parametric specifications: the estimated discontinuity should remain stable as the chosen bandwidth (i.e. range of observations used in estimation) becomes smaller; and covariates should show no discontinuity at the threshold since they are not influenced by treatment, something discussed above (Angrist and Pischke 2009, p257).

In contrast, Lee and Lemieux (2010) suggest that non-parametric estimation should be seen as a complement to parametric estimation rather than a replacement. Imbens and Lemieux (2008) suggest using local linear regression as the preferred parametric specification, since it conveys the advantages of easy implementation and transparency of design. This method involves fitting linear functions to the observations either side of the threshold. The authors show that this involves calculating:

$$\min_{\alpha_l,\beta_l} \sum_{i:c-h<X_i<c} \left(Y_i - \alpha_l - \beta_l(X_i - c)\right)^2 \qquad (1)$$

and

$$\min_{\alpha_r,\beta_r} \sum_{i:c\leq X_i<c+h} \left(Y_i - \alpha_r - \beta_r(X_i - c)\right)^2 \qquad (2)$$

where Y is the outcome variable, X is the running variable, c is the threshold value of the running variable, h is the bandwidth radius (units either side of the threshold included in the estimation), and the subscripts l and r stand for left and right of the threshold, respectively. The treatment effect ($\hat{\tau}_{RD}$) is estimated by subtracting the right-hand limit of the conditional mean of the outcome variable from the left-hand limit of the conditional mean of the outcome variable, where the conditional means are defined as:

$$\mu_l(x) = \lim_{z \uparrow x} E[Y(0)|X = z]$$

and

$$\mu_r(x) = \lim_{z \downarrow x} E[Y(1)|X = z]$$

Estimating equations (1) and (2) provide values for the conditional means:

$$\widehat{\mu_l(c)} = \hat{\alpha}_l + \hat{\beta}_l(c - c) = \hat{\alpha}_l$$

$$\widehat{\mu_r(c)} = \hat{\alpha}_r + \hat{\beta}_r(c - c) = \hat{\alpha}_r$$

and thus

$$\hat{\tau}_{RD} = \hat{\alpha}_r - \hat{\alpha}_l$$

If a rectangular kernel is used in estimating the above non-parametrically,[19] this is equivalent to the following specification, where D = 0 for observations left of the threshold and D = 1 for observations right of the threshold (Lee & Lemieux 2010):

$$Y_i = \beta_0 + \tau_{RD} D_i + \beta_1 X_i + \beta_2 D_i X_i$$

The interaction term allows the slope to vary either side of the threshold.

[19] Other kernel types (triangular, quartic, Gaussian, etc.) could be used, but Lee and Lemieux (2010) argue that efficiency gains from doing so are small compared to the convenience gains from using a rectangular kernel, and that the kernel used typically does not affect the results a great deal.

It is important to note that the interpretation of RD estimates is limited to the vicinity of the threshold – that is, the estimates are of local average treatment effects (Imbens & Angrist 1994). In the context of alcohol, this means that estimates from the US cannot be generalised to a country such as Australia (and vice versa), since the two countries have different drinking ages. Moreover, the external validity of extrapolating estimates from any country to another is questionable, even if the two have the same MLDA, since other institutional differences will alter the effect of the policy.

Barreca et al. (2011) discuss the possibility that measurement error in the vicinity of the threshold may bias RD estimates. They demonstrate that previous RD studies finding a strong effect of medical intervention on infant survival rates are highly sensitive to the removal of observations very close to the birth weight threshold used. They argue that may be due to manipulation of recorded birth weight by medical staff in order to receive a favourable treatment for infants perceived to be at risk. This potential source of bias can be tested by removing observations adjacent to the threshold and observing the effect on the estimated discontinuity – a process that has been likened to forming a 'donut' from the data, with the removed observations comprising the donut hole.

Another sensitivity test for RD estimates involves including covariates in the regression. This should not dramatically alter the estimated discontinuity, as the RD methodology relies on the assumption that only the treatment (i.e. legal access to alcohol) changes sharply at the threshold. Imbens & Lemieux (2008) point out that the inclusion of covariates will address potential bias introduced by using a sample with observations outside the proximity of the threshold.

Boes and Stillman (2013) question the interpretation of RD results. They estimate the effects of the MLDA in New Zealand on alcohol-related hospitalisations and motor vehicle accidents (MVAs) using a difference-in-difference model,[20] exploiting a change in the drinking age in 1999, and an RD model. The difference-in-differences estimates indicate that the change in the MLDA from 20

[20] A discussion of this methodology can be found in section 5.5, later in this chapter.

to 18 made no impact on either of the outcomes. In contrast, the RD model estimated a 25 per cent increase in alcohol-related MVAs caused by the 18-year-old MLDA. The authors suggest that the disparity between the two sets of results is due to RD designs estimating local average treatment effects for individuals who change their behaviour based on the policy. This subset of the population is likely to have minimal prior experience with alcohol and therefore will be the most susceptible to adverse effects from consumption. Using RD estimates as evidence for changing MLDA policies might therefore be problematic, since negative outcomes may not be reduced but rather the sudden spike will occur at a different age group to the same affected subset of the population.

All of the studies mentioned at the beginning of this section tested the sensitivity of results to changes in bandwidth and inclusion of covariates (Carpenter & Dobkin 2009; Carrell et al. 2011; Yörük & Yörük 2011; Crost & Guerrero 2012; Callaghan et al. 2013; Carpenter & Dobkin 2013). Only Carpenter and Dobkin (2009; 2010) and Carrell et al. (2011) test for donuts, however, and only in the context of 'birthday effects' – removing the individual's MLDA birthday and the following day. There may not be birthday effects in the other studies, especially those investigating outcomes that represent more permanent shifts in behaviour (such as the decision to begin smoking marijuana) rather than infrequent events (such as mortality). Nonetheless, testing for birthday effects and reporting the results is a low-cost way to improve validity, and would have improved internal validity.

Carpenter and Dobkin (2013) estimated the effects of the MLDA on alcohol consumption and crime in the US using an RD design. They found that the MLDA causes an increase of 15 to 16 per cent in the proportion of individuals who report consuming alcohol in the past month, and an increase of 6 per cent in total crimes. Disaggregating into individual categories, the authors found increases of around 6 per cent in assaults, 6.5 per cent in robberies, and approximately 25 per cent in disorderly conduct offences. They found no significant discontinuities for any other crime categories. Although, as discussed above, the authors test their results for sensitivity to bandwidth and covariates, several aspects of their study are worth considering as opportunities for

improvement. First, although the authors make some attempt to incorporate the influence of donut effects, this is limited to including a dummy variable for the 21st birthday and the following day. It remains possible that other observations close to the threshold could be exerting a disproportionate influence on the results, so testing for a larger range of donut sizes would improve validity and also enhance the discussion of their results. Second, the authors use a quadratic specification for their estimates. An earlier working paper (Carpenter & Dobkin 2010) also reports results from a linear specification, and estimates do not differ much between the two. The linear specification has the advantage of being more parsimonious and also a better approximation to non-parametric methods (Imbens & Lemieux 2008). Using a linear specification for the reported results may improve the validity of the study.

5.3 Instrumental Variables (IV)

Many studies have used an IV approach to attempt to identify causal effects of alcohol. Instruments used include: alcohol policies (Balsa et al. 2008); parental alcohol consumption (Tauchmann et al. 2012); alcohol taxes (Dee & Evans 2003; Young & Bielinska-Kwapisz 2006; Corman & Mocan 2013); age, peer alcohol use and perceived harm from marijuana use (Austin 2012); and minimum legal drinking ages (Dee 1999a; Dee & Evans 2003; Corman & Mocan 2013). Stock and Trebbi (2003) discuss the debate about who was responsible for inventing this approach, but regardless of the author, the IV methodology was first outlined in Wright (1928). Included in an appendix to a treatise on a specific subset of tariffs, IV was initially used as a means to separately identify supply and demand elasticities.

Using an IV approach isolates the exogenous component of the explanatory variable, hence yielding estimates free from endogeneity bias (Stock & Watson 2012, p.461). IV estimation requires an instrument – a variable that is uncorrelated with the error term but correlated with the explanatory variable of interest. These two conditions are known respectively as instrument exogeneity and instrument relevance.

Angrist & Pischke (2009, pp.115-116) explain the mathematics underlying this approach. With Y the outcome variable and s the independent variable for which causal effect estimates are desired, the simple OLS model would be:

$$Y_i = \alpha + \rho s + \eta_i$$

However, endogeneity bias (from omitted variables, measurement error, simultaneous causality, etc.) means the idiosyncratic error term, η, will be correlated with s, and therefore estimates of ρ will be biased. If the omitted variables were observed, they could be included in the regression to eliminate this problem. If they are unobserved and have no available proxies, an instrument may be used instead to eliminate the bias.

Reiterating from above, the instrument must be exogenous (1) and relevant (2), that is:

$$Cov(Z_i, \eta_i) = 0 \qquad (1)$$

$$Cov(Z_i, s_i) \neq 0 \qquad (2)$$

If condition (1) holds, then:

$$\rho = \frac{Cov(Y_i, Z_i)}{Cov(s_i, Z_i)}$$

Bound et al. (1995) assert that if condition (2) is not met, or holds only weakly, then IV estimates will be biased in the same direction as OLS estimates.

Interpretation of the effect is constrained by the use of the instrument. Only observations affected by the instrument will alter s in response, and therefore these observations will be responsible for the estimated effect. Imbens & Angrist (1994) suggest that estimates from IV can be interpreted as a weighted average of local average treatment effects, with more weight given to observations affected more strongly by the instrument.

The chief disadvantages of the IV approach are twofold: a reliance on instrument validity, and a restriction of the estimates to local average treatment effects for the subset of the population responsive to the instrument.

Invalid instruments are a major problem for the IV approach, as if the instruments used are invalid then bias will still exist. Angrist & Krueger (2001) caution that using non-exogenous instruments (correlated with the error term) can result in greater bias than using an OLS estimator. Exogeneity cannot be tested directly, but relies on a convincing conceptual argument. Taking just one example from above, Tauchmann et al. (2012) use parental alcohol consumption as an instrument to identify the causal effects of alcohol consumption on tobacco use. Parental alcohol consumption is clearly a relevant instrument for offspring alcohol consumption, and the authors confirm this by showing the strong correlation between the two. The assumption that it is exogenous to offspring tobacco use, however, is questionable. It is possible that parents have some innate tendency towards addiction that is passed on to their children, and thus individuals who consume large amounts of alcohol are more likely to have children who consume large quantities of addictive substances in general – including both alcohol and tobacco. If this is the case, then the exogeneity assumption is violated and the estimated effects will be biased.

Even if IV estimates are unbiased, they remain local average treatment effects. The subset of the population to which the estimate applies may be difficult to conceptualise or target policy towards. For example, again using the Tauchmann et al. (2012) tobacco and alcohol study, the estimated effect would apply to individuals for whom their parents' alcohol consumption strongly influenced their own. It is difficult to identify who would fit this description, and more difficult still to imagine how policy could be designed to target this group's tobacco use.

5.4 Fixed Effects

A fixed effects approach has been used to estimate alcohol consumption's effect on outcomes such as: crime (Joksch & Jones 1993; Fergusson & Horwood 2000); alcohol disorders in later life (Blozis et al. 2007);[21] and high school achievement (Balsa et al. 2011).

Fixed effects estimation can eliminate bias due to omitted variables that are either time-invariant or entity-invariant (Stock & Watson 2012, p.396). Entity fixed effects estimation removes the bias from omitted variables that have the same effect on a single entity in every time period, and period fixed effects estimation removes the bias from omitted variables that have the same effect on all entities in a single time period. This methodology requires panel data in order to remove time- or entity-invariant effects and still retain variation to estimate a causal relationship.

Stock & Watson (2012, pp.396-399) outline the mathematics of this approach.[22] Suppose an outcome *Y* is modelled:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Z_i + u_{it} \qquad (3)$$

where *X* is the variable of interest that varies over time and between entities (indicated by the subscripts *i* and *t*), while *Z* is an unobserved variable that varies only between entities (i.e. it is time-invariant). If *Y* were simply regressed on *X*, the estimated coefficient β_1 would be biased due to the omission of *Z*. To rectify this, time-invariant unobserved factors (i.e. *Z*) must be eliminated from the model. Consider a second model using the arithmetic mean of each variable in equation (3) across time periods:[23]

$$\bar{Y}_i = \beta_0 + \beta_1 \bar{X}_i + \beta_2 Z_i + \bar{u}_i \qquad (4)$$

Subtracting equation (4) from (3) gives:

$$(Y_{it} - \bar{Y}_i) = \beta_1 (X_{it} - \bar{X}_i) + (u_{it} - \bar{u}_i) \qquad (5)$$

[21] This study used a random effects model, which is a special type of fixed effects model in which the entity- or time-invariant effects are assumed to be uncorrelated with the independent variables (Wooldridge 2002, p.257).
[22] The following applies to entity fixed effects regression, but an analogous procedure is used for period fixed effects.
[23] That is, $\bar{Y}_i = \frac{1}{T}\sum_{t=1}^{T} Y_{it}$ and similar for the other variables.

Letting

$\tilde{Y}_{it} = (Y_{it} - \bar{Y}_i)$, $\tilde{X}_{it} = (X_{it} - \bar{X}_i)$ and $\tilde{u}_{it} = (u_{it} - \bar{u}_i)$

Equation (5) can be written:

$$\tilde{Y}_{it} = \beta_1 \tilde{X}_{it} + \tilde{u}_{it}$$

This specification provides an unbiased estimate of β_1.[24]

Apart from the limitation of relying on rich panel data, fixed effects models depend on the assumption that any omitted variables are time- or entity-invariant. Since the variables are unobserved, this assumption can only be supported by conceptual argument; it is not possible to test statistically. Also, unlike RD, fixed effects models require changes in the explanatory variable to estimate effects. For policies such as the MLDA that change very rarely, this limits the application of this methodology.

5.5 Difference-in-Difference

Ashenfelter and Card (1985) pioneered the difference-in-difference (D-in-D) methodology in their study of the effects of training programs on participants' earnings. Since then, several studies have used this approach in the context of alcohol, including: Dee (1999b), who estimated the effects of state alcohol policies on alcohol consumption and traffic fatalities; Kaestner (2000), who examined the effects of the MLDA on alcohol consumption; and Liang and Huang (2008), where the authors estimated the effects of zero-tolerance laws on drunk driving. All of these studies used US data. More recently, Boes and Stillman (2013) used D-in-D to estimate the effects of New Zealand lowering the MLDA on alcohol-related hospitalisations and motor vehicle accidents.

[24] The process outlined above is known as entity-demeaning. Another alternative yielding the same result is to estimating equation (2) omitting the unobserved *Z* term but including dummy variables for each entity to allow the intercept to vary between states.

Angrist & Pischke (2009, p.227) argue that the difference-in-difference methodology is akin to a fixed effects approach using aggregate data or repeated cross-sectional data.[25] This approach exploits 'natural experiments' to identify causal effects of a treatment. Two populations (US states, for example) with similar characteristics are examined both before and after a change to which only one is exposed. The control state is used as a counter-factual for the treated state. This allows the change in the control state's outcome variable between the two periods to be used as a proxy for the hypothetical trajectory of the treated state's outcome variable *in the absence of treatment*. By comparing the hypothetical untreated outcome with the true, treated outcome, the causal effect of the treatment can be identified.

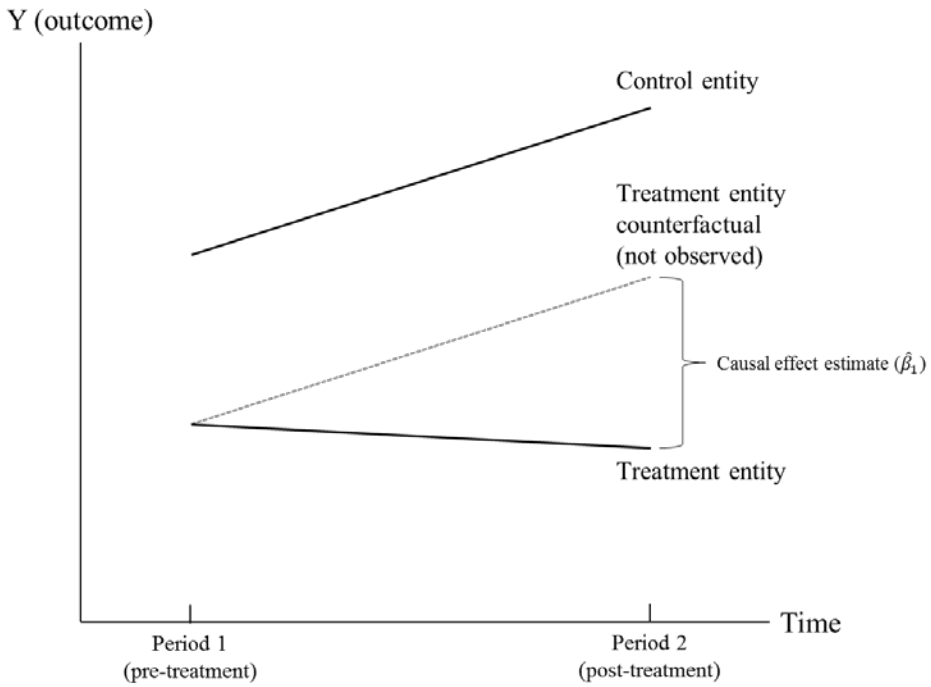
Stock & Watson (2012, p.532) provide the formula for calculating the D-in-D treatment estimate:

$$\hat{\beta}_1 = \left(\bar{Y}_{T,1} - \bar{Y}_{T,0}\right) - \left(\bar{Y}_{C,1} - \bar{Y}_{C,0}\right)$$
$$= \Delta\bar{Y}_T - \Delta\bar{Y}_C$$

where the subscript T stands for the treatment entity, C for the control entity, 1 for the after-treatment period and 0 for the pre-treatment period. Figure 5.1 shows a graphical representation of this method.

[25] In contrast to panel data, repeated cross-sectional data are observations of the same population over multiple time periods, but with a different sample each time (Almond & Sinharay 2012).

Figure 5.1



Taking the difference in outcomes between the two entities will eliminate bias due to omitted variables that differ between the two, but only if these do not change over time. That is, identification of the true causal effect relies on omitted variables being time-invariant. If this does not hold, the assumption that the untreated entity is a valid counterfactual for the treated entity is invalid. Also, as for fixed effects, the D-in-D approach requires a change in the independent variable to estimate a causal relationship. In Australia, the MLDA has not been changed for some time, limiting the possibility of using D-in-D to estimate effects of legal alcohol access.

5.6 Summary and Literature Gap

Four main methodologies have been used to solve the problem of endogeneity bias in the empirical literature on alcohol: regression discontinuity (RD), instrumental variables (IV), fixed effects, and difference-in-difference (D-in-D). Each of these approaches has been applied to the MLDA, but data and validity constraints make RD the best choice for the current study. Fixed effects and D-in-D both require changes in the independent variable, but the MLDA has not changed in Australia for

several decades. IV studies have previously used the MLDA as an instrument for alcohol consumption, but this approach is flawed because the drinking age is unlikely to be exogenous due to the accompanying change in location access discussed above. RD estimates are local average treatment effects and thus intrinsically limited in scope for generalisation; despite this the RD methodology provides a robust means to estimate the effects of the Australian MLDA using contemporary data.

Other studies have used an RD methodology on the MLDA, but very few examine crime rates as the outcome, and none has focused on Australia. This thesis will fill this gap in the literature, but also go beyond this by relating the results to theoretical hypotheses and also by explicitly discussing the identification problem created by the dual alcohol and location access change at the MLDA.

6 Data

"It is a very sad thing that nowadays there is so little useless information." – Oscar Wilde

This chapter describes the data used in the empirical section of this thesis, including descriptions of the sample, variable construction, and some descriptive statistics. The data used in measuring alcohol consumption is considered first, followed by the crime data from QLD and NSW.

6.1 Alcohol Consumption – HILDA

6.1.1 Background

The alcohol consumption and covariate data come from the first eleven waves (2001-2011) of the Household, Income and Labour Dynamics in Australia (HILDA) survey. This survey is an unbalanced panel but changes in household composition and a top-up sample added in wave 11 mean that the number of individuals has increased over time (Summerfield et al. 2012, p.11). 19,914 individuals were initially included, and as additional people joined the household they were also surveyed until they left the household. Of the initial 19,914 individuals, 13,969 completed the person questionnaire (PQ), with non-responses either due to ineligibility (as for children under 15), refusal or non-contact. In 2011 a top-up sample of 2153 extra households was added, meaning the 2011 wave sampled 29,489 individuals, of whom 13,603 were eligible and completed the PQ (Summerfield et al. 2012, pp.11 & 132). In each of the eleven waves, between 85 and 94 per cent of individuals who completed the PQ also responded to the self-completion questionnaire (SCQ).

Although HILDA is a panel dataset, the methodology used in this study only requires cross-sectional data. The eleven waves are therefore merged into a single long data file, with each individual in each year comprising one observation. In order to match the alcohol consumption data to the crime data as closely as possible, only individuals from NSW and QLD are used in the analysis. After children (individuals under 15 years old) and non-responders are accounted for,

103,271 observations remain – 61,695 in NSW and 41,576 in QLD. Of these, 8,172 are aged between 15 and 21 years old, three years either side of the MLDA threshold – 4,732 in NSW and 3,440 in QLD.

Table 6.1 shows the HILDA variables used. A respondent's age relative to 18 was constructed as the difference between the questionnaire completion date and the individual's date of birth. Every wave contains a completion date for the Person Questionnaire (PQ), which is administered by an interviewer. Questions on alcohol consumption are contained in the Self-Completion Questionnaire (SCQ), however, which is left with the respondent and collected at a later date. Using the PQ completion date may introduce measurement error in the dependent variable. This possibility is discussed further below.

The alcohol consumption questions are a dual measure of whether an individual has ever consumed alcohol and also how often he or she currently consumes alcohol. Responses are either: "No, I have never drunk alcohol"; "No, I no longer drink alcohol"; or six categories indicating drinking frequency for individuals who report currently drinking alcohol, from "rarely" to "every day".

Table 6.1

HILDA data – variables used		
Variable name	**Waves**	**Description**
hhstate	All	State
hgsex	All	Individual's sex
hgdob	All	Individual's date of birth
hhidate	All	Date of Person Questionnaire completion. This questionnaire was administered by an interviewer.
scdate	9, 10, 11	Date of Self-Completion Questionnaire completion. This questionnaire was delivered by an interviewer and collected at a later date (or returned by mail).
esempst	All	Current employment status.
bncoth1	All	Receiving government benefits. "Excluding any Family Tax Benefit payment, do you currently receive any (other) income from the government in the form of a benefit, pension or allowance?"
esbrd	All	Labour force status.
edhists	All	Highest year of school completed/currently attending.
lsdrkf	2 – 11	Alcohol consumption frequency. "Do you drink alcohol?"
lsdrink	1	Alcohol consumption frequency. "How often do you drink alcohol?"

Source: HILDA 2011 Cross-wave Index, Melbourne Institute for Applied Economic and Social Research

6.1.2 Descriptive Statistics

Figure 6.1 shows the relevant section of the age distribution of observations from NSW and QLD in the pooled cross-sectional dataset. Each bar represents 50 days, and the range is slightly less than three years either side of individuals' 18th birthdays. The distribution is fairly uniform, and most importantly, displays no sharp discontinuities at any point. Imbens and Lemieux (2008) claim that testing the density of the running variable (i.e. age, in this context) is a necessary validity check for RD designs. If the age profile was discontinuous at 18, it would suggest that individuals may have been able to manipulate their position in the distribution, which would lead to biased estimates. Here, the absence of any discontinuities in the age profile suggests that individuals did not attempt to alter their survey completion date due to proximity to their 18th birthday.

Figure 6.1

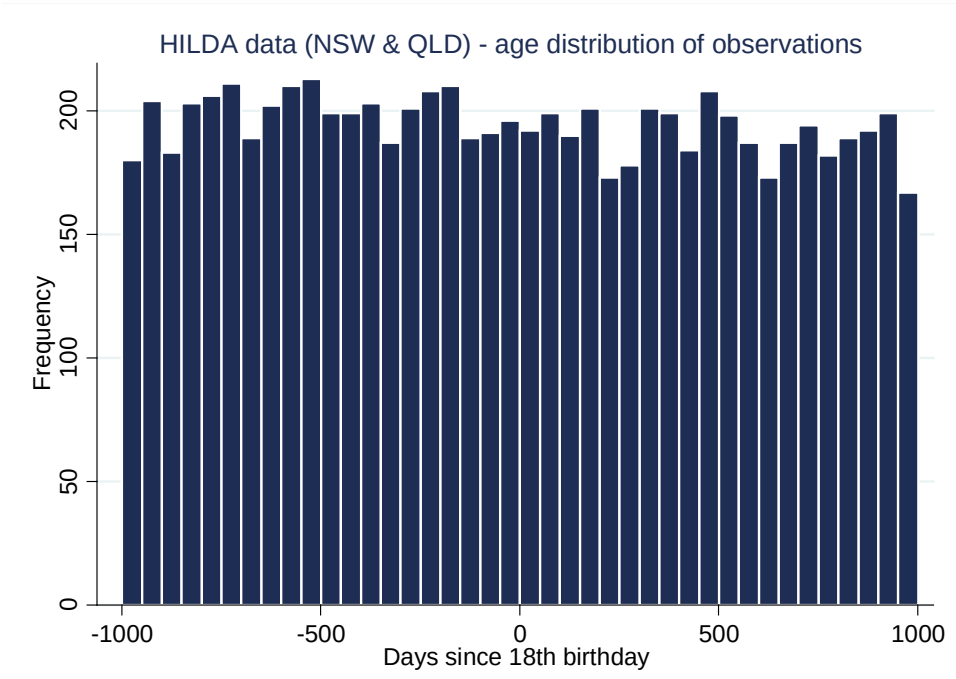


Table 6.2 provides summary statistics for the sample. The sex distribution of individuals in the sample is almost perfectly even with slightly more females than males, which reflects the same trend at the population level in Australia (ABS 2012b). Just over 90 per cent of the observations are of individuals with a year 10 education, while less than half are for individuals with a year 12 education. Mostly this is because the sample encompasses individuals aged as young as 15, who

will still be completing the final stages of their education, but in part it reflects the distribution of educational qualifications in the Australian population. 30 per cent of observations are for individuals not in the labour force, which is in line with expectations about the 15 to 21-year-old age category – many of them will choose not to seek work while studying. One ninth of the observations are of individuals in the labour force but unemployed, and the remaining 59 per cent are of unemployed individuals. For the dependent variables, over 70 per cent of the sample falls in the category of ever drinking alcohol, while just over a quarter are of individuals who drink at least weekly.

Table 6.2

HILDA data (NSW & QLD) descriptive statistics				
Variable	*Category*	*Per cent*		*N*
Sex	Male	49.67		**8,172**
	Female	50.33		
Year 10 completion	Finished Year 10	90.96		**8,166**
	Not Finished Year 10	9.04		
Year 12 completion	Finished Year 12	43.53		**8,166**
	Not Finished Year 12	56.47		
Labour force status	Not In Labour Force	30.03		**8,172**
	In Labour Force – *Employed*	*11.11*	69.97	
	In Labour Force – *Unemployed*	*58.86*		
Ever drunk alcohol	Yes	71.37		**6,951**
	No	28.63		
Drink alcohol weekly or more frequently	Yes	25.38		**6,951**
	No	74.62		

Note: six observations had no information recorded for educational qualifications, four of which were for the same individual during different waves. Statistics in table are for individuals aged 15 to 21 at the date of the survey.

In the HILDA data, although there is no reason to expect any measurement error in date of birth, it may be present in the completion date variable. Specifically, for waves 1 to 8 the completion date is based on the date recorded by the interviewer upon completion of the person-level questionnaire (PQ). The alcohol consumption questions are contained in the self-completion questionnaire (SCQ), the completion date of which is unobserved. For waves 9 to 11, however, the participant was asked to record the date they completed the SCQ, providing greater accuracy for mapping alcohol consumption data to the exact age relative to 18. Comparing the completion dates of the PQ and the SCQ for these three waves also mitigates concerns about measurement error for the

previous waves. Table 6.3 indicates that 82.8 per cent of individuals completed the PQ and the SCQ within the same seven-day period. Measurement error is therefore likely to be small in magnitude, but testing for the effect of a donut of at least seven days is necessary to verify internal validity.[26]

Table 6.3

HILDA data (NSW & QLD) – gap between SCQ and PQ completion		
Gap between SCQ and PQ completion	*Frequency*	*Per cent*
Seven or fewer days	16,384	82.8
Greater than seven days	3,403	17.2
Total	**19,787**	**100**

Note: includes all ages, but only for waves containing completion date for SCQ and PQ (i.e. 2009, 2010, 2011).

6.2 Crime

Data on crime can be captured at a number of different stages in the justice system; Figure 6.2 illustrates the process. Of the crimes that are committed (A), some proportion of these are either reported to or caught by the police (B). The police then decide how to proceed against the suspect, which may involve dropping the case, proceeding to court, or proceeding to something other than court (which can include cautions, warnings, or infringement notices). The court case (C) may be escalated to a higher court in the case of serious offences, but ultimately a verdict will be reached – either guilty (D) or not guilty. For defendants found guilty, the sentence can either involve imprisonment (E) or other punishments. A complication arises from the potential for innocent individuals to be falsely accused (Z). These individuals may be filtered out at either the police or the court level, but there remains the possibility that they will be found guilty of a crime they didn't commit.

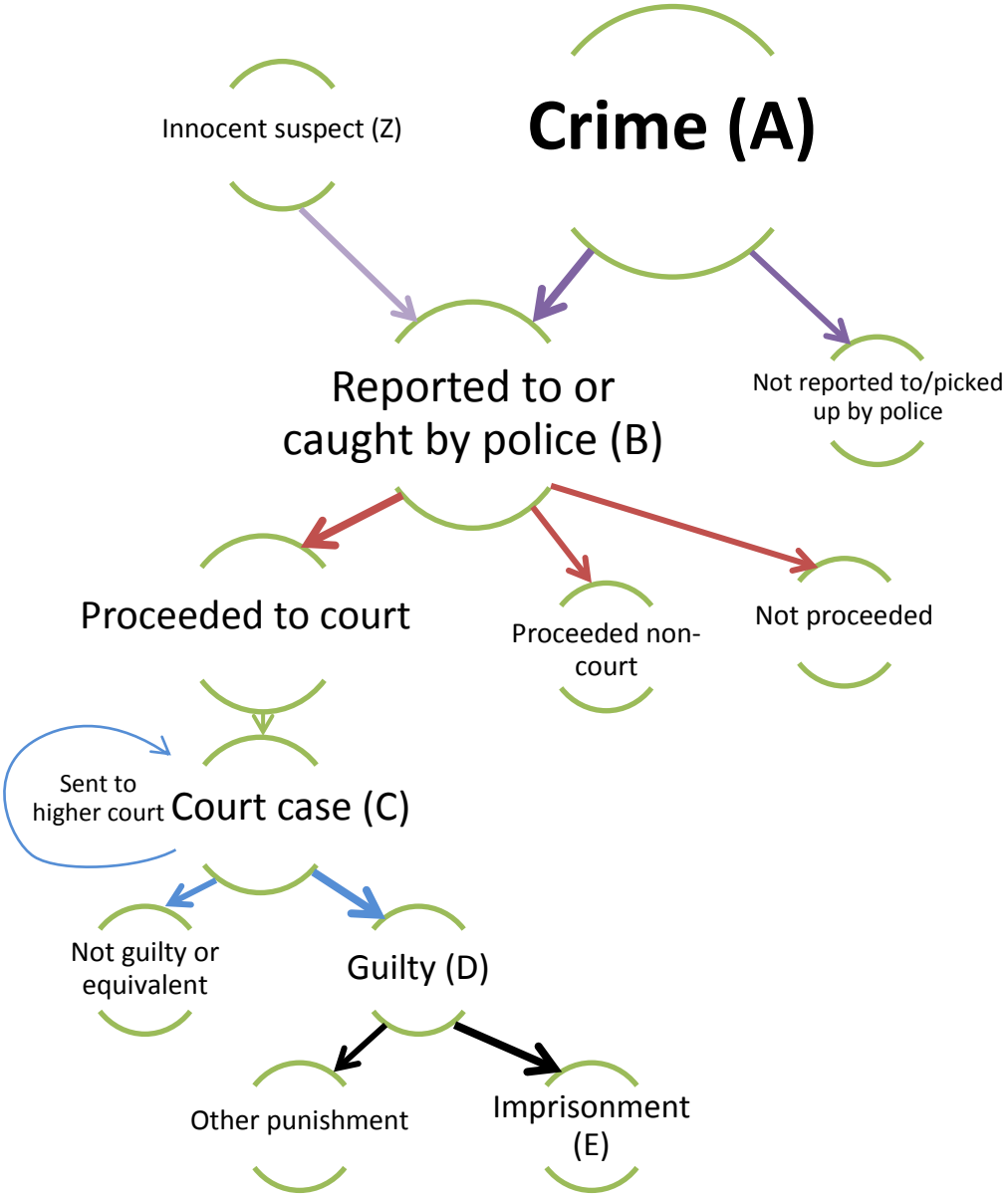
The crime data from QLD are incidents from point C in Figure 6.2, whereas the data from NSW are incidents from point B. It is preferable to use observations from point D rather than point C, however, as a guilty verdict is more convincing evidence that the person of interest actually

[26] See section 5.2 for the meaning of 'donuts'.

committed the crime (rather than entering the data from point Z). Further discussion of this can be found below.

This section continues by examining the QLD and NSW crime data in turn, before discussing the method used to convert crime rates into a unit comparable across samples.

Figure 6.2



6.2.1 Queensland

This section discusses the QLD court data, beginning with a description of the court and justice system, and then presenting some descriptive statistics.

Background

Queensland's justice system has an interesting feature shared by no other states or territories. While in every other state and territory individuals are treated as adults in the courts at the same time as they receive other adult privileges as the right to vote and drink alcohol, Queensland's court system considers individuals as adults once they turn 17 (AIC 2011).

The change from the juvenile to the adult justice system has large consequences for offenders. Before a case even reaches the courts, the Queensland Youth Justice Act (1992, Part 11 section 1) instructs police to consider alternative courses of action against juveniles other than formal proceedings (which typically end up in court). These alternatives include: taking no action, administering a caution, or referring the offence to a conference. It is likely, then, that there is a substitution from these more informal enforcement channels towards formal channels for offenders aged over 17 years. This will show up in the data as a large increase at 17 years – not necessarily reflecting an increase in crimes but rather the change in probability of an offence being formally proceeded against. There is also a preference expressed in this Act to avoid arresting juvenile offenders where possible, relying instead on their voluntary cooperation with police. Lastly, in Queensland as in all parts of Australia, incarceration of juveniles is avoided wherever possible (AIC 2011).

The distinction between individuals aged 16 years, 364 days and those aged 17 years exactly is not as clear cut as it sounds, however. Individuals who committed a crime while still a juvenile are tried as a juvenile even if they have subsequently turned 17, with some exceptions. Namely: if the offender turns 18 before proceedings begin, then they are tried and sentenced as an adult; if the offender turns 18 during proceedings (for a crime committed while a minor), then the trial is still conducted as per the child provisions, but they are sentenced as an adult; or if the offender turns 18

and has been found guilty but has been unable to be sentenced due to misbehaviour (escape from detention, failure to appear or failure to return to detention after approved leave), then they will be sentenced as an adult. Apart from these, the court may also decide to try to defendant as an adult if they are being tried alongside an adult for the same offence.

This suggests that there may be an additional reason for a discontinuity at age 18 – if the offender's 18th birthday is soon, then the prosecutor may have an incentive to delay in order to secure an adult trial and sentencing. This should not create a problem for the current study, however, as the date of the offence is used to create the age variable, rather than the date of the trial.

The data originate from the Queensland Department of Justice and Attorney General. The organisation provided records of all individuals aged between 15 and 23 years at the time of their alleged offence who appeared in any QLD court (see below for a description of the court system) between July 2005 and December 2011. Although data prior to July 2005 is available, its validity is questionable since not all jurisdictions are included.

Queensland has a four-tier court system, as shown in Figure 6.3. Most cases are initially heard in the Magistrates Court, presided over by a judge with no jury. As Table 6.4 suggests, the matter is often settled in this court, but more serious cases are escalated to higher courts – charges such as robbery, rape and fraud are usually heard in the District Court, whereas the Supreme Court deals with the most serious offences such as murder or drug offences. The Court of Appeals hears all appeals from every court. For juvenile offenders, there is an equivalent children's court at the lower two levels: the Children's Court corresponds to the Magistrates Court, and the Children's Court of Queensland corresponds to the District Court. In some circumstances a juvenile may be tried as an adult (e.g. if an adult is also accused of the same crime or if the crime is deemed serious enough), although as Table 6.4 shows, these cases are quite rare, representing less than 0.1 per cent of all observations in the data.

Figure 6.3: QLD court system

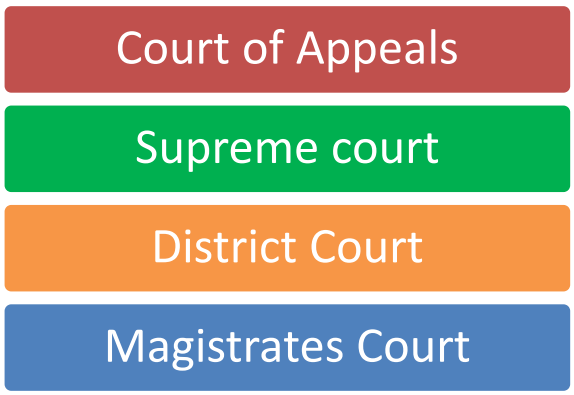


Table 6.4

QLD court data – court type frequencies		
Court	*Frequency*	*Per cent*
Magistrates	712,517	82.83
Children's (Magistrate)	85,209	9.91
District	47,827	5.56
Children's Court of Queensland	9,216	1.07
Supreme	4,673	0.54
District (Juvenile offender)	719	0.08
Supreme (Juvenile offender)	72	0.01
Total	**860,233**	**100**

Table 6.5 shows the amount and proportion of cases sent to a higher court for trial (i.e. from a lower court). This occurs when an offence is serious enough to warrant a more involved process – e.g. trial by jury instead of by magistrate. These observations are for the same individual and same offence, so in order to avoid double-counting they will be dropped. From here on in, cases sent to a higher court for trial have been dropped from the data, leaving 828,104 unique observations.

Table 6.5

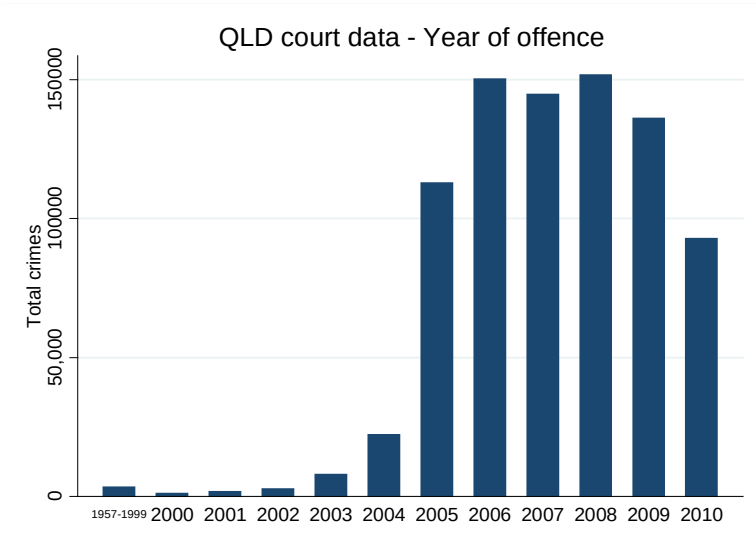
QLD court data – observations sent to a higher court		
	Frequency	*Per cent*
Not Sent	828,104	96.27
Sent	32,129	3.73
Total	**860,233**	**100**

Each observation in the data is for a single charge, that is, one offence an individual is being tried for. 72 per cent of the individuals in the dataset appear for only one charge at a time (although they may return to court later), and 90 per cent are charged with five or fewer. There is a very long tail

of individuals with more than five charges, however: the largest number of charges is 1240 and the second largest 606. The skewed nature of the distribution of crimes introduces a large amount of noise into the data, and as such the observations are collapsed into a new dataset with a unit of analysis consisting of individuals on specific dates. For example, the individual with 1240 charges against them (99% of which were for graffiti and the remainder trespass) for crimes committed on two separate dates will now comprise two observations in the new dataset rather than 1240. The new observations will contain a series of binary indicators for which types of crime were committed on that date. This means that the capacity to distinguish between someone who commits ten acts of burglary and someone who only commits one is lost, but this is a necessary cost of reducing the noise in the data.

Since the selection criteria for an individual's inclusion in the dataset is being aged between 15 and 23 *at the date of offence*, some observations are for crimes committed decades prior to the court case. Thus, offence dates span 1957 to 2010, but most of the observations (~99 per cent) are from the 2000s, and more than 80 per cent are from the years 2006 to 2010 (Figure 6.4). Apart from constituting a very small proportion of the total observations, this should not cause an issue since the minimum legal drinking age has been 18 years in QLD since 1974 (Queensland Office of Liquor, Gaming and Registration 2013).

Figure 6.4



The outcome of the court process is worth considering in this context. If a defendant is found not guilty, then it is reasonable to claim that the crime for which they were accused should not be counted in our analysis. This creates a mismatch in the observations included in the QLD and NSW datasets, but since as Table 6.6 shows, only a small proportion of the cases received a 'not guilty' verdict or equivalent, this should not be a major problem.[27] Estimates are insensitive to the inclusion of 'not guilty' observations – see Appendix B for sensitivity tests.

Table 6.6

QLD court data – Observations with 'Not Guilty' verdict or equivalent[2]		
	Frequency	*Per cent*
Guilty	756,360	91.34
Not Guilty or equivalent	71,744	8.66
Total	**828,104**	**100**

Descriptive Statistics

The individuals in the dataset are predominantly male, with males the majority offenders in every individual offence category as well as the total. Table 6.7 shows that females are least well represented as offenders in sexual assaults, burglaries, prohibited weapons & explosives offences

[27] Verdicts classed as equivalent to not guilty are those where the defendant is not convicted: 'Dismissed or discharged', 'No true bill' meaning that there has been judged to be insufficient evidence for charging the defendant with a crime, 'Nolle prosequi' meaning that the prosecutor voluntarily discontinued pursuit of the case, and 'Withdrawn, not proceeded with'.

and property damage offences, where they constitute less than 10 per cent of the number of offenders. At the other end of the scale are fraud offences, where females represent almost 40 per cent of the offences.

'Traffic & vehicle regulatory offences' is overwhelmingly the largest category, followed by 'theft and related offences'. Interestingly, driving under the influence of alcohol varies in its classification. Minor cases are classed as a traffic offence, but if injury is caused or is perceived to have been likely, then it becomes a 'dangerous or negligent act endangering persons'. If someone is killed by a driver who is under the influence, then the individual is charged under 'homicide and related offences'.

Aggregate categories into which offences are divided are indicated in Table 6.7. 'Other' crimes constitute the largest category, followed by property crimes and then violent crimes. 'Robbery, extortion and related offences' is classed as both a violent crime and a property crime since it involves violence against an individual but also pecuniary gain to the offender.

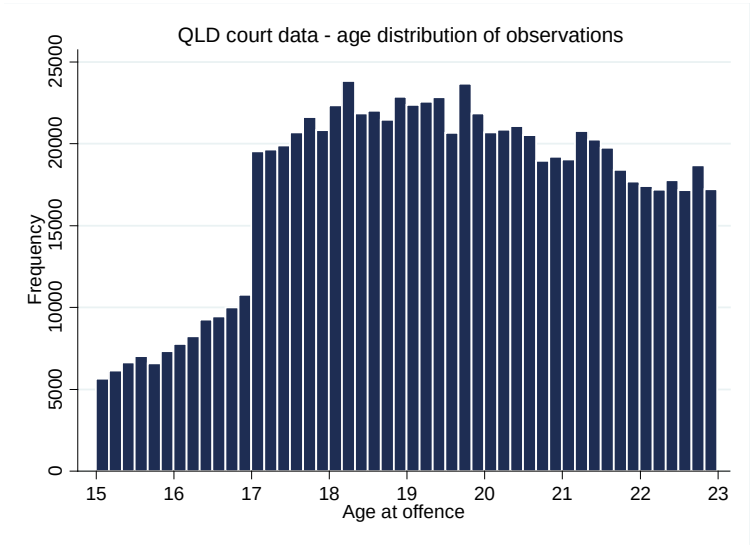
Figure 6.5 shows the distribution of observations by age.[28] The court data contains observations for individuals aged between 15 and 23 at the date of offence. The histogram shows that the offence rate seems to be rising during the teenage years to peak at around 19, when it starts to decline. The large increase at age 17 may be partially attributed to the change in justice system at this age, causing the effects discussed earlier – a substitution towards formal proceedings rather than cautions or the like, and a greater willingness to arrest suspects (causing a higher probability of an individual appearing in court conditional on being a person of interest).

[28] After deleting duplicates, as discussed above.

Table 6.7

QLD Court Data – Gender by Offence					
Aggregate category	*Offence Category (ordered by ASOC classification)*	*Male*	*Female*	*Unknown*	*Total*
Violent	Homicide And Related Offences	280	36	0	316
	Acts Intended To Cause Injury	24,004	5,887	0	29,891
	Sexual Assault And Related Offences	5,605	165	4	5,774
	Dangerous Or Negligent Acts Endangering Persons	27,731	4,416	182	32,329
	Abduction, Harassment And Other Offences Against The Person	1,386	297	0	1,683
Violent, Property	Robbery, Extortion And Related Offences	4,829	592	2	5,423
Property	Unlawful Entry With Intent/Burglary, Break And Enter	61,319	3,849	3	65,171
	Theft And Related Offences	93,423	24,478	8	117,909
	Fraud, Deception And Related Offences	27,482	17,459	51	44,992
	Illicit Drug Offences	43,098	9,257	6	52,361
Other	Prohibited And Regulated Weapons And Explosives Offences	5,326	473	1	5,800
	Property Damage And Environmental Pollution	58,323	4,565	3	62,891
	Public Order Offences	66,988	11,151	30	78,169
	Traffic And Vehicle Regulatory Offences	194,122	39,878	217	234,217
	Offences Against Justice Procedures, Government Security And Government Operations	74,217	15,555	30	89,802
	Miscellaneous Offences	1,143	230	3	1,376
Total		**689,276**	**138,288**	**540**	**828,104**

Figure 6.5



6.2.2 New South Wales

Background

The NSW crime data are police records from the NSW Computerised Operational Policing System (COPS) provided by the NSW Bureau of Crime Statistics and Research (BOCSAR). Each observation in the data corresponds to a criminal incident detected by or reported to the police.[29] The data requested was for the years 1995-2011, which contains some observations for which the offence was committed in an earlier year but the offender was only caught (and is therefore included in the data) during this time period. Using police data rather than court data has both advantages and disadvantages, which are discussed below.

There are two chief advantages of the police data. The first is sheer size – even restricting the data to individuals aged 15 to 23 at the offence date, there are still over three million observations. The second is that there won't be bias introduced (as in the court data) from systematic differences in the offences that end up in court and those that don't. The police records contain information on every offence reported to or detected by the police, regardless of how the incident is processed,

[29] The exception is for murder and manslaughter, for which there is a separate observation for each victim.

whereas the court data is inevitably restricted to include only the incidents that have been reported to police and then processed by the police to the court system.

That said, however, the crimes contained in the police data are far from the entire population. Two main reasons exist for this: under-reporting and reliance on police effectiveness.

Under-reporting is an acknowledged problem, especially for crimes such as assault, sexual assaults and robberies (BOCSAR 2012). The reasons for this could include an unwillingness to involve the police, a desire to protect the offender (domestic violence cases are particularly susceptible to this), or a fear of further victimisation if the incident is reported. Although this will decrease the precision of estimates by reducing the available data, it should not threaten the methodology so long as there is no change at 18 in the probability of an incident being reported. An argument could be made, however, that this might exist – with reference to the victim's desire to protect the offender, the knowledge that the offender will be tried as an adult (and hence be more likely to receive a harsh sentence) may discourage reporting. This seems unlikely, but if it is a real phenomenon it will attenuate the estimates towards zero. Carpenter & Dobkin (2010) discuss a similar possibility – incidents occurring in public locations (e.g. near bars, etc.) may have a higher probability of being reported. If the same number of crimes was committed but the individuals involved were more likely to be present in locations such as bars and nightclubs, this would lead to a false discontinuity in the data. That is, the increase would not be due to more crimes being committed but rather to a greater number of crimes being reported.

Certain offences (drug offences, drink driving, offensive behaviour and receiving stolen goods) are not typically reported by civilians but only identified as a result of police action. This means that differences in police effectiveness and activity levels between locations and also between periods will affect the rates of these crimes. It may be the case that the police deliberately avoid locations frequented by minors and concentrate on adult offenders instead, but again, this seems unlikely. So long as there is no discontinuity in police presence or effectiveness in detecting offenders at 18 years old, estimates should not be affected by this factor.

The data are divided into criminal incidents. A single incident has the same: offender; victims(s); location; uninterrupted time period;[30] offence category; and incident type[31] (except for murder and manslaughter, where each individual victim is assigned a unique incident). This means that although most individuals in the dataset have only one associated incident, there is a very long, narrow tail of observations with one individual committing multiple offences. As per QLD, the data is collapsed into a new dataset where the unit of analysis is an individual offender on a given date, with binary indicators for each category of crime committed.

Incidents dealt with by the police are processed in one of three ways – either the incident is not proceeded against (the case is dropped, essentially), proceeded against informally (e.g. a caution, warning or infringement notice), or proceeded against formally in court. Figure 6.6 shows the split between these three categories within age groups. The key message from this figure is that incidents are more likely to end up in court for offenders over 18 years old, and that the prevalence of incidents not proceeded against drops steadily from the age of 15 until reaching the lowest point at 19.

As for QLD, individuals are included in the dataset who are aged between 15 and 23 *at the date of offence*. For the NSW data, offences are observed between 1949 and 2011. Figure 6.7 shows the majority of offence dates are from after 2000, and almost occur between 1995 and 2011, the period for which the data were requested. The increase in observations in 2001 is due to a change in police recording practices. Prior to this year, infringement notices (often issued for driving and vehicle offences) were not included in the COPS records. The small number of observations from years prior to 1995 should not pose a problem since the MLDA has been 18 years in NSW since 1906 (Liquor Amendment Act 1905).

[30] The data only contain a variable indicating the date when the offence began. The small number of incidents spanning multiple dates will therefore be treated as occurring on the date they began.
[31] Incident type indicates whether the act was carried out (‘actual’), attempted or merely planned (‘conspiracy’).

Figure 6.6

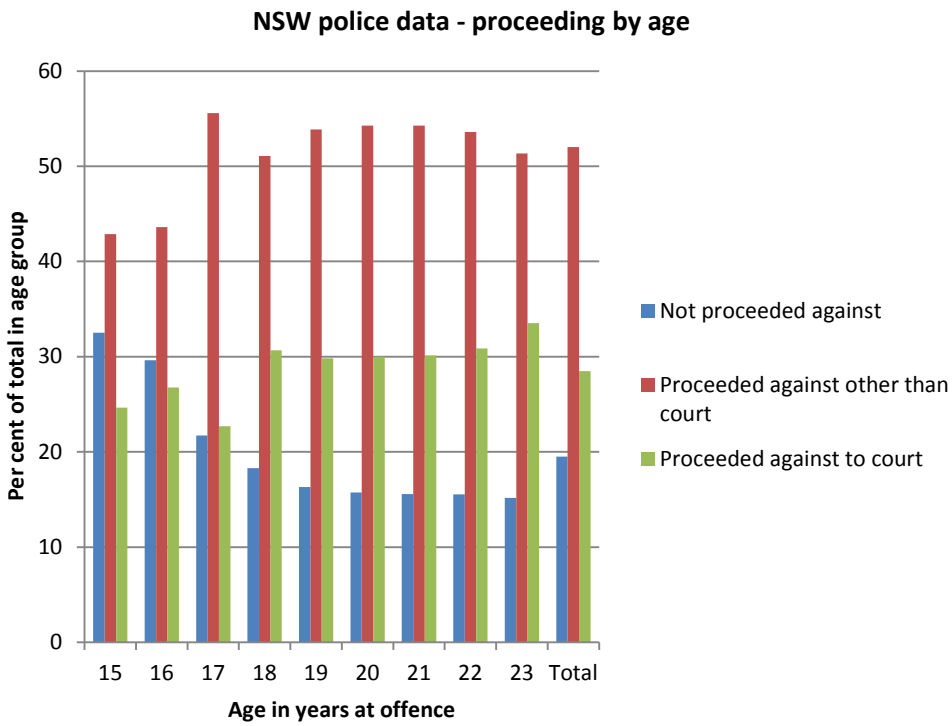
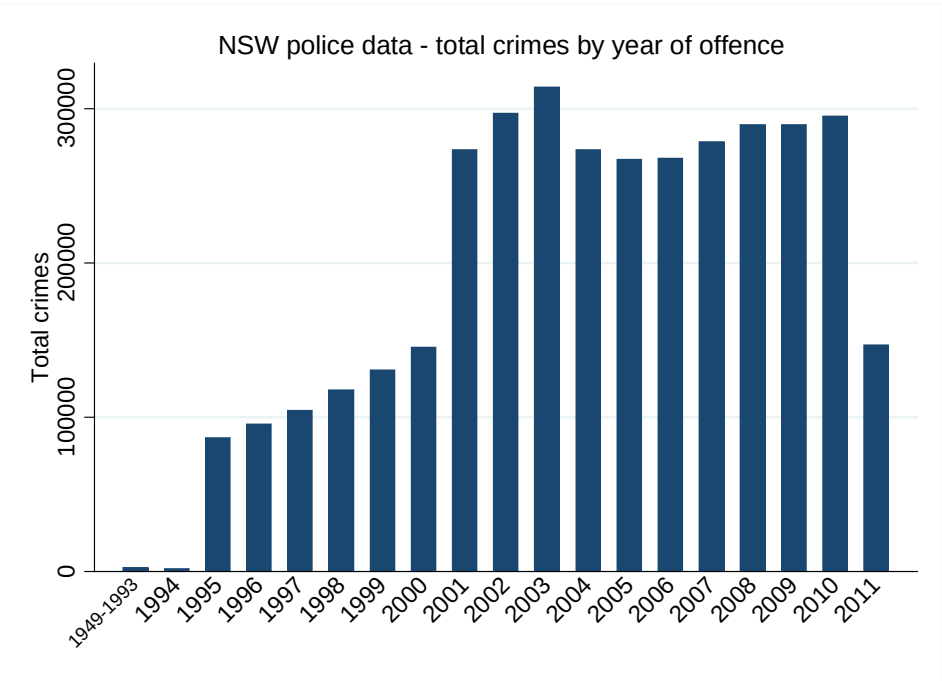


Figure 6.7



Descriptive Statistics

Table 6.8 outlines the distribution of offences in the whole sample. Driving offences constitute the largest category, accounting for 47 per cent of total offences. Theft is the next largest category, followed by assault and transport regulatory offences. The aggregate category into which each offence fits is indicated, with the 'other' category constituting the largest category after driving offences. Driving offences are assigned their own aggregate category in the NSW data due to the proportion of the data they represent; driving offences would completely dominate the results from any aggregate category in which they were included.

Males outnumber females both overall and in each individual offence category. The difference between the sexes is most pronounced in the 'Sexual Offences' category, where females are responsible for less than 4 per cent of the total. The 'Betting and Gaming Offences' and 'Prostitution Offences' categories contain the highest proportion of female offenders.

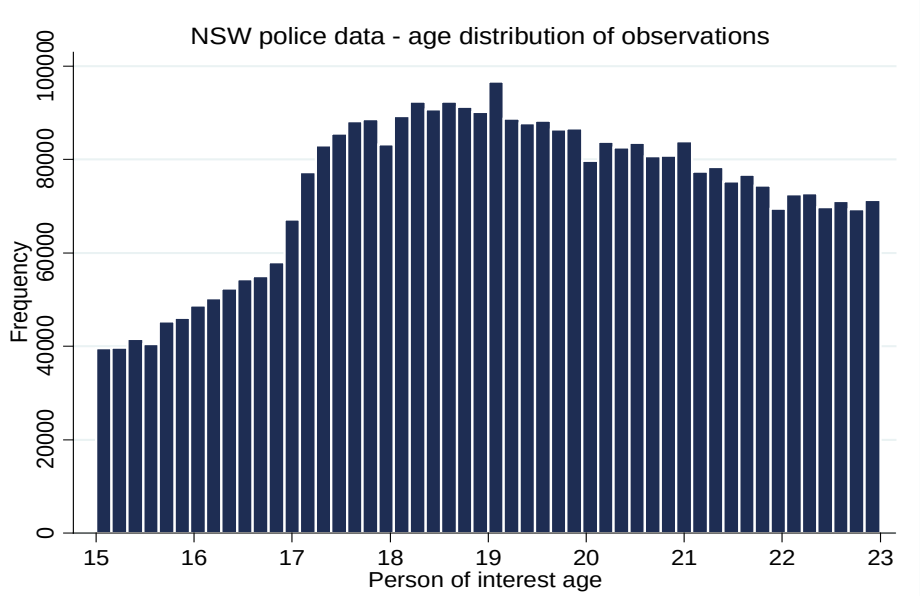
Like QLD, the NSW offence categories are based on the Australian Standard Offence Classification (ABS 2008) system, with one key difference. QLD's 'Public Order Offences' category contains three subcategories: disorderly conduct, offensive conduct, and regulated public order offences. The third of these includes betting and gaming offences, liquor offences, and prostitution offences, all of which have their own dedicated subcategories in the NSW data. The NSW category 'Disorderly conduct' is therefore treated as analogous to the QLD 'Public order offences' category from here on.

Figure 6.8 shows the age distribution of total crimes in NSW. There is no obvious discontinuity at age 18, suggesting that disaggregation will be necessary to identify any effects of the MLDA. There is some evidence of a discontinuity and change in trajectory at age 17. This is attributable to the provisional driving regulations in NSW – 17 is the earliest that individuals may receive their first provisional driver's licence. Driving offences constitute a large proportion of the data, and as more young people are legally allowed to drive unsupervised, the amount of driving offences will rise.

Table 6.8

NSW police data – Offence category frequencies by gender					
Aggregate category	*Offence Category*	*Female*	*Male*	*Unknown*	*Total*
Violent	Homicide	139	1,276	1	1,416
	Assault	58,555	205,034	73	263,662
	Sexual offences	631	18,508	7	19,146
	Pornography offences	29	244	0	273
	Other offences against the person	661	2,976	3	3,640
	Harassment, threatening behaviour and private nuisance	14,397	46,218	9	60,624
	Abduction and kidnapping	195	1,386	0	1,581
Violent & Property	Robbery	3,987	33,187	6	37,180
Property	Blackmail and extortion	23	208	0	231
	Theft	110,927	384,191	230	495,348
	Drug offences	18,859	109,243	68	128,170
Other	Prohibited and regulated weapons offences	2,808	35,234	11	38,053
	Arson	471	4,952	0	5,423
	Malicious damage to property	21,809	142,544	42	164,395
	Disorderly conduct	24,276	143,433	61	167,770
	Betting and gaming offences	64	119	0	183
	Liquor offences	21,856	72,949	39	94,844
	Prostitution offences	839	1,829	2	2,670
	Against justice procedures	25,351	136,734	42	162,127
	Transport regulatory offences	52,907	170,014	119	223,040
	Other offences	11,044	55,381	31	66,456
Driving and Vehicle	Driving offences	354,084	1,385,129	2,160	1,741,373
Total		**723,912**	**2,950,789**	**2,904**	**3,677,605**

Figure 6.8



6.2.3 Conversion to person years

Since the crime data covering multiple years are collapsed into a cross-sectional dataset, a naïve comparison of criminal incidents will be inflated both by the size of the population and the length of the sample. To avoid this issue and therefore provide estimates that will be comparable across sub-groups (i.e. NSW and QLD), the dependent variable used is *crimes per 10,000 person years*.[32] The individual's 18th birthday date was subtracted from the incident date to measure when the crime was committed relative to the MLDA.

This is calculated as follows:

$$\frac{\text{(number of crimes per day) x (days in a year) x (desired denominator)}}{\text{(number of years in sample) x (average population aged 18 across sample period)}}$$

$$= \frac{\text{(number of crimes per day) x (365) x (10,000)}}{\text{(T) x } (P_{18})}$$

where T (number of years in the sample) is 17 for NSW and 5.5 for QLD, and P_{18} (the average population aged 18 across the sample period)[33] is 45,427 for NSW and 29,124 for QLD (ABS 2012b).

[32] Although typically used in epidemiological research, crimes per *X* person years has been used in crime estimates previously (e.g. Carpenter & Dobkin 2010).

[33] Average population aged 18 is used because this is the age for which the causal effect is to be estimated. It would be equally valid to use the population aged 17, but there is very little difference between the two.

7 Results

"2 is not equal to 3, not even for large values of 2." – Grabel's Law

This chapter presents the results of MLDA effects on alcohol consumption and crime, including discussion of sensitivity to various parameters. The first section covers results for alcohol consumption. The crime results from QLD and NSW are reviewed in the second and third sections, respectively.

7.1 Alcohol Consumption

The two measures of alcohol consumption from the HILDA survey are whether an individual reports ever having drunk alcohol, and their drinking frequency. Individuals who report consuming alcohol at least weekly are designated 'frequent' drinkers. The estimates in Table 7.1 indicate that in QLD, using a two-year bandwidth, passing the MLDA is associated with an 11.6 percentage-point increase in the proportion of individuals who report ever drinking alcohol and an increase of 14.7 percentage points in the proportion of individuals who are frequent drinkers. In NSW, passing the MLDA is associated with a 14.6 percentage-point increase in the proportion of individuals who report ever drinking alcohol and an increase of 22.9 percentage points in the proportion of individuals who are frequent drinkers. Figures 7.1 & 7.2 demonstrate these results graphically, showing a clear discontinuity in the fitted lines at 18 years.

Table 7.1

HILDA data – estimates of discontinuities in alcohol consumption variables (two-year bandwidth)			
State	*Variable*	*Discontinuity estimate*	*Standard error*
QLD	Ever drinking	0.0762**	0.0377
	Drinking weekly	0.1332***	0.0452
NSW	Ever drinking	0.1457***	0.0348
	Drinking weekly	0.2290***	0.0377

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively.

Figure 7.1

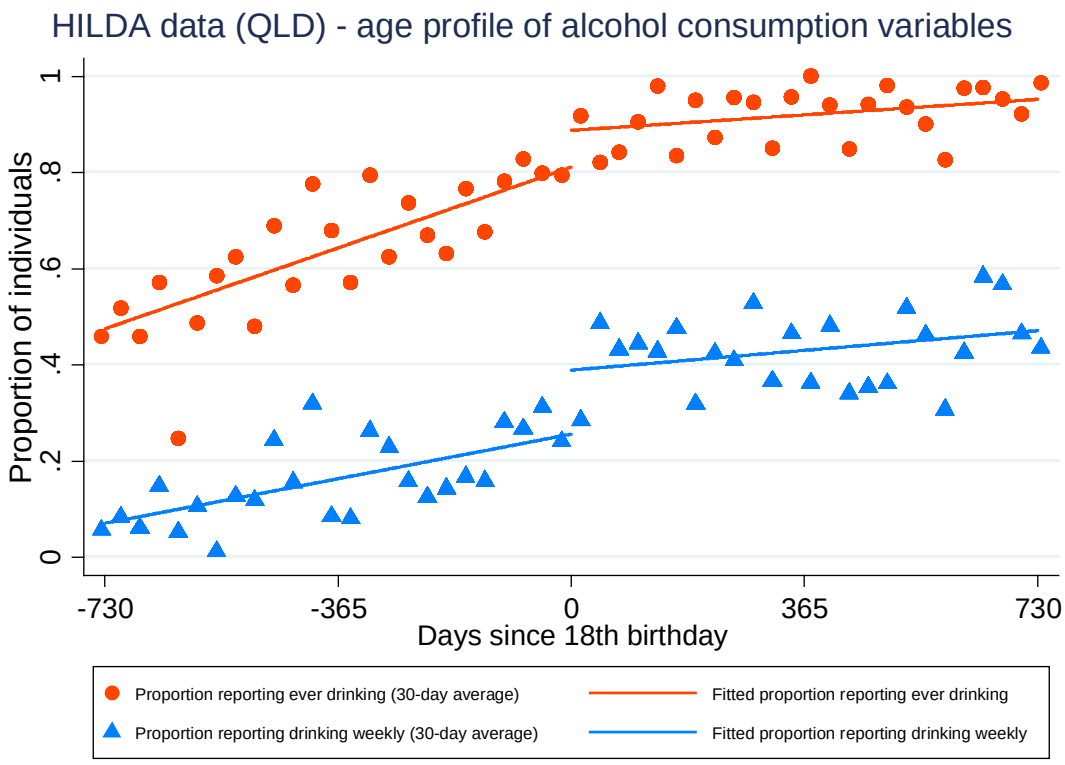
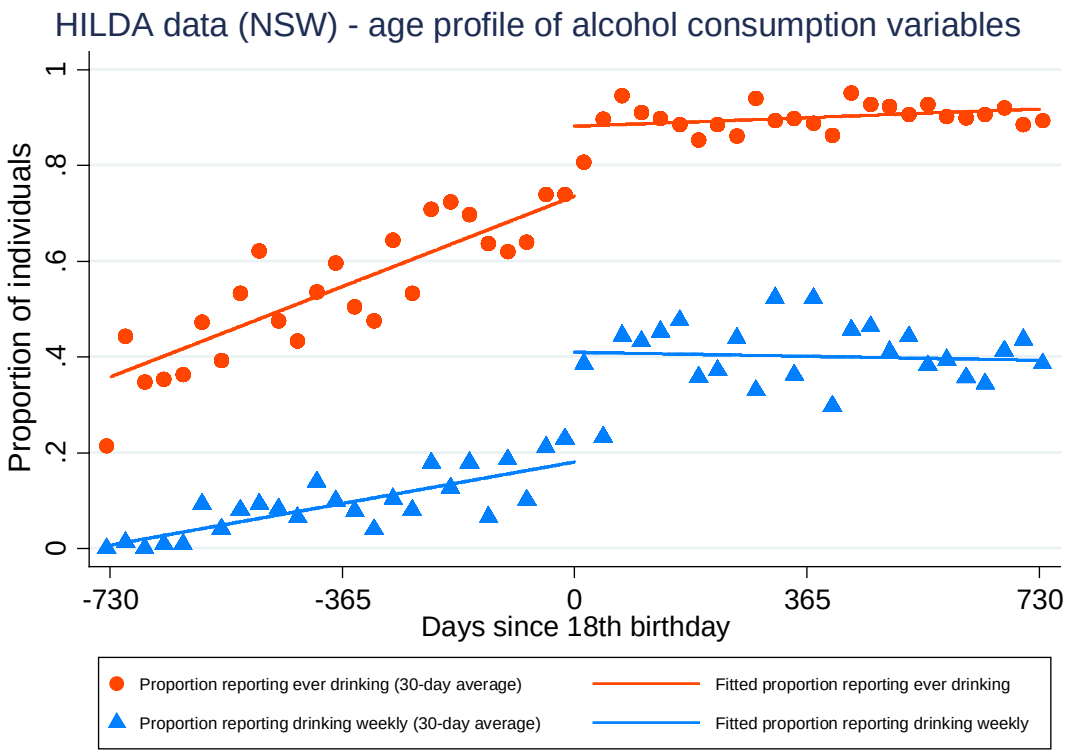


Figure 7.2



7.1.1 Sensitivity Tests

Chapter 5 outlined the key validity checks for RD estimation, which involve checking the estimates' sensitivity to: bandwidth, donut size, and covariate inclusion.

The estimates for both alcohol consumption variables remain stable for bandwidths between 1.5 and 3 years in both states. Discontinuity estimates are significant at the 5% level for both dependent variables in NSW and for weekly alcohol consumption in QLD. The discontinuity in the proportion of individuals reporting ever having consumed alcohol is insignificant at the 5% level for a large range of bandwidths. This suggests that the null hypothesis of no change at the MLDA in the proportion of QLD youths who have ever drunk alcohol cannot be rejected.

The estimates for all four variables are fairly insensitive to donut size, with some fluctuations (+/- 2 percentage points) around the reported values.

Including covariates decreased the estimated discontinuities slightly. The estimates fell by between 0.1 and 1.2 percentage points, indicating that the choice of a two-year bandwidth may have biased the estimates slightly upwards.[34]

Complete results from these sensitivity tests may be found in Appendix A.

7.1.2 Testing Hypotheses 1 and 1a

The results support Hypothesis 1, as both measures of alcohol consumption rise in NSW at the MLDA and weekly alcohol consumption rises in QLD. The point estimate for the increase in the proportion of individuals who had ever drunk alcohol in QLD is positive and significant at the 5% level, but sensitivity analysis revealed that this is highly dependent on the bandwidth chosen. In part, this may be due to a smaller sample size.

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[34] See the discussion in Chapter 5 on this sensitivity test.

Notwithstanding the influence of the sample size, this result is also evidence for Hypothesis 1a: that alcohol consumption will increase at the MLDA by a greater amount in NSW than in QLD. This prediction stems from the assertion that underage individuals face higher implicit costs in obtaining alcohol than those past the MLDA. Harsher penalties for the supply of alcohol to minors in NSW than in QLD coupled with more rigorous police campaigns suggest that implicit costs of alcohol access for minors are higher in NSW. Thus these results confirm Hypothesis 1a, but weaknesses in the data mean that further work is needed.

It is interesting to note the difference between the discontinuities in the two measures of alcohol consumption. The proportion of individuals who report drinking weekly increases approximately 50 per cent in QLD and more than 100 per cent in NSW. The proportion who report ever drinking alcohol, on the other hand, increases by approximately 20 per cent in NSW and 8 per cent in QLD, although the latter is only marginally significant and is sensitive to bandwidth choice. This indicates that the increase in alcohol consumption at the MLDA is driven far more by individuals who increase their drinking frequency rather than by individuals who have their first experience with alcohol. This fits with Hypothesis 1 – suppose the costs of obtaining alcohol are not fixed but follow some distribution, but that underage individuals still face higher costs on average.[35] A large number of individuals are likely to have encountered at least one situation with low costs of alcohol access, thus facilitating a potential first experience with alcohol. For individuals who choose to drink weekly, however, the variation in alcohol access costs will be reduced due to the frequency of their consumption; they will face the average price over the long run. The average price decreases suddenly at the MLDA (due to the decrease in implicit costs of access), therefore facilitating more frequent drinking behaviour.

[35] For example, there will be situations in which alcohol access is free for the individual, such as at a party, and situations in which it is more costly than usual, such as travelling in a remote location with few alcohol vendors.

7.2 Crime

The crime results are discussed below, first for QLD and then NSW. Discontinuity estimates in aggregate crime categories are presented, followed by estimates for individual categories. A consideration of sensitivity tests follows, and a discussion of the results concludes the section.

7.2.1 QLD

As an initial indicator, discontinuities in aggregate categories of crime are considered. Table 7.2 provides the estimated change associated with passing the MLDA: violent crimes increase by a non-significant 20 crimes per 10,000 person years, property crimes *decrease* by 44 (significant only at the 10% level), 'other' crimes increase by 365, and total crimes increase by 339.[36] Figure 7.3 illustrates the discontinuities.

Table 7.2

QLD court data – estimates of discontinuities in crime rates per 10,000 person years (one-year bandwidth)		
Aggregate category	*Discontinuity estimate*	*Standard error*
Violent crime	19.66	15.02
Property crime	-43.65*	25.90
Other crime	365.35***	50.87
Total crime	339.36***	65.31

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. The crime categories are as follows: violent crimes are those with an Australian Standard Offence Classification (ABS 2008) code between 1000 & 6999; property crimes are those with an ASOC code between 6000 & 10999; other crimes are those with an ASOC code 11000 and above; and the total crime category includes all crimes.

[36] An explanation for the meaning and calculation of crimes per 10,000 person years can be found in Chapter 6.

Figure 7.3

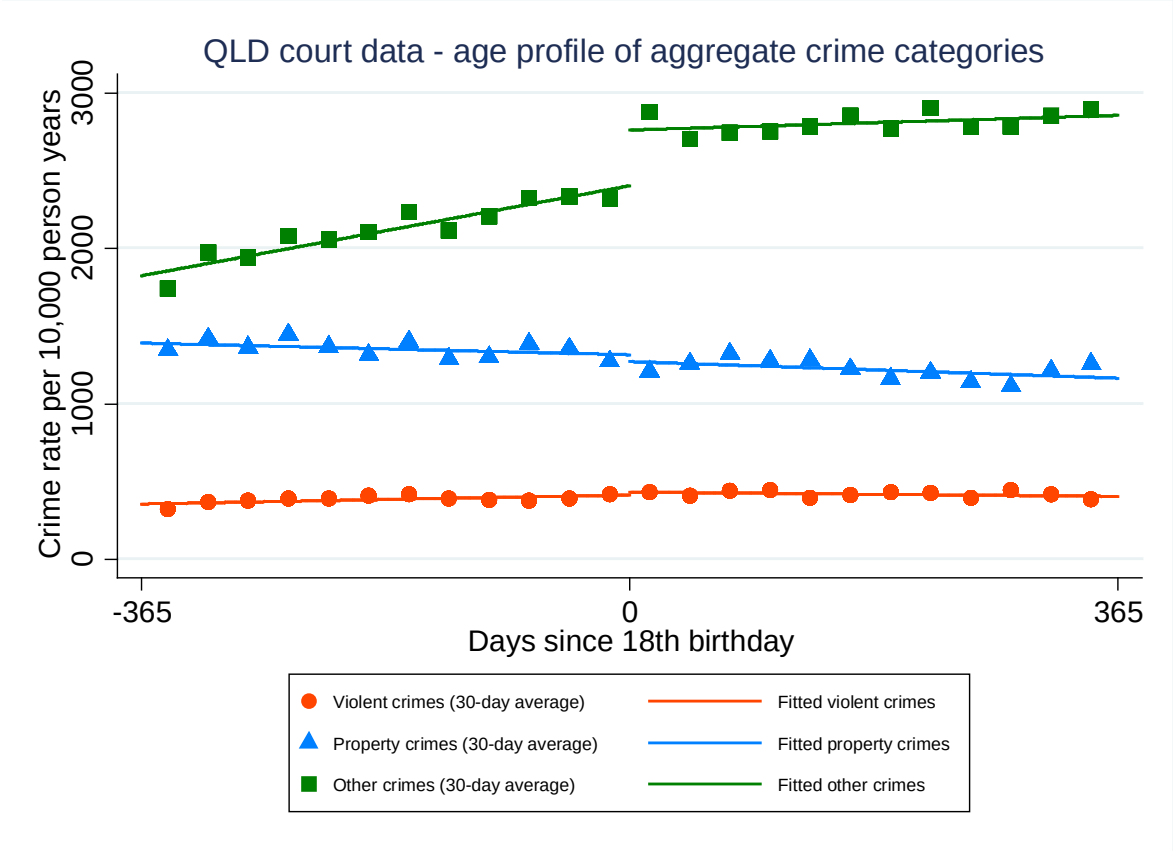


Table 7.3 gives the estimates for individual crime categories, with discontinuities that are significant and greater than 2 crimes per 10,000 person years in magnitude in bold. Although the violent crime aggregate category shows no significant increase, an examination of specific categories reveals that 'acts intended to cause injury' increase by 23.8 crimes per 10,000 person years at the MLDA. Within the 'other' crime category, there is an increase of (per 10,000 person years): 268.1 public order offences, 60.2 traffic and vehicle regulatory offences, and 42.8 offences against justice procedures and government. Figures 7.4 and 7.5 illustrate these results.

Table 7.3

QLD court data - estimates of discontinuities in crime rates per 10,000 person years (one-year bandwidth)		
Offence category	*Discontinuity estimate*	*Standard error*
Homicide and Related Offences	-0.74	0.59
Acts Intended To Cause Injury	**23.79****	**9.68**
Sexual Assault and Related Offences	-2.03	3.18
Dangerous or Negligent Acts Endangering Persons	-1.84	9.97
Abduction Harassment and Other Offences	-1.52	1.92
Robbery Extortion and Related Offences	2.00	3.35
Unlawful Entry With Intent, Burglary, Break and Entering	-21.82*	11.64
Theft and Related Offences	-20.02	16.86
Fraud, Deception and Related Offences	-7.74	8.22
Illicit Drug Offences	3.93	11.09
Prohibited and Regulated Weapons and Explosives Offences	-0.96	5.29
Property Damage and Environmental Pollution	-2.37	11.57
Public Order Offences	**268.11*****	**28.44**
Traffic and Vehicle Regulatory Offences	**60.19*****	**20.55**
Offences Against Justice Procedures, Government Security and Government Operations	**42.81****	**20.18**
Miscellaneous Offences	-2.43	1.89

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. Offences are ordered according to their Australian Standard Offence Classification (ABS 2008) classification. Offence categories with discontinuities significant at the 5% level that are greater than 2 crimes per 10,000 person years in magnitude appear in bold.

Figure 7.4

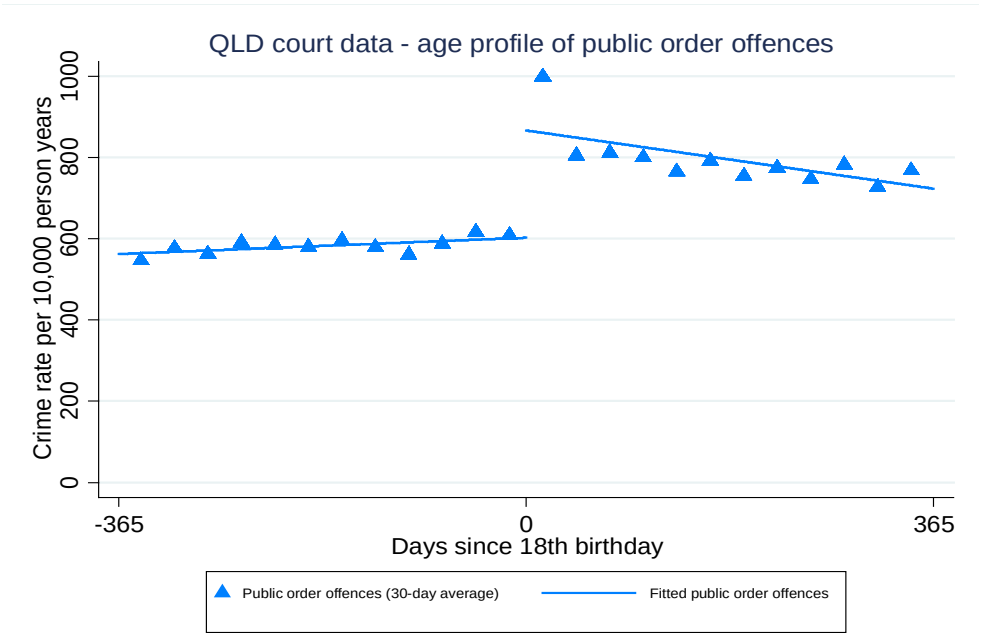
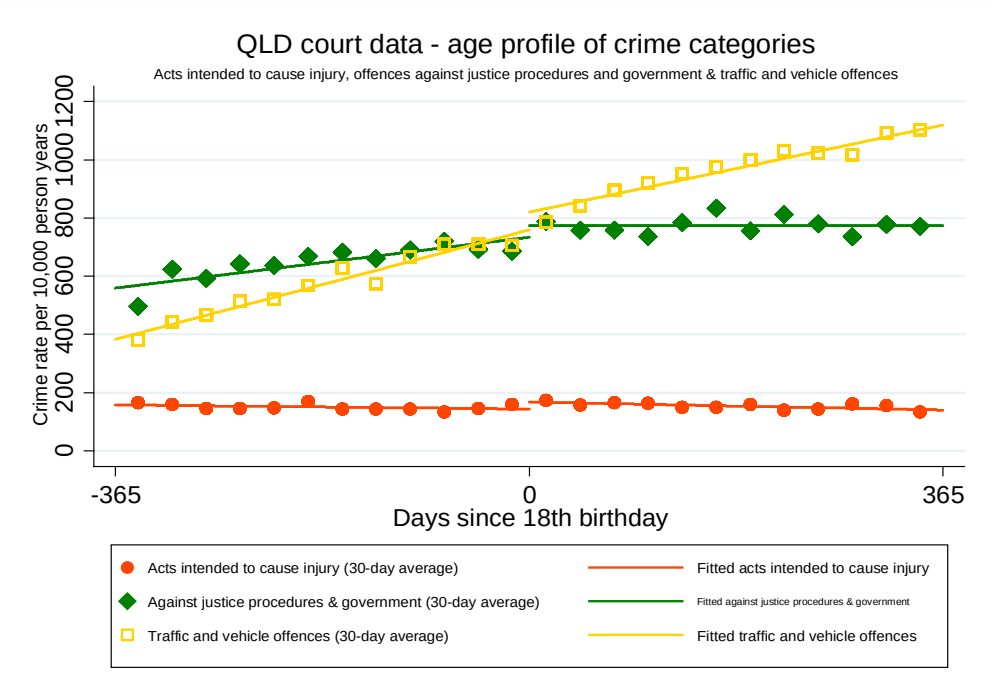


Figure 7.5



Using the costs of per reported crime estimated by Byrnes et al. (2012), the results can be translated into dollar terms. Each reported public order offence[37] has an expected cost of $3004,[38] yielding a total social cost of increased crime due to passing the MLDA of $805,402 per 10,000 person years.[39] Multiplying this by a factor of 3.1529 to match the current population of 18-year-olds in QLD[40] gives a total cost of increased crime in QLD due to the MLDA of $2,539,352.

Sensitivity Tests[41]

Of the four categories displaying significant discontinuities at the MLDA, only the 'public order offences' category remains significant across all bandwidths from 30 days to one year. The estimated discontinuities for 'acts intended to cause injury' and 'traffic and vehicle offences' are

[37] The authors estimate costs for 'disorderly conduct offences', but these are analogous to public order offences – see Chapter 6 for a discussion of this point.
[38] In 2006 dollars – this figure could be adjusted for inflation to yield a cost in 2013 dollars, but the difference in the results will be negligible given the short time period.
[39] This is a lower bound on the cost, since it only accounts for the increase in public order offences – as the other crime categories are sensitive to bandwidth choice, these are excluded.
[40] The population of 18-year-olds in QLD was 31,529 in June 2012 according to ABS (2013) estimates.
[41] No test for the inclusion of covariates is performed as the crime data do not include covariates.

significant at the 5% level only at the end of this bandwidth range, and the estimate for 'offences against justice procedures, government security and government operations' is significant for subsets of this range.

The inclusion of a zero-day donut (that is, excluding the 18th birthday) decreases three of the estimates by a small amount (between 1.2 and 3.4 per cent), except for 'offences against justice procedures, government security and government operations' which is reduced by 6.4 per cent and remains barely significant at the 5% level. If a five-day donut is used instead, the 'offences against justice procedures, government security and government operations' discontinuity becomes insignificant, the 'public order offences' and 'acts intended to cause injury' discontinuities both decrease by approximately 16 per cent, and 'traffic and vehicle offences' discontinuity remains stable.

The outcome from the sensitivity tests indicates that of the four crime categories exhibiting significant discontinuities, only the increase in 'public order offences' can be considered a reliable estimate. The sizable decrease in the point estimate when including zero- and five-day donuts indicates that part of the increase is attributable to a 'celebration effect' – a temporary change in behaviour in the vicinity of the 18th birthday. To what extent this effect is common to all birthdays is unclear, but it may be that the transition to adulthood is particularly affected.[42] Future research using US data comparing changes in the crime rate at 18 (the age of majority for most aspects of life such as voting and army service) and 21 (the MLDA) would shed light on this question.

Complete results from these sensitivity tests may be found in Appendix B.

[42] Carrell et al. (2011) test for birthday effects at age 20 and 22 in their RD study estimating the effects of the MLDA on university results in the US, finding minimal evidence for effects at 20 years and none for 22.

Testing Hypotheses 2 and 4

Hypothesis 2: All crimes will increase in QLD at the minimum legal drinking age (18).

Hypothesis 4: Violent and nuisance crimes will increase in QLD and NSW at the minimum legal drinking age due to a combination of greater alcohol consumption and riskier location choice, on average.

The absence of any increase in the majority of crime categories at the MLDA is evidence against Hypothesis 2. In particular, no significant increase was found for any property crime category, and 'unlawful entry with intent, burglary, break and entering' decreases by 22 crimes per 10,000 person years (significant at the 10% level). In contrast, the evidence supports Hypothesis 4. Nuisance crimes, represented by the 'public order offences' category, certainly increase at the MLDA, and although 'acts intended to cause injury' is the only violent crime category that shows an increase, this could be due to data paucity.[43]

7.2.2 NSW

Table 7.4 shows the estimated discontinuities in aggregate crime categories for NSW using a one-year bandwidth. After passing the MLDA, violent crimes increase by 27 crimes per 10,000 person years, property crimes increase by an insignificant 12 crimes per 10,000 person years, other crimes decrease by 146 crimes per 10,000 person years, driving and vehicle offences decrease by 98 crimes per 10,000 person years, and total crimes decrease by 201 crimes per 10,000 person years. Figure 7.6 illustrates these results, clearly demonstrating that the estimated discontinuity in the 'driving and vehicle offences' category is due to a functional form misspecification.[44]

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[43] The 'dangerous or negligent acts endangering persons' category constitutes 3.9 per cent of all offences in QLD, and none of the other categories constitutes more than 0.7 per cent individually.

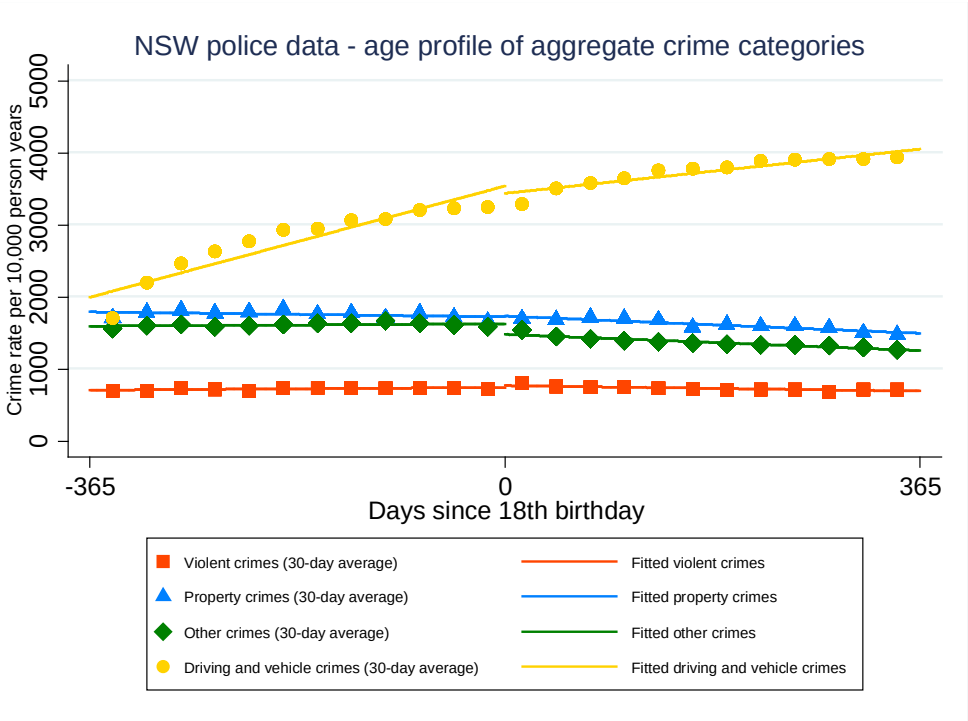
[44] The non-linearity in this category is attributable to the change in access to provisional drivers' licences occurring at 17 in QLD.

Table 7.4

NSW police data - estimates of discontinuities in crime rates per 10,000 person years (one-year bandwidth)		
Aggregate category	*Discontinuity estimate*	*Standard error*
Violent	27.02**	13.01
Property	12.09	20.30
Other	-146.17***	20.80
Driving and vehicle	-98.54***	33.54
Total	-201.45***	55.05

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively.

Figure 7.6



Disaggregating into individual crime categories provides a more complete indication of the change in crime at 18 years. Table 7.5 shows discontinuity estimates for individual crime categories, with discontinuities that are significant and greater than 2 crimes per 10,000 person years in magnitude in bold.[45] The decrease in the 'other' aggregate category is almost completely caused by liquor offences, which decrease by 248.5 crimes per 10,000 person years at the MLDA.[46] Weapons offences and arson also decrease at the MLDA threshold, but these account for a very small

[45] Except for driving offences, since they have already been considered above.
[46] This is consistent with the institutional change, since for individuals aged 18 and over possession or consumption of alcohol is no longer illegal.

proportion of all crimes (~1% together). The increase in violent crimes is almost entirely caused by assaults, which increase by 27.3 per 10,000 person years. Three remaining categories also increase at the MLDA (in per 10,000 person year terms): disorderly conduct increases by 72, drug offences by 16, and transport regulatory offences by 22. Figures 7.7 and 7.8 illustrate these results.

Table 7.5

NSW police data - estimates of discontinuities in crime rates per 10,000 person years (one-year bandwidth)		
Offence category	*Discontinuity estimate*	*Standard error*
Homicide	0.16	0.53
Assault	**27.30*** **	**9.83**
Sexual offences	2.99	2.14
Pornography offences	-0.01	0.22
Other offences against the person	1.68*	0.90
Harassment threatening behaviour and private nuisance	-0.76	4.05
Abduction and kidnapping	-0.17	0.59
Robbery	-4.16	3.20
Blackmail and extortion	0.01	0.20
Theft	1.91	13.46
Drug offences	**15.93*** **	**5.65**
Prohibited and regulated weapons offences	-6.22*	3.21
Arson	**-2.61** **	**1.19**
Malicious damage to property	7.23	10.89
Public order offences	**72.05*** **	**8.46**
Betting and gaming offences	-0.71***	0.24
Liquor offences	**-248.51*** **	**8.30**
Prostitution offences	-0.55	0.80
Driving offences	-98.54***	33.54
Against justice procedures	10.20	6.49
Transport regulatory offences	**22.20*** **	**7.74**
Other offences	-0.84	4.19

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. Offences are ordered according to their Australian Standard Offence Classification (ABS 2008) classification. Offence categories with discontinuities significant at the 5% level that are greater than 2 crimes per 10,000 person years in magnitude appear in bold, except for driving offences.

Figure 7.7

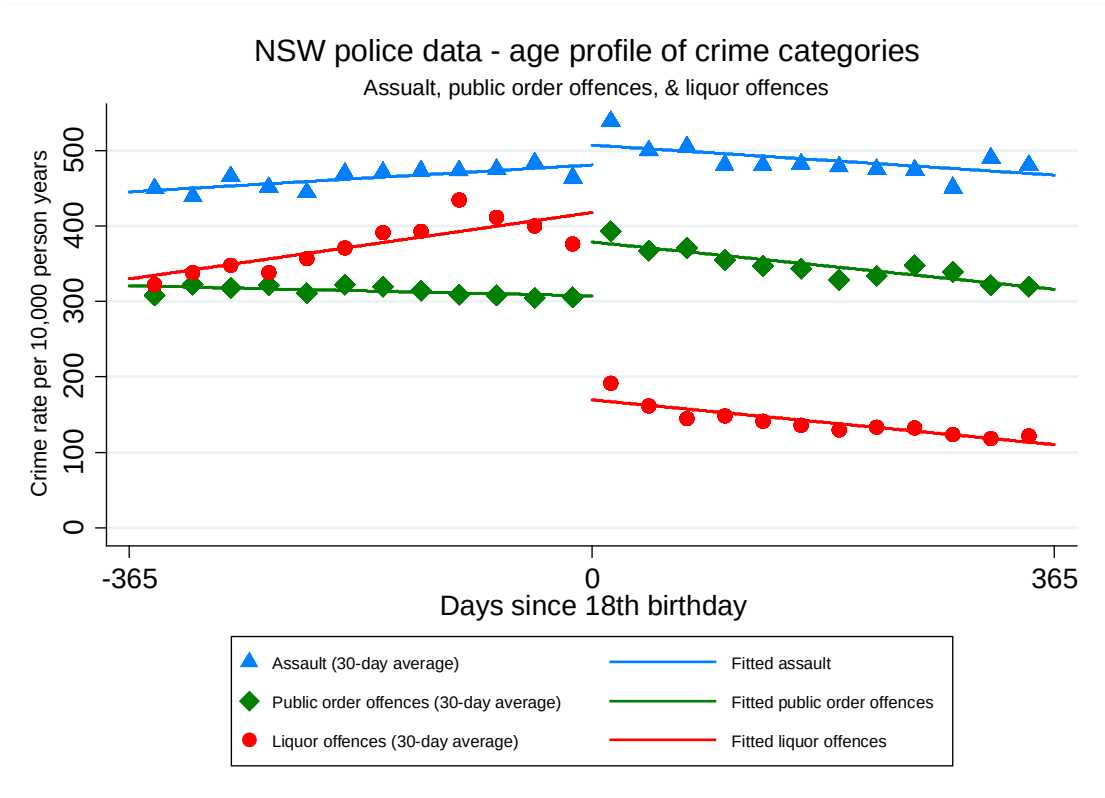
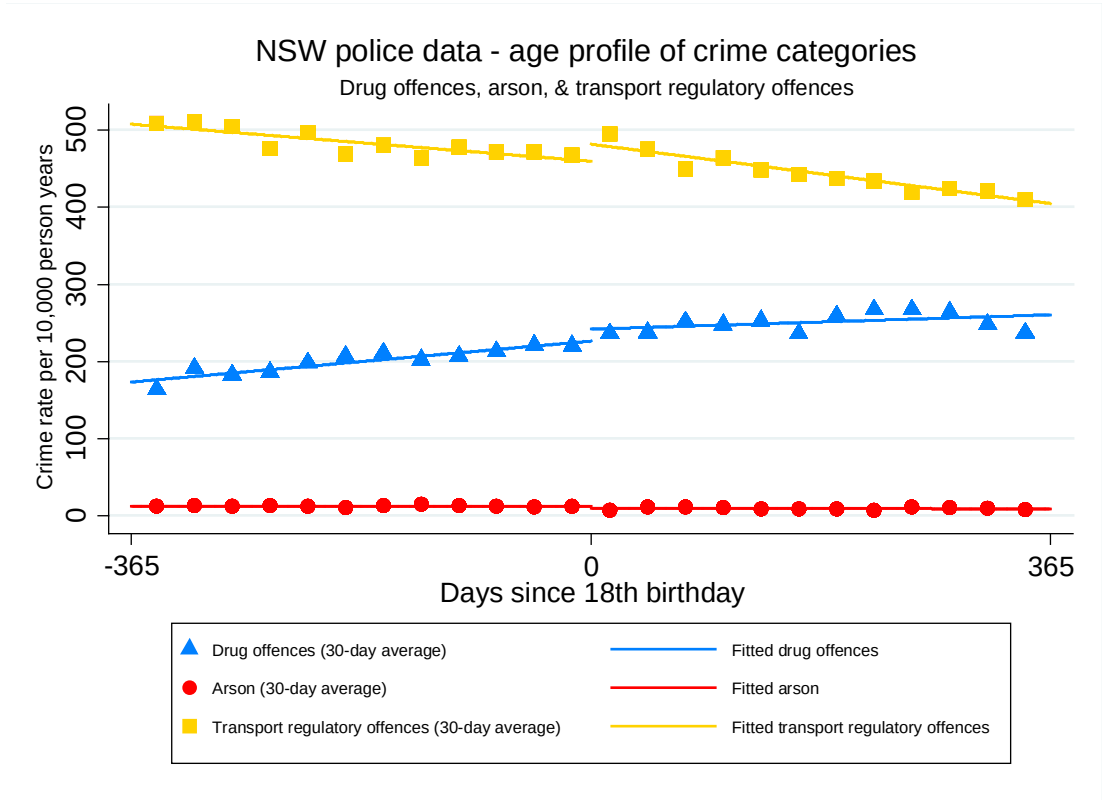


Figure 7.8



Using the costs of per reported crime estimated by Byrnes et al. (2012), the results can be translated into dollar terms. Each reported public order offence has an expected cost of $3004 and each assault has an expected cost of $14,254,[47] yielding a total social cost of increased crime due to passing the MLDA of $605,572 per 10,000 person years. Multiplying this by a factor of 4.798 to match the current population of 18-year-olds in NSW[48] gives a total cost of increased crime in NSW due to the MLDA of $2,900,084.

Sensitivity Tests[49]

Estimated discontinuities for the 'assault' and 'public order offences' categories remain fairly stable and significant at the 5% level for bandwidth choices between 30 days and one year. The estimated discontinuity for assaults declines as the bandwidth increases, indicating that the point estimate obtained using a one year bandwidth is conservative. The discontinuity in liquor offences increases with bandwidth radius and is significant over the whole range, but the other three categories considered above are quite sensitive to bandwidth, ceasing to be significant at the 5% level for large subsets of the bandwidth range.

Including a zero-day donut decreases the estimated discontinuity in assaults by 20 per cent and in public order offences by 6 per cent, and a five-day donut decreases the estimated discontinuities by 36 and 13 per cent respectively. At donut sizes larger than five days, the discontinuity in assaults ceases to be significant at the 5% level, but the estimated discontinuity in public order offences remains significant. The magnitude of the estimated decrease in liquor offences increases as the donut size grows, by 2 per cent after incorporating a zero-day donut and 4 per cent incorporating a five-day donut.

[47] In 2006 dollars – this figure could be adjusted for inflation to yield a cost in 2013 dollars, but the difference in the results will be negligible given the time period.
[48] The population of 18-year-olds in NSW was 47,980 in June 2012 according to ABS (2013) estimates.
[49] No test for the inclusion of covariates is performed as the crime data do not include covariates.

As for QLD, the inclusion of donuts reveals that the increase in crimes in NSW at the MLDA is partly attributable to 'celebration effects'. Indeed, these effects may completely cause the increase in assaults, since the estimated discontinuity for this category becomes insignificant when donuts greater than five days are included. In contrast, the 'public order offences' category is fairly insensitive to donut size, indicating that although some celebration effects may be occurring, the MLDA causes a more permanent change in behaviour for these crimes.

Complete results from these sensitivity tests may be found in Appendix B.

Testing Hypotheses 3a, 3b and 4

Hypothesis 3a: All crimes will increase in NSW at the minimum legal drinking age (18) due to the alcohol consumption effect dominating the deterrence effect.

Hypothesis 3b: All crimes will decrease in NSW at the minimum legal drinking age (18) due to the deterrence effect dominating the alcohol consumption effect.

Hypothesis 4: Violent and nuisance crimes will increase in QLD and NSW at the minimum legal drinking age due to a combination of greater alcohol consumption and riskier location choice, on average.

The NSW results also provide evidence against Hypotheses 3a and 3b: the majority of crime categories displayed no increase at the MLDA. If either hypothesis were correct, then for each of these categories the deterrence effect from the change in justice system must cancel out the increase due to alcohol. The prediction that all crimes will increase at the MLDA due to increased alcohol consumption does not fit the evidence, as it is unlikely that the deterrence effect from the justice system was responsible for the lack of change in most categories. In particular, the QLD results suggest that property crimes are not influenced by the MLDA itself, meaning that the deterrence effect alone should be operating, causing a decrease in property crime categories in

NSW. This does not occur, however. One category of property crimes, ‘drug offences’, did increase, but bandwidth sensitivity tests suggest that this is unreliable.

The results provide reasonable confirmation for Hypothesis 4, on the other hand. Positive discontinuities were estimated for public order offences and assaults, fitting the prediction that violent and nuisance crimes would increase at the MLDA. Stronger support for this hypothesis would exist if more violent crime categories increased at the threshold, but again the absence of effects may simply be due to the small sample of crimes in these categories.

8 Discussion and Conclusion

"There's no hurry anymore when all is said and done." – ABBA

8.1 Thesis Objectives

This thesis had three main objectives: (i) to provide a new theory to better account for the influence of legal access to alcohol on crime; (ii) to provide the first estimates of the effect of the MLDA on crime in Australia; and (iii) to use these results to test hypotheses arising from both existing theory and the theory developed in this thesis.

To achieve these aims, an extension to the rational crime theory was developed to account for alcohol and a novel theory was created. The theoretical predictions from both were tested using HILDA survey data, police records from NSW and court records from QLD. An RD methodology was used to obtain estimates of the increases in alcohol consumption and crime (both in aggregate and individual crime categories) caused by passing the MLDA.

8.2 Main Findings

The empirical results from each data source were used to test the hypotheses derived from the rational crime model and the new emotional shock model. Alcohol consumption increased in NSW and QLD at the MLDA, but the increase was greater in NSW, supporting Hypothesis 1 and Hypothesis 1a. Only a minority of crime categories increased at the MLDA in QLD, which counters Hypothesis 2. Public order offences did increase at this point, however, as did acts intended to cause injury (although the latter was sensitive to bandwidth choice), providing evidence in support of Hypothesis 4. Most NSW crime categories displayed no change at the MLDA, which suggests neither Hypothesis 3a nor 3b is correct as otherwise the increase due to alcohol would have to exactly equal the decrease from the change in justice system for each of the unchanged

categories. Assaults and public order offences both increased, again providing evidence supporting Hypothesis 4.

Comparing the results from the two states also reveals some important insights. The NSW and QLD results are striking in the similarity of which crime categories increased at the MLDA. For both states, assaults and public order offences were the only categories yielding reliable discontinuities, although QLD's equivalent for the former, 'acts intended to cause injury', was sensitive to bandwidth choice. This consistency suggests the existence of a limited subset of crimes influenced by the MLDA, which should be the targets of any policy intervention in this area. The affected categories fit the prediction from the emotional shock model that violent and nuisance crimes will increase at the MLDA.

Although the increase in alcohol consumption was smaller in QLD than in NSW (for both measures), the aggregate increase in crime was greater for QLD. Several possible explanations exist for this dichotomy. First, it may be that Queenslanders most influenced by the MLDA[50] are also those most affected by alcohol's influence on criminal behaviour. Although this seems plausible in general, the differential between the states is difficult to justify. Second, some other change at 18 years – right and obligation to vote, ability to purchase tobacco, eligibility for second provisional driver's licence – may serve to increase crime in some manner that affects QLD residents more than NSW residents. Again, this seems unlikely, not just because of the state differential but also because the other factors that change discontinuously at 18 are unlikely to have any noticeable effect on crime.[51] Third, this trend may reflect a difference between the two states in the primary mechanism through which the MLDA causes additional crime – in NSW this may be alcohol consumption itself, whereas in QLD the increase in crime may largely be caused by the riskier location choice associated with passing the MLDA. This seems the most likely possibility, although the data does not allow for confirmation either way; there is scope for valuable further research into the relative effect of each mechanism.

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[50] That is, the individuals who either delay their first experience with alcohol until after they turn 18 or who increase their alcohol consumption by the largest margin at the MLDA.
[51] See section 5.2 for a discussion of this point.

Further interesting insights emerge from comparing these results with those obtained by Carpenter and Dobkin (2013) in their study on the effects of legal access to alcohol on crime in the US. The authors find a similarly dramatic increase in alcohol consumption after passing the MLDA, although their measures are different to those used in this research.[52] They find that passing the MLDA causes a 6 per cent increase in total crimes. Disaggregating into individual categories, they find that assaults increase by around 6 per cent, robberies increase by 6.5 per cent, and the other violent crime categories increase but not by a statistically significant amount. They also find no significant increase for any property crimes (motor vehicle theft, stolen property or vandalism), and an approximately 25 per cent increase in disorderly conduct offences. These results are remarkably similar to those obtained in the current study, providing further evidence that the MLDA affects certain crimes strongly, such as violent and nuisance crimes, but has no impact on others, particularly property crimes. The similarity between the results from Australia and the US is particularly significant considering the three-year difference in drinking ages and other institutional differences between the two countries. This finding suggests that effects of legal access to alcohol may be common across countries and ages, but more research is needed to identify whether this is truly the case.

Overall, the evidence supports the prediction arising from the emotional shock model developed in this thesis (Hypothesis 4), but does not support the predictions based on the alcohol-augmented rational crime model (Hypotheses 2, 3a & 3b). This indicates that the rational crime model's predictions may fit certain crimes and situations better than others, and that young people could be a subset of the population to which the model applies less. Perhaps this dichotomy emerges from the more headstrong nature of youth compared to the calm, calculating approach that takes hold with age. Nonetheless, the rational crime model remains the cornerstone of economic crime theories. The augmentations made in this thesis to the rational crime model accounting for the effects of alcohol provide a possible starting point for future theoretical work on alcohol

[52] Carpenter and Dobkin (2010) use whether an individual has consumed alcohol in the past month, how many days they consumed alcohol in the past month, how many alcoholic beverages they consumed each day on which drinking occurred, and how many days in the past month they consumed more than five standard drinks in one session.

consumption and crime.[53] Developing new models based on rational behaviour but incorporating alcohol's effects on the individual's risk preference and subjective judgements would improve the theoretical contribution to understanding alcohol-related crime.

The emotional shock model suggests that rather than a calculated cost/benefit evaluation underlying young individuals' crime commission, a temporary loss of control may be responsible. Certainly this explanation holds more appeal for understanding crimes such as violent and nuisance offences, where the benefits seem to be small and relatively ephemeral compared to the costs. Modelling alcohol as inflating an individual's reaction to shocks also fits with the idea of an increase in individuals' behavioural volatility while they are drinking. Alternatively, the locational aspect of the theoretical model may be solely responsible for the results; this suggests that future research could be done to disentangle the two mechanisms. Further testing and refining this model may prove useful in understanding the links between alcohol and crime, particularly in the context of the MLDA.

8.3 Limitations and Further Research

One unavoidable limitation of the RD methodology is that the estimates are of local average treatment effects. This means that extrapolating the results from this thesis to other potential threshold locations is invalid. It cannot be claimed, for example, that increasing the MLDA to 19 years in Australia would prevent a certain amount of crimes from occurring based on estimates on the effect of an 18-year-old MLDA. The drinking age has been set at 18 in Australia for some time now, however, making credible estimates of the effect of changing the MLDA difficult to obtain.

As mentioned in Chapter 3, the new theoretical model could also prove useful in studying the effects of other substance consumption on crime – for example, marijuana could be modelled as deflating individuals' reactions to shocks. It would be difficult to test this model using an RD study

[53] The same framework could also be used to analyse the link between crime and consumption of other substances.

because no convenient threshold occurs for marijuana use as it does for alcohol, but changes in countries' marijuana laws would provide a good application of D-in-D. Research into the effects of other drugs on crime using the theoretical framework developed in this thesis would be a worthwhile addition to the literature.

A second limitation on studies estimating the effects of MLDA legislation has been discussed previously: an inability to separately identify the mechanisms causing any increase in crime at this point. Since both legal access to alcohol and also legal access to alcohol-serving locations changes at the threshold, the RD methodology estimates the joint effect of both changes. This thesis addresses this limitation by constructing a theory encompassing both effects, and also by discussing the possible magnitude of each in the results. The smaller increase in alcohol consumption in QLD than in NSW could mean that location choice exerts a larger influence on crime in this state, but this cannot be proven using the current results. Future research disentangling the two effects would contribute to an understanding of the determinants of crime, thus providing better scope for specific policies targeting crime. This could be accomplished using an IV methodology, but would require a data source containing variables on both crime and alcohol consumption (or location choice) for the same individuals.[54]

Lastly, the results from including donuts in the specification indicated that a proportion of the increase in crime at the MLDA was due to a 'celebration effect'. It is unclear, however, how much of this is due to celebrating becoming legally permitted to consume alcohol and how much is due to turning 18 in itself – the age marking a transition into adulthood. The higher MLDA in the US could be exploited here, comparing the crime results at 18 with the results at 21 to separately identify the effect of adulthood celebrations from legal alcohol access celebrations. A similar possibility is that some of the behaviour is due to a 'learning effect' – individuals have their first experience with alcohol and take a certain period of time to adjust their behaviour to compensate for its effects. Boes and Stillman (2013) briefly discuss this idea, but further research examining

[54] As opposed to this thesis, which uses different datasets for alcohol consumption and crime.

how prevalent learning effects are in accounting for increases in negative outcomes at the MLDA would provide valuable insights.

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Youth Justice Act 1992 (QLD).

10 Appendix A

10.1 Alcohol consumption results sensitivity tests

10.1.1 Bandwidth

These alcohol consumption discontinuity estimates are insensitive to choice of bandwidth over a large range. Figure 10.1 shows confidence intervals for the discontinuity in proportion of individuals in QLD ever drinking for bandwidths between 30 days and three years. For all bandwidths greater than half a year and up to three years, the estimated increase is statistically significant at the 5% level and also quite stable, fluctuating only slightly around the reported value of 11.6 percentage points. Figure 10.2 shows confidence intervals for the proportion of individuals drinking at least weekly. The estimated discontinuity is significant for all bandwidths over 200 days and remains stable at the reported value for bandwidths greater than 1.5 years.

Figure 10.1

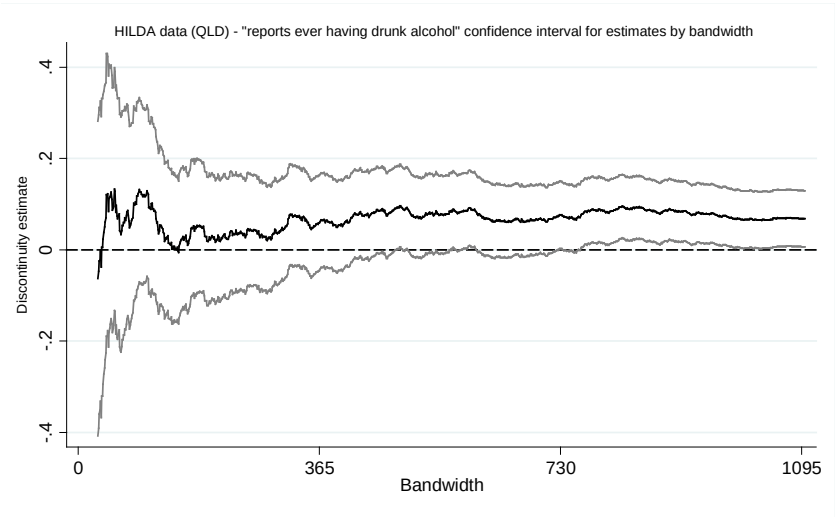


Figure 10.2

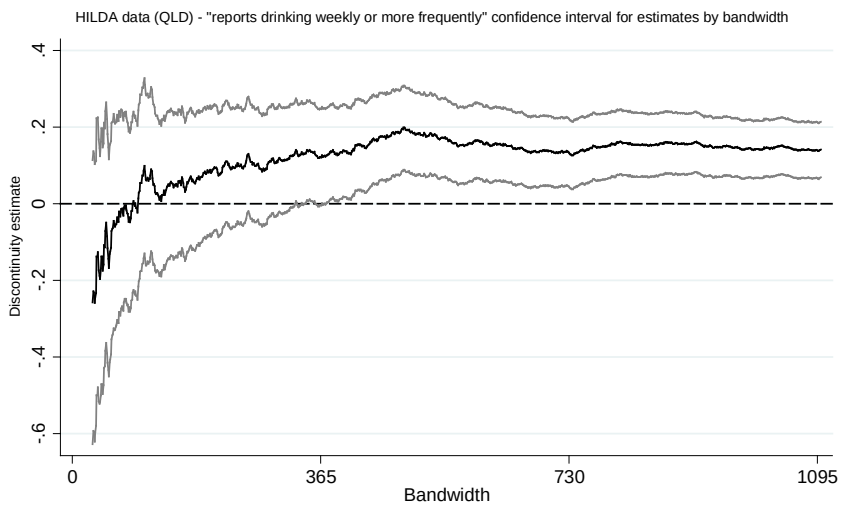


Figure 10.3 shows NSW discontinuity confidence intervals for the proportion of individuals reporting ever having drunk alcohol over bandwidths between 30 days and three years. For all bandwidths greater than half a year and up to three years, the estimated increase in the proportion who report ever drinking is statistically significant at the 5% level and also quite stable, fluctuating only slightly around the reported value of 14.6 percentage points. Figure 10.4 shows similar results for stability and significance for the estimated increase in the proportion who report drinking at least weekly.

Figure 10.3

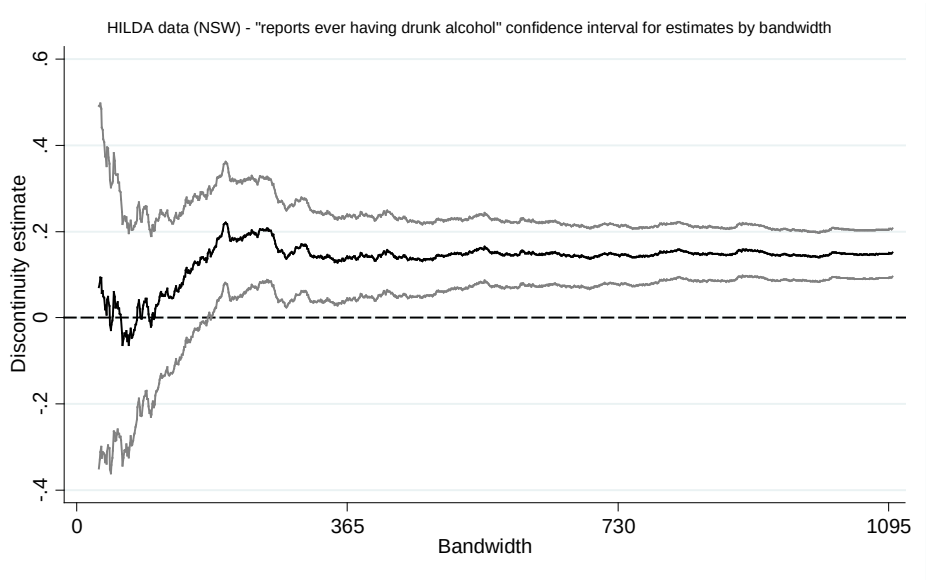
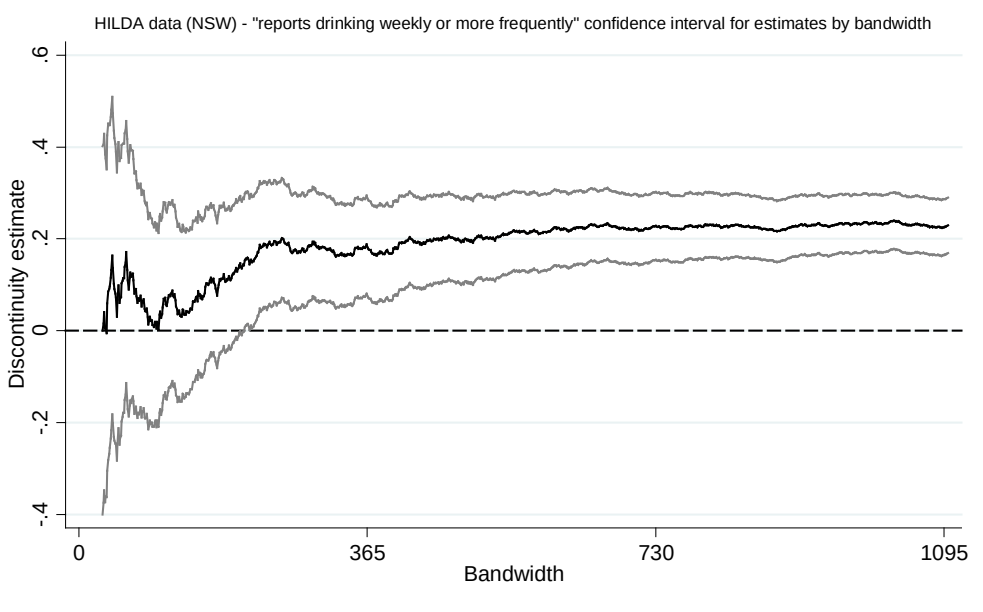


Figure 10.4



10.1.2 Donuts

Table 10.1 provides a comparison of discontinuity estimates for QLD with and without a seven-day donut.[55] The discontinuity in the proportion of individuals who report ever drinking increases to 8.7 percentage points. This indicates that the initial discontinuity (with no donut) can be considered a conservative estimate. The discontinuity in the proportion of frequent drinkers is almost unchanged, increasing from 13.3 to 15.4 per cent.

Table 10.1 also compares discontinuity estimates for NSW with and without a seven-day donut. The discontinuity in the proportion of individuals who report ever drinking increases from 14.6 to 15.8 percentage points. The discontinuity in the proportion who report drinking at least weekly increases from 22.9 to 23.9 percentage points. Again, this indicates that the donut-free estimates can be considered conservative.

Table 10.1

HILDA data – estimates of discontinuities in alcohol consumption variables (two-year bandwidth)			
State	*Variable*	*Discontinuity estimate with donut*	*Discontinuity estimate without donut (from Table 7.1)*
QLD	Ever drinking	0.0867** (0.0381)	0.0762** (0.0377)
	Drinking weekly	0.1535*** (0.0465)	0.1332*** (0.0452)
NSW	Ever drinking	0.1578*** (0.0351)	0.1457*** (0.0348)
	Drinking weekly	0.2393*** (0.0382)	0.2290*** (0.0377)

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. Standard errors are in parentheses. A seven-day donut is used.

10.1.3 Covariate Inclusion

Table 10.2 compares the estimated discontinuities for QLD with and without covariates included. The estimated discontinuities in the proportion ever drinking and the proportion drinking weekly decrease by 0.7 percentage points and 0.3 percentage points respectively when covariates are included.

Table 10.2 also does the same for NSW. Here the estimated discontinuity for the proportion ever drinking decreases by 1 percentage point, and the proportion drinking weekly decreases by 0.1 percentage points when covariates are included. This suggests that the bandwidth chosen may have slightly biased the discontinuity estimates upwards, but that this is not a major threat to validity.

[55] A seven-day donut means that fifteen observations in total are excluded from the data – the 18th birthday itself and seven days either side.

Table 10.2

HILDA data – estimates of discontinuities in alcohol consumption variables (two-year bandwidth)			
State	*Variable*	*Discontinuity estimate with covariates*	*Discontinuity estimate without covariates (from Table 7.1)*
QLD	Ever drinking	0.0653* (0.0376)	0.0762** (0.0377)
	Drinking weekly	0.1213*** (0.0453)	0.1332*** (0.0452)
NSW	Ever drinking	0.1363*** (0.0340)	0.1457*** (0.0348)
	Drinking weekly	0.2280*** (0.0378)	0.2290*** (0.0377)

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. Standard errors are in parentheses. Included covariates are: proportion employed, proportion in labour force, proportion finished year 12, and proportion receiving government benefits.

Figure 10.5 shows the estimated discontinuity at age 18 for the proportion of individuals reporting ever drinking alcohol in QLD and associated confidence interval for a range of donut sizes, from 0 days to one month (30 days). The horizontal axis indicates the number of days either side of 18 years that have been removed, so that the 0-day donut involves removing only the observations falling on the 18th birthday. The estimates remain significant over the whole range of donut sizes and are quite stable, indicating that there is no threat to validity from a systematic difference in observations near the threshold. Figure 10.6 shows the estimated discontinuity at age 18 for the proportion of individuals reporting drinking alcohol weekly or more often and associated confidence interval for a range of donut sizes. Again, the estimates remain both significant and stable over the range of donut sizes, indicating no potential bias. Figures 10.7 and 10.8 show the same for NSW.

Figure 10.5

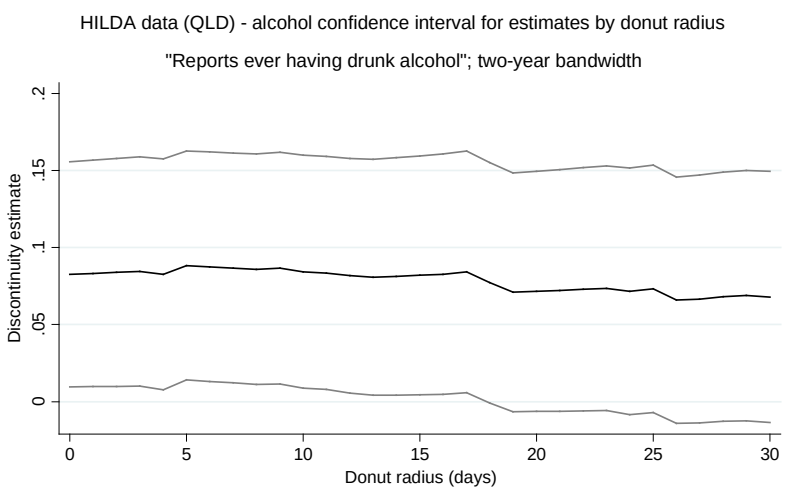


Figure 10.6

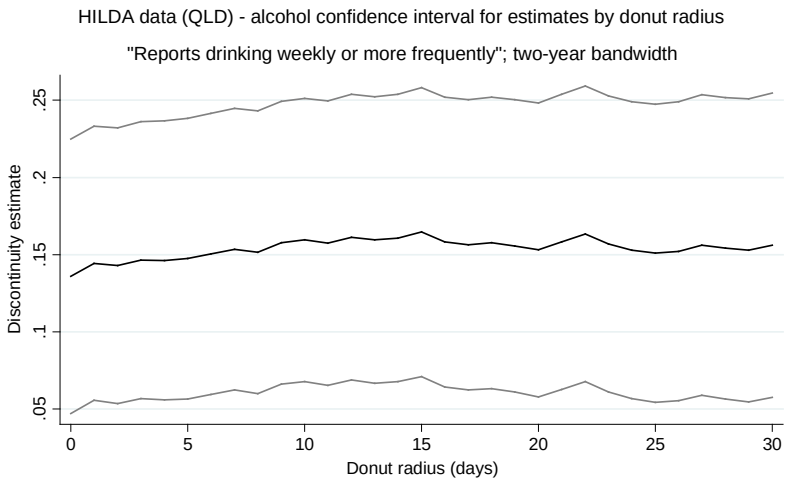


Figure 10.7

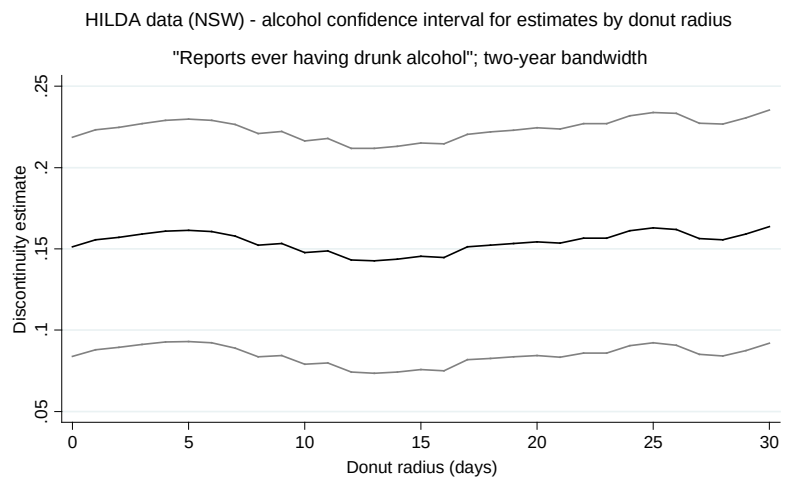
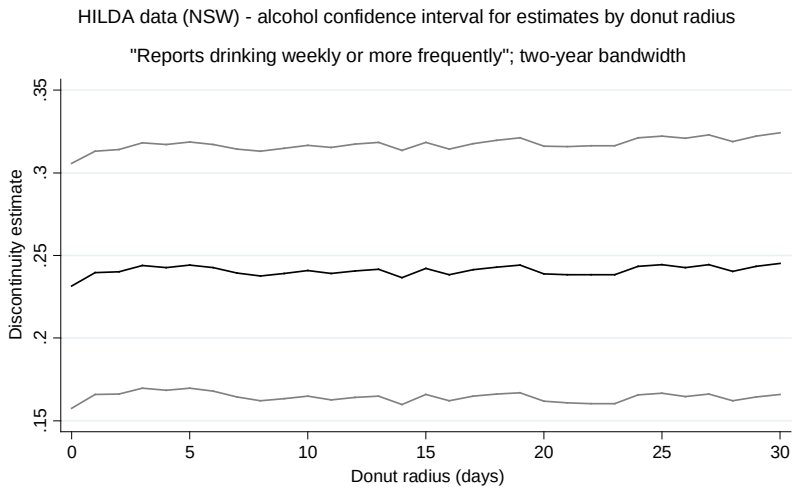


Figure 10.8



11 Appendix B

11.1 Crime results sensitivity tests

11.1.1 QLD

Not Guilty Observations

Table 11.1 shows estimates when 'not guilty' observations remain in the QLD data.

Table 11.1

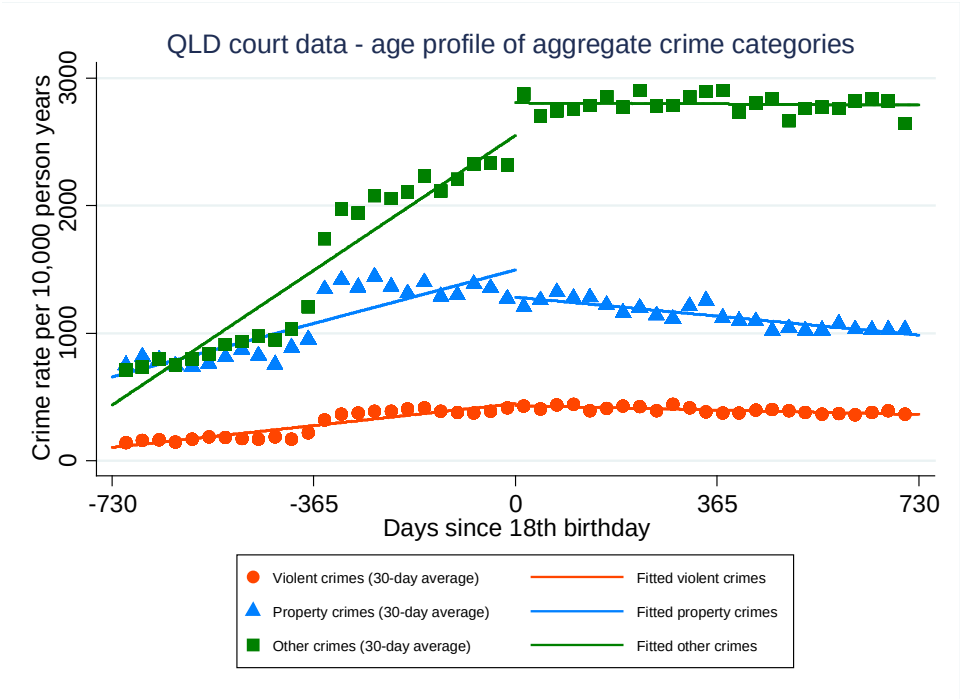
QLD court data – estimates of discontinuities in crime rates per 10,000 person years (one-year bandwidth)		
Offence category	*Discontinuity estimate with 'not guilty' included*	*Discontinuity estimate with 'not guilty' dropped (from table 7.3)*
Homicide and Related Offences	-1.86 (1.34)	-0.74 (0.59)
Acts Intended To Cause Injury	27.54** (11.44)	23.79** (9.68)
Sexual Assault and Related Offences	-5.32 (4.68)	-2.03 (3.18)
Dangerous Or Negligent Acts Endangering Persons	-1.22 (10.49)	-1.84 (9.97)
Abduction Harassment and Other Offences	-0.33 (2.36)	-1.52 (1.92)
Robbery Extortion and Related Offences	4.64 (5.15)	2.00 (3.35)
Unlawful Entry With Intent, Burglary, Break and Entering	-30.08** (13.95)	-21.82* (11.64)
Theft and Related Offences	-30.06 (18.6)	-20.02 (16.86)
Fraud, Deception and Related Offences	3.81 (9.21)	-7.74 (8.22)
Illicit Drug Offences	-1.52 (11.57)	3.93 (11.09)
Prohibited and Regulated Weapons and Explosives Offences	-0.28 (5.42)	-0.96 (5.29)
Property Damage and Environmental Pollution	2.13 (12.49)	-2.37 (11.57)
Public Order Offences	276.74*** (28.67)	268.11*** (28.44)
Traffic and Vehicle Regulatory Offences	51.94** (21.35)	60.19*** (20.55)
Offences Against Justice Procedures, Government Security and Government Operations	51.00** (21.06)	42.81** (20.18)
Miscellaneous Offences	-2.82 (1.91)	-2.43 (1.89)

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. Offences are ordered according to their Australian Standard Offence Classification (ABS 2008) classification. Offence categories with discontinuities significant at the 5% level that are greater than 2 crimes per 10,000 person years in magnitude appear in bold. Standard errors are in parentheses.

Bandwidth

Figure 11.1 shows the age profile of aggregate crime categories for QLD using a two-year bandwidth. This demonstrates that a two-year bandwidth is inappropriate for linear RD estimates in this context, as there is a clear discontinuity at age 17 affecting the estimates. As discussed in Chapter 6, several important factors change at age 17, including: capacity to obtain a provisional licence, right to leave school without being in another form of education or employment, and (in QLD) a transition from the juvenile to the adult justice system. Since these are expected to cause large changes in criminal behaviour, using a bandwidth of observations encompassing the 17th birthday will bias the results. Therefore, one year is the upper limit for appropriate bandwidth.

Figure 11.1



Noting the one-year upper bound, sensitivity to a range of bandwidths smaller than this must be ascertained. Figure 11.2 demonstrates that the discontinuity estimates for the 'other crimes' category are significant for the entire range of bandwidths from 30 days to 365 days. They remain very stable from 150 days to 365 days, declining slightly towards the upper end of the range. In contrast, Figure 11.3 indicates that three of the crime categories are fairly sensitive to bandwidth choice – 'public order offences' is the only category that stays consistently significant over the whole range of bandwidths. The discontinuity in 'public order offences' declines gradually as the bandwidth becomes wider, indicating the use of a one-year bandwidth is appropriate to avoid artificially inflating the estimated effect.

Figure 11.2

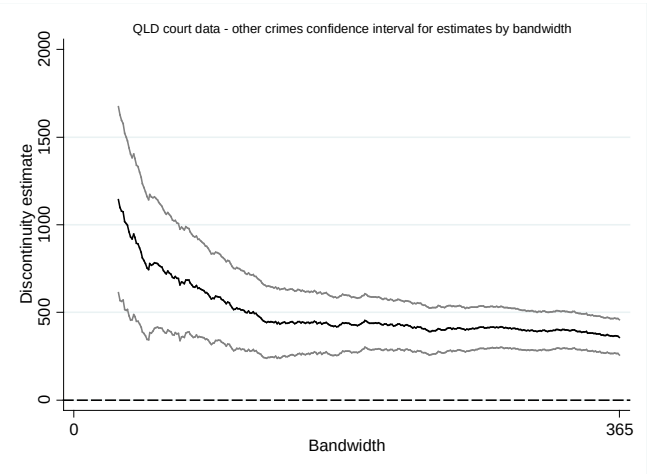
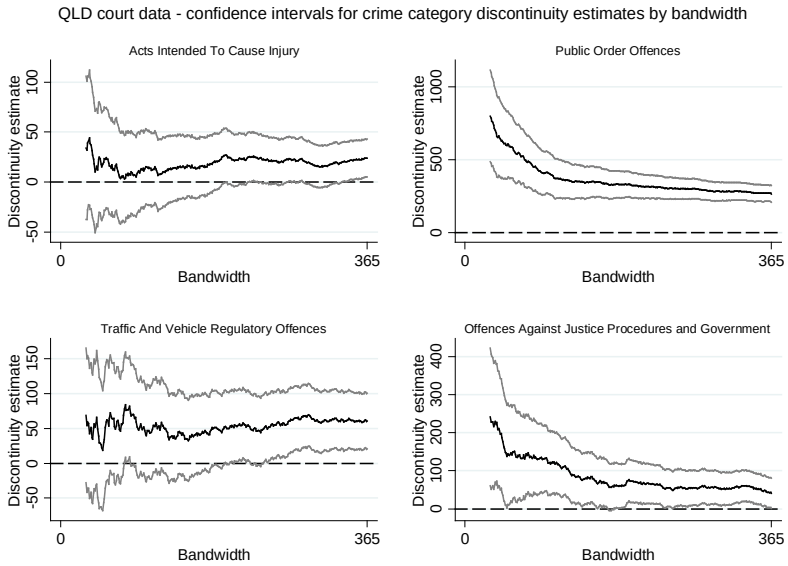


Figure 11.3



Donuts

Testing for donuts[56] will be important in the crime context, as inspection of Figure 11.4 demonstrates that there is certainly amplified criminal behaviour on the day of an individual's 18th birthday and the following day. An argument could also be made that this 'celebration effect' might systematically differ for up to five days in each direction to account for proximity of an individual's birthday to the weekend – someone whose birthday falls on a Monday may delay their celebration until the Friday or Saturday and may attempt to have a quiet weekend before.

[56] For an explanation of the meaning behind 'donuts', see section 5.2.

Figure 11.4

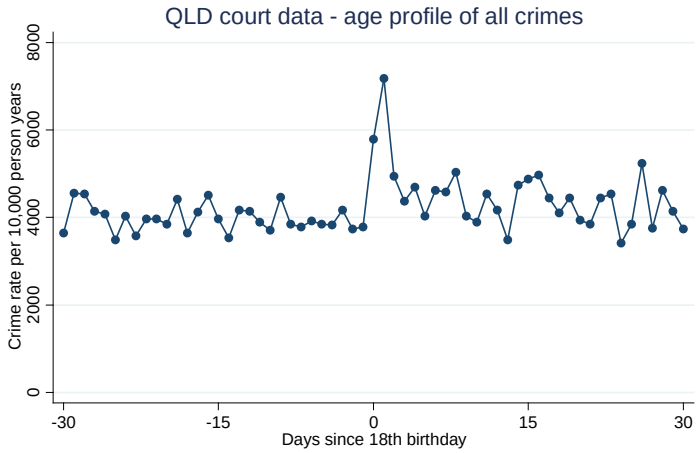


Table 11.2 compares the discontinuity estimates obtained with and without a five-day donut.[57] The estimated discontinuity for offences against justice procedures and government decreases and is no longer significant at the 10% level once a five-day donut is incorporated. The estimated discontinuities for acts intended to cause injury and public order offences remain significant after incorporating the five-day donut, but decrease by 16 and 16.4 per cent, respectively. This indicates that for all three of the offence categories just mentioned, a large proportion of the increase after passing the MLDA is attributable to altered behaviour in the close vicinity of the 18th birthday. In contrast, the estimated discontinuity in traffic and vehicle regulatory offences increases slightly after incorporating the donut, but is essentially unchanged.

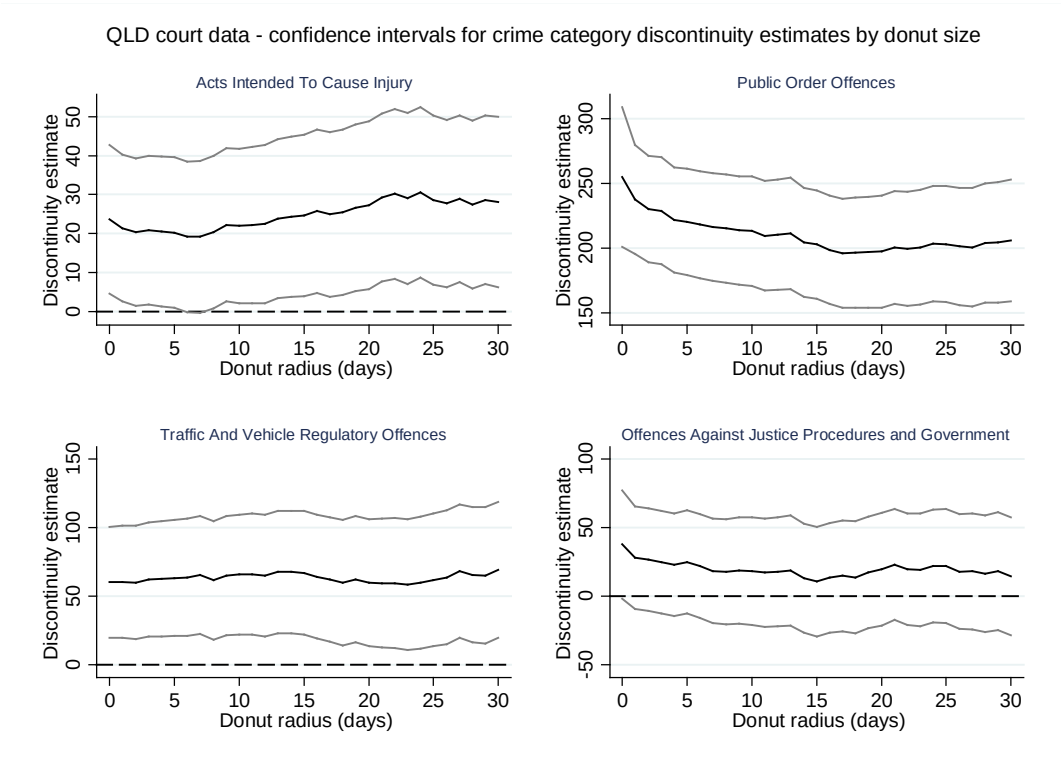
Table 11.2

QLD court data – estimates of discontinuities in crime rates per 10,000 person years (one-year bandwidth)			
Offence category	*Discontinuity estimate with zero-day donut*	*Discontinuity estimate with five-day donut*	*Discontinuity estimate without donut (from Table 7.3)*
Acts intended to cause injury	23.38** 9.73	19.96** (9.87)	23.79** (9.68)
Public order offences	258.87*** 27.24	224.25*** (20.44)	268.11*** (28.44)
Traffic and vehicle regulatory offences	59.42*** 20.66	62.63*** (21.69)	60.19*** (20.55)
Offences against justice procedures & government	40.05** 20.11	27.38 (19.21)	42.81** (20.18)

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. Standard errors are in parentheses.

[57] A five-day donut means that eleven observations will be excluded in total – see footnote 53.

Figure 11.5


QLD court data - confidence intervals for crime category discontinuity estimates by donut size
Acts Intended To Cause Injury
Public Order Offences
Traffic And Vehicle Regulatory Offences
Offences Against Justice Procedures and Government
Discontinuity estimate
Donut radius (days)

11.1.2 NSW

Bandwidth

Figures 11.6 and 11.7 show confidence intervals for the discontinuity estimates for bandwidths between 30 and 365 days. The estimates for assault and disorderly conduct are significant over the whole range, and remain quite stable. The discontinuities decrease as the bandwidth widens, so using a one-year bandwidth provides conservative estimates. The estimated decrease in liquor offences also remains significant over the whole range of considered bandwidths, although the estimate more than doubles when using a one-year bandwidth instead of a 30-day bandwidth. The other four categories are quite sensitive to choice of bandwidth, and are only significant for a small subset of the considered bandwidth range.

Figure 11.6

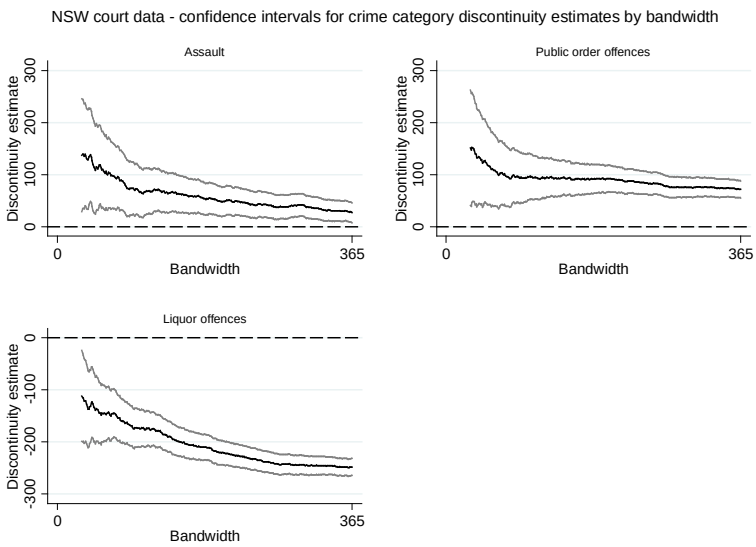
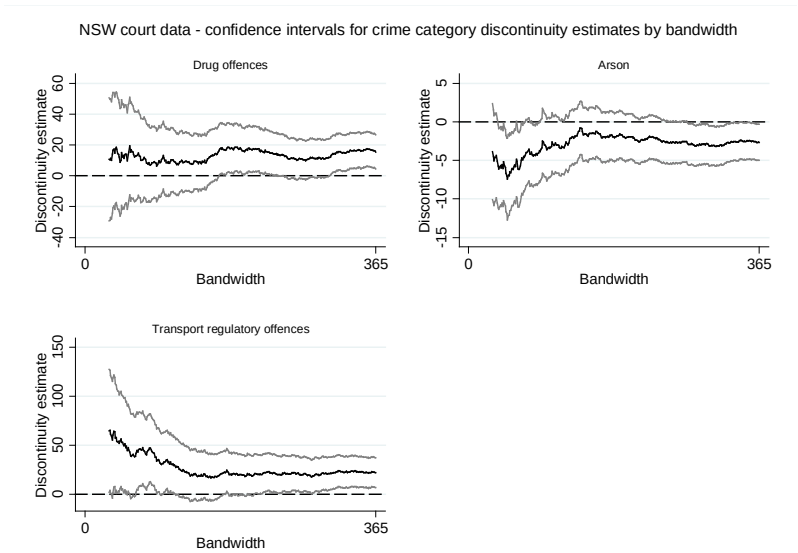


Figure 11.7



Donuts

Inspection of Figure 11.8 suggests that, as for QLD, the NSW data exhibits significant 'celebration effects'. Again, a five-day donut is appropriate due to the potential for birthday timing to affect behaviour on proximal weekends in particular. Table 11.3 compares the estimated discontinuities with and without donuts. The estimated discontinuities for assault and disorderly conduct decrease by 36 and 13 per cent respectively once a five-day donut is incorporated; this suggests that behaviour in the near vicinity of the 18th birthday threshold is a large driver of the increase in these crimes. The estimated decrease in liquor offences is larger using the donut specification, but estimated discontinuities for the other offences vary little between the standard specification and five-day donut. Figures 11.9 and 11.10 show estimated discontinuities for a range of donuts from 0 to 30 days.

Figure 11.8

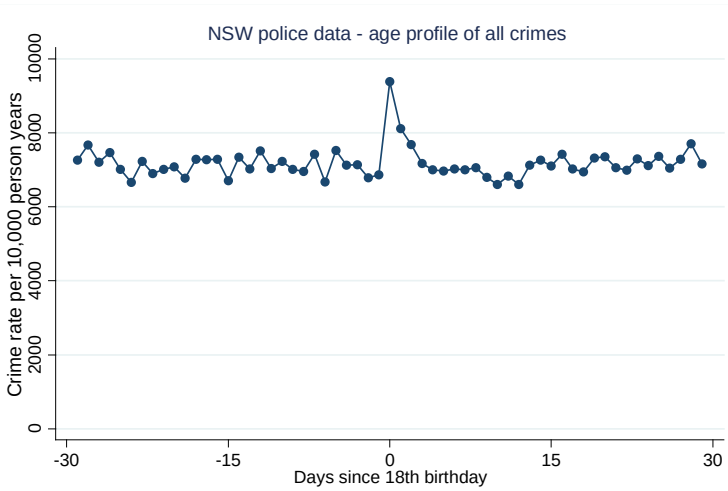


Table 11.3

NSW police data – estimates of discontinuities in crime rates per 10,000 person years (one-year bandwidth)			
Offence category	*Discontinuity estimate with zero-day donut*	*Discontinuity estimate with five-day donut*	*Discontinuity estimate without donut (from Table 7.5)*
Assault	21.90*** (8.32)	17.59** (8.01)	27.30*** (9.83)
Public order offences	67.63*** (7.31)	62.79*** (6.48)	72.05*** (8.46)
Liquor offences	-252.53*** (7.31)	-259.12*** (7.34)	-248.51*** (8.30)
Drug offences	15.57*** (5.67)	13.56** (5.86)	15.93*** (5.65)
Weapons offences	-6.64** (3.19)	-5.88* (3.34)	-6.22* (3.21)
Arson	-2.55** (1.20)	-2.16* (1.24)	-2.61** (1.19)
Transport regulatory offences	20.17*** (7.52)	20.61*** (7.58)	22.20*** (7.74)

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively. Standard errors are in parentheses.

Figure 11.9

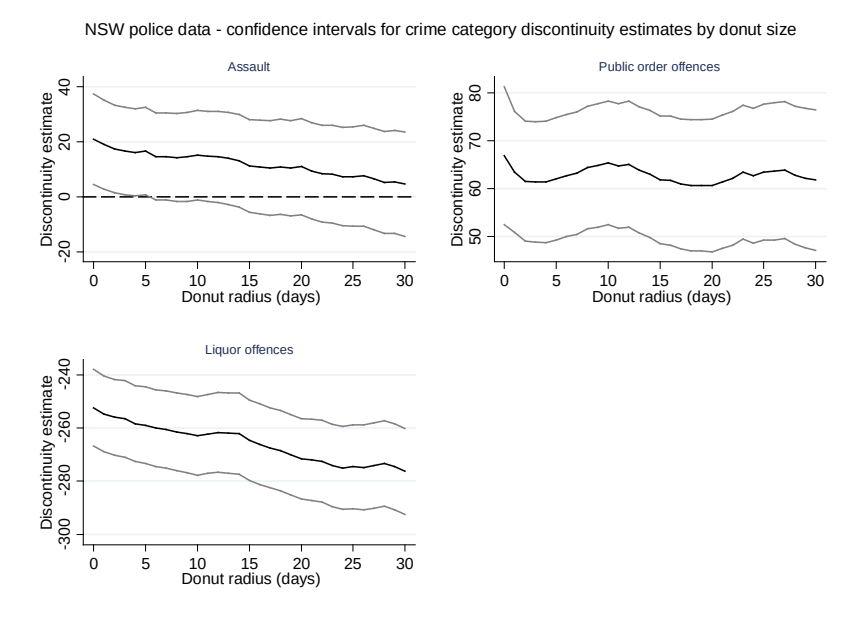
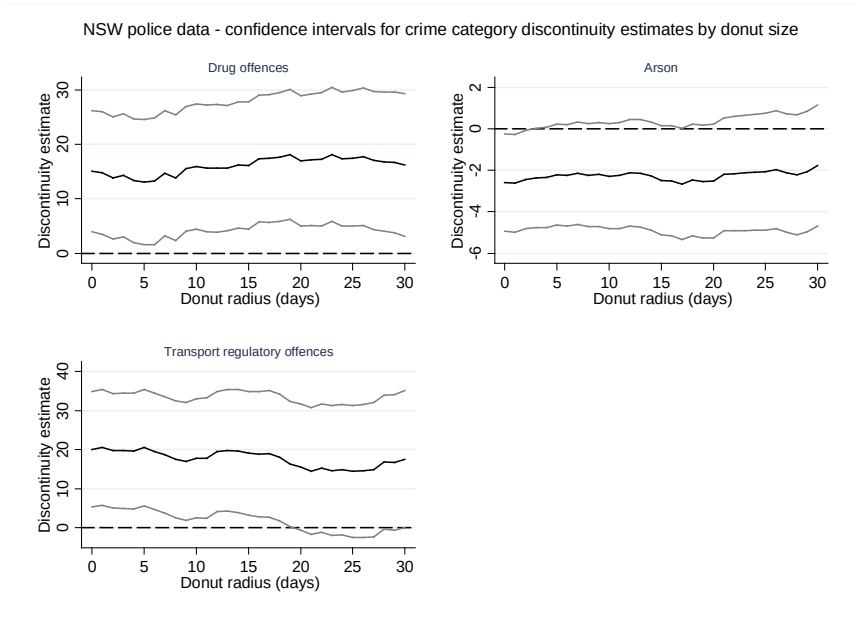


Figure 11.10



Covariates

A key validity check for the RD methodology is whether relevant covariates are discontinuous at the threshold – that is, whether the identification is unconfounded. Employment, education and receipt of government benefits could plausibly affect crime rates. Table 11.4 shows discontinuity estimates for four variables indicating the proportion of individuals who: are employed, are in the labour force, have completed year 12, and are receiving government benefits. Figure 11.11 illustrates these results. Of these, only the discontinuity in the proportion in the labour force is significant at the 5% level; the remainder are not significant at the 10% level. Figure 11.12, however, shows that this significance is an artefact of the bandwidth chosen – for the majority of

bandwidth choices between 30 days and three years, the discontinuity in proportion in the labour force (as well as the other three variables) is not significant at the 5% level.

Table 11.4

HILDA data (NSW & QLD) – estimates of discontinuities in covariates (two-year bandwidth)		
	Discontinuity estimate	Standard error
Employed	0.038	0.031
In labour force	0.075**	0.029
Completed year 12	0.026	0.029
Receiving government benefits	-0.032	0.027

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels of significance, respectively.

Figure 11.11

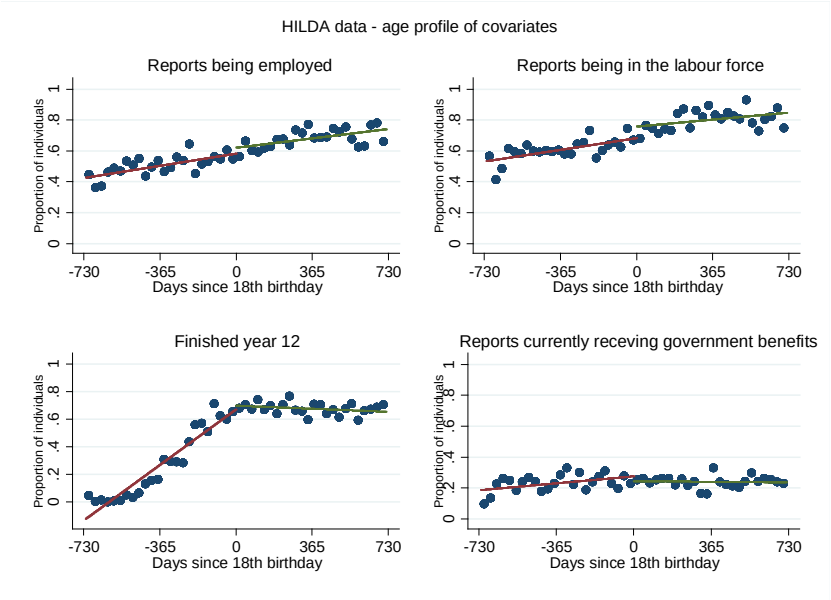


Figure 11.12