



Lockouts and last drinks:

The impact of the January 2014 liquor licence reforms on assaults in NSW, Australia

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Aims: To determine (1) whether the January 2014 reforms to the NSW Liquor Act reduced the incidence of assault in the Kings Cross and Sydney CBD Entertainment Precincts. (2) Whether the incidence of assault increased in areas proximate to these Precincts or in nightspots further away but still within easy reach of these Precincts. (3) If there is evidence of displacement, and whether the reduction in assaults in the Kings Cross and Sydney CBD Entertainment Precincts was larger than the increase in the number of assaults in the displacement areas.

Method: We examine the effects of the legislative reforms introduced in January 2014 using time series structural models. These models are used to estimate the underlying long term dynamics of the time series of police recorded non-domestic assaults in NSW between January 2009 and December 2013. The effect of the January 2014 reform is captured by including terms in the models reflecting the timing of the change. Separate analyses are carried out for: the Kings Cross Precinct (KXP); the Sydney CBD Entertainment Precinct (CBD); an area contiguous with KXP and CBD that we refer to as the proximal displacement area (PDA); a group of entertainment areas not far from the Kings Cross or the Sydney CBD Precincts, which we refer to as the distal displacement area (DDA) and the rest of NSW.

Results: Following the reforms statistically significant and substantial reductions in assault occurred in both the Kings Cross (down 32%) and Sydney CBD Entertainment Precinct (down 26 %) (including a 40% decline in the sub-section George Street – South). A smaller but still significant reduction in assault occurred across the rest of NSW (9% decrease). The January 2014 reforms were also associated with small decreases in assault in the PDA and the DDA but neither of these changes was statistically significant. There was some evidence that assaults increased in and around The Star casino, however the effects are not statistically significant and the reduction in assault elsewhere was much larger than the increase around The Star casino.

Conclusion: The January 2014 reforms appear to have reduced the incidence of assault in the Kings Cross and CBD Entertainment Precincts. The extent to which this is due to a change in alcohol consumption or a change in the number of people visiting the Kings Cross and Sydney Entertainment Precincts remains unknown.

Keywords: alcohol, assault, trading-hours, liquor licence, Kings Cross, Sydney, time series structural models, displacement.

INTRODUCTION

On New Year's Eve, 2013, a young man named Daniel Christie was assaulted in Kings Cross; dying 11 days later as a result of his injuries. The incident sparked immediate calls for tougher regulation of licensed premises, especially in Kings Cross and the Sydney Central Business District (CBD) (Roth, 2014). On the 21st of January, 2014 the New South Wales (NSW) State Government announced new restrictions (hereafter referred to as the January 2014 reforms) on licensed premises to curb alcohol-related violence¹. The new restrictions (contained in the Liquor Amendment Act, 2014) imposed by the State Government took effect on the 24th of February 2014² and included:

1. 1.30am lockouts³ at hotels, registered clubs, nightclubs and karaoke bars in two designated areas: the Sydney CBD Entertainment Precinct and Kings Cross Precinct;
2. 3.00am cessation of alcohol service in venues in these Precincts;
3. A freeze on new liquor licences and approvals for existing licences across the Sydney CBD Entertainment Precinct and continuation of the existing freeze in the Kings Cross Precinct⁴;
4. A ban on takeaway alcohol sales after 10.00pm across NSW;
5. The extension of temporary and long-term banning orders issued to designated 'trouble-makers' to prevent them entering most licensed premises in the Kings Cross and Sydney CBD entertainment precincts;

6. The introduction of a new risk based licence fee for all licensed premises in which the annual fee payable by a particular venue depends upon its licence type, compliance history and trading hours;
7. The suspension of on-line responsible service of alcohol training.

Our aim in this study was to address three questions: (1) Have the January 2014 reforms reduced the incidence of assault in the Kings Cross and Sydney CBD Entertainment Precincts? (2) Has the incidence of assault increased in areas proximate to these Precincts or in nightspots further away but still within easy reach of these Precincts (3). If there is evidence of displacement, is the reduction in assaults in the Kings Cross and Sydney CBD Entertainment Precincts larger than the rise in the number of assaults in the displacement areas?

In answering these questions we make no attempt to isolate the separate effects of the 1.30am lockouts, the 3.00am cessation of alcohol service and the introduction of temporary banning orders for 'trouble makers' in the Sydney CBD Entertainment Precinct. Our focus here is solely on the joint impact of the initiatives just mentioned.

THE CURRENT STUDY

Past research suggests that trading hours have a powerful influence on levels of alcohol-related crime. A number of studies have found that longer trading hours for licensed premises are associated with higher levels of alcohol-related violence (e.g. Chikritzhs & Stockwell, 2002. See also the review by Stockwell & Chikritzhs, 2009). Several studies have also found that liquor licence restrictions reduce alcohol-related violence (Douglas, 1998; Voas, Lange & Johnson, 2002; Voas, Romano, Kelly-Baker & Tippetts, 2006; Duailibi, Ponicki, Grube, Pinsky, Laranjeira & Raw, 2007; Kypri, Jones, McElduff & Barker, 2011). Kypri et al. (2011), for example, found that the introduction of lockouts and earlier closing times across 14 licensed premises in Newcastle (a coastal city located some 160km north of Sydney) in 2008, was associated with a substantial fall in assaults, without resulting in any displacement of violence into a neighbouring 'control' area.

Although the Newcastle study and other similar studies provide support for a policy of restricting liquor licensed trading hours, there are some significant differences between Newcastle and Sydney that might blunt the effects of similar restrictions in the Kings Cross and Sydney CBD Entertainment Precincts. To begin with, the annual number of assaults recorded in the Sydney Local Government Area (LGA) is more than three times the number recorded in Newcastle LGA, while the number of licensed premises in the Sydney LGA (2,285) is nearly six times the number in Newcastle LGA (398) (NSW Office of Liquor,

Gaming and Racing, 2014). Even without any displacement this could make enforcement of the new laws potentially more difficult. Secondly, and more importantly, drinkers unable to consume alcohol in the Kings Cross and Sydney CBD Entertainment Precincts only have to travel a short distance to reach licensed premises unaffected by the restrictions (see Figure 1). Drinkers in Newcastle showed no propensity to travel to Hamilton (a nearby suburb without the same liquor license restrictions) but the range of alternative licensed venues is far larger in Sydney than in Newcastle.

Studies of the impact of spatially concentrated crime control initiatives sometimes report geographical displacement (the crime problem shifts to an area outside the target areas) and sometimes report a diffusion of benefits (the crime problem reduces in the target area and in areas surrounding the target area). The available evidence suggests that diffusion of crime benefits is more common than crime displacement (Bowers et al., 2011). There are at least two ways, nonetheless, in which spatial displacement might manifest itself in response to the January 2014 reforms. The first is an increase in violence in areas contiguous to the Kings Cross and Sydney CBD Entertainment Precincts (e.g. The Star casino, Ultimo, Surry Hills). The second is an increase in violence in nightspots some distance away from the Kings Cross and Sydney CBD Entertainment Precincts but within easy reach of those Precincts (e.g. Double Bay, Newtown, and Bondi among others).

With one exception, the January 2014 reforms listed above were targeted at the Kings Cross and Sydney CBD Entertainment Precincts. The exception is item four: the ban on takeaway alcohol sales after 10.00pm which applies across NSW. For the purposes of our analysis of the impact of the January 2014 reforms on violence, NSW is divided into six regions (see Figures 1 and 2). The first is the Kings Cross Precinct (KXP). The second is the Sydney CBD Entertainment Precinct (CBD). The third is George Street – South (GSt) which is a non-domestic assault hotspot within the the Sydney CBD Entertainment Precinct .The fourth consists of an area contiguous with KXP and CBD and referred to hereafter as the proximal displacement area (PDA). The fifth comprises a group of entertainment areas not far from the Kings Cross or the Sydney CBD Precincts and referred to hereafter as the distal displacement area (DDA). The sixth region consists of the rest of NSW (and will be referred to as such). The first five regions are highlighted in Figure 1, which shows the target Precincts in blue and red and George Street South in diagonal lines; the PDA in yellow and The Star Casino in the dotted area. Figure 2 shows the DDA in yellow. The rest of NSW is not shown.

If the January 2014 reforms achieve their intended purpose, we would expect to see a reduction in assault in the target areas (i.e. the KXP and CBD). Because four out of the five reforms apply only in the target areas, we would expect any reduction in

Figure 1. The two target areas, Sydney CBD Entertainment including George Street South and Kings Cross Precincts, together with the proximal displacement area

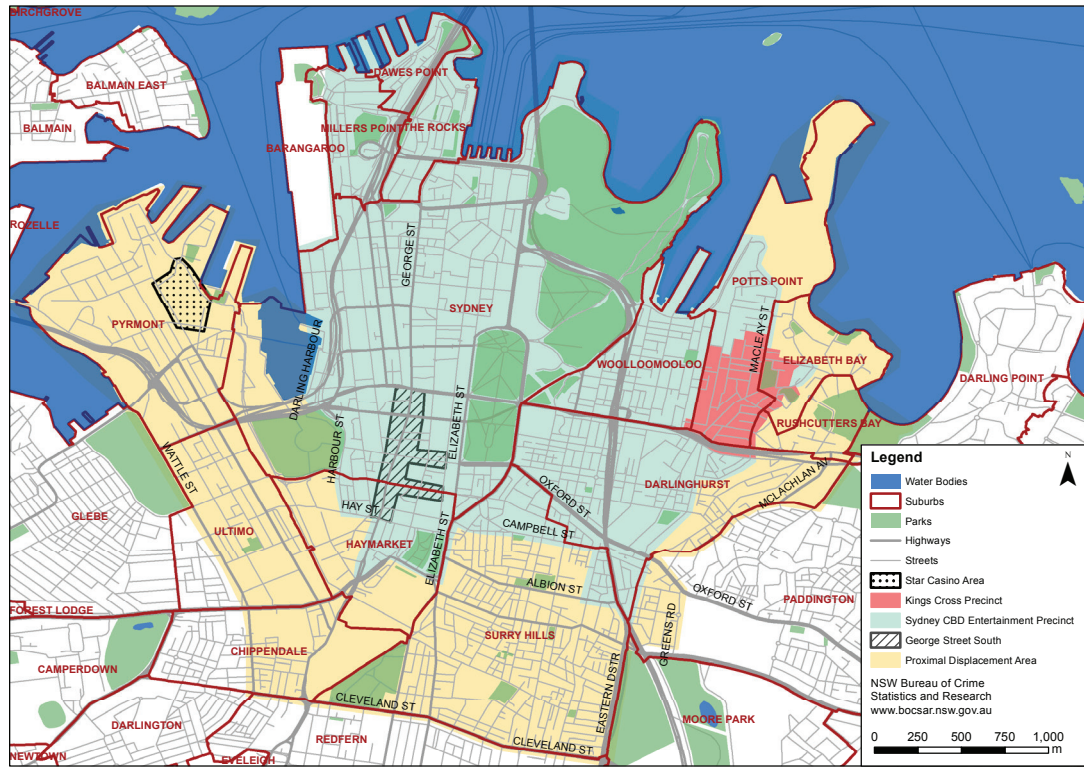


Figure 2. Distal displacement areas in orange including Bondi Beach, Coogee, Double Bay and Newtown

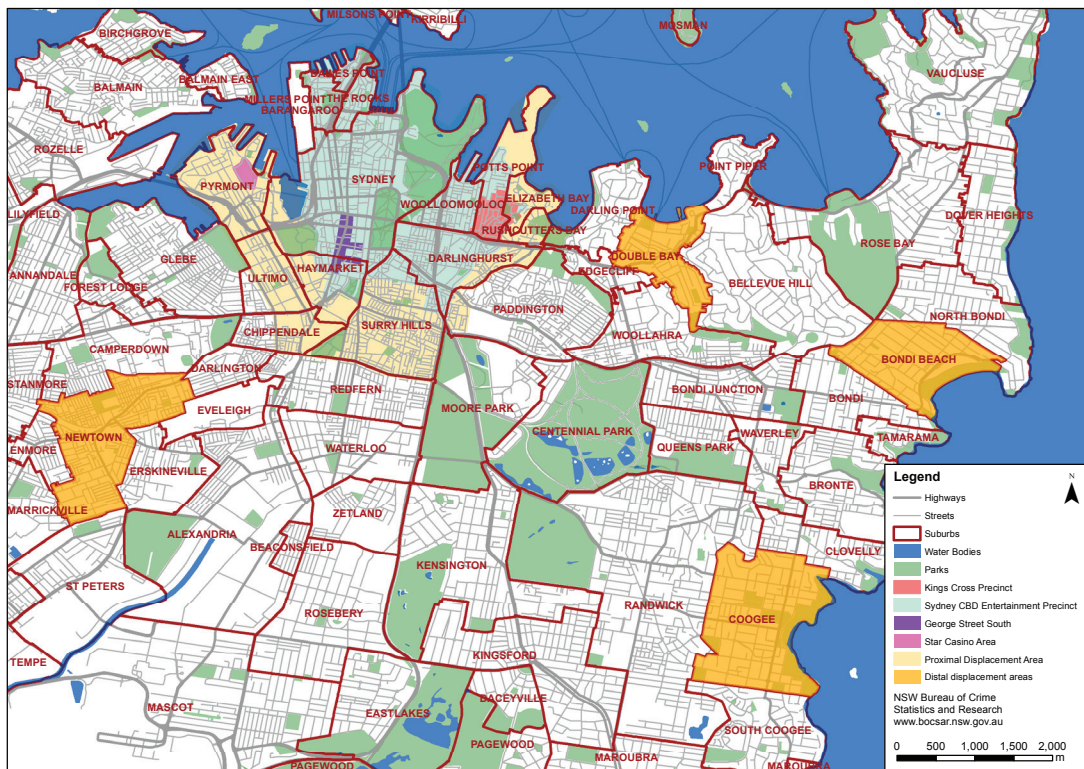
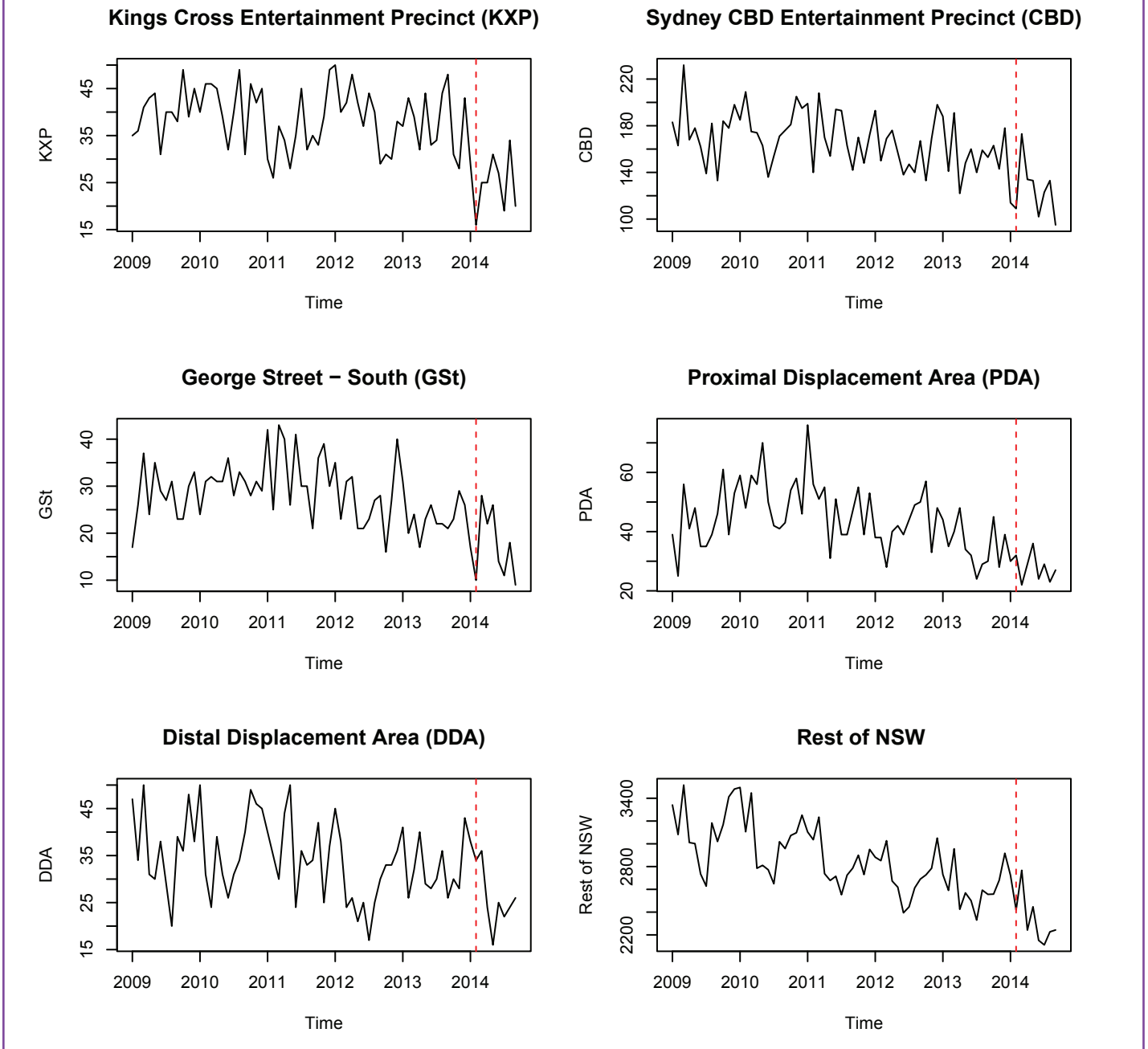


Figure 3. Time series of the number of assaults for Kings Cross Precinct, Sydney CBD Entertainment Precinct, proximal and distal displacement areas together with the rest of NSW



assault in the target area to be larger than the reduction in assault in the rest of NSW. If the reforms result in a displacement of assault to the PDA or DDA, we would expect to see an increase in assault or, at the very least, a deceleration in the downward trend in assault in one or both of these areas. If there is an increase in assault in the PDA or DDA, we can assess the size of the problem by comparing the increase in assault in these areas to the increase in the target area. If a diffusion of benefits occurs we would expect to see a reduction in assault in one or both the PDA and DDA. If a diffusion of benefits occurs to the PDA and displacement occurs to the DDA, we would expect to see a fall in assault in KXP, CBD, GSt and PDA and a rise in the DDA.

METHODS

DATA SETS

The outcome measure used in this study is the monthly count of non-domestic assaults recorded by the NSW police between January 2009 and September 2014. Figure 3 shows the number of assaults over this period in the six locations of this study: KXP, CBD, GSt, PDA, DDA and rest of NSW.

ANALYSIS

Generalized linear models (GLM, McCullagh & Nelder, 1989) such as Poisson or Negative Binomial regression are often used

to model count data. Models such as these are appropriate when strong autocorrelation is not present and when simple time trends are adequate to model the outcome of interest. However, if strong autocorrelation and complex time dependent trends are present in the data, Poisson and Negative Binomial regression can produce biased estimates.

Because of the presence of autocorrelation and highly non-linear trends in our data, we use an approach based on time series structural models (Harvey, 1989) and their representation as state space models for count data (Durbin & Koopman, 2012). State space models produce a dynamic picture of the different building blocks of a time series, namely, the trend, cycle and seasonal components. A further advantage of these models is that additional variables of interest can easily be included.

There are several ways in which the January 2014 reforms might influence assaults. One possibility is an instantaneous but transitory effect after which assaults return to previous levels. This is known as a pulse intervention effect (see top panel of Figure 4).

A third possibility is a slow changing response or smooth step intervention effect (see bottom panel of Figure 4). This sort of change might be expected if the reforms have a slow but steady effect that starts when new reforms are introduced and continues until the number of assaults reaches a steady level. The model for such an effect is:

$$x_t = \begin{cases} 0 & \text{if } t \leq \tau_1 \\ (t - \tau_1) / (\tau_2 - \tau_1) & \text{if } t \in (\tau_1, \tau_2) \\ 1 & \text{if } t \geq \tau_2 \end{cases}$$

where τ_1 and τ_2 represent the onset and termination of the intervention effect. In this study, τ_2 was set beyond the end of the available data as it is possible that the full effect of the intervention has not yet been reached.

We have little *a priori* basis on which to determine which model is more appropriate and, at this stage, too little post-intervention data to arbitrate between the possibilities. Our approach, therefore, is to consider a number of models (including combinations of the above intervention variables) and use the Akaike Information Criterion (AIC) to select the best-fitting model. The AIC balances the goodness of fit of a model against its complexity (Akaike, 1974, Durbin & Koopman, 2012). The smaller the AIC value, the better the model. The independence assumption of the residuals will be checked via the Box-Ljung test based on the first 24 autocorrelations (Ljung & Box, 1978) of the Pearson residuals. The detailed models used in this study are described in Appendix A.

All the analyses in this study were done using R version 3.1.2 (R core team, 2015) and in particular, the zoo (Zeileis et al., 2014) and KFAS (Helske, 2014) packages.

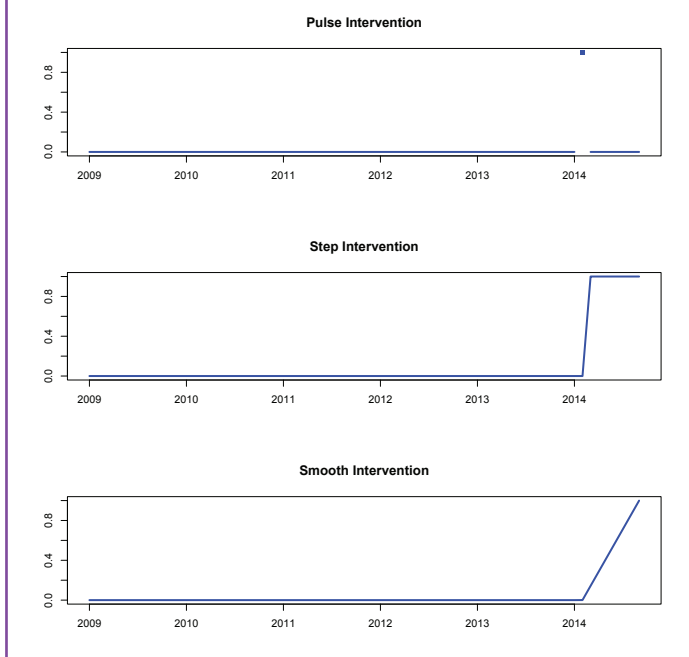
RESULTS

Three sets of analyses were carried out in this investigation. In the first, we investigated the possibility of a sudden and permanent change in the monthly count of assaults after the new reforms. In the second, we evaluated the possibility that the reforms triggered a slow change in assault incidence. Finally, we examine the possibility that the intervention effect was transient followed by a slow effect and that was modelled via a pulse plus a smooth step intervention.

Table 1. Results for model comparison via Akaike Information Criterion (AIC)

	KXP	CBD	GSt	PDA	DDA	Rest of NSW
Step Intervention	8.025	10.495	7.779	8.617	8.150	14.026
Smooth Intervention	8.110	10.300	7.741	8.604	8.123	14.023
Pulse + Smooth intervention	8.152	10.308	7.777	8.712	8.256	14.200

Figure 4. Intervention variables representing pulse, step and smooth intervention effects



Letting τ_1 represent the time when the intervention was introduced, the pulse intervention variable can be modelled as follows:

$$x_t = \begin{cases} 0 & \text{if } t \neq \tau_1 \\ 1 & \text{if } t = \tau_1 \end{cases}$$

Another possibility is a step intervention. In this case the change takes the form of a permanent and immediate shift in the level in assaults. The step intervention variable (see the middle panel of Figure 4) can be described as:

$$x_t = \begin{cases} 0 & \text{if } t < \tau_1 \\ 1 & \text{if } t \geq \tau_1 \end{cases}$$

Table 2. Model comparison between the selected models with and without seasonal component

Model	KXP	CBD	GSt	PDA	DDA	Rest of NSW
Seasonal Model	8.025	10.300	7.741	8.604	8.123	14.023
Non-Seasonal Model	6.991	10.427	6.890	7.791	7.314	14.123
Intervention	Step	Smooth	Smooth	Smooth	Smooth	Smooth

Table 3. Final model estimates of changes in assault by area

	KXP	CBD	GSt	PDA	DDA	Rest of NSW
β	-0.390	-0.300	-0.525	-0.078	-0.381	-0.09
C.I	(-0.609, -0.171)	(-0.535, -0.065)	(-0.995, -0.056)	(-0.707, 0.551)	(-1.107, 0.345)	(-0.104, -0.076)
pval	<0.001	0.018	0.028	0.809	0.304	<0.001
Box-Ljung	0.333	0.067	0.425	0.246	0.558	0.178
loglik	-237.186	-351.360	-233.719	-264.783	-248.333	-467.097
AIC	6.991	10.300	6.890	7.791	7.314	13.655
Reduction	-32.270%	-25.929%	-40.851%	-7.471%	-31.675%	-8.630%
Intervention	Step	smooth	smooth	Smooth	Smooth	Smooth

The results of the model assessments are shown in Table 1. Each cell in the table contains the AIC value for the model in each of the six locations. The locations are the two target sites (KXP and CBD), the George Street South sub-section (GSt), the proximal displacement area (PDA), the distal displacement area (DDA) and the rest of NSW. Smaller AIC values indicate a better fitting model. The best model for KXP is a step intervention effect while the other areas are better characterised by a smooth step intervention effect.

The data for the rest of NSW show obvious seasonality as displayed in Figure 3, but the other data (KXP, CBD, GSt, PDA

and DDA) only show a weak seasonality. We therefore estimated the same selected models in Table 1 without the seasonal component and the AIC results for model comparison are displayed in Table 2. The AIC values indicate that models without seasonal components were a better fit for all the data except for the Sydney CBD Entertainment Precinct and for the rest of NSW.

The final selected model results are presented in Table 3. The first row shows the estimated effect of the January 2014 reforms. The second row presents the parameter estimate 95% confidence intervals. The third row shows the results of a two-tailed t-test with $H_0: \beta=0$ (p-value). The fourth row presents the results from the Box-Ljung portmanteau test to check the

Figure 5. Estimated assault trend for the Kings Cross Precinct (KXP): Jan 2009-Sep 2014

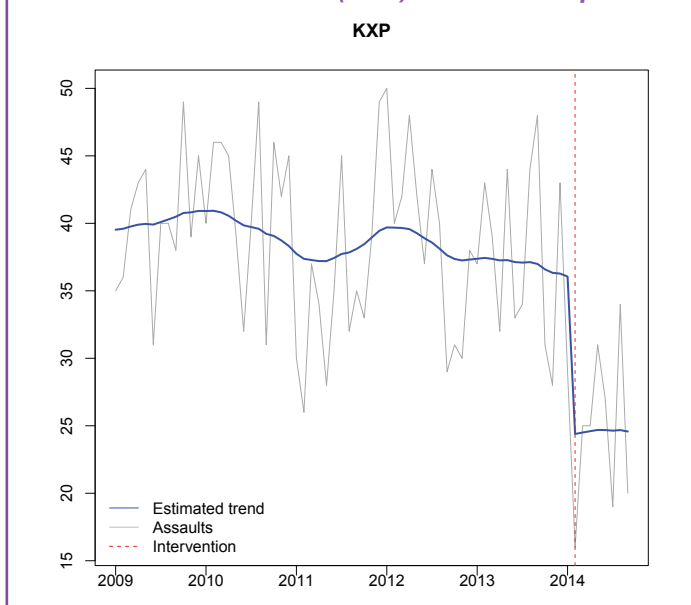


Figure 6. Estimated assault trend for the Sydney CBD Entertainment Precinct (CBD): Jan 2009-Sep 2014

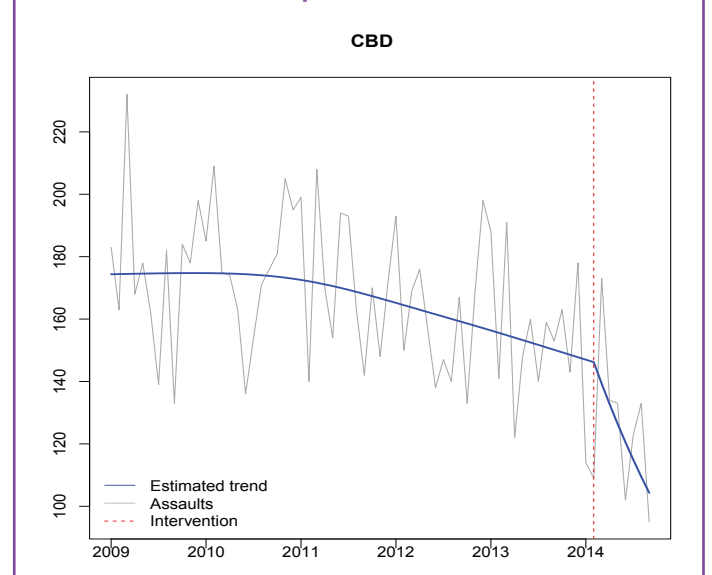


Figure 7. Estimated trend for the number of assaults for the George Street South (GSt): Jan 2009-Sep 2014

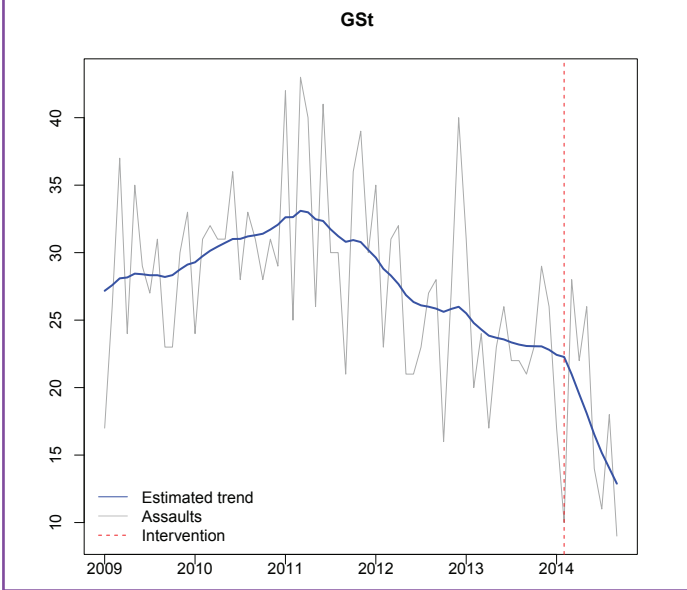


Figure 9. Estimated trend for the number of assaults for the Distal Displacement Area (DDA)

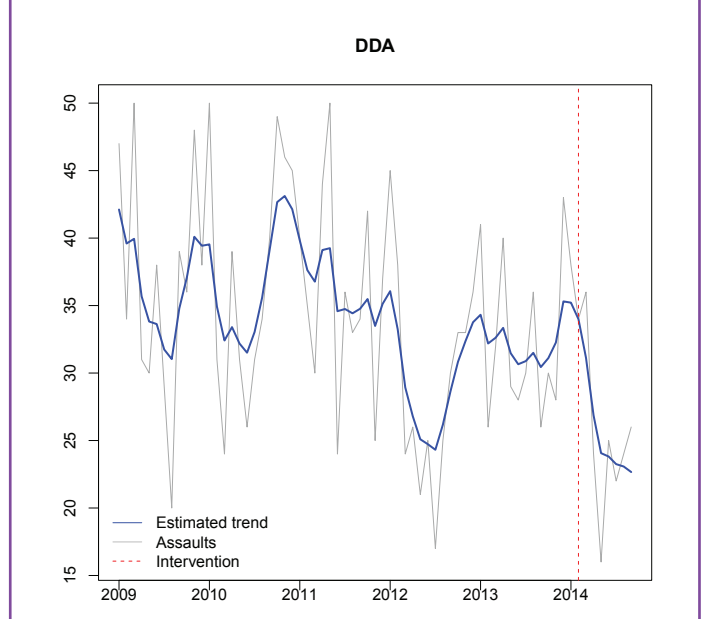


Figure 8. Estimated trend in assaults for the Proximal Displacement Area (PDA): Jan 2009-Sep 2014

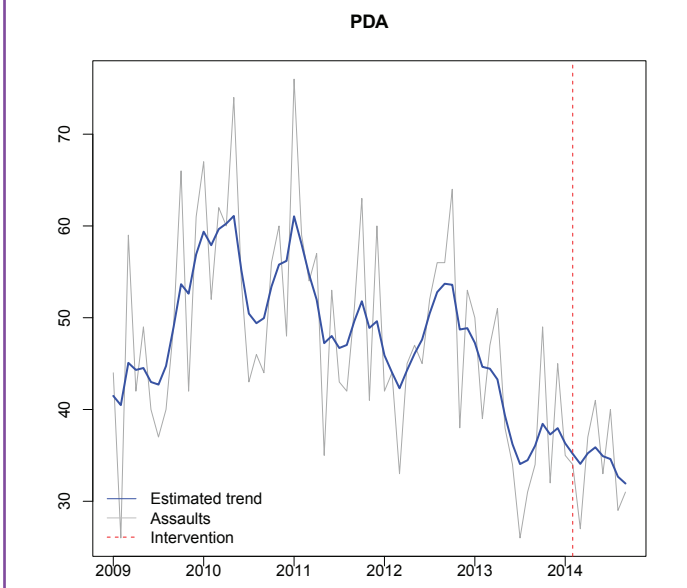
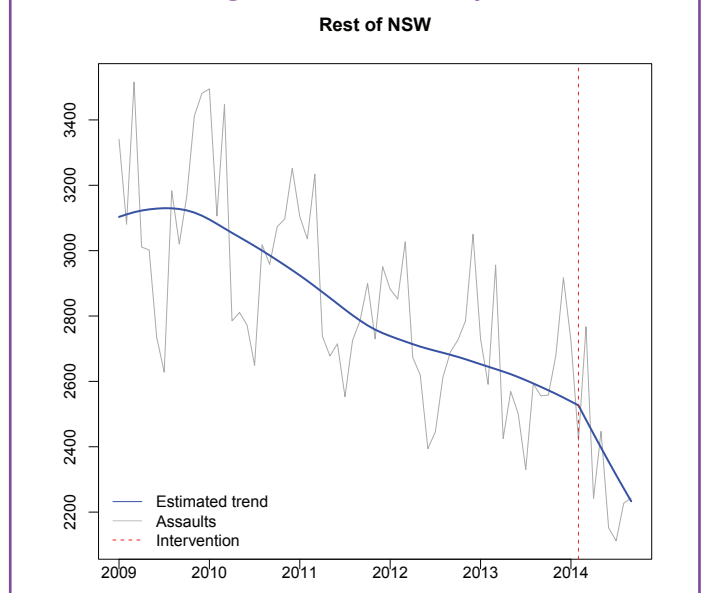


Figure 10. Estimated trend for the number of assaults in the rest of NSW which excludes the targeted areas and displacement areas



presence of autocorrelation in the model residuals (p-value). The fifth and sixth rows provide, respectively, the log-likelihood and AIC values associated with each model. The seventh row displays the percentage reduction in assault associated with the January 2014 reforms. The final row shows the intervention variable included in each of the models.

Results for KXP and CBD, shown in Table 3, indicate that there are substantial statistically significant reductions in assault in both the Kings Cross (down 32%) and Sydney CBD Entertainment Precinct (down 26%). The identified assault

hotspot along George Street – South, a subsection of the CBD Entertainment precinct, showed a 40 per cent reduction. The first (KXP) effect has a narrower confidence interval than the second and third one, as shown in the table. The negative coefficients on the intervention variable, displayed in the columns headed 'PDA' and 'DDA', suggest that the January 2014 reforms were associated with a small decrease in assault incidence in the proximal displacement area and a larger decrease in assault incidence in the distal displacement areas, but the confidence intervals in both cases are wide with effects that are not statistically significant at a 5 per cent level. The column labelled

'Rest of NSW' indicates that the January 2014 reforms were associated with a smaller but still significant reduction in assault across the rest of NSW (9% decrease).

The effects can be seen clearly if we examine the estimated trend in assaults for each of the models. We do this in Figures 5 to 10. The raw data on assaults are plotted and the solid line shows the estimated trend in assaults, while the dotted line marks the beginning of the intervention.

In Kings Cross (Figure 5), we observe an immediate drop in the number of assaults following the January 2014 reforms, after which the assault level appears to stabilise at a new lower level.

In the Sydney CBD and George St – South (Figures 6 and 7) there are clear downward trends in the number of assaults in the three years prior to the January 2014 reforms; however the slope of the downward trend is much steeper following the introduction of the reforms than before.

The estimated trend for the proximal displacement area (PDA) is displayed in Figure 8. There is a declining trend in assaults in the period leading up to the January 2014 reforms. However, the intervention effects are not statistically significant at a 5 per cent level.

One key licensed venue, which is included in the proximal displacement area and which has been the subject of a number of media reports concerning alcohol related violence (e.g. SMH, 30 August 2014), is The Star casino. The Star Casino has a 24-hour liquor licence and is not subject to the January 2014 reforms. A separate analysis was conducted of assaults specifically occurring at The Star Casino and in the surrounding streets (see Figure 11, Appendix B) to test the possibility of displacement to this site.

This analysis revealed some evidence of displacement (for details, see Table B1 and Figure 12 in Appendix B). Between February and September 2013 the number of assaults at The Star casino averaged 3.5 per month, whereas for the same period in 2014 it averaged 6.3 per month. There are three points to note about this. Firstly, but for the increase in assaults at The Star casino, the trend in assaults in the PDA would probably have continued the downward trajectory that exhibited prior to the January 2014 reforms (see Figure 8). Secondly, the confidence intervals around the parameter estimates for The Star casino analysis are rather large and the effect appears to be not significant (see Appendix B for model details); thus raising doubts about whether the change in assault incidence at The Star casino after the January 2014 reforms was due to random fluctuation. Finally, even if we take the apparent increase in assaults at The Star casino at face value, the increase in absolute terms (i.e., 2.8 per month) was much smaller than the decreases in the Kings Cross (from 39.6 in 2013 to 24.6 in 2014) and Sydney CBD Entertainment (from 151.8 in 2013 to 125.3 in 2014) Precincts (41.5 assaults per month across the two Precincts).

Figure 9 shows the estimated trend in assaults in the distal displacement area (DDA). In this case, the intervention effects are not statistically significant and thus no further conclusions can be drawn. A longer follow-up period will be necessary to get a clearer picture of the trend in the DDA.

Figure 10 shows the trend in assault for the rest of New South Wales. The trend is somewhat similar to that observed for the CBD model; a pre-existing downward trend that accelerates following the introduction of the January 2014 reforms.

DISCUSSION

Our aim in this study was to address three questions: (1) Have the January 2014 reforms reduced the incidence of assault in the Kings Cross and Sydney Entertainment Precincts? (2) Has the incidence of assault increased in areas proximate to these Precincts or in nightspots further away but still within easy reach of these Precincts? (3) If there is evidence of geographical displacement was the reduction in assaults in the Kings Cross and Sydney Entertainment Precincts larger than the increase in the number of assaults in the displacement areas? (i.e., what is the net effect?)

The results show that the January 2014 reforms were associated with immediate and substantial reductions in assault in Kings Cross and less immediate but substantial and perhaps ongoing reductions in the Sydney CBD. These Precincts were the focus of the January 2014 reforms and the decline in assault in these areas was larger than anywhere else. There is little evidence that assaults were displaced to areas adjacent to these Precincts or to entertainment areas within easy reach of these Precincts. The only exception to this was The Star casino, where the number of assaults increased following the January 2014 reforms. As we have already noted, the increase in assaults around the casino was much smaller in absolute terms than the fall in assaults in the Kings Cross and Sydney CBD Entertainment Precincts. The net result, therefore, appears to have been a 'diffusion of benefits' (Johnson, Guerette & Bowers, 2014). All these findings are consistent with evidence reviewed in the introduction to this bulletin; evidence which suggests that restrictions on liquor trading hours are an effective way of reducing alcohol-related violence.

Notwithstanding the consistency of the current findings with past studies examining restrictions on alcohol availability, it is important to remember that the restrictions on liquor licence trading hours were not the only component of the January 2014 reforms capable of producing a reduction in violence. Other key elements included the extension of temporary and long-term banning orders issued to designated 'trouble-makers' to prevent them entering most licensed premises in the Kings Cross and Sydney CBD Entertainment Precincts, and the introduction of a new risk based licence fee for all licensed premises in which the annual fee payable by a particular venue depends upon its

licence type, compliance history and trading hours. The first of these initiatives might have helped reduce the number of assaults on licensed premises. The second is unlikely to have had much effect as the scheme had not been implemented during the period covered by this analysis.

It is also possible that other factors associated with the January 2014 reforms were partly responsible for the fall in assault that occurred following the reforms. The fall in assault, after all, was not limited to the areas that were the principal target of the January 2014 reforms. The deaths of Thomas Kelly (July 2012) and Daniel Christie (January 2014) focussed a great deal of public and media attention on alcohol related violence in Kings Cross and the Sydney CBD. It is possible this adverse publicity, either alone or (more likely) in conjunction with new restrictions on late-night drinking (introduced in July 2014 under the CBD plan of management) (OLGR, 2015), discouraged people from going to Kings Cross and the Sydney CBD. The NSW Legislative Assembly Law and Safety Committee's Enquiry into Alcohol and Drug-Related Violence heard evidence from business groups suggesting that the number of visitors to Kings Cross and the Sydney CBD had declined; with business revenue allegedly falling by between 20 and 50 per cent (NSW Legislative Assembly, 2014, p. 44). This suggestion that the number of visitors to Kings Cross has declined is supported by transport data. Between 2013 and 2014, counts of the number of passenger crossings in Kings Cross Station certainly declined, whereas over the same period rail patronage at all other City rail stations increased (see Table C1, Appendix C). Taxi patronage at the Bayswater Road secure taxi-rank (a major taxi-rank in Kings Cross) also shows a decline, although taxi patronage at the Darlinghurst Road secure Taxi Rank (another taxi-rank in Kings Cross) slightly increased (see Table C2, Appendix C).

We will have a clearer picture of the mechanisms underpinning the fall in assaults once we have examined their temporal and spatial dimensions more closely. If the January 2014 reforms are responsible for the reduction in assault, we should expect to see a significant fall in the incidence of assault at times when licensed premises would normally have continued to serve alcohol (viz. prior to the January 2014 reforms). We might also expect to see a larger reduction in assault on licensed premises than in assaults in the street, although this will depend on overall visitor levels in Kings Cross and the CBD. If the January 2014 reforms reduced the incidence of assaults, not because they reduced alcohol consumption in Kings Cross and the CBD during hours when assault rates normally peak, but because the reforms discouraged people from visiting these areas, we might expect to see a general reduction in assault, even at times where there are no restrictions on sales of alcohol. It is still too soon to examine these issues in any detail. The follow-up period in the current study is quite short. Further monitoring will be necessary to assess the durability of the effects reported here and to obtain sufficient data to conduct a detailed analysis of changes in the temporal patterning of assaults on and off licensed premises.

ACKNOWLEDGMENTS

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NOTES

1. A more detailed description of the reforms can be accessed in the second reading speech to the Bill (Second-Reading Speech, Liquor Amendment Bill 2014; Hansard, 30th January, 2014 [http://www.parliament.nsw.gov.au/prod/parlament/nswbills.nsf/0/bb87f6864d9693c1ca257c6f007fec0e/\\$FILE/2R%20Crimes%20and%20Liquor.pdf](http://www.parliament.nsw.gov.au/prod/parlament/nswbills.nsf/0/bb87f6864d9693c1ca257c6f007fec0e/$FILE/2R%20Crimes%20and%20Liquor.pdf) and here: http://www.olgr.nsw.gov.au/news_New_Initiatives_Announced.asp.
2. Although we refer to the reforms as the January 2014 reforms, it should be noted that further restrictions were placed on the 18th of July 2014 under the CBD Plan of Management.
3. A 'lockout' law is a law which permits licensed premises to continue serving alcohol to people on the premises past a specified hour but which prohibits anyone seeking to enter or re-enter the premises after that hour.
4. This change only applied to higher risk premises

REFERENCES

- Akaike, H. (1974). A new look at the statistical model identification, *Automatic Control, IEEE Transactions on Automatic Control*, 19(6), 716-723.
- Bowers, K., Johnson, S., Guerette, R.T., Summers, L. & Poynton, S. (2011). Spatial displacement and diffusion of benefits among geographically focussed policing initiatives. *Campbell Systematic Reviews* 3, DOI: 10.4073/csr.2011.3
- Chikritzhs, T. N., and T. R. Stockwell (2002). The impact of later trading hours for Australian public houses (hotels) on levels of violence. *Journal of Studies on Alcohol* 63 (5): 591-599.
- Douglas, M. (1998). Restriction of the hours of sale of alcohol in a small community: A beneficial impact, *Australian and New Zealand Journal of Public Health*. 22(6), 714-719.
- Dualibi, S., Ponicki, W., Grube, J., Pinsky, I. Laranjeira, R., and Raw, M. (2007). The effect of restricting opening hours on alcohol-related violence. *American Journal of Public Health*, 97(12), 2276-2280.
- Durbin, J., & Koopman, S.J. (2012). *Time series analysis by state space methods* (No 38). Oxford: Oxford University Press.
- Harvey, A.,C. (1989). *Forecasting, structural time series models and the Kalman Filter*. Cambridge: Cambridge University Press.

Helske, J. (2014). KFAS: Kalman filter and smoothers for exponential family state space models. *R package version 1.0.4-1*. URL: <http://CRAN.R-project.org/package=KFAS>.

Johnson, S.D., Guerette, R.T., & Bowers, K. (2014). Crime Displacement: what we know, what we don't, and what it means for crime reduction. *Journal of Experimental Criminology*, 10(4), 549-571.

Kypri, K., Jones, C., McElduff, D. & Barker, D. (2011). Effects of restricting pub closing times on night-time assaults in an Australian city. *Addiction*, 106(2), 303–310.

Ljung, G.M., Box, G.E. (1978). On a measure of lack of fit in time series models. *Biometrika*, 65(2),297-303.

McCullagh, P., & Nelder, J. A. (1989). *Generalized Linear Models, Generalized Linear Models*. 2nd ed. Chapman & Hall/CRC, Boca Raton, Florida.

NSW Legislative Assembly Committee on Law and Justice (2014). *Measures to reduce drug and alcohol-related violence: Preliminary Enquiry*, Report 4/55, November. Sydney: NSW Legislative Assembly.

NSW Office of Liquor, Gaming and Racing (2014). *Personal Communication*, Ms Catherine Bass-Kendzy, Program Coordinator, Compliance Branch. 19th, November, 2014.

R Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.

Roth, L. (2014). *Liquor Licensing Restrictions to Address Alcohol-Related Violence in NSW: 2008-2014*. Sydney: NSW Parliamentary Research Service, March, e-brief 4/2014

OLGR (2014). CBD Plan of Management for the Sydney CBD Entertainment Precinct, http://www.olgr.nsw.gov.au/liquor_SydneyCBD_precinct.asp, retrieved 1/4/2015.

Stockwell, T. & Chikritzhs, T. (2009). Do relaxed trading hours for bars and clubs mean more relaxed drinking? A review of international research on the impacts of changes to permitted hours of drinking. *Crime Prevention and Community Safety* 11, 153-170.

Sydney Morning Herald (2014) 'And the Winner of Sydney's Lockout law is ... Star Casino', 30 August 2014. Retrieved from: <http://www.smh.com.au/nsw/and-the-winner-of-sydneys-lockout-laws-is--star-casino-20140829-108efu.html>

Voas, R.B., Lange, J.E. & Johnson, M.B. (2002). Reducing High-Risk Drinking by Young Americans South of the Border: The impact of a partial ban on the sale of alcohol. *Journal of Studies in Alcohol*, 63(3), 286-292.

Voas, R.B., Romano, E., Kelly-Baker, T. & Tippetts, A.S. (2006). A Partial Ban on Sales to reduce High-Risk Drinking South of the Border: Seven Years Later. *Journal of Studies in Alcohol*, 67(5), 746-753.

Zeileis, A., Grothendieck, G., Ryan, J. A., Andrews, F., & Zeileis, M. A. (2014). Package 'zoo'. R package version 1.7-12. URL: <http://CRAN.R-project.org/package=zoo>.

APPENDIX A

The model is based on the Poisson distribution with mean $\exp(\theta_t)$, that is, $y_t \sim \text{Poisson}(\exp(\theta_t))$ where the probability of y_t can be written as follows:

$$\text{prob}(y_t = k) = \exp \{ k\theta_t - \exp(\theta_t) - \log k! \}, t = 1, \dots, n$$

Our objective is to model θ_t . In order to do that the chosen model can be written as

$$\theta_t = \mu_t + \gamma_t + \beta x_t$$

where μ_t represents the level, γ_t the seasonal component and x_t the intervention variable with effect or intervention parameter which measures the effect of the January 2014 intervention: β .

The level μ_t is modelled by a local linear level model

$$\mu_t = \mu_{t-1} + v_t + \eta_t$$

$$v_t = v_{t-1} + \zeta_t$$

with $\eta_t \sim N(0, \sigma_\eta^2)$ and $\zeta_t \sim N(0, \sigma_\zeta^2)$. The monthly seasonality γ_t is described by

$$\sum_{j=0}^{11} \gamma_{t+1-j} = \varpi_t$$

with $\varpi_t \sim N(0, \sigma_\varpi^2)$.

All the disturbances in the model $\eta_t, \zeta_t, \varpi_t$ are independent.

The estimated trend displayed in Figures 5-8 is calculated as $\mu_t + \beta x_t$ and in Figure 9 as $\mu_t + \beta x_t$ for t varying between January 2009 and September 2014.

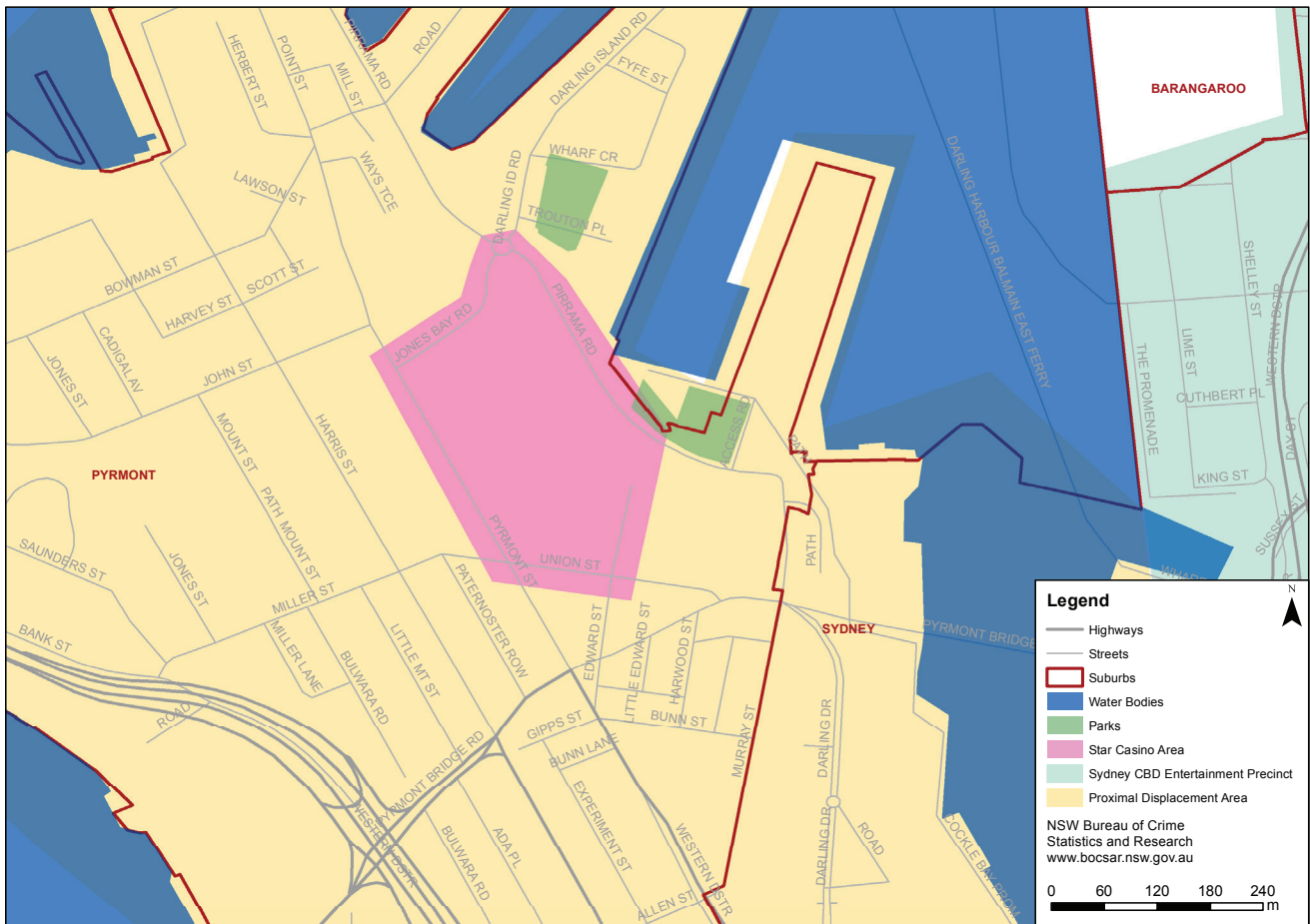
APPENDIX B

Figure 11 displays The Star casino and surrounding streets considered in this study.

The intervention analysis results for The Star casino and surrounding streets are shown in Table B1 together with the analysis of the proximal displacement area without including The Star casino. The rows of Table B1 represent the same values as those in Table 3 with the only difference here being the specification of the intervention variable for the analysis of The Star casino. Now, we assume that the intervention effect at the Star casino was also gradual but in this case the effect starts in February 2014 and finishes in June 2014. The reason for selecting this particular model was based on statistical model selection considerations based on the AIC criterion.

Whereas these results suggest an increasing trend in the number of assaults happening at The Star Casino and neighbouring streets, they also show a decrease on the number of assaults in the proximal displacement area (without

Figure 11. Zoomed view of The Star Casino and surrounding streets



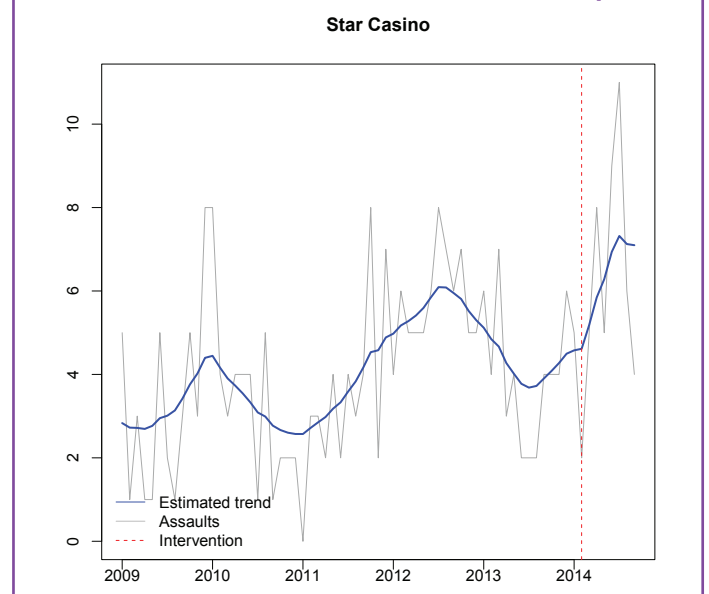
including The Star casino); indicating that the increase in the proximal displacement area (with the Casino and surrounding streets included) reported earlier was mostly driven by the assaults happening at The Star Casino and bordering streets. However the effects are not statistically significant and thus solid conclusions cannot be made at this stage.

Table B1. Final model estimates of changes in assault at The Star casino in Pyrmont

	The Star casino and surrounding streets	PDA without casino and surrounding areas
β	0.790	-0.105
C.I	(-0.145, 1.725)	(-0.672, 0.461)
pval	0.097	0.715
Box-Ljung	0.979	0.308
loglik	-163.534	-275.385
AIC	5.233	8.475
Reduction	120.396%	-10.009%
Intervention	Smooth (Feb-May)	Smooth (Feb-Sep)

Figure 12 displays the estimated trend in assaults for The Star Casino showing an increasing trend following the January 2014 reforms.

Figure 12. Estimated trend for the number of assaults in The Star Casino between Jan 2009-Sep 2014



APPENDIX C

Train passenger data have been provided by the NSW Bureau of Transport Statistics. The data consist of monthly counts of the number of gate entries and exits on Fridays and Saturdays between February 2013 and September 2014 in Kings Cross train station along with Central, Town Hall, Museum, St James, Martin Place and Wynyard counted between 8:00pm and 3:00am.

The average number of passengers crossing the validation gates on Fridays and Saturdays (from 8:00pm until 3am) between February to September in 2013 and 2014 Saturday are shown in Table C1.

These figures show that the number of passengers crossing Kings Cross Station has declined in 2014 with respect to 2013. However, over the same period, rail patronage at all other city rail stations increased.

Taxi rank patronage data on the Darlinghurst Road and Bayswater Road secure taxi ranks (both located in the Kings Cross Entertainment Precinct) was provided by the Department of Transport. The average number of patrons during the weekends (Friday and Saturday) between February and December 2013 and 2014 (from 9pm and 6am) are displayed in Table C2. The averages shown in the table show a decline in taxi patronage at the Bayswater Road secure taxi-rank in 2014 with respect to 2013, whereas taxi patronage at the Darlinghurst Road secure taxi rank has increased in 2014.

Table C1. Average number of passengers crossings the validation gates each month on Friday and Saturdays between 8:00pm and 3:00am from February to September in 2013 and 2014

Weekend Averages	Entries 2013	Entries 2014	Exits 2013	Exits 2014
Central	6587.48	8008.96	3480.70	4092.94
Kings Cross	1241.02	1204.24	2063.85	2016.54
Martin Place	521.13	680.84	206.44	239.76
Museum	180.61	314.94	249.20	322.94
St. James	52.69	281.71	29.41	107.49
Town Hall	7603.98	9534.59	3553.13	4299.32
Wynyard	2097.53	2885.31	980.49	1283.60

Table C2. Average number of patrons using the secure taxi ranks in Kings Cross each month on Friday and Saturdays between 9:00pm and 3:00am from February to September in 2013 and 2014

Taxi Ranks	2013	2014
Darlinghurst Road	2495.87	2668.87
Bayswater Road	7488.12	4108.50