Alcohol Outlets and Crime: Instrumental Variable Approach

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Abstract

The relationship between the density of alcohol outlets and crime rates is an extensively researched question with immediate policy implications. Standard approaches almost universally show that alcohol availability leads to an increase in most crimes. This is the first study that addresses the endogeneity of the relationship between crime and alcohol by using a unique, historical shock to liquor license availability in the state of New South Wales (NSW), Australia where around 10% of alcohol outlets were closed in the early 20^{th} Century. We show that a higher density of liquor premises substantially increases non-domestic violence-related assaults, but has no effect on domestic violence-related assaults, sexual assaults or assaults on police. Policymakers must seek other ways of reducing domestic violence and alcohol harm minimisation requires location specific policy.

Keywords: Alcohol availability; assaults; outlet density; violence
JEL Codes:

1 Introduction

The relationship between crime and alcohol availability is a well-researched and long-established question in substance abuse literature. This question became particularly prominent during the COVID-19 pandemic where at-risk families were isolated from normal support networks, and alcohol consumption increased significantly (Callinan and MacLean 2020; Callinan et al. 2020; Neill et al. 2020; Tran et al. 2020)

The medical profession has established multiple potential channels that suggest that alcohol availability may increases nearby crime: alcohol has a direct effect on physical and cognitive functioning, contributing to violence through, for example, reducing self-control (Bechara 2005); alcohol can be used to prepare for or excuse violent acts (Graham et al. 2011; Leonard 2002); prenatal alcohol exposure can affect fetal development and consequently is linked to behavioral problems in later life, including delinquent behavior and violence (Sood et al. 2001); and, alcohol and violence may be linked through common risk factors (for example, an underlying anti-social personality disorder may lead to both heavy drinking and violent behavior) (Moeller and Dougherty 2001).

Informed by these mechanisms, numerous studies have sought to quantify the relationship between crime and alcohol availability. Most studies focus on the cross-sectional correlation between crime and alcohol outlets, controlling for socio-economic and demographic variables. From urban areas down to street blocks, a large range of geographies consistently show a significant and positive relationship between alcohol outlet density and violence.[1] Gruenewald and Remer (2006), Livingston (2011), and Norström (2000) confirm positive relationship using longitudinal data and panel data analysis techniques. Kearns et al. (2015) were particularly interested in the relationship between domestic violence and the numbers of alcohol outlets. They reviewed relevant studies[2] and showed that most (but not all) studies indicating that higher densities of alcohol outlets are associated with higher rates of domestic violence.

The interactions between outlet density and neighborhood characteristics do not produce consistent results. Gruenewald et al. (2006) and Smith et al. (2000) show that the relationship is stronger in socially disadvantaged areas, while Nielsen and Jr. (2003) finds no difference dependent on an area's characteristics. Grubesic and Pridemore (2011) show that area with spatially dense outlets appear to be more prone to assaultive violence. Along the same lines, Donnelly et al. (2014) and Livingston (2008) show that the relationship between crime and outlets are non-linear, implying existence of optimal amount of licenses.

Contributions to understanding the relationship between alcoholic availability and crime by economists are rare. Luca et al. (2015) used state and temporal variation in alcohol control in India (within a two-way fixed effect model) to show that prohibition policies are associated with lower rates of drinking among men and lower rates of domestic violence.

Although empirical evidence of this link is well-established, the evidence has been

[1] For a sample of this literature see: Costanza et al. (2001), Gruenewald et al. (2006), Livingston et al. (2007), Peterson et al. (2000), Reid et al. (2003), Roncek and Maier (1991), Scribner et al. (1999, 1995), Stevenson et al. (1999), and Zhu et al. (2004). Unusually, Gorman et al. (1998) found no relationship using data from New Jersey, but subsequent work shows this to be an artifact of an incorrectly chosen geographic unit of analysis (Speer et al. 1998).

[2] These are: Cunradi et al. (2011), Duailibi et al. (2007), Durrance et al. (2011), Herttua et al. (2008), Iritani et al. (2013), Livingston (2010), McKinney et al. (2009), Norström (2000), Sabia (2004), Waller et al. (2012), and Zeoli and Webster (2010)

almost exclusively in the form of associations, leaving a causal interpretation intangible. A notable exception is the use of arguably exogenous changes in public transportation (Jackson and Owens 2011; Phillips and Sandler 2015). Reliance on cross-sectional or longitudinal approaches is problematic as it implicitly assumes that people or local governments do not respond to potential alcohol threats endogenously. In reality, those who prefer to eliminate the risks associated with alcohol availability can relocate, choose partners or friends with comparable drinking habits, and avoid alcohol or groups of people who chose to consume alcohol. Therefore, a prediction that alcohol or alcohol availability causes violence or crimes is theoretically ambiguous.

Beyond this one example, the research question is generally plagued by issues such as omitted variables and reverse causality. For example, if people prone to criminal activity like to spend time at pubs, higher demand leads to more pubs opening, causing an observed correlation between crime and alcohol premises. There may also be an external factor affecting both the level of crime and availability of alcohol. For example, alcoholism that varies by region may cause higher crime levels and more pubs to be located in the same area. Problematic use of alcohol can also develop as a coping mechanism among victims of crime, causing simultaneity between crime and the presence of alcohol. The presence of alcohol premises is also the result of a complicated interaction between businesses that want to operate in those areas and local governments that may not allow the operation.

To address the endogeneity issues and establish a causal relationship between alcohol availability and crime, we use an instrument based on a unique situation in Australia where a vote in the state of NSW in 1907 led to the closure of around 10% of all pubs in operation at the time. Notably, these closures varied on a local level depending on the results of the vote in the local electorate. While the electoral system in place in 1907 has no direct relation to today's criminal, political, social, or regulatory environment, we show that this century-old vote has had a permanent effect on the number of alcohol outlets in areas that voted in favor of reduction. The vote result in 1907 created, from the point of view of today, an "as good as random" variation in the number of alcohol outlets in NSW.

We first analyze the prevalence of serious crimes, including murder, domestic violence, non-domestic violence, sexual assault, and assaulting a police officer, as well as two crimes associated with substance abuse: liquor offenses and cannabis offenses. We find that using simple cross-sectional correlations produces a strong relationship between the number of pubs and the crime rate for all these offenses. This finding is in line with previous literature cited.

After using the random variation brought on by the 1907 vote, we find that pubs only contribute to an increase in non-domestic violence and liquor offenses. This indicates that the availability of alcohol in public places does genuinely cause an increase in assault in public spaces. The rate of domestic assault, sexual assault, and assaulting police are not affected by pubs in a local area.

A subgroup analysis indicates that built-up metropolitan areas are driving the increase in crime that we identify - particularly in areas with a combination of high general crime rates and high income. This suggests that policies to minimize the harm of alcohol availability need to be well targeted on high-risk locations rather than broad brush reductions in availability.

The results are robust to using different instruments from the 1907 vote. We also conduct placebo tests, where we look at crimes not likely affected by alcohol availability

(fraud, growing cannabis, importing drugs, and pornography offenses) and find that, once we use the random variation from the 1907 vote, there is no statistically significant relationship. In addition, we analyze some non-criminal socio-economic outcomes that could potentially be affected by alcohol availability (employment in hospitality, socio-economic disadvantage, and hotel presence) and find results consistent with common intuition. These robustness checks provide evidence that our overall finding is reliable.

2 Institutional context

Alcohol has been an important part of economic life of NSW since its establishment as a colony in 1788. It has been a central feature of a rum fuelled rebellion (1808) and as a de-facto currency (with local coinage first issued in 1813). By 1837 Sydney, with a population of 23,000, had 224 licensed taverns – about 1 per 100 residents which is 12x the current prevalence – plus a large number of sly grog shops (Hanna 2016). By 1880, there were nearly 4,000 pubs in NSW **(Powell 1988, 40)**.

Early tools of colonial alcohol policy focussed on customs and excise duties, in 1896-7 63% of tax revenue in NSW came from customs and excise on alcohol. Later in the 19th Century, availability controls, largely through liquor licensing, were the major alcohol control policies in the Australian colonies. For example, in 1881 residents were given the right to veto new liquor licenses in their local district with polls held to coincide with colonial elections. This approach led to a decrease in the number of licensed pubs in Sydney (although there was an increase in regional areas) (NSW Government 1909).

In the early 20th Century, backed by growing support for prohibition, The Liquor Amendment Act of 1905 provided a number of additional controls on liquor licencing in NSW. First, it provided stringent regulation of the licensing, management of pubs and clubs. It also placed limits on the number of liquor licences, whereby the number in any electorate was not to exceed the number at the commencement of the Act, except where an increase is granted on account of growth of population. Clubs were not to exceed the number formed before November, 1905, and registered before March, 1906 (NSW Government 1909).

The Act also provided for a 'Local Option' poll, conceptually a strengthened version of the local votes conducted since 1881. The Local Option poll was run at the same time as state elections. The first poll was held in 1907 and allowed voters to decide in favour of 'Continuance', 'Reduction', or 'No License' in each electorate. A 'No Licence' result required 60% of the total votes and that the voters must represent at least 3O% of all voters in the electorate (at that time, voting in Australia was not compulsory). If 'No Licence' was not carried than the votes were added to those for 'Reduction'. No compensation was to be provided to licencees in the event of a 'Reduction' or 'No Licence' result.

NSW held only three genuine local option polls (in 1907, 1910 and 1913 – see Figure 1) before they were suspended. The 1907 poll was the strongest in favour of Reduction. At a state level, in 1907, 'Continuance' received 45.1% of vote, 'Reduction' 16.3% and 'No Licence' 38.5%. In later polls 'Continuance' performed more strongly. While local option was in force in NSW, no electorate carried a 'No Licence' result.

While the overall state result was in favour of 'Reduction', there was significant variance between electorates, see Figure 2. In total 65 electorates carried a Reduction while 25 carried a Continuance. The geographic pattern involved most regional electorates in the east voting in favour of 'Reduction' except for the densely populated inner city

Figure 1: Summary of Results of Local Option Vote

NEW SOUTH WALES.—EFFECTS OF LOCAL OPTION VOTES, 1907, 1910, and 1913.

Particulars.	General Election, 1907.		General Election, 1910.		General Election, 1913.	
	Electorates.	Votes.	Electorates.	Votes.	Electorates.	Votes.
Results in favour of—						
(*a*) Continuance ..	25	209,384	76	324,973	75	380,707
(*b*) Reduction ..	65	75,706	14	38,856	15	44,453
(*c*) No license ..	Nil	178,580	Nil	212,889	Nil	245,202

Notes:
Source: Commonwealth Government (1921, p. 1050)

electorates.

Where a Reduction was implemented it was required that a local court be established to reduce licences by up to 20% with minimum reductions being set in legislation. The reductions were scheduled with priority given to locations with previous convictions. Pubs with two convictions were allowed one year to close, those with one conviction were allowed two years. If this was not enough to reach the target reduction of 20%, then the Court applied reductions having regard to the convenience of the local public. These pubs were allowed up to three years to close, with extensions possible depending on lease conditions (Arnott 1934).

The final Reductions associated with the 1907 vote took place in 1913, ultimately totalling 293 pubs, around 10% of the pubs in existence in 1907. Of the 65 electorates that carried Reduction, only three (Allowrie, Broken Hill and Sturt) did not carry out any Reductions (NSW Government 1954).

In 1928, Local Option Polls were suspended in NSW. This was partially because the approach to reductions had come to favour the use of a Licence Reduction Board (established in 1919) which could directly implement the removal of hotel licences, rather than relying on a local vote. An important feature of the Licence Reduction Board is that it made it difficult to gain a new liquor licence, effectively locking in the results of the Local Option polls.

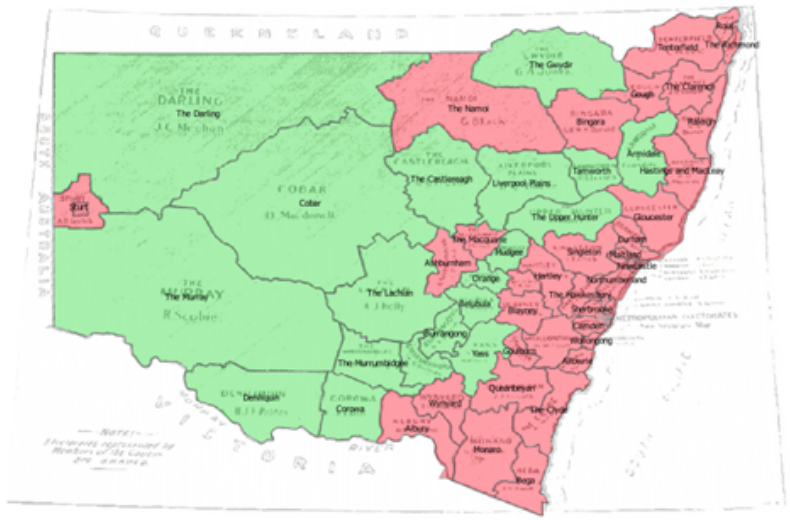
The combinations of policies arising from the 1905 Act (a restriction on new licences and a geographically varied reduction in licences in 1907) combined with the transition to a Licence Reduction Board that purposefully kept new licences from being issued, means that the results of the Local Option polls in the early 20th Century could, potentially, have had a long term effect on the current location of pubs in NSW and, hence, on the availability of alcohol. An anecdotal example of the potential long run impacts of local option can be seen in Camberwell and Box Hill in Melbourne which went dry at the 1920 local option poll in Victoria **(Moyes 2009; Fitzgerald and Jordan 2009, 171)**. These suburbs remained dry, with no hotels, at the end of the period in 2010 **(Australian Financial Review 2014)**.

3 Data

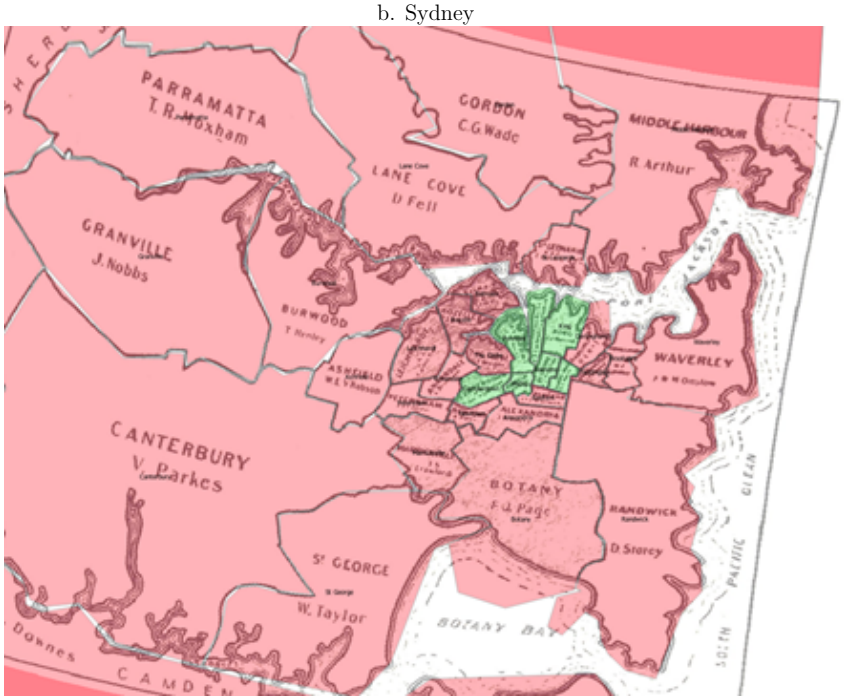
We use a number of different administrative data sets and bring them together using GIS software. Each step is explained below.

Figure 2: Locations that passed a reduction in licences in 1907

a. NSW



b. Sydney



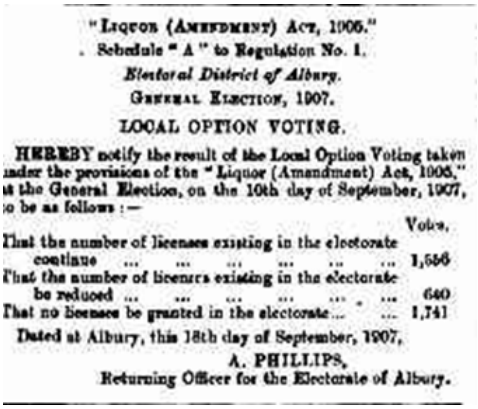
Notes: A reduction in licence occurred if the combined total of votes for No Licence and Reduction was greater than 50%.
Source: NSW Government (1907).

3.1 Voting data

We start with data on the 1907 election, provided by the Parliament of NSW. This data covers the election results for each electorate in 1907 including the number of votes and the total number of voters on the electoral roll Parliament of NSW (2007). Maps of each electorate were sourced from Pernica (1958, pp.142-143). The reported maps were for 1910 but additional research indicated no significant changes in electorate boundaries between 1907 and 1910. These maps were digitized by hand using GIS software, the results of this process can be seen in Figure 2.

Parliament of NSW (2007) does not record the results of the Local Option poll and so these results were sourced from the NSW Government Gazette (NSW Government 1907). Figure 3 shows how the results were reported in the Gazette. Of the 90 electorates, 89 had results reported in the 1907 Gazette, no data was found for the electorate of Tenterfield. Additional research indicated that Tenterfield voted to Reduce, although no vote shares could be sourced. From the raw vote data, outcomes were calculated using the formula described in Section 2. This identified 26 electorates voting to Continue and 64 voting to Reduce, this is different to what is reported in the Commonwealth Yearbook. This difference could be caused by errors in the Gazette, the Commonwealth Yearbook or in transcription. We note that different reports over time have shown different results. For example, an article in the Sydney Morning Herald from 1934 quotes 206,844 votes for Continuance while the Commonwealth Yearbook quotes 209,384 (Arnott 1934). Our total for Continuance, 207,202 falls within this range.

Figure 3: Format of data in historical documents



"LIQUOR (AMENDMENT) ACT, 1905."
Schedule "A" to Regulation No. 1.
Electoral District of Albury.
GENERAL ELECTION, 1907.
LOCAL OPTION VOTING.

HEREBY notify the result of the Local Option Voting taken under the provisions of the "Liquor (Amendment) Act, 1905," at the General Election, on the 10th day of September, 1907, to be as follows:—

	Votes.
That the number of licenses existing in the electorate continue	1,556
That the number of licenses existing in the electorate be reduced	640
That no licenses be granted in the electorate	1,741

Dated at Albury, this 18th day of September, 1907.

A. PHILLIPS,
Returning Officer for the Electorate of Albury.

Notes: .
Source: NSW Government (1907).

3.2 Licensing data

We identify current pubs using the liquor licensing data maintained by the NSW Office of Liquor Gaming and Racing (OLGR) (OLGR 2019). We used a pre-COVID-19 database to reflect normal market conditions. The data contain details of all liquor licences currently operating in NSW, including the licence name, type and address.

OLGR has six primary classifications for liquor licences in NSW: (i) hotels; (ii) packaged liquor; (iii) clubs; (iv) on-premises; (v) limited licences and; (vi) producer/wholesaler. The database was refined to focus on hotel and club licences as these were the licences targetted in the Local Option polls and still remain the major locations for 'on premise' alcohol consumption in NSW.

This resulted in around 4000 individual licences being identified in the OLGR data. The addresses were used to geocode the licences for use in the GIS software. A total of 3975 of the addresses were successfully geocoded. The geocoding process was accurate, 3047 were exact matches while 3612 were $\geq$90% matches. We also undertook spot checks of known locations by hand to verify accuracy.

3.3 Crime data

Data on current crime levels were sourced from the NSW Bureau of Crime Statistics and Rearch (BOCSARS), in particular "Recorded Criminal Incident by month" at the suburb level (BOCSAR 2020). The data covers the period January 1995 to December 2019 and lists monthly counts of 62 offences.[3]

The BOCSARS data was processed to take the average number of crimes committed in each suburb in a year. This was converted to an average rate per $100,000$ population using 2016 census population figures (Australian Bureau of Statistics 2017).

The BOCSARS data set covers a wide range of crimes. For this analysis we have selected a subset with the aim of covering serious crimes that could reasonably related to alcohol consumption (including murder, domestic violence, non-domestic violence, sexual assault, and assaulting a police officer), as well as crimes associated with substance abuse that could be reasonably be related to alcohol consumption (liquor offenses and cannabis offenses) as well as crimes not likely to be affected by alcohol availability (fraud, growing cannabis, importing drugs, and pornography offenses).

3.4 Final data set

Additional data on currnet socio-demographics was sourced from the ABS's regional profiles (Australian Bureau of Statistics 2020).[4] This data is at the SA2 level and covers the years 2013-2018. Available variables include age, income, and proportion of English Second Language (ESL) speakers.

We took the following steps in the GIS software to merge together all data sets:

1. The 1907 electorate level voting data was merged with the electorate polygons.
2. The ABS sociodemographic data was merged with the SA2 polygons.
3. The BOCSAR crime data was merged with suburb polygons.
4. The intersection of the electorates, SA2s and suburbs was taken.
5. For each area, the number of pubs and clubs located within the region was counted and added to the data.

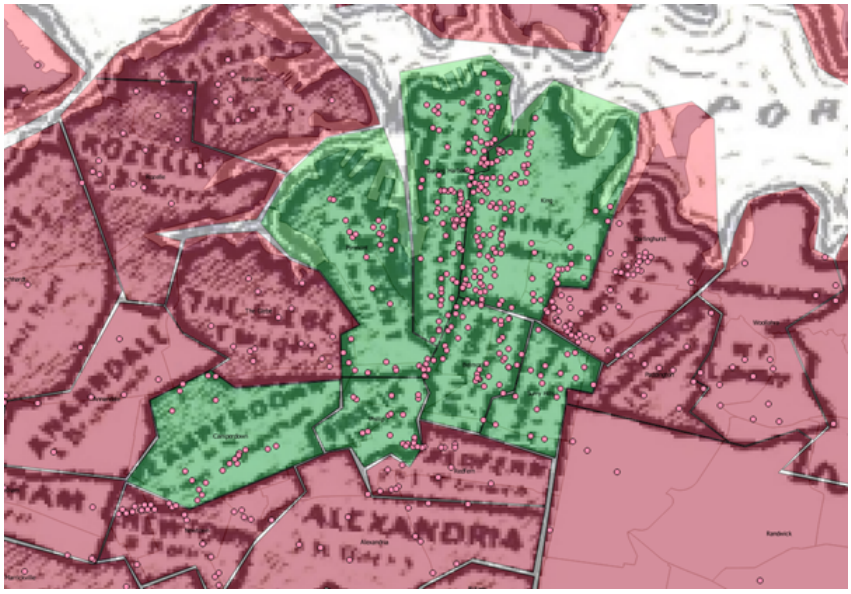
This process created a total of 7300 geographical areas. Figure 4 provides an example of what the merged data looks like for the Sydney CBD.

Finally, we removed polygons outside NSW (for example, the Australian Capital Territory was created after the 1907 election) as well as polygons without any pubs

[3]Offences covered include murder, domestic violence assault, other assault, sexual assault, various types of robbery, various types of drug related charges and various types of other offences.

[4]There are around 2,200 SA2s in Australia with populations in the range of 3,000 - 25,000 and an average population of around 10,000. Each SA2 aims to represent a community that interacts together socially and economically

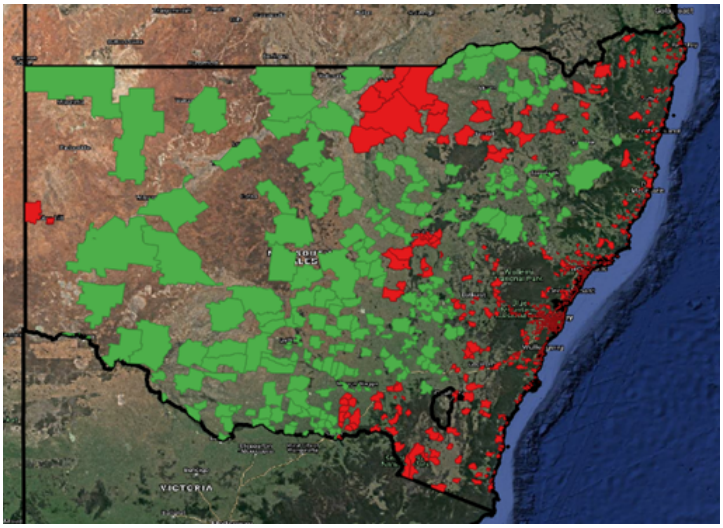
Figure 4: Example of Merged Data Sets



Notes: .
Source: .

located within them, mostly sparsely populated areas of Western NSW. This left a final data set of 1332 observations. The remaining geographic areas are shown in Figure 5 with summary statistics provided in Table 1.

Figure 5: Final Geographic Location



Notes: Red indicates 'Reduction' in the 1907 Local Option poll while green indicates 'Continuance'.
Source: Author's calculations.

Table 1: Summary statistics for final data set

	All Data		'Reduce'		'Continue'	
	Mean	SD	Mean	SD	Mean	SD
Murder	0.8	1.0	2.4	17.5	3.4	9.2
Domestic Violence	6.4	0.9	395.0	613.7	584.1	1,093.4
Non Domestic Violence	6.7	1.0	934.2	6,634.0	1,082.0	4,243.4
Assault Police	3.5	1.7	83.9	985.2	93.5	410.8
Sexual Assault	4.7	1.1	82.1	227.3	134.9	400.3
Liquor Offences	5.2	1.7	807.4	13,144.8	590.3	1,979.1
Cannabis	5.6	1.2	508.3	5,799.6	400.1	1,080.9
Break and Enter	7.0	0.9	706.5	492.5	672.8	745.3
Steal from Motor	7.1	1.0	1,516.9	12,382.5	1,025.3	2,402.2
Property Damage	7.6	0.8	1,695.6	7,413.2	1,794.6	5,371.0
Offensive Conduct	4.1	1.8	207.6	2,664.3	299.5	1,873.3
Total Population	13,829.4	7,239.2	14,847.1	7,107.9	10,188.5	6,505.5
Mean Total income	60,181.6	19,095.4	61,453.5	20,591.9	55,644.8	11,272.6
Median Age Persons	40.7	5.9	40.6	6.2	40.8	5.2
ESL Proportion	15.9	19.8	18.4	20.7	6.8	12.4
Employment Rate	0.7	0.1	0.7	0.1	0.7	0.1
Population density	1,600.0	2,573.2	1,746.6	2,334.1	1,066.7	3,249.4
SEIFA Ec Res	5.0	2.8	5.4	2.9	3.6	2.0
Business closure rate	0.1	0.03	0.1	0.03	0.1	0.02
Number of Observations	1,332		1,041		291	

4 Econometric model and first stage results

The goal of our analysis is to estimate the effects of alcohol availability on crime rates. Analysing this relationship is challenging as alcohol could cause crime but crime could also cause alcohol availability, a classic endogeneity problem.

We use an instrumental variables (IV) approach to overcome this endogeneity problem. This leads to a simple econometric specification:

$$ln(Crime_i) = \beta \hat{Pubs}_i + X_i\phi + \nu_i \tag{1}$$

$$Pubs_i = \alpha 1907.Voting_i + X_i\lambda + \varepsilon_i, \tag{2}$$

where $Crime_i$ is a crime outcome measured in rate per 100,000 people. $Pubs_i$ is the number of pubs in location i, it is the endogenous regressor and is instrumented using Equation 2. X_i are social and demographic covariates. We consulted past research to construct control variables that correlate with rate of crime (Ingilevich and Ivanov 2018; Stavrou and Poynton 2016; Weatherburn 2001). These are total population, average income, median age and the proportion of English Second Language speakers. The term ν_i stands for the econometric error.

The results of Hausman endogeneity test on the model in Equation 1 indicate that there is evidence of endogeneity for the number of pubs at the 5% significance level (p-value 0.033). This provides evidence that the storyline around endogeneity is legitimate and that addressing endogeneity is important for arriving at unbiased estimates of β.

Table 2: The estimated effect of pubs on assaults in NSW

	(1)	(2)	(3)	(4)
	Dependent variable:			
	Domestic violence assault		Non-domestic violence assault	
	OLS	2SLS	OLS	2SLS
Number of pubs	4.913**	6.986	10.404*	42.873**
	(1.919)	(20.196)	(5.875)	(20.003)
Observations	739	729	739	729
R^2	0.383	0.382	0.571	0.476

Notes: The table reports OLS and 2SLS estimates of the effect of number of pubs on violence. Instrument is a share of voted for prohibiting pubs in 1907. Controls include total population, mean total income, median age, population density, English speakers proportion, average household size, housing median price.
Source: OLGR 2020, COPS 2020, The State Library of NSW.

In Equation 2, $1907.Voting_i$ is an outcome from the 1907 Local Option poll. There are a few options for how to define $1907.Voting_i$, all described below. We also provide the case that the result of the 1907 Local Option poll is not related to the present day crime levels, except through its direct effect on the number of pubs in a location and the case for monotonicity (the voting either reduced or had no effect on the number of pubs). With these three assumptions, the interpretation of β will be the Local Average Treatment Effect (LATE), which will capture the average effect of an additional pub on crime rates in the local area. X_i are social and demographic covariates, as in Equation 1. ϵ_i is the error term.

The interpretation of the results is straightforward: an additional pub in a location will cause an increase in the crime of interest by $(100 \times beta_1)\%$. As we are estimating the LATE, the correct interpretation is that this is the impact of a pub on crime rates among areas where more votes for Reduction in 1907 led to fewer pubs. This highlights

the need for caution in extrapolating the causal effects we estimate to other areas and settings.

4.1 Instrument Relevance

For the instrument to be relevant, the closure of pubs following the 1907 Local Option poll must have a lasting impact on the number of pubs today. In general, there is mounting evidence that historical events do have long term effects REFERENCES NEEDED, but there are unique characteristics of Australian pubs and licensing which effectively locked-in the changes that happened following the 1907 Local Option poll.

First, pubs in Australia are often large buildings in prominent locations, such as the intersection of busy roads, a pub closure cannot be easily undone due to lack of potential alternative locations. Further, the terms of The Liquor Amendment Act of 1905 mean that the number of pubs could not again exceed the number present in 1905 (NSW Government 1954). In later decades, licensing limits were stringently enforced by the Licence Reduction Board (Ross n.d.). Then, later in the 20th Century, pubs in Sydney were effectively controlled by a duopoly of breweries (Tooths and Tooheys) that strictly limited competition and new entry (Stubbs 1999). Although liberalisation of licensing laws began in the mid-1950s, there still remains strong restrictions on opening new pubs. For example, to apply to open a pub in 2020, the applicant must consult with: local government, neighbouring local governments, local police, NSW Health, Department of Family and Community Services, Transport for NSW, Local Aboriginal Communities and all neighbouring premises within a 100m radius (NSW Government 2020). Taken together, these restrictions on competition and free entry are likely to mean that the reduction in the number of pubs in NSW in 1907 has had enduring effects on the number of pubs in a given location today.

To test whether this story is genuine, we can look at a number of outcomes from the 1907 Local Option Poll and their effect on the current number of pubs. A range of outcomes are shown in Table 3. The results show that, in most cases, the variables are statistically significant at conventional levels and the sign is as expected. For example, Column 1 shows that going form 0% of votes for No Licence to 100% of votes for No Licence in 1907 reduces the number of pubs in a location today by about 7. The exception is Reduce (%), which is not statistically significant and is wrong signed.

The results suggest that most of these variables would make for a relevant instrumental variable. Most have an F statistic above 10, a rule of thumb used to indicate relevance of an instrumental variable. No Licence is our preferred instrument as it has the strongest case for exogeneity and monotonicity, explained in more detail below. The results for No Licence are shown graphically in a binned scatter plot in Figure 6.

4.2 Instrument Exogeneity

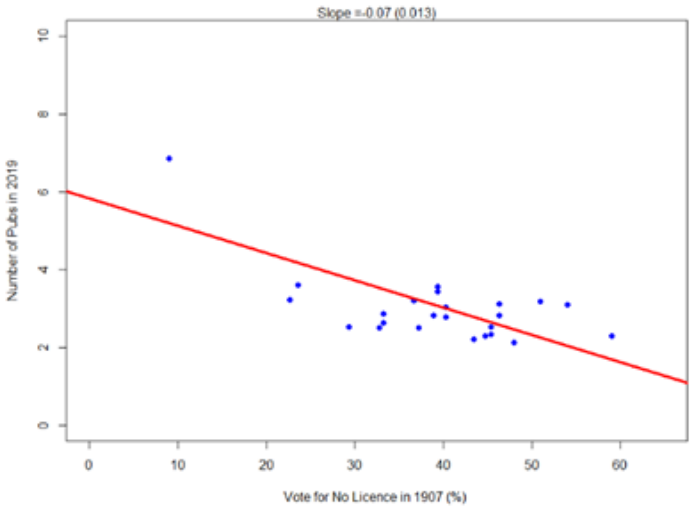
For an instrument (in this case, the results of the 1907 election) to be valid it has to affect the outcome (in this case, crime rates) only via the endogenous regressor (in this case, the number of pubs and clubs). We believe that there is a plausible case for exogeneity of our instrumental variable.

The large amount of time elapsed since the 1907 vote means that many potential avenues through which the vote could affect crime rates have been extinguished. First, the people who voted in the 1907 election are no longer alive. In fact, the population of

Table 3: First Stage Regression for Potential Instrumental Variables

	Dependent variable:							
	$Pubs_i$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No Licence (%)	−7.016***				−8.153***	−4.566*		
	(1.340)				(1.671)	(2.328)		
Reduce (%)		5.193**			−3.338		4.848**	
		(2.370)			(2.928)		(2.350)	
Continue (%)			8.385***			3.733	8.283***	
			(1.671)			(2.900)	(1.670)	
Reduce (Indicator)				−1.314***				
				(0.317)				
No Licence + Reduce (%)								−8.265***
								(1.672)
Constant	5.835***	2.186***	−0.701	4.007***	6.810***	3.199	−1.400*	7.611***
	(0.561)	(0.387)	(0.746)	(0.280)	(1.022)	(2.124)	(0.818)	(0.945)
F	27.4	4.8	25.16	17.23	14.35	14.53	14.74	24.45
Observations	1,319	1,319	1,319	1,332	1,319	1,319	1,319	1,319
R^2	0.020	0.004	0.019	0.013	0.021	0.022	0.022	0.018
Adjusted R^2	0.020	0.003	0.018	0.012	0.020	0.020	0.020	0.017

Figure 6: Binned Scatter Plot of First Stage regression for No Licence (%)



Notes: This is a binned scatter plot, each point has about 50 observations averaged.
Source: Author's calculations.

NSW is a completely different set of people to those who voted in 1907. This means that, at the level of the voter, social or personal characteristics which affected the decision to vote in 1907 can not affect any outcomes today. This argument is bolstered by the fact that the approach used in the 1907 vote was quickly scrapped, with no votes beyond 1913.

The large amount of time elapsed also means that the electoral districts used in 1907 are no longer relevant. The 1907 electorate boundaries do not align with any current electoral or administrative boundaries relevant to decision making. In particular, the boundaries are not at all associated with current local government areas or state electorates which are relevant for current decisions on liquor licensing.

Additionally, given the large amount of time elapsed, most NSW residents would be completely unaware of the 1907 vote let alone its effect on alcohol availability in the area where they live. That is, the results of the 1907 election are extremely unlikely to have any direct effect on the thoughts or actions of current residents as these residents simply do not know about the election.

There is some potential for long term impacts of the 1907 vote through intergenerational socio-demographic factors. For example, a 'working class' area in 1907 may have been more likely to oppose any form of prohibition. The socio-demographic characteristics of the area could potentially be passed down through multiple generations leading to a relationship with crime today. However, many of the social factors driving the results of the election have changed significantly. For example, inner city electorates that voted in favour of continuance (Darling Harbour, Pyrmont, Surry Hills, Redfern and Camperdown) were, at the time, relatively poor working class neighbourhoods but are now among the highest socioeconomic status in Australia. Australia has also, generally, undergone significant changes in socio-demographics with among the highest rates of migration in the world throughout the latter half of the twentieth century.

Overall, we believe that the time elapsed since the vote and the large political, administrative social and demographic changes that have occurred since 1907 mean that our propose instrument is likely to be exogenous. This means that the vote result in 1907 created, from the point of view of today, an "as good as random" variation in the number of alcohol outlets in NSW.

4.3 Instrument Monotonicity

In the context of instrumental variables, monotonicity requires that there are no 'defiers'. Within the context of study a defier would be a location where the 1907 vote was for Reduction but the location ended up increasing the number of alcohol licenses.

A number of institutional factors relating to the 1907 vote means that the presence of defiers is extremely unlikely. In particular, Local Option Courts were established after the vote to enforce reductions in all locations that voted for Reduction. The Sydney Morning Herald (21 June 1934 pg 8) provides detail on the structured approach used by these courts: "hotels with two convictions were allowed one year [to close], and those with one conviction were allowed two years [to close]. If there were insufficient hotels with convictions against them to make up the desired reduction of one fourth, then the Court applied reduction to ' hotels with clean records, having regard to 'the convenience of the public in the localities affected'. These latter hotels were all allowed three years [to close]."

As is shown in the Figure below, the final Reductions associated with the 1907 vote

took place in 1913, ultimately totalling 293 pubs, around 10% of the pubs in existence in 1907. Of the 65 electorates that carried Reduction, only three (Allowrie, Broken Hill and Sturt) did not carry out any Reductions (NSW Government 1954).

Figure 7: Implemented reductions in Pub Licences

PUBLICANS' LICENCES.

Year in which Licences to cease.	Number of Publicans' Licences to cease under respective votes.			
	1907 Vote.	1910 Vote.	1913 Vote.	Total.
1907	Nil	...	...	Nil
1908	17	...	...	17
1909	63	...	...	63
1910	Nil	Nil	...	Nil
1911	151	Nil	...	151
1912	5	1	...	6
1913	57	3	...	60
1914	Nil	24	Nil	24
1915	Nil	Nil	1	1
1916	Nil	Nil	Nil	Nil
1917	Nil	Nil	22	22
Total ...	293	28	23	344

*69329—3

Notes:
Source: .

In addition to this institutional context, we also tested a number of key subgroups for estimating the instrumental variable to support consideration of monotonicity. NEED A REFERENCE FOR WHY THIS IS USEFUL? The subgroups considered are based on regions, crime rates and income levels. The sign of the instrumental variable is consistent throughout all subgroups providing additional evidence of monotonicity being likely.

The analysis in this section provides both contextual and data-based support for the monotonicity if our proposed instrument. With the present of the monotonicity assumption the instrument provides the Local Average Treatment Effect (LATE), which will capture the average effect of an additional pub on crime rates in the local area.

Table 4

	Dependent variable:							
	$Pubs_i$							
	All	Sydney	Regional	Murders > 0	Low Crime	High Crime	Low Income	High Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No Licence (%)	−8.110***	−24.505***	−2.182*	−8.122***	−1.123**	−11.959***	−1.508	−15.604***
	(1.402)	(3.518)	(1.254)	(1.407)	(0.529)	(2.558)	(1.068)	(2.946)
Total Population	0.0001***	0.0001**	0.0001***	0.0001***	0.00001	0.0002***	0.0001***	0.0001**
	(0.00002)	(0.00004)	(0.00003)	(0.00002)	(0.00001)	(0.00004)	(0.00002)	(0.00004)
Mean Total income	−0.00001	−0.00001	0.00001	−0.00001	0.00001***	−0.00001	−0.00000	−0.00001
	(0.00001)	(0.00001)	(0.00002)	(0.00001)	(0.00000)	(0.00002)	(0.00000)	(0.00002)
Median Age Persons	−0.021	−0.102	−0.008	−0.020	0.031***	−0.008	−0.023	−0.032
	(0.029)	(0.075)	(0.029)	(0.029)	(0.010)	(0.056)	(0.022)	(0.074)
ESL Proportion	0.001	0.016	0.034	0.001	0.007**	−0.005	−0.008	0.017
	(0.009)	(0.015)	(0.032)	(0.009)	(0.003)	(0.016)	(0.007)	(0.017)
Constant	6.179***	15.698***	2.666	6.168***	0.146	7.626***	3.975***	9.285***
	(1.480)	(3.519)	(1.867)	(1.482)	(0.522)	(2.921)	(1.091)	(3.387)
Observations	1,315	547	768	1,313	663	650	714	601
R^2	0.045	0.122	0.025	0.045	0.040	0.065	0.019	0.072
Adjusted R^2	0.041	0.114	0.018	0.041	0.032	0.058	0.012	0.065
Note:								*p<0.1; **p<0.05; ***p<0.01

5 Results

Start by looking at naive results, in line with the literature, we see an almost universally positive relationship between the presence of Pubs and crime rates. As discussed, there are significant concerns with this approach to estimation.

Table 5: Naive OLS results

	Dependent variable:										
	Murder	Domestic Violence	Non Domestic Violence	Assault Police	Sexual Assault	Liquor Offences	Cannabis	Break and Enter	Steal from Motor	Property Damage	Offensive Conduct
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Pubs	0.027***	0.025**	0.061***	0.092***	0.039***	0.105***	0.052***	0.010	0.041***	0.042***	0.122***
	(0.009)	(0.010)	(0.017)	(0.035)	(0.010)	(0.031)	(0.017)	(0.016)	(0.012)	(0.015)	(0.040)
Total Population	−0.00001	−0.00001*	−0.00001**	0.00000	−0.00000	−0.00003***	−0.00001	0.00000	0.00000	−0.00000	−0.00001
	(0.00000)	(0.00000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00000)	(0.00001)
Mean Total income	−0.00000	−0.00001***	−0.00000	−0.00001	−0.00001	−0.00000	−0.00001	0.00001***	0.00001***	0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00001)	(0.00000)	(0.00001)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00001)
Median Age Persons	−0.017***	−0.040***	−0.039***	−0.044***	−0.032***	−0.013	−0.013	−0.021***	−0.036***	−0.030***	−0.028***
	(0.006)	(0.006)	(0.006)	(0.010)	(0.006)	(0.013)	(0.008)	(0.007)	(0.006)	(0.005)	(0.010)
ESL Proportion	−0.003	−0.016***	−0.018***	−0.021***	−0.022***	−0.021***	−0.014***	−0.007***	−0.010***	−0.015***	−0.034***
	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)
Employment Rate	−2.489***	−3.996***	−4.688***	−5.955***	−3.948***	−1.416	−3.515***	−3.824***	−3.268***	−3.005***	−5.085***
	(0.511)	(0.472)	(0.634)	(1.072)	(0.507)	(1.167)	(0.767)	(0.506)	(0.574)	(0.481)	(0.979)
Population density	0.0001***	0.00002	0.0001***	0.0001***	0.00001	0.0001***	0.0001***	0.00001	0.0001***	0.00002**	0.0002***
	(0.00002)	(0.00001)	(0.00002)	(0.00002)	(0.00002)	(0.00003)	(0.00003)	(0.00002)	(0.00001)	(0.00001)	(0.00003)
SEIFA Ec Res	−0.009	−0.007	0.002	0.014	−0.004	−0.037*	−0.011	−0.004	0.015	0.010	0.009
	(0.010)	(0.009)	(0.012)	(0.018)	(0.010)	(0.022)	(0.014)	(0.012)	(0.012)	(0.009)	(0.019)
Business closure rate	−0.574	0.714	−0.535	2.631	0.199	−5.907**	−2.192*	3.264**	3.124*	1.084	−3.039*
	(1.040)	(1.147)	(1.166)	(2.249)	(1.108)	(2.641)	(1.207)	(1.569)	(1.801)	(1.360)	(1.736)
Constant	3.355***	11.484***	11.836***	9.201***	9.164***	7.824***	9.308***	9.550***	9.641***	10.721***	9.195***
	(0.517)	(0.462)	(0.567)	(0.943)	(0.469)	(1.108)	(0.668)	(0.509)	(0.508)	(0.454)	(0.897)
Observations	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271
R^2	0.100	0.261	0.262	0.210	0.186	0.185	0.145	0.140	0.289	0.190	0.234
Adjusted R^2	0.094	0.256	0.256	0.204	0.181	0.180	0.139	0.134	0.283	0.184	0.228
Note:											*p<0.1; **p<0.05; ***p<0.01

We then move on to look at Instrumental Variable results. In this specification, the endogenous variable, Pubs, has been instrument with the outcome of the 1907 vote. After introducing this instrument, the previously identified effect is eliminated for all crimes except non-domestic violence, liquor offences and offensive conduct. This suggests that the present of pubs, and therefor alcohol, does lead to an increase in this specific subset of 'public' crime. This result aligns with intuition that the presence of pubs could lead to more public drunkenness and, therefore, to an increase in some public crimes.

Table 6: IV results

	Dependent variable:										
	Murder	Domestic Violence	Non Domestic Violence	Assault Police	Sexual Assault	Liquor Offences	Cannabis	Break and Enter	Steal from Motor	Property Damage	Offensive Conduct
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Pubs	0.066	0.039	0.125**	0.054	0.102	0.450*	0.078	−0.141*	−0.073	0.041	0.199**
	(0.059)	(0.049)	(0.057)	(0.092)	(0.065)	(0.234)	(0.083)	(0.072)	(0.100)	(0.042)	(0.096)
Total Population	−0.00001	−0.00001	−0.00002**	0.00000	−0.00001	−0.0001***	−0.00001	0.00001*	0.00001	−0.00000	−0.00001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Mean Total income	−0.00000	−0.00001***	−0.00000	−0.00001	−0.00001	−0.00000	−0.00001	0.00001***	0.00001**	0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00001)	(0.00000)	(0.00001)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Median Age Persons	−0.015**	−0.041***	−0.037***	−0.048***	−0.030***	0.004	−0.012	−0.030***	−0.042***	−0.030***	−0.025**
	(0.007)	(0.006)	(0.007)	(0.011)	(0.006)	(0.017)	(0.009)	(0.009)	(0.008)	(0.006)	(0.011)
ESL Proportion	−0.002	−0.015***	−0.016***	−0.022***	−0.020***	−0.010	−0.013***	−0.012***	−0.013***	−0.015***	−0.032***
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)	(0.010)	(0.003)	(0.003)	(0.005)	(0.002)	(0.004)
Employment Rate	−2.163***	−3.823***	−4.072***	−6.112***	−3.352***	1.508	−3.237***	−5.028***	−4.190***	−2.956***	−4.309***
	(0.670)	(0.605)	(0.710)	(1.332)	(0.679)	(1.926)	(1.117)	(0.902)	(0.909)	(0.605)	(1.240)
Population density	0.00004*	0.00001	0.0001**	0.0001***	−0.00001	0.00001	0.0001*	0.0001*	0.0001***	0.00002	0.0001***
	(0.00003)	(0.00002)	(0.00003)	(0.00004)	(0.00003)	(0.0001)	(0.00004)	(0.00004)	(0.00004)	(0.00002)	(0.00004)
SEIFA Ec Res	−0.006	−0.006	0.005	0.013	−0.00002	−0.020	−0.009	−0.012	0.009	0.010	0.014
	(0.010)	(0.009)	(0.012)	(0.019)	(0.011)	(0.031)	(0.014)	(0.014)	(0.014)	(0.008)	(0.018)
Business closure rate	0.071	1.028	0.649	2.235	1.353	−0.194	−1.690	0.842	1.273	1.147	−1.626
	(1.410)	(1.372)	(1.538)	(2.621)	(1.607)	(3.296)	(1.676)	(1.534)	(1.900)	(1.619)	(2.232)
Constant	2.883***	11.292***	11.031***	9.561***	8.389***	3.745	8.970***	11.307***	10.970***	10.696***	8.194***
	(0.804)	(0.670)	(0.807)	(1.401)	(0.796)	(2.547)	(1.216)	(1.029)	(1.139)	(0.686)	(1.383)
Observations	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258
R^2	0.065	0.252	0.175	0.198	0.106	−0.743	0.132	−0.532	−0.034	0.189	0.190
Adjusted R^2	0.059	0.246	0.169	0.192	0.100	−0.755	0.126	−0.543	−0.042	0.183	0.184
Note:											*p<0.1; **p<0.05; ***p<0.01

The table below provides a direct comparison between the Naive and IV results for different crimes. This shows that, for most crimes, the IV result is large in magnitude, although often with a higher standard error.

Table 7: Comparison of Naive and IV

	Dependent variable:											
	Domestic Violence		Non-Domestic Violence		Break and Enter		Steal from Motor		Property Damage		Offensive Conduct	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Pubs	0.025**		0.061***		0.010		0.041***		0.042***		0.122***	
	(0.010)		(0.017)		(0.016)		(0.012)		(0.015)		(0.040)	
$\hat{Pubs}$		0.039		0.125**		−0.141*		−0.073		0.041		0.199**
		(0.049)		(0.057)		(0.072)		(0.100)		(0.042)		(0.096)
Total Population	−0.00001*	−0.00001	−0.00001**	−0.00002**	0.00000	0.00001*	0.00000	0.00001	−0.00000	−0.00000	−0.00001	−0.00001
	(0.00000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00000)	(0.00001)	(0.00001)	(0.00001)
Mean Total income	−0.00001***	−0.00001***	−0.00000	−0.00000	0.00001***	0.00001***	0.00001***	0.00001**	0.00000	0.00000	−0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00001)	(0.00000)
Median Age Persons	−0.040***	−0.041***	−0.039***	−0.037***	−0.021***	−0.030***	−0.036***	−0.042***	−0.030***	−0.030***	−0.028***	−0.025**
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.006)	(0.008)	(0.005)	(0.006)	(0.010)	(0.011)
ESL Proportion	−0.016***	−0.015***	−0.018***	−0.016***	−0.007***	−0.012***	−0.010***	−0.013***	−0.015***	−0.015***	−0.034***	−0.032***
	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.005)	(0.001)	(0.002)	(0.003)	(0.004)
Employment Rate	−3.996***	−3.823***	−4.688***	−4.072***	−3.824***	−5.028***	−3.268***	−4.190***	−3.005***	−2.956***	−5.085***	−4.309***
	(0.472)	(0.605)	(0.634)	(0.710)	(0.506)	(0.902)	(0.574)	(0.909)	(0.481)	(0.605)	(0.979)	(1.240)
Population density	0.00002	0.00001	0.0001***	0.0001**	0.00001	0.0001*	0.0001***	0.0001***	0.00002**	0.00002	0.0002***	0.0001***
	(0.00001)	(0.00002)	(0.00002)	(0.00003)	(0.00002)	(0.00004)	(0.00001)	(0.00004)	(0.00001)	(0.00002)	(0.00003)	(0.00004)
SEIFA Ec Res	−0.007	−0.006	0.002	0.005	−0.004	−0.012	0.015	0.009	0.010	0.010	0.009	0.014
	(0.009)	(0.009)	(0.012)	(0.012)	(0.012)	(0.014)	(0.012)	(0.014)	(0.009)	(0.008)	(0.019)	(0.018)
Business closure rate	0.714	1.028	−0.535	0.649	3.264**	0.842	3.124*	1.273	1.084	1.147	−3.039*	−1.626
	(1.147)	(1.372)	(1.166)	(1.538)	(1.569)	(1.534)	(1.801)	(1.900)	(1.360)	(1.619)	(1.736)	(2.232)
Constant	11.484***	11.292***	11.836***	11.031***	9.550***	11.307***	9.641***	10.970***	10.721***	10.696***	9.195***	8.194***
	(0.462)	(0.670)	(0.567)	(0.807)	(0.509)	(1.029)	(0.508)	(1.139)	(0.454)	(0.686)	(0.897)	(1.383)
Observations	1,271	1,258	1,271	1,258	1,271	1,258	1,271	1,258	1,271	1,258	1,271	1,258
R^2	0.261	0.252	0.262	0.175	0.140	−0.532	0.289	−0.034	0.190	0.189	0.234	0.190
Adjusted R^2	0.256	0.246	0.256	0.169	0.134	−0.543	0.283	−0.042	0.184	0.183	0.228	0.184
Note:												*p<0.1; **p<0.05; ***p<0.01

As non-domestic violence is a key finding hte main results, the table below present a further investigation of how the addition of covariates affects the estimated marginal impact of a pub. Overall, the parameter estimate against Pubs remains statistically significant, of hte same sign and fairly stable in magniude across all specifications. This indicates that the particular set of covariates selected in the modelling is unlikely to unduly influence the final results.

A subgroup analysis for Non-Domestic Vioulence is presented int he following table. Sub groups have been defined based on geographic variables as well as crime based variables. It appears that, for Non-Domestic Violence at least, the main results are driven by locations within Sydney that have high levels of crime as well as high Incomes. These are likely to be areas close to the city centre that combine both high crime and high income locations. This is a somewhat unexpected finding and indicates that policy needs to be highly targeted to specific areas rather than applied in a blanket fashion across hte city or state.

Overall finding of the results is that, after correcting with an instrumental variable, the often found positive relationship between alcohol availability and crime is much reduced. A positive relationship is still found for some select 'public' crimes and this is being driven by urban areas that combine both high incomes and high general crime rates.

Table 8: Covariate build up

	Dependent variable:								
	Non-Domestic Violence								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\hat{Pubs}$	0.193**	0.166***	0.189***	0.160***	0.143***	0.153***	0.117**	0.120**	0.125**
	(0.077)	(0.058)	(0.065)	(0.056)	(0.051)	(0.051)	(0.047)	(0.050)	(0.057)
Total Population		−0.00002***	−0.00002**	−0.00002***	−0.00002**	−0.00001**	−0.00001**	−0.00002**	−0.00002**
		(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Mean Total income			−0.00000	−0.00001*	−0.00001**	0.00000	−0.00000	−0.00000	−0.00000
			(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Median Age Persons				−0.026***	−0.035***	−0.036***	−0.035***	−0.037***	−0.037***
				(0.007)	(0.008)	(0.007)	(0.006)	(0.006)	(0.007)
ESL Proportion					−0.006***	−0.012***	−0.016***	−0.016***	−0.016***
					(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Employment Rate						−4.170***	−4.100***	−4.167***	−4.072***
						(0.651)	(0.630)	(0.654)	(0.710)
Population density							0.0001**	0.0001**	0.0001**
							(0.00002)	(0.00002)	(0.00003)
SEIFA Ec Res								0.007	0.005
								(0.012)	(0.012)
Business closure rate									0.649
									(1.538)
Constant	6.077***	6.420***	6.593***	7.894***	8.350***	10.826***	11.001***	11.176***	11.031***
	(0.215)	(0.131)	(0.207)	(0.406)	(0.448)	(0.624)	(0.619)	(0.640)	(0.807)
Observations	1,316	1,316	1,314	1,314	1,313	1,311	1,305	1,258	1,258
R^2	−0.202	−0.063	−0.154	−0.020	0.044	0.072	0.184	0.188	0.175
Adjusted R^2	−0.203	−0.065	−0.157	−0.024	0.040	0.068	0.179	0.183	0.169

Note: *p<0.1; **p<0.05; ***p<0.01

Table 9: Sub group analysis

	Dependent variable:							
				Non Domestic Violence				
	All	Sydney	Regional	Murders>0	Low Crime	High Crime	Low Income	High Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\hat{Pubs}$	0.143***	0.129***	0.250*	0.125**	0.240	0.080**	0.358	0.085**
	(0.051)	(0.032)	(0.148)	(0.051)	(0.300)	(0.039)	(0.341)	(0.038)
Total Population	−0.00002**	−0.00002**	−0.00003**	−0.00002***	−0.00001	−0.00001	−0.00003	−0.00001
	(0.00001)	(0.00001)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00002)	(0.00001)
Mean Total income	−0.00001**	−0.00001**	−0.00001	−0.00000*	−0.00001**	0.00001*	−0.00000	−0.00001
	(0.00000)	(0.00000)	(0.00001)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Median Age Persons	−0.035***	−0.049***	−0.023***	−0.037***	−0.011	−0.035***	−0.035**	−0.029***
	(0.008)	(0.014)	(0.009)	(0.007)	(0.011)	(0.007)	(0.014)	(0.011)
ESL Proportion	−0.006***	−0.023***	−0.006	−0.016***	−0.008***	−0.014***	−0.017***	−0.016***
	(0.002)	(0.003)	(0.014)	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)
Employment Rate		−4.691***	−3.608***	−4.072***	−1.976***	−3.415***	−3.990***	−3.666***
		(0.924)	(1.283)	(0.635)	(0.557)	(0.664)	(1.103)	(1.240)
Population density		0.00003	0.0002**	0.0001**	0.00004	0.00000	0.0001	0.0001***
		(0.00002)	(0.0001)	(0.00002)	(0.00004)	(0.00002)	(0.0001)	(0.00002)
SEIFA Ec Res		−0.005	−0.020	0.005	−0.002	0.013	−0.019	−0.003
		(0.017)	(0.023)	(0.011)	(0.012)	(0.013)	(0.036)	(0.015)
Business closure rate		−1.313	0.379	0.649	1.627	−1.095	4.419	−2.983
		(1.754)	(4.090)	(1.403)	(1.336)	(2.117)	(4.988)	(2.365)
Constant	8.350***	12.745***	10.147***	11.031***	7.847***	10.738***	10.144***	10.960***
	(0.448)	(1.019)	(1.247)	(0.747)	(0.548)	(0.721)	(2.254)	(1.053)
Observations	1,313	519	739	1,258	638	620	685	573
R^2	0.044	0.083	0.009	0.175	0.107	0.063	−0.120	0.259
Adjusted R^2	0.040	0.067	−0.003	0.169	0.094	0.049	−0.134	0.248
Note:								*p<0.1; **p<0.05; ***p<0.01

6 Robustness Tests

The first robustness test is to simply vary which instruments are used. The main results use our preferred instrument, No Licence, the table below uses a different instrument which adds together the proportion of voters voting for No Licence and those voting for Reduce. This is abroader indication of support for prohibition in 1907. Overall, the results are broadly aligned between the main results and this robustness test.

Table 10: IV results - No Licence + Reduce

	Dependent variable:										
	Murder	Domestic Violence	Non Domestic Violence	Assault Police	Sexual Assault	Liquor Offences	Cannabis	Break and Enter	Steal from Motor	Property Damage	Offensive Conduct
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Pubs	0.021	−0.008	0.084**	−0.014	0.067	0.314***	0.008	−0.124***	−0.039	0.024	0.142**
	(0.039)	(0.033)	(0.039)	(0.067)	(0.042)	(0.079)	(0.049)	(0.044)	(0.038)	(0.030)	(0.067)
Total Population	−0.00000	−0.00000	−0.00001**	0.00001	−0.00000	−0.00005***	−0.00000	0.00001**	0.00001	−0.00000	−0.00001
	(0.00001)	(0.00000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00000)	(0.00001)
Mean Total income	−0.00000	−0.00001***	−0.00000*	−0.00001**	−0.00001**	−0.00000	−0.00001***	0.00001***	0.00001***	0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Median Age Persons	−0.017***	−0.043***	−0.039***	−0.052***	−0.032***	−0.003	−0.016**	−0.029***	−0.040***	−0.031***	−0.028***
	(0.006)	(0.005)	(0.006)	(0.011)	(0.006)	(0.012)	(0.008)	(0.007)	(0.006)	(0.005)	(0.010)
ESL Proportion	−0.003	−0.017***	−0.018***	−0.024***	−0.021***	−0.015***	−0.015***	−0.011***	−0.012***	−0.015***	−0.034***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.005)	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)
Employment Rate	−2.543***	−4.211***	−4.414***	−6.676***	−3.643***	0.376	−3.820***	−4.886***	−3.910***	−3.096***	−4.786***
	(0.565)	(0.470)	(0.556)	(0.969)	(0.598)	(1.136)	(0.707)	(0.637)	(0.551)	(0.438)	(0.961)
Population density	0.0001***	0.00003	0.0001***	0.0002***	0.00000	0.0001	0.0001***	0.0001**	0.0001***	0.00003*	0.0002***
	(0.00002)	(0.00002)	(0.00002)	(0.00004)	(0.00002)	(0.00004)	(0.00003)	(0.00002)	(0.00002)	(0.00002)	(0.00004)
SEIFA Ec Res	−0.008	−0.009	0.003	0.010	−0.002	−0.027	−0.013	−0.011	0.011	0.009	0.011
	(0.010)	(0.009)	(0.010)	(0.018)	(0.011)	(0.021)	(0.013)	(0.012)	(0.010)	(0.008)	(0.018)
Business closure rate	−0.681	0.259	−0.029	1.119	0.777	−2.434	−2.843*	1.122	1.827	0.869	−2.570
	(1.270)	(1.057)	(1.250)	(2.180)	(1.345)	(2.556)	(1.589)	(1.432)	(1.239)	(0.984)	(2.161)
Constant	3.424***	11.845***	11.519***	10.364***	8.804***	5.356***	9.799***	11.106***	10.572***	10.896***	8.872***
	(0.634)	(0.528)	(0.625)	(1.089)	(0.672)	(1.277)	(0.794)	(0.716)	(0.619)	(0.492)	(1.079)
Observations	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258
R^2	0.101	0.223	0.249	0.119	0.168	−0.157	0.112	−0.389	0.128	0.177	0.230
Adjusted R^2	0.095	0.217	0.244	0.112	0.162	−0.165	0.105	−0.399	0.121	0.171	0.224
Note:											*p<0.1; **p<0.05; ***p<0.01

Another alternative instrumental variable is to simply use an indicator variable if Reduction was passed in the electorate. This approach flattens out some of the variability seen in the 1907 vote and should be expected to provide a less effective instrument than our preferred one. The results are, again, broadly aligned with the main results with a reduction in statistical significance for some variables (notably, Non-Domestic violence and Offensive conduct)

Table 11: IV results - Indicator for Reduction

	Dependent variable:										
	Murder	Domestic Violence	Non Domestic Violence	Assault Police	Sexual Assault	Liquor Offences	Cannabis	Break and Enter	Steal from Motor	Property Damage	Offensive Conduct
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Pubs	0.094**	−0.035	0.073*	−0.036	0.094*	0.427***	0.052	−0.157***	−0.066	−0.007	0.099
	(0.048)	(0.039)	(0.044)	(0.079)	(0.049)	(0.107)	(0.055)	(0.056)	(0.047)	(0.036)	(0.077)
Total Population	−0.00001	−0.00000	−0.00001**	0.00001	−0.00001	−0.0001***	−0.00001	0.00002**	0.00001	0.00000	−0.00001
	(0.00001)	(0.00000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00000)	(0.00001)
Mean Total income	−0.00000	−0.00001***	−0.00000*	−0.00001**	−0.00001**	−0.00000	−0.00001***	0.00001***	0.00001***	0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Median Age Persons	−0.013**	−0.044***	−0.039***	−0.051***	−0.029***	0.005	−0.013*	−0.030***	−0.042***	−0.032***	−0.029***
	(0.007)	(0.005)	(0.006)	(0.011)	(0.007)	(0.015)	(0.008)	(0.008)	(0.006)	(0.005)	(0.011)
ESL Proportion	−0.001	−0.018***	−0.018***	−0.025***	−0.020***	−0.011*	−0.014***	−0.012***	−0.013***	−0.016***	−0.035***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.006)	(0.003)	(0.003)	(0.003)	(0.002)	(0.004)
Employment Rate	−1.932***	−4.499***	−4.590***	−7.022***	−3.495***	1.265	−3.514***	−5.213***	−4.165***	−3.417***	−5.278***
	(0.632)	(0.517)	(0.580)	(1.040)	(0.644)	(1.410)	(0.727)	(0.734)	(0.617)	(0.480)	(1.011)
Population density	0.00003	0.00004**	0.0001***	0.0002***	−0.00001	0.00002	0.0001***	0.0001**	0.0001***	0.00004**	0.0002***
	(0.00002)	(0.00002)	(0.00002)	(0.00004)	(0.00002)	(0.0001)	(0.00003)	(0.00003)	(0.00002)	(0.00002)	(0.00004)
SEIFA Ec Res	−0.005	−0.011	0.002	0.007	−0.001	−0.020	−0.011	−0.013	0.009	0.007	0.008
	(0.011)	(0.009)	(0.010)	(0.018)	(0.011)	(0.025)	(0.013)	(0.013)	(0.011)	(0.008)	(0.018)
Business closure rate	0.502	−0.258	−0.347	0.571	1.074	−0.733	−2.190	0.582	1.393	0.289	−3.412
	(1.395)	(1.141)	(1.280)	(2.297)	(1.422)	(3.113)	(1.604)	(1.622)	(1.363)	(1.061)	(2.232)
Constant	2.560***	12.202***	11.696***	10.723***	8.518***	4.000**	9.307***	11.531***	10.920***	11.308***	9.471***
	(0.731)	(0.598)	(0.671)	(1.204)	(0.745)	(1.632)	(0.841)	(0.850)	(0.714)	(0.556)	(1.170)
Observations	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271	1,271
R^2	−0.007	0.151	0.259	0.077	0.127	−0.611	0.145	−0.684	−0.0002	0.099	0.230
Adjusted R^2	−0.014	0.145	0.254	0.071	0.121	−0.623	0.139	−0.696	−0.007	0.093	0.224
Note:											*p<0.1; **p<0.05; ***p<0.01

The next robustness test changes the dependent variable to a select group of non-crime indicators that are likely to be associated with the presence of pubs. These are the number of public safety workers, the number of accommodation workers and the number of large hotels. It's likely that districts where there are a large number of pubs will also be home to active nightlife activity and the associated need for safety workers. In this table, the first column of each pair shows the naive regression results while the second shows the IV results. The naive results are mixed with a negative relationship between the number of public safety workers and Pubs. However, after introducing the IV all parameters are of the expected sign and two are highly statistically significant. This result supports the view that the IV addresses endogeneity issues with the naive regression.

Table 12: Non-Crime outcomes

	Dependent variable:					
	Num Public Safety Workers		Accommodation Workers		Num Large Hotels (¿15 Rooms)	
	(1)	(2)	(3)	(4)	(5)	(6)
Pubs	−0.011		0.178***		0.621***	
	(0.016)		(0.015)		(0.050)	
$\hat{Pubs}$		0.359**		0.152		3.131***
		(0.181)		(0.142)		(0.831)
Total Population	−0.00000	−0.00003	0.00005***	0.00005***	0.0002***	−0.00003
	(0.00001)	(0.00002)	(0.00001)	(0.00002)	(0.0001)	(0.0001)
Mean Total income	−0.00002***	−0.00002***	−0.00004***	−0.00004***	−0.0001**	−0.0001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00003)	(0.0001)
Median Age Persons	−0.121***	−0.102***	0.087***	0.090***	0.014	0.164
	(0.017)	(0.022)	(0.016)	(0.017)	(0.063)	(0.138)
ESL Proportion	−0.053***	−0.043***	−0.012**	−0.013*	0.036	0.062
	(0.006)	(0.009)	(0.006)	(0.007)	(0.025)	(0.051)
Employment Rate	5.138***	8.196***	−5.290***	−5.882***	4.644	27.089**
	(1.362)	(2.269)	(1.279)	(1.778)	(5.194)	(12.842)
Population density	−0.00002	−0.0002*	0.0003***	0.0004***	0.0001	−0.001
	(0.00005)	(0.0001)	(0.00004)	(0.0001)	(0.0002)	(0.0004)
SEIFA Ec Res	−0.070**	−0.056	−0.020	−0.024	−0.281**	−0.103
	(0.030)	(0.037)	(0.028)	(0.029)	(0.116)	(0.243)
Business closure rate	15.951***	24.189***	16.351***	15.190***	−27.285*	31.927
	(3.827)	(6.146)	(3.595)	(4.815)	(15.760)	(37.360)
Constant	8.497***	4.026	6.391***	6.953***	3.953	−28.919**
	(1.295)	(2.736)	(1.217)	(2.143)	(4.689)	(14.417)
Observations	1,271	1,258	1,271	1,258	827	821
R^2	0.117	−0.258	0.289	0.293	0.222	−2.183
Adjusted R^2	0.111	−0.267	0.284	0.288	0.213	−2.218
Note:						*p<0.1; **p<0.05; ***p<0.01

7 Discussion

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