The Impacts of Liquor Outlets in Manukau City

Report No. 4
A spatial econometric analysis of selected impacts of liquor outlet density in Manukau City

Alcohol Advisory Council of New Zealand

JANUARY 2012

ALCOHOL ADVISORY COUNCIL OF NEW ZEALAND
Kaunihera Whakatupato Waipiro o Aotearoa

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ABSTRACT

This paper employs a spatial seemingly unrelated regression approach to investigate the cross-sectional association between density of liquor outlets in Manukau City (as at 31 January 2009) and a range of alcohol-related harms such as police events and motor vehicle accidents in the period 1 July 2008 to 30 June 2009. Holding all other variables constant, our preferred specification shows that three density measures (off-licence density, club and bar density, and restaurant and cafe density) have a range of associated alcohol-related harms, including violent offences, family violence, sexual offences, drug and alcohol offences, property damage, property abuses, antisocial behaviour, dishonesty offences, traffic offences, and motor vehicle accidents. Further research is needed to analyse the effects of liquor outlet density across all of New Zealand. The approach described in this report is easily transferable to investigate the relationships in other parts of the country.

Keywords: liquor outlets, density, alcohol, Manukau, New Zealand, spatial, econometric

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LINKS TO OTHER REPORTS

This is the fourth report in a series of five reports commissioned by ALAC in partnership with Manukau City. The research was undertaken by researchers from the University of Waikato between 2008 and 2011. The five reports in The Impacts of Liquor Outlets series are:

- Report 1 – A review of the international academic literature and New Zealand media reports
- Report 2 – Community stakeholder views on the impacts of liquor outlets in Manukau City
- Report 3 – The spatial and other characteristics of liquor outlets in Manukau City
- Report 4 – A spatial econometric analysis of selected impacts of liquor outlets in Manukau City (this report)
- Summary report – The impacts of liquor outlets in Manukau City (revised January 2012).

The summary report was initially released in March 2010. That report provided short summaries of the content of the main reports cited above. The summary provided for Report 4 contained a preliminary analysis of the impacts. Since the release of the summary report, the authors have presented the preliminary findings at a number of conferences and received additional peer review and feedback on the methodology. The summary report has been revised and re-released (January 2012) with updated information from Report 4.

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EXECUTIVE SUMMARY

There has been significant recent debate on the impacts of liquor outlets on communities in New Zealand. This report estimated the impacts of liquor outlet density on a range of indicators in Manukau City, including police events, motor vehicle accidents, and health-related events. We applied a range of aspatial and spatial data analysis techniques, finally adopting a preferred specification that utilised spatial seemingly unrelated regression (SSUR) to estimate a system of related cross-sectional equations.

Data on liquor outlets were obtained from an administrative database, supplemented by additional field research to obtain an accurate assessment of liquor outlet density as at 31 January 2009. Other data were obtained for a reference period of 1 July 2008 to 30 June 2009.

Based on a common specification, a model for each outcome was first estimated using a robust ordinary least squares estimator. The residuals of these estimations were then examined for the presence of spatial dependence, and spatial dependence was confirmed for many of the models. Second, following the determination of an appropriate spatial lag structure, spatial Durbin models were estimated followed by several SSUR models that estimated all equations simultaneously. All specifications resulted in qualitatively and quantitatively similar results, which suggested that the results were relatively robust. The preferred specification included nine categories of police event and motor vehicle accidents (in total).

Across the range of specifications (both single equation and seemingly unrelated regression models), an additional off-licence outlet is associated with 10.4 to 25.3 additional police events and 2.0 to 3.8 additional motor vehicle accidents, an additional club or bar is associated with 40.4 to 54.0 additional police events and 2.9 to 3.6 additional motor vehicle accidents, and an additional restaurant or cafe is associated with 45.3 to 47.1 additional police events and 4.5 to 4.9 additional motor vehicle accidents.

Holding all other variables constant, our preferred specification showed that off-licence density is significantly positively associated with violent offences, sexual offences, and drug and alcohol offences, and significantly negatively associated with family violence; the density of clubs and bars is significantly positively associated with violent offences, drug and alcohol offences, property damage, property abuses, antisocial behaviour, dishonesty offences, and traffic offences; and the density of restaurants and cafes is significantly positively associated with violent offences, family violence, property damage, property abuses, antisocial behaviour, dishonesty offences, traffic offences, and motor vehicle accidents.

These results do not specifically imply causality, and owing to the context specificity found in other studies care should be taken in applying them to other regions of New Zealand or elsewhere. However, this research represents an examination of the effects of liquor outlet density on a wider range of alcohol-related harms than those considered in the extant New Zealand literature. Further research is needed to analyse the effects of liquor outlet density across all of New Zealand. The approach described in this report is easily transferable to investigate the relationships in other parts of the country.

1 INTRODUCTION

There has been significant recent debate on the impacts of liquor outlets on communities in New Zealand. This has arisen in part because of the liberalisation of the sale of alcohol following the Sale of Liquor Act 1989, which allowed the sale of wine in supermarkets and grocery outlets and generated a substantial increase in the number of outlets supplying alcohol. As a result of this ongoing debate, interest has been raised in the effects of liquor outlet density on alcohol-related harms in New Zealand, and whether the number of liquor licences should be more tightly controlled by local or central government. Community stakeholders in Manukau City are particularly concerned about liquor outlet density (McNeill *et al.*, 2012).

Cameron *et al*. (2012b) described the spatial and other characteristics of liquor outlets in the Manukau City area in January 2009, finding that:

- on-licence outlets are most dense in areas with good transport links, such as town centres, and in areas with high amenity value. This is because these outlets cater to consumers who are looking for a destination at which to drink, or where drinking is incidental to some other activity such as a meal
- off-licence outlet density is related to population density, i.e. a higher population density is associated with a higher density of off-licence outlets, and with relative deprivation, i.e. a higher relative deprivation is associated with a higher density of off-licence outlets
- off-licence outlets are typically not gathered together in clusters. Rather they are distributed throughout the area in order to reduce local competition
- the price and availability of alcohol at off-licence outlets are related to off-licence outlet density. Areas with a higher density of off-licence outlets have higher competition among those outlets, leading to lower prices, longer operating hours, and later weekend closing times.

Whilst informative, such a description alone is inadequate to the task of providing a deeper understanding of the observed patterns, or to understanding any direct or indirect association with alcohol-related harms. Given the spatial nature of the phenomenon and the data in question, further exploration requires a formal modelling approach grounded in the field of spatial econometrics.

A proposed spatial modelling approach designed to estimate quantitatively the effects of liquor outlets on communities in Manukau City was presented in Cameron *et al*. (2009). This report follows a similar approach to that earlier proposal, although modified to take account of the actual data that were obtained. Specifically, this report presents results in terms of the impacts of liquor outlet density on a range of indicators in Manukau City, including police events, motor vehicle accidents, accident and emergency admissions, and hospital discharges. The report proceeds as follows. Section 2 discusses the theoretical mechanisms through which liquor outlet density is posited to affect alcohol-related harms, particularly crime, motor vehicle accidents, and hospital events. Section 3 outlines the data and quantitative methods employed in the analysis, and the caveats associated with these methods; Section 4 presents the modelling results, with additional discussion of the combined marginal effects of additional liquor outlets in Section 5; Section 6 discusses the results in the context of the extant international literature; and Section 7 concludes.

2 LIQUOR OUTLET DENSITY AND ALCOHOL-RELATED HARM

Alcohol-related harm has often been linked to the availability of alcohol. Indeed, most studies of the impacts of liquor outlets have used ‘availability theory’, under which negative social outcomes are linked directly or indirectly to the availability of alcohol (e.g. see Gruenewald *et al.*, 1993). This theoretical position relies on a causal chain, whereby a greater availability of alcohol (i.e. through a higher density of liquor outlets) leads to a greater consumption of alcohol, which in turn leads to negative social outcomes. Livingston *et al.* (2007) refer to relationships that conform to this pattern as proximity effects.

In addition to simply increasing the accessibility of alcohol, proximity effects may arise where a higher density of liquor outlets leads to decreases in the ‘full price’ of alcohol, which is made up of the real price of alcohol plus the costs (predominantly travel and time costs) associated with obtaining the alcohol (Stockwell and Gruenewald, 2004). In areas where there is a higher density of liquor outlets, customers do not need to travel as far to purchase alcohol, reducing the travel and time costs and hence reducing the full price of alcohol to the purchaser, and increasing the quantity of consumption. Another mechanism through which outlet density may lead to proximity effects is where a higher density of outlets increases local competition. Greater local competition may in turn reduce the real price of alcohol, as more competitive outlets attempt to attract customers with lower prices and longer and later operating hours (Cameron *et al.*,2012b).

There are other potential explanations for a causal link between alcohol outlet density and negative social outcomes. For instance, concentrations of alcohol outlets may attract antisocial people or heavy drinkers (Gruenewald, 2007). This process of social selection creates an effect of alcohol outlet density on negative social outcomes that is independent of the level of alcohol consumption. Livingston *et al.* (2007) refer to these relationships as amenity effects.

Amenity effects may arise where a given location attracts drinkers (and associated problems) to a greater extent than might be expected given the number of individual outlets present in that location. This might be true of an entertainment district, for instance, which will attract large numbers of (predominantly young) people (Livingston *et al.*, 2007). Crimes and other alcohol-related harms are more likely to occur where large numbers of potential alcohol-impaired victims and offenders congregate (Roncek and Maier, 1991), consistent with ‘routine activity theory’, which suggests that crime increases where the opportunities available for criminal activity are higher (Clarke and Felson, 1993). Amenity effects might also arise where a higher outlet density changes the distribution of ‘routine drinking activities’, such as encouraging more drinkers to drink in bars as opposed to at home, or encouraging drinkers to drink more (Stockwell and Gruenewald, 2004).

Finally, an observed relationship between liquor outlet density and social harms might occur where there is no causal relationship but where liquor outlet density acts as a proxy for some other variable that is related to social harms. For instance, ‘social disorganisation theory’ suggests that crimes and other social harms are associated with a lack of social cohesion and social trust (Sampson and Groves, 1989; Krivo and Peterson, 1996). Social disorganisation might also be related to liquor outlet density, because areas that have low social cohesion are less able to resist the opening of additional liquor outlets in their areas through political and legal means (Livingston *et al.*, 2007; Peterson *et al.*, 2000). This results in a contemporaneous association between crime or other social harms and liquor outlet density. A separate contemporaneous association might also be observed between social deprivation or social disadvantage and liquor outlets (e.g. Cameron *et al.*, 2012b), and liquor outlets and alcohol-related harm. This might occur where social deprivation itself attracts liquor outlets to locate there, potentially owing to a higher demand for alcohol in deprived areas and lower mobility of the population (Cameron *et al.*,2012b).

As most studies to date have examined availability theory, evaluations of proximity effects dominate the literature on the impacts of liquor outlets. Livingston *et al.* (2007) recently reviewed this theoretical and empirical literature, while Cameron *et al.* (2012a) also conducted a broad review with a further focus on the limited New Zealand literature. Overall, the literature provides mixed results for a relationship between liquor outlet density and a range of outcome variables. In particular, liquor outlet density appears to be related to (among other things) violent and other crime (Livingston, 2008; Chikritzhs *et al.*, 2007), motor vehicle accidents (Scribner *et al.*, 1994; Millar and Gruenewald, 1997), and accident and emergency events (Tatlow *et al.*, 2000; Wood and Gruenewald, 2006).

Many of the relationships between liquor outlet density and alcohol-related harms appear to be context specific. That is, the relationship between liquor outlet density depends on the characteristics of outlets or the types of outlet density considered, such as off-licence density or on-licence density (see also Stockwell *et al.* (1992), and the discussion by Graham (2006)), the type of outcome variable considered, and the nature of the location in terms of its socioeconomic and other characteristics (e.g. Livingston, 2008). It seems likely that the differences in impacts by liquor outlet type relate to differences in the observed relationships. For instance, on-licence outlets typically co-locate in areas of high amenity value (Cameron *et al.*, 2012b), leading to a combination of amenity effects and proximity effects. In contrast, off-licence outlets tend not to cluster together and tend to locate in areas of higher deprivation (Cameron *et al.*, 2012b), leading to proximity effects and the non-causal relationships noted above. The relationships between liquor outlet density and outcome variables may also vary over time, although there are currently no long-term longitudinal studies to verify this.

3 METHODOLOGY

This section discusses the motivation for the use of spatial methods of data analysis, before outlining some of the main models used in cross-sectional spatial modelling and the data sources available. Having briefly examined these models we then outline our motivation for choosing the spatial Durbin model (SDM) as the basis of our single equation models. The adoption of the multi-equation Spatial Seemingly Unrelated Regression (SSUR) as the basis for our preferred final model is then justified.

3.1 THE NEED FOR A SPATIAL APPROACH

Cameron *et al*. (2012b) found considerable descriptive evidence of the effects of varying alcohol outlet density across Manukau City. It is clear from their findings that the effects are spatially specific, and such spatial specificity has significant consequences for the modelling of these effects. As Waller *et al*. (2007) point out, the assumptions that underpin the standard tools of quantitative analysis in the social sciences, primarily linear regression and the associated models for categorical data, break down when analysing geographically referenced data. In particular, the assumptions of independence of observations and the constancy of association between observations and covariates are frequently violated when dealing with geo-referenced data owing to two factors.

The first of these is what has come to be known as Tobler's 'First Law of Geography':

> *"Everything is related to everything else, but near things are more related than distant things." (Tobler, 1970, p. 236)*

This implies that observations of a phenomenon taken close together geographically are more likely to be correlated than those taken farther apart, a phenomenon known as spatial autocorrelation, thus breaching the assumption of independence of observations.

Second, it is quite possible that all areas are not equally influenced by their neighbours. For instance, highly accessible places, say metropolitan areas with dense road networks and large concentrations of economic activity, will exert stronger effects on their neighbours than relatively isolated and peripheral regions (Longhi *et al*., 2006). This 'spatial heterogeneity' results in non-stationarity of the relationship between observations and covariates,[1] clearly violating the constancy of association assumption.

3.2 CROSS-SECTIONAL SPATIAL MODELS

The factors noted above point to the need for techniques tailored to address spatial autocorrelation.[2] This is evident in the extant literature on alcohol-related harm, where the use of spatial techniques has become widespread.[3]

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[1] That is, the relationship varies geographically.
[2] It should be noted that we do not directly address the issue of spatial heterogeneity in this report.
[3] For instance, Livingston (2008), in a non-exhaustive listing, identifies more than ten studies using spatial techniques to examine the link between alcohol outlet density and rates of violence. Cameron *et al*. (2012b) provide a more complete review of the literature in this area, including spatial analyses.

There are a number of methods commonly used to model the effects of spatial dependence. These include:

i) The spatial lag model (SAR)

In the case of the spatial lag model (SAR), spatial dependence is incorporated by including a function of the dependent variable observed at other locations on the right-hand side of the specification (Anselin, 1988), i.e:

$$y_i = g(y_{J_i}, \theta) + x_i \beta + \varepsilon_i \tag{1}$$

where J_i includes all the neighbouring locations j of i (but of course $j \neq i$). While the function g can in principle be very general and non-linear, in practice it is usually a linearly weighted combination of the values of the dependent variable in the neighbouring locations, with the weights together forming a spatial weights matrix. This concept of a spatial weights matrix is central to many of the methods developed to deal with spatial data (Anselin *et al*., 2000). The spatial weights matrix is a square matrix of dimension equal to the number of observations, with each row and column corresponding to a spatial unit. In its simplest form, an element w_{ij} of the weights matrix W is equal to one if locations i and j are neighbours, and equal to zero otherwise (the diagonal elements w_{ii} also equal zero). Commonly the weights matrix is row standardised so that weights add up to one when summing over j, as this facilitates interpretation and comparison between models.

A wide range of criteria may be used to specify the spatial weights matrix, with Getis and Aldstadt (2004) identifying no fewer than eight commonly used methods[4] and a plethora of lesser known or emergent approaches.[5] It should be noted that the construction of spatial weights matrices is not limited to geographic or Euclidean distance (Beck *et al*., 2005; Leenders, 2002); these matrices may be constructed on the basis of any kind of spatial interaction, such as the flow of goods or persons, or the regularity of air or train services between places. Indeed Conley and Topa (2002) take this even further by constructing indices of distance between areas based on sociological factors, such as ethnicity and occupational structure. A more detailed discussion of spatial weights matrices can be found in Bavaud (1998).

In matrix notation then, simplifying *g* through the use of the spatial weights matrix W, we have the spatial lag model:

$$y = \rho W y + \alpha l_n + X\beta + \varepsilon \tag{2}$$

---

[4] Spatial contiguity, inverse distances raised to some power, length of shared borders divided by the perimeter, n^{th} nearest neighbours, ranked distances, constrained weights for an observation equal to some constant, all centroids within distance *d* and band width as the n^{th} nearest neighbours' distance (Getis and Aldstadt, 2004).

[5] Getis and Aldstadt (2004) cite bandwidth distance decay, Gaussian distance decline and tri-cube distance decline functions as examples. Their own AMOEBA methodology should also be added to this list (Aldstadt and Getis, 2006).

with ρ being the spatial autoregressive coefficient[6] and ε an independently and identically distributed (i.i.d.) error term (LeSage and Pace, 2009).

ii) The spatial error model (SEM)

In the SEM, spatial dependence is introduced through specifying a spatial process for the random disturbance term. Formally for the case of a spatial autoregressive process (SAR) we have:

$$y = \alpha l_n + X\beta + u \text{ with } u = \theta Wu + \varepsilon \tag{3}$$

where y is a vector of observations on the dependent variable, W is again the spatial weights matrix, X is a matrix of observations on the explanatory variables, u is a vector of spatially auto-correlated error terms, ε is a vector of independent and identically distributed (i.i.d.) errors, and θ and β are parameters (LeSage and Pace, 2009).

iii) The spatial Durbin model (SDM)

The SDM is essentially an extension of the SAR model in which lags on the explanatory variables are included in the model in addition to the lag on the dependent variable (LeSage and Pace, 2009):

$$y = \rho Wy + \alpha l_n + X\beta + WX\gamma + \varepsilon \tag{4}$$

iv) The general spatial model (SAC)

The final model discussed here is the general spatial model (SAC), which combines the SAR and SEM. That is, the model includes both a lag on the dependent variable and a spatial process for the random disturbance term. Equation 5 shows this (LeSage and Pace, 2009):

$$y = \alpha l_n + \rho W_1 y + X\beta + u \text{ with } u = \theta W_2 u + \varepsilon \tag{5}$$

It should be noted that the two weights matrices, W_1 and W_2, may be identical matrices.

While the SAR and SEM specifications of spatial regression are probably the most commonly used models in the literature, LeSage and Pace (2009) make a compelling case for the use of the SDM. They argue that the SDM is the only model that will produce unbiased coefficient estimates under all four (SAR, SEM, SDM and SAC) data-generating processes as well as allowing correct inferences

[6] The spatial autoregressive coefficient indicates the degree to which the dependent variable at location i , y_i, is influenced by the values of *y* in neighbouring areas, y_{J_i}.

regarding these parameter estimates to be conducted in the case of the SAR, SEM and SDM data-generating processes.[7]

In addition, the SDM will help to protect against omitted variable bias. That is, bias in the estimation of a model's parameters arising from variables that exert an influence on the dependent variable but are not included in the model. Such problems are common in spatial modelling (see LeSage and Pace, 2009). Under these circumstances we adopt the SDM specification in our single equation models and for the equation specification in the SSUR in the following section.

3.3 SPATIAL SEEMINGLY UNRELATED REGRESSION (SSUR)

When a number of equations drawing on the same source of data are to be estimated, as is the case in this study, it is possible to estimate the system of equations simultaneously; estimators of this kind are called seemingly unrelated regression (SUR) models (Zellner, 1962). This approach exploits the contemporaneous correlation in the error terms of the equations to gain efficiency in the estimation (Baum, 2006).[8] Furthermore, when the error terms within a system of equations are correlated, this violates the i.i.d. assumption that underlies ordinary least squares estimation (i.e. the assumption that errors are distributed independently), necessitating an alternative approach to the modelling.

In the situation here where the equations differ only in the inclusion of the spatial lag of the dependent variable on the right-hand side of the estimating equations, the gains in efficiency (over single equation models) are likely to be small. However, diagnostics conducted on the system of equations when run as an SUR will indicate whether the correlation between the error terms is large enough to justify the adoption of the SUR in a single equation approach.

This being the case, in our preferred model we estimate a system of equations, each relating to a different dependent variable, with each equation being equivalent to an SDM specification.

3.4 DATA

The data used in this project were drawn from a number of sources, for a reference period of 1 July 2008 to 30 June 2009:

- Data on on-licence and off-licence liquor outlets in Manukau City were initially obtained from Manukau City Council, then verified by a telephone survey and additional fieldwork as described in Cameron *et al*. (2012b) to provide an accurate snapshot of the spatial distribution of liquor outlets by type as at 31 January 2009. The distribution of the database by type of outlet is summarised in Table 1.
- The 2006 Census of Population and Dwellings provided basic variables such as the usually resident populations of the census area units (CAUs) that constitute the spatial frame used here.

[7] LeSage and Pace (2009) note that the impact on inference of adopting SDM, when in fact the true data-generating process is SAC, is as yet unclear.
[8] In other words, because the error terms in each single equation are correlated with each other, SUR models are able to obtain more precise estimates of each of the coefficients.

- The New Zealand Deprivation Index (NZDep2006) is a commonly used index of small-area socioeconomic deprivation in New Zealand based on a number of variables drawn from the Census of Population and Dwellings. A full description can be found in Salmond *et al.* (2007), while Table 2 lists the component variables used in its construction.
- The NZ Transport Agency's Crash Analysis System (CAS) contains records of New Zealand Police reported traffic crashes back to 1980. This includes all fatal, injury and non-injury crashes reported to Land Transport New Zealand by New Zealand Police. Data were obtained for all traffic crashes recorded in CAS in the Manukau District, including both alcohol-related and non-alcohol related crashes (n=2866).
- Accident and emergency events data for Manukau District residents at Middlemore Hospital, the only public hospital within Manukau City (from Counties Manukau District Health Board). This dataset included all alcohol-related and non-alcohol-related accident and emergency events, including events that ultimately resulted in hospital admissions and those that did not (n=17,458).
- General discharge data for all alcohol- and injury-related admissions to Middlemore Hospital (also from Counties Manukau District Health Board) (n=651).
- New Zealand Police data on all police attendances for the reference period for Manukau District, obtained from the New Zealand Police Communications and Resource Deployment (CARD) database. These attendances were filtered to remove instances unlikely to be directly related to the consumption of alcohol, and grouped into event types as shown in Table 3.

Table 1: Active liquor licences in Manukau City by outlet type, 31 January 2009

Outlet type	**Number of active licences on 31 January 2009**
Restaurants/cafes/function centres/other on-licence	192
Pubs/bars/taverns/night clubs	60
Clubs	69
Liquor stores	90
Dairies/superettes	21
Supermarkets	22
Other off-licence[9] (excluded from analyses)	22
TOTAL	476

[9] 'Other off-licence' includes gift shops, florists, specialty stores, and vineyards. The characteristics of liquor sales from these off-licence outlets are quite different from those of other off-licence outlets, and as such they are excluded from the analysis of off-licence outlet density in the remainder of this report.

Table 2: Variables included in NZDep2006

Variable (proportions in small areas) in order of decreasing weight in the index
People aged 18-64 receiving a means-tested benefit
People living in equivalised* households with incomes below an income threshold
People not living in own home
People aged <65 living in a single-parent family
People aged 18-64 unemployed
People aged 18-64 without any qualifications
People living in equivalised* households below a bedroom occupancy threshold
People with no access to a telephone
People with no access to a car

*Equivalisation: methods used to control for household composition

Source: Salmond *et al*. (2007, p. 21)

Table 3: Police event type definitions

	Event		
	Violence offences n=3042	**Family violence** n=8039	**Sexual offences** n=201
Description	Homicide Kidnapping and Abduction Robbery Grievous Assaults Serious Assaults Minor Assaults Intimidation/Threats Unlawful Assembly Harassment	Child Abuse Domestic Violence Domestic Dispute	Sexual Affronts Sexual Attacks Rape Unlawful Sex Indecent Videos
	Event		
	Drug and alcohol offences n=1578	**Property damage** n=1751	**Property abuses** n=1641
Description	Drugs (Not Cannabis) Drugs (Cannabis Only) Liquor Offences Solvent Abuse Drunk Home Drunk Custody/Detox Centre Breach of Local Council Liquor Ban	Arson Wilful Damage Wilful Damage – Graffiti Endangering/Interfering	Trespass Littering Animal Cruelty Postal/Rail/Fire Service Abuses Telephone Offences Firearms Offences
	Event		
	Antisocial n*=13,512	**Dishonesty offences** n=13458	**Traffic offences** n=6890
Description	Disorder Car/Person Acting Suspiciously Mental Noise Control Breach of the Peace	Burglary Car Conversion Interference with Cars Theft Ex Shop Theft Ex Car General Theft	Traffic Incident Vehicle Collision Unauthorised Street and Drag Racing Traffic Offending

* n = total number of events in this category

One point to note is that our 'family violence' category (see Table 3) doesn't necessarily match up with the definition of family violence used by service agencies. In particular, some events such as minor and serious assaults, intimidation and threats are included in violence events rather than family violence. It should also be noted that family violence is reported through many channels in New Zealand, of which only one is the police.

Each dataset was cleaned to remove duplicate events or occurrences, and geocoded to obtain counts for each CAU.[10] However, the populations of two of these CAUs (Mangere Station (population 165) and Middlemore (population 273)) are so small that they result in substantial outliers in the dependent and key explanatory variables. As such these two outlier CAUs were combined with their nearest neighbours (Mangere Station was combined with Harania East and Middlemore was combined with Mangere East), leaving 86 CAUs in the final dataset.[11]

Liquor outlet densities were computed for each CAU as the number of outlets per 10,000 Census usually resident population (CURP). Population was used as the denominator in these measures as it is analogous to the availability of alcohol – if there are more outlets per person (or 10,000 people) within a small area, alcohol is more available.[12] Three separate approaches to the measurement of liquor outlet density were tried:

- The number of outlets of all types[13] per 10,000 usually resident population (all outlet density).
- Disaggregating the outlet density into off-licences per 10,000 usually resident population (off-licence density) and on-licences per 10,000 usually resident population (on-licence density).
- Disaggregating the outlet density into off-licences per 10,000 usually resident population (off-licence density), clubs and bars per off-licence per 10,000 usually resident population (club and bar density), and restaurants and cafes per 10,000 usually resident population (restaurant and cafe density). The split of on-licences into clubs and bars on the one hand and restaurants and cafes on the other reflects a fundamental difference in purpose between establishments. Where drinking is one of the main activities (as in clubs and bars) the marginal effects are different to on-licence outlets where drinking is incidental to another activity (such as restaurants and cafes). Similar logic could also have been applied to the off-licence category, which could have been split between

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[10] Owing to the relative coarse coding to CAU level, there were very few apparent geocoding errors. All errors that could not be immediately resolved were omitted from the final counts.
[11] This reduction in data to remove outliers almost entirely explains any difference between the results presented in this report and earlier results presented at the ALAC Working Together Conference 2010, the New Zealand Association of Economists Conference 2010, and a University of Waikato seminar in June 2010, and in the summary report (released March 2010).
[12] An alternative to using population as the denominator is to use the area of the CAU (in square kilometres, for instance). Using alternative measures based on an area denominator leads to qualitatively similar results.
[13] Excluding gift shops, florists, specialty stores, and vineyards.

supermarkets, dairies, and liquor stores. Unfortunately the relatively small number of dairies and supermarkets in Manukau City precluded this.

In a similar fashion, the density of total police events per 10,000 CURP of each CAU was created, along with similar densities for each of the nine categories of police event noted in Table 3. Two density measures of motor vehicle accidents per 10,000 CURP of each CAU were also created: (1) density of all motor vehicle accidents per 10,000 usually resident population; and (2) density of Friday and Saturday night (occurring between the hours of 10pm and 6am) motor vehicle accidents per 10,000 usually resident population. Two density measures of accident and emergency admissions per 10,000 CURP of each CAU were also created: (1) density of all accident and emergency admissions per 10,000 usually resident population; and (2) density of Friday and Saturday night (occurring between the hours of 10pm and 6am) accident and emergency admissions per 10,000 usually resident population. Finally, the density of alcohol-related hospital admissions per 10,000 CURP of each CAU was also created.

The primary variables derived from these datasets and descriptive statistics are shown in Table 4.

Table 4: Variable definitions and descriptive statistics (n=86)

Key explanatory variables						
Variable name	**Variable definition**	**Mean**	**Median**	**Std. dev.**	**Min.**	**Max.**
Total outlet density	The number of liquor outlets (excluding vineyards, gift shops, and florists) per 10,000 CURP of CAU	14.80	8.95	16.03	0	90.35
Off-licence density	The number of off-licence outlets per 10,000 CURP in CAU	4.47	3.11	4.97	0	22.59
On-licence density	The number of on-licence outlets per 10,000 CURP of CAU	10.33	6.12	12.29	0	67.76
Club/bar density	The number of clubs and bars per 10,000 CURP of CAU	4.09	2.51	5.31	0	28.25
Restaurant/cafe density	The number of restaurants and cafes per 10,000 CURP of CAU	6.24	0	10.06	0	48.40
Control variables						
Variable name	**Variable definition**	**Mean**	**Median**	**Std. dev.**	**Min.**	**Max.**
Population density	The CURP of CAU per square kilometre	2627.84	2768.72	1236.07	10.94	4917.27
NZ deprivation	New Zealand deprivation index (2006) score of CAU	1042.64	1035.5	108.00	888	1250
Dependent variables						
Variable name	**Variable definition**	**Mean**	**Median**	**Std. dev.**	**Min.**	**Max.**
Total police events	The number of recorded police events per 10,000 CURP of CAU	1567.51	1431.03	1136.68	260.07	8773.80
Violent offences	The number of recorded police events in the violence category per 10,000 CURP of CAU	94.56	89.31	69.72	13.63	432.40
Family violence	The number of recorded police events in the family violence category per 10,000 CURP of CAU	246.74	248.73	172.62	8.09	657.28
Sexual offences	The number of recorded police events in the sexual offences category per 10,000 CURP of CAU	6.31	5.19	5.85	0	35.50
Drug and alcohol offences	The number of recorded police events in the drug and alcohol offences category per 10,000 CURP of CAU	49.45	40.51	48.29	0	275.34

Table 4 ctd.: Variable definitions and descriptive statistics (n=86)

Variable Name	Variable Definition	Mean	Median	Std. Dev.	Min.	Max.
Property damage	The number of recorded police events in the property damage category per 10,000 CURP of CAU	55.90	47.21	40.34	5.01	197.68
Property abuses	The number of recorded police events in the property abuses category per 10,000 CURP of CAU	50.85	42.47	44.23	0	335.59
Antisocial behaviour	The number of recorded police events in the antisocial behaviour category per 10,000 CURP of CAU	422.54	382.30	280.30	54.95	1794.13
Dishonesty offences	The number of recorded police events in the dishonesty offences category per 10,000 CURP of CAU	420.42	333.82	423.64	58.48	3610.84
Traffic offences	The number of recorded police events in the traffic offences category per 10,000 CURP of CAU	220.74	167.15	215.99	14.33	1813.49
All motor vehicle accidents	The number of recorded motor vehicle accidents per 10,000 CURP of CAU	93.23	59.93	117.65	0	980.96
Friday/Saturday night MVAs	The number of recorded motor vehicle accidents occurring on Friday and Saturday night per 10,000 CURP of CAU	7.42	4.90	8.12	0	48.40
Emergency room admissions	The number of recorded emergency room admissions at Middlemore Hospital originating from the CAU, per 10,000 CURP of CAU	309.11	307.93	137.88	115.08	862.84
Friday/Saturday night emergency room admissions	The number of recorded emergency room admissions occurring on Friday and Saturday night at Middlemore Hospital originating from the CAU, per 10,000 CURP of CAU	25.47	22.69	15.54	0	81.40
Alcohol-related hospital admissions	The number of recorded hospital admissions at Middlemore Hospital related to alcohol originating from the CAU, per 10,000 CURP of CAU	13.66	11.78	9.65	0	52.72

3.5 MODELLING THE EFFECTS OF LIQUOR OUTLETS IN MANUKAU CITY

The modelling strategy involved the estimation of a series of cross-sectional models described in Sections 3.2 and 3.3, using the data described in Section 3.4. The aim was to develop a model that 'best' explains the cross-sectional associations between liquor outlet density measures (key explanatory variables) and alcohol-related harms (dependent variables), controlling for other variables (control variables) that are thought to influence the observed alcohol-related harms.

Two caveats should immediately be noted. First, as noted above, all of these models address the issue of spatial dependence as opposed to spatial heterogeneity. That is, the models take into account that observations taken close together are more likely to be correlated than those taken farther apart, but they assume that the observed associations are constant across space. Second, these models should be interpreted as describing associations between the included variables without necessarily implying causality.[14]

Our modelling strategy consisted of three stages:

1. To establish the extent of spatial dependence and double-check that a spatial approach to the modelling was warranted, a single equation model for each dependent variable was estimated using a robust ordinary least squares estimator. [15] The residuals of these estimations were then examined for the presence of spatial dependence (see Anselin, 2005). The specification of the model for each outcome was identical with the explanatory variables being measures of liquor outlet density, a measure of social deprivation to control for socioeconomic context (NZDep2006), and a measure of population density (population per square kilometre).

   A wide variety of candidate control variables were considered for inclusion but discarded on the basis that they either added nothing to the explanatory power of the model or proved to be highly correlated with other explanatory or control variables. Examples of the variables that were tried include:

   - the proportion of the population in certain age groups (to control for differences in demographic structure)
   - retail density calculated as the proportion of employment in the CAU in the retail or wholesale sectors (to control for the extent of commercial activity in the CAU or the relative absence of residential activity)

[14] In order to infer causality properly, a randomised controlled experiment where the number of liquor outlets is altered through a random process would be required. Alternatively, natural experiments or panel data may be used, although such data is still not definitive in terms of causality.

[15] Robust estimators are used as the variation in the size of the CAU populations is likely to be a source of heteroskedasticity (where the variance of the error terms is not constant), particularly as the majority of the independent variables used in the model are ratios with the CAU population as a denominator.

- the proportion of immigrants and ethnicity (to control for social differences in the population)
- interaction terms between many of the explanatory and control variables
- squared explanatory and control variables (to control for the potential non-linearity of effects as noted by Livingston *et al.* (2007)).

2 In the second round of modelling, SDMs for each dependent variable were estimated, in order to account for the observed spatial dependence. As noted above, the standard SDM includes the spatial lag of the dependent variable, explanatory variables (in this case the measures of outlet density, NZDep2006 and population density), and their spatial lags on the right-hand side of the model.

Here the standard SDM was augmented by the inclusion of two locational variables: the northing of the centroid of each CAU (y-centroid); and the easting of the centroid (x-centroid) of each CAU. These variables controlled for directionality in the data, i.e. increases in the dependent variables from east to west and north to south, which was not accounted for by the other included variables. This directionality in the data is further discussed in Section 4.2.

In addition, a number of possible methods for calculating the lag variables (variables that account for the spill-over effects that liquor outlets in one CAU have on dependent variables such as police events in neighbouring CAUs) were considered. These included:

- calculating the lags as the density of liquor outlets in neighbouring (contiguous) CAUs. That is, the lags were calculated as the number of liquor outlets in contiguous CAUs per 10,000 total usually resident population of those CAUs
- calculating the lags as the number of liquor outlets in contiguous CAUs per 10,000 total usually resident population of the CAU in question. This in effect treated all liquor outlets in neighbouring (contiguous) CAUs as being in the CAU in question and was intended to capture some idea of the number of liquor outlets to which the population had ready access
- calculating lags on the basis of various reciprocal distance weightings, for instance creating the spatial weights matrix used to calculate the lag variable on the basis of the reciprocal of the square of the distance between CAU centroids
- a simple spatial lag in which the spatial lag of a variable was the unweighted average of the values of that variable over the contiguous CAUs.

The last of these types of lag is probably the most common in the literature and was adopted in the final models reported here. This decision was taken largely because the alternatives yielded similar results but sacrificed much in the way of simplicity, familiarity and ease of interpretation.

3 Finally, the single equation SDMs were re-estimated as a multi-equation system using the SUR methodology outlined above. A top-down modelling approach was employed, wherein we initially estimated a system of equations that included all dependent variables, then progressively eliminated equations where outlet densities were not significant explanatory variables or where the explanatory power of the model was low. This left a final specification that included only ten equations: the nine categories of police events, and all motor vehicle accidents.

All SSUR models were estimated using an iterative process that continued until the coefficient estimates converged to the maximum likelihood results. This method is preferable to the standard two-stage SUR where coefficient estimates are not optimised to maximum likelihood results.

In all three stages of the modelling, separate models (or systems of models) were estimated for the three sets of outlet density measures, namely: (1) all outlet density; (2) off-licence density and on-licence density; and (3) off-licence density, club and bar density, and restaurant and cafe density.

4 MODEL RESULTS

This section briefly discusses the results from the aspatial single equation models and single equation SDMs, before presenting the results of the preferred specification; that is, the SSUR models.

4.1 ASPATIAL SINGLE EQUATION MODELS

The estimated aspatial single equation models are presented in Appendices I-III, with three alternative sets of outlet densities as key explanatory variables: (1) total outlet density (Models 1.1-1.15); (2) off-licence density and on-licence density (Models 2.1-2.15); and (3) off-licence density, club and bar density, and restaurant and cafe density (Models 3.1-3.15). The third set of outlet densities is preferred, as it seems reasonable to assume that the marginal effects of on-licence outlets where drinking is one of the main activities (as in clubs and bars) are different from the marginal effects of on-licence outlets where drinking is incidental to other activities such as meals (as in restaurants and cafes).

The overall fit of the models is good, with R-squared values between 0.4 and 0.7 in most cases (see Appendices I-III). The notable exceptions are the models of sexual offences, hospital discharge rates and Friday/Saturday night motor vehicle accidents, which have low explanatory power and as such are unlikely to provide good point estimates of the effects of liquor outlet density.

The coefficients of the key explanatory variables in those models show the size of the direct effect associated with one additional liquor outlet in an area. In these aspatial models, the total police events is positively associated with total outlet density (Model 1.1), but when disaggregated it appears that the association is with on-licence density (Model 2.1) and surprisingly with restaurant and cafe density (Model 3.1). Antisocial behaviour, dishonesty offences, traffic offences, and alcohol-related hospital admissions have similar associations. Violent offences are positively associated with total outlet density (Model 1.2), but more specifically with off-licence density (Models 2.2 and 3.2). Property damage events are positively associated with total outlet density (Model 1.6), but more specifically with on-licence density (Model 2.6) and both types of on-licence (Model 3.6).

Property abuse events, traffic offences, and all motor vehicle accidents are each positively associated with total outlet density, but the association becomes insignificant when outlet density is disaggregated into different types of outlet. Surprisingly, family violence is negatively associated with off-licence density – a point to which we will return in the Discussion section. Sexual offences may be associated with off-licence density, but drug and alcohol offences are not significantly associated with any of the density measures.

Emergency room admissions, and Friday/Saturday night emergency room admissions, appear to be associated with club and bar density but not with other density measures.

Social deprivation shows a significant and positive association in all models, suggesting that, holding all else constant, areas of higher deprivation experience more police events, more of each type of police event, more motor vehicle accidents, and more adverse health events. In contrast, population density is only significant (and negative) in the models of traffic offences and motor vehicle accidents, suggesting that these events tend to occur more in areas of lower population density. This seems reasonable, given that areas of lower population density also tend to be the areas that have motorways and major arterial roads running through them.

As demonstrated by the Moran's I, LM lag and LM error test statistics in Appendices I-III, seven of the models exhibit significant spatial effects, with four of those exhibiting both significant spatial lag dependence and significant spatial error dependence. Many of the other models have test statistics for spatial dependence that are close to significant. Because of the presence of spatial dependence in the aspatial models, it is highly likely that the assumptions that underlie ordinary least squares regression will be violated as noted in Section 3.1 above. These aspatial models should therefore only be interpreted as a starting point in this investigation of the effects of liquor outlet density, as given these issues SARs or SEMs may be more appropriate for estimating marginal effects. The results of SDMs (which account for both spatial lag dependence and spatial error dependence) are discussed in the next section.

4.2 SINGLE EQUATION SDMS

As noted in Section 4.1, many of the aspatial models exhibit significant spatial effects, suggesting that either SARs or SEMs would be more appropriate for an estimation of the marginal effects. Given that some of the aspatial models exhibit *both* spatial lag dependence and spatial error dependence, the more general SDM was estimated for each dependent variable.[16]

The estimated single equation SDMs are presented in Appendices IV-VI, again with three alternative sets of outlet densities included as dependent variables: (1) total outlet density (Models 4.1-4.15); (2) off-licence density and on-licence density (Models 5.1-5.15); and (3) off-licence density, club and bar density, and restaurant and cafe density (Models 6.1-6.15). Again the third set of outlet densities is the preferred set and detailed results for this set of models are presented in Appendix VI.

The coefficients in the SDMs are mostly qualitatively the same as in the non-spatial models, differing only in the level of significance. All outlet density coefficients that were significant in the aspatial models remain significant in the SDMs, with the exception of club and bar density in the health models, which becomes insignificant. However, in the other models, many additional direct density variables become significant once spatial effects are taken into account.[17]

As shown in Appendix VI, in addition to the significant direct density variables, several of the lag density variables are significant. This suggests that liquor outlet densities have not only local effects but also neighbourhood effects. For instance, in the model of total police events (Model 6.1), the lag of restaurant and cafe density is significant and positive. Across the models these neighbourhood (lag) effects are most prominent for restaurant and cafe density, although the lag of off-licence density

[16] Both SARs and SEMs were also estimated, and the results were qualitatively similar to those reported here for the SDMs. However, as SDMs dominate these other spatial models in terms of their efficiency and lack of bias (as noted in Section 3.2), only the SDM results are reported here.

[17] Compare the significance of the coefficients in Appendix III with those in Appendix VI. For instance, in the equation for total police events, club and bar density and restaurant and café density are both highly significant in the SDM, when only restaurant and café density was significant (and only marginally so) in the aspatial model.

is also significant in the model of property abuses. The significant neighbourhood effects for restaurant and cafe density are all positive, as well as larger in absolute terms than the direct effects of restaurant and cafe density. This suggests that areas contiguous with areas of high restaurant and cafe density tend to be associated with a greater density of police events than those areas themselves. The neighbourhood effects are mostly negative for club and bar density but none of the effects is significant, and the only significant neighbourhood effect of off-licence density is negative in sign. This might suggest a displacement effect – whereby a higher outlet density attracts police events, increasing the number of police events in areas of higher outlet density, but reducing police events in neighbouring CAUs.

The *y-centroid* variable is significant and negative in all of the models of police events and motor vehicle accidents, suggesting that there remains a significant geographical gradient running from north to south (such that, holding all else equal, areas further south have more police events and motor vehicle accidents). In contrast, the *x-centroid* variable is only significant (and negative) in the health-related models where the *y-centroid* is not significant. This suggests that, holding all else constant, areas further to the west have more accident and emergency admissions and alcohol-related hospital admissions. This directionality in the data almost certainly arises from some omitted variable from the model. Considering the nature of Manukau City, there are clear differences between the east (rural) and west (urban) and the north (bordering Auckland City) and south (bordering Papakura District). As noted in Section 3.5, a wide range of other candidate variables was tried in order to reduce the effect of this directionality, including demographic variables, ethnicity, and retail density. However, these variables added little explanatory power and did not reduce the significant effect of the direction variables. The significance of the *y-centroid* variable may be picking up unmeasured lag effects from areas outside the boundary of Manukau City (referred to as 'edge effects' in the spatial econometrics literature (see Anselin, 1988; Haining, 1997)). These edge effects occur because we have considered Manukau City as an 'island' and the modelling does not allow for the relationship between liquor outlets in neighbouring districts and the social harms in Manukau City. Manukau City is bordered by Auckland City to the north and by Papakura District to the south. Auckland City has a higher population density and higher alcohol outlet density (per square kilometre) than Papakura District, so any effect of alcohol outlet density on social harms is likely to be higher in the north of Manukau City as a result. Unfortunately the depth of data used in this study is not available for surrounding areas, so we are unable to test this. The significance of the *x-centroid* in the health models may be due to distance from Middlemore Hospital, which is located in the western part of Manukau City. When accident or emergency events occur in Manukau City, patients will likely present at the nearest hospital, which is Middlemore Hospital for those in the centre or west of the city. However, those in the east of the city may present instead at accident and emergency clinics in Botany, Takanini, or Papakura, of which any may be physically closer than Middlemore Hospital. Unfortunately, we do not have data on accident and emergency events presenting at clinics other than Middlemore Hospital, so are unable to verify this.

Diagnostics show that the residuals of these single equation Durbin models are correlated, thereby violating the assumptions underlying the OLS model (Breusch-Pagan test of independence; $Chi^2(91) = 1548.5$; $p<0.0001$). These models are therefore only a further intermediate step in this investigation of the effects of liquor outlet density. SSUR models (based on the SDM specification) will be presented in the next section.

4.3 SSUR MODELS

As noted in Sections 4.1 and 4.2, the residuals from many of the single equation models are correlated, violating the independent and identically distributed assumption of OLS regression. To account for these correlations, and to derive estimates of the marginal effects that are more efficient, an SSUR specification was applied.

Several specifications of SSUR were estimated, using a top-down approach. Each specification included a different set of equations (a different set of dependent variables), with each subsequent model excluding equations from the previous model where outlet density measures were insignificant or where the equation had low explanatory power. These resulting specifications are summarised in Table 5.[18] All specifications used three measures of outlet density as explanatory variables (as in the preferred specifications of the single equation models). The estimated preferred final specification of SSUR (Model 10) is presented in Table 6, while detailed results for the other specifications are included in Appendices VII-IX.

Table 5: Summary of specifications of alternative SSURs

Model	Dependent variables	Explanatory variables
7	Nine categories of police event; all motor vehicle accidents and Friday/Saturday night motor vehicle accidents; all emergency room admissions and Friday/Saturday night emergency room admissions; and alcohol-related hospital admissions (14 equations).	The lag of each dependent variable, outlet density measures and their lags; deprivation and its lag; population density and its lag, and *x*- and *y-centroids*.
8	Nine categories of police event; all motor vehicle accidents and Friday/Saturday night motor vehicle accidents; and alcohol-related hospital admissions (12 equations).	The lag of each dependent variable, outlet density measures and their lags; deprivation and its lag; population density and its lag, and *x*- and *y-centroids*.
9	Nine categories of police event; all motor vehicle accidents; and alcohol-related hospital admissions (11 equations).	The lag of each dependent variable, outlet density measures and their lags; deprivation and its lag; population density and its lag, and *x*- and *y-centroids*.
10	Nine categories of police event and all motor vehicle accidents (10 equations).	The lag of each dependent variable, outlet density measures and their lags; deprivation and its lag; population density and its lag, and *x*- and *y-centroids*.

[18] Specifications of the SUR models that included equations that had each outlet density variable as dependent variables were also estimated, although convergence in these models proved to be difficult using maximum likelihood estimation, owing to insufficient degrees of freedom.

The SSUR models are mostly qualitatively the same as the earlier models, mostly differing only in the level of significance of the variables. As all equations are simultaneously estimated, there is no model for total police events – instead this must be inferred from summing the marginal effects of each type of event (see the following section). In the preferred model shown in Table 6 (Model 10), the equations have relatively high R-squared values, suggesting that they adequately fit the data being modelled. The exception to this is the equation for sexual offences, which has an R-squared of 0.39, signifying that the explanatory power within that equation is much lower.

Off-licence density is significantly positively associated with violent offences, sexual offences, and drug and alcohol offences, and significantly negatively associated with family violence.[19] The density of clubs and bars is significantly positively associated with violent offences, drug and alcohol offences, property damage, property abuses, antisocial behaviour, dishonesty offences, and traffic offences. The density of restaurants and cafes is significantly positively associated with violent offences, family violence, property damage, property abuses, antisocial behaviour, dishonesty offences, traffic offences, and motor vehicle accidents.

Social deprivation remains significant and positive in many of the equations, while population density is only significant in a few of the equations. The spatial variables and neighbourhood effects retain similar levels of significance (and similar interpretations) to those observed in the single equation SDMs.[20]

4.4 ROBUSTNESS OF THESE RESULTS

The close similarity of results between the aspatial single equation models, single equation SDMs, and SSUR models suggests that these results are relatively robust to alternative specifications. Furthermore, as described earlier, the addition of alternative demographic and industry control variables (demographic structure, retail density, proportion of immigrants, ethnicity), interaction variables, and non-linearity added little to the explanatory power of the model.

In particular, we can be reasonably confident that these results reflect the cross-sectional associations between outlet densities and alcohol-related harms rather than a more general relationship between retail areas and alcohol-related harms, because the inclusion of a retail density measure in the specification does not cause the key explanatory variables to become insignificant (results not shown).[21] Furthermore, although these results do not imply causality, they are consistent with the theory noted in Section 2.

However, as these results are based on cross-sectional data they possess its inherent limitations in terms of causality. Improved models involving repeated cross-sectional data, longitudinal data, or

[19] See the Discussion section for further discussion of the unusual and unexpected family violence results.

[20] The only exception was the lag of restaurant and café density, which lost its significance in some of the SUR models, including the preferred Model 10.

[21] Including retail density and its lag into Model 10 only makes club and bar density insignificant in the equations for drug and alcohol offences and property damage, leaving all other direct effects of outlet density significant.

panel data would likely further improve the accuracy of these results, allowing more defendable conclusions about the impacts of liquor outlet density to be drawn.

Table 6: SSUR results for Model 10

	Violent offences (10.1)		Family violence (10.2)		Sexual offences (10.3)		Drug and alcohol offences (10.4)		Property damage (10.5)		Property abuses (10.6)	
Observations	86		86		86		86		86		86	
R-squared	0.7586		0.9060		0.3925		0.6241		0.5856		0.6162	
RMSE	34.056		52.618		4.5295		29.432		25.815		27.243	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.1710	0.182	0.3159	0.030**	-0.3087	0.134	-0.0434	0.809	0.0561	0.705	0.1807	0.226
Off-licence density	3.4915	0.003***	-4.1620	0.022**	0.3764	0.016**	2.6328	0.009***	-0.8503	0.341	1.0407	0.273
Club/bar density	2.8859	0.003***	-0.8152	0.592	0.0763	0.568	1.5830	0.063*	1.2553	0.093*	2.4000	0.002***
Restaurant/cafe density	1.8786	0.001***	1.7766	0.045**	0.0105	0.891	0.4885	0.325	1.2032	0.006***	1.5392	0.001***
Pop. density	-0.0006	0.896	-0.0118	0.082*	-0.0011	0.049**	-0.0055	0.147	-0.0063	0.059*	-0.00003	0.991
NZ deprivation	0.1653	0.035**	1.4333	<0.001***	0.0081	0.451	0.0885	0.193	0.3035	<0.001***	0.1151	0.066*
Lag of off-licence density	-1.2212	0.669	1.5022	0.730	0.1919	0.629	-2.2463	0.366	0.7615	0.720	-4.7372	0.035**
Lag of club/bar density	-0.1584	0.933	-0.5652	0.841	0.0252	0.920	-0.4227	0.791	-1.0188	0.462	-2.1289	0.160
Lag of rest./cafe density	2.6377	0.052*	-1.2414	0.549	0.0315	0.858	0.9213	0.424	-0.6827	0.503	2.1764	0.049**
Lag of pop. den.	0.0296	<0.001***	0.0230	0.060*	0.0028	0.008***	0.0167	0.014**	0.0100	0.092*	0.0091	0.160
Lag of NZDep	0.1432	0.256	-0.7145	0.004***	-0.0057	0.734	0.2188	0.043**	-0.1627	0.088*	0.0276	0.781
x-centroid	-0.0017	0.179	0.0005	0.794	-0.0002	0.283	0.0005	0.668	-0.0002	0.834	-0.0001	0.920
y-centroid	-0.0054	<0.001***	-0.0075	0.002***	-0.0004	0.010**	-0.0011	0.302	-0.0016	0.075*	-0.0030	0.005***
Constant	39051	<0.001***	46,678	0.007***	3,171.8	0.014**	5,563.3	0.513	11,047	0.131	19,563	0.017**

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table 6 ctd.: SSUR results for Model 10

	Antisocial behaviour (10.7)		Dishonesty offences (10.8)		Traffic offences (10.9)		All motor vehicle accidents (10.10)	
Observations	86		86		86		86	
R-squared	0.7255		0.6379		0.6148		0.5128	
RMSE	146.01		253.43		133.28		81.645	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.1194	0.312	-0.0988	0.395	-0.1811	0.158	-0.0671	0.644
Off-licence density	6.8461	0.173	9.8319	0.260	6.1031	0.184	3.7015	0.188
Club/bar density	12.457	0.003***	25.499	0.001***	8.6898	0.026**	3.6318	0.127
Restaurant/cafe density	8.5346	0.001***	20.749	<0.001***	9.6859	<0.001***	4.5328	0.001***
Pop. density	-0.0313	0.097*	-0.0476	0.146	-0.0558	0.001***	-0.0339	0.001***
NZ deprivation	0.7905	0.018**	0.0770	0.895	0.2962	0.334	0.1378	0.464
Lag of off-licence density	-14.442	0.234	-22.039	0.293	3.2708	0.770	1.3724	0.842
Lag of club/bar density	-5.0025	0.530	-17.540	0.208	-5.3223	0.467	-0.9675	0.830
Lag of rest./cafe density	11.708	0.044**	27.323	0.008***	12.282	0.022**	5.2660	0.106
Lag of pop. den.	0.1270	<0.001***	0.1384	0.017**	0.0631	0.038**	0.0475	0.011**
Lag of NZDep	0.7166	0.180	0.2340	0.797	0.1812	0.708	-0.1028	0.727
x-centroid	-0.0002	0.972	-0.0149	0.115	-0.0047	0.328	-0.0032	0.290
y-centroid	-0.0201	<0.001***	-0.0393	<0.001***	-0.0156	0.001***	-0.0071	0.013**
Constant	129,138	0.003***	293,934	<0.001***	113,484	0.002***	54,302	0.017**

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

5 THE MARGINAL EFFECTS OF ADDITIONAL LIQUOR OUTLETS IN MANUKAU CITY

Although the models presented above provide little guidance as to causality or even the specific mechanism of association between liquor outlet density and alcohol-related harms, we may infer from the estimated coefficients the cross-sectional marginal effect of an additional liquor outlet on a given CAU.[22] Table 7 presents the range (lowest to highest) of the coefficient point estimates from the models that disaggregated liquor outlet density into three variables (Models 3, 6, and 7-10).[23] For instance, one additional off-licence outlet is associated with between 2.7 and 3.5 additional violent offences.

Table 7 also presents the derived marginal effects expressed as a percentage change (evaluated at the mean number of total police events) and as an elasticity (evaluated at the mean number of total police events and the mean number of liquor outlets). These marginal effects should be interpreted with care, as many of the coefficients used to construct them are not statistically significant. This is denoted in Table 7 by the number of asterisks, with more asterisks denoting a higher consistency of statistical significance across the range of models.

Table 7: Minimum and maximum point estimates of the marginal effects associated with additional liquor outlets from the three model specifications

Effect	Off-licence outlets	Clubs and bars	Restaurants and cafes
Violent offences	2.7 – 3.5***	2.4 – 2.9**	1.8 – 1.9**
Family violence events	5.6 – -4.2***	-1.0 – 0.3	1.6 – 1.8**
Sexual offences	0.3 – 0.4**	0.1 – 0.1	0.0 – 0.0
Drug and alcohol offences	2.4 – 2.6**	1.4 – 1.6**	0.4 – 0.5
Property damage events	-1.3 – -0.7	1.1 – 1.3*	1.2 – 1.4***
Property abuse events	0.7 – 1.0	1.4 – 2.4**	1.5 – 1.6**
Antisocial behaviour events	4.4 – 6.9	10.4 – 12.6**	8.2 – 8.8***
Dishonesty offences	4.3 – 9.8	16.0 – 25.5**	20.7 – 21.1***
Traffic offences	2.4 – 6.3	7.1 – 8.7**	9.4 – 10.2***
Total police events	**10.4 – 25.3**	**40.4 – 54.0**	**45.3 – 47.1**
As a percentage change	*0.7% – 1.6%*	*2.6% – 3.4%*	*2.9% – 3.0%*
As an elasticity	*0.03 – 0.07*	*0.11 – 0.14*	*0.18 – 0.19*
Motor vehicle accidents	**2.0 – 3.8**	**2.9 – 3.6**	**4.5 – 4.8****
As a percentage change	*2.2% – 4.1%*	*3.1% – 3.9%*	*4.9% – 5.2%*
As an elasticity	*0.10 – 0.18*	*0.14 – 0.17*	*0.22 – 0.23*

*** = significant in all spatial and aspatial models, ** = significant in all spatial models, * = significant in some (but not all) models

As Table 7 shows, holding all else constant, an additional off-licence outlet is associated with an additional 10.4 to 25.3 police events per year, representing an increase of between 0.7% and 1.6%

[22] As all variables are expressed as the number of outlets (or events) per 10,000 population in the CAU, the coefficients are the same as the marginal effects, or the number of events associated with an increase in the number of outlets by one.

[23] From Table 6, Appendix III, and Appendices VI-IX.

over the mean number of police events in a CAU. The largest contributors to these additional police events are dishonesty offences, antisocial behaviour events, and traffic offences. Holding all else constant, an additional off-licence outlet is associated with an additional 2.0 to 3.8 motor vehicle accidents per year, representing an increase of between 2.2% and 4.1% over the mean number of motor vehicle accidents in a CAU. Holding all else constant in a representative (mean) CAU, a 1% higher number of off-licence outlets is associated with a 0.03-0.07% higher number of total police events and a 0.10-0.18% higher number of motor vehicle accidents.

Holding all else constant, an additional club or bar is associated with an additional 40.4 to 54.0 police events per year, representing an increase of between 2.6% and 3.4% over the mean number of police events in a CAU. The largest contributors to these additional police events are dishonesty offences, antisocial behaviour events, and traffic offences. Holding all else constant, an additional club or bar is associated with an additional 2.9 to 3.6 motor vehicle accidents per year, representing an increase of between 3.1% and 3.9% over the mean number of motor vehicle accidents in a CAU. Holding all else constant in a representative (mean) CAU, a 1% higher number of off-licence outlets is associated with a 0.11-0.14% higher number of total police events and a 0.14-0.17% higher number of motor vehicle accidents.

Holding all else constant, an additional restaurant or cafe is associated with an additional 45.3 to 47.1 police events per year, representing an increase of between 2.9% and 3.0% over the mean number of police events in a CAU. The largest contributors to these additional police events are dishonesty offences, traffic offences, and antisocial behaviour. Holding all else constant, an additional restaurant or cafe is associated with an additional 4.5 to 4.8 motor vehicle accidents per year, representing an increase of between 4.9% and 5.2% over the mean number of motor vehicle accidents in a CAU. Holding all else constant in a representative (mean) CAU, a 1% higher number of off-licence outlets is associated with a 0.18-0.19% higher number of total police events and a 0.22-0.23% higher number of motor vehicle accidents.

6 DISCUSSION

Cameron *et al*. (2012a) reviewed the international literature on the impacts of liquor outlets on various alcohol-related harm indicators. They concluded that the international academic literature provides mixed results for the relationship between liquor outlet density and a range of outcome variables. Furthermore, they noted that it is likely that any statistically significant relationships are highly context specific, as well as varying temporally, spatially, and by the type of outlet considered. The results of this study need to be viewed within the context of the extant international literature, and the theoretical mechanisms through which liquor outlet density affects social harms as outlined in Section 2.

Violent offences are significantly positively associated with all three types of liquor outlet density (off-licence, clubs and bars, and restaurants and cafes), which is similar to the results of Scribner *et al*. (1995) for Los Angeles. These associations are consistent with proximity effects, wherein the full cost of alcohol is reduced and consumption increases as a result (consistent with availability theory and the other explanations in Section 2). The association with the two on-licence densities is also consistent with an amenity effect, wherein the outlets cluster in areas that attract a large number of drinkers, which in turn attracts violent offending owing to over-consumption of alcohol and a greater number of potential targets of violence. However, other studies have found that off-licence outlets are significantly positively associated with violence but that on-licence outlets are not (Gruenewald *et al*., 2006; Scribner *et al*., 1999; Costanza *et al*., 2001), while others have found the reverse (Lipton and Gruenewald, 2002; Roman *et al*., 2008).

We found that family violence was positively associated with restaurant and cafe density, and negatively associated with off-licence density. This result is quite different from Freisthler (2004), who found that a higher density of bars was significantly positively associated with substantiated reports of child abuse and neglect in California, but the density of off-licence outlets and restaurants was not. Similarly, Freisthler *et al*. (2004) found that child physical abuse was significantly related to the density of off-licence outlets but not other outlet types, and child neglect was significantly related to the density of bars, but not other outlet types. As noted in Section 3.4, our family violence variable includes child abuse, domestic violence, and domestic disputes, but not assaults or intimidation and threats. Notwithstanding the differences in definition, these results are difficult to reconcile with the international studies. It is not clear what is behind these unexpected findings. However if biases in family violence statistics occur across the Manukau region then this could potentially account for these results. For example, the west of Manukau city contains a higher density of liquor outlets (Cameron *et al.,* 2012b) so these results could be related to social disorganisation (Browning, 2002). As noted in Section 2 and in Cameron *et al.* (2012b), areas of lower social cohesion attract liquor outlets, and these may also be the areas where reporting of family violence is lower (Gracia and Herrero, 2007). This or similar biases for family violence statistics could explain the unexpected negative association observed between family violence and alcohol outlet density.

We found significant positive associations between club and bar density and restaurant and cafe density and antisocial behaviour, property damage, and property abuses. These are similar results to those observed by Donnelly *et al*. (2006) for New South Wales, but different from Roman *et al*. (2008) and Rabow and Watts (1982), who found no association between outlet density and disorderly conduct in Washington, DC and public drunkenness in California respectively. Like the violence results, these are consistent with both proximity and amenity effects.

We found that motor vehicle accidents were significantly positively associated with restaurant and cafe density, but not other outlet densities. This is similar to Scribner et al. (1994), who found that alcohol-related crashes resulting in injury were significantly associated with the density of restaurants, liquor stores, and mini-markets with liquor licences, but not bars. They also found that alcohol-related crashes resulting in property damage were significantly associated with the density of restaurants and bars, but not other outlet types. Similarly, Gruenewald *et al*. (2002) found that drinking and driving was positively associated with restaurant density, but negatively associated with off-licence density, and had no association with bar density. Other studies (McCarthy, 2003; Gruenewald *et al*., 1996) have found similar results.

The insignificant effect of off-licence outlet density on motor vehicle accidents can be explained in part by the relationship between outlet density and purchasing behaviour, as described in Brown *et al.* (1996). A decrease in off-licence outlet density increases the travel distance (and travel cost) associated with purchasing alcohol. This reduces alcohol consumption, which in turn reduces drink driving and the number of alcohol-related motor vehicle accidents. Furthermore, as the travel distance increases, consumers make fewer trips to purchase alcohol, which has a similar effect. However, increased travel distance also means that consumers must travel farther in order to obtain alcohol, which increases the likelihood of a motor vehicle accident. Overall the effect of alcohol outlet density on motor vehicle accidents may be indeterminate rather than significantly positive, since this would depend on the size of the first two effects combined being smaller than the third. In contrast to off-licence outlet density, a change in on-licence density has little effect on travel distance for consumers, since on-licence outlets tend to co-locate in areas of high amenity value (Cameron *et al*., 2012b). The significant effect of restaurant and cafe density and the insignificance of club and bar density on motor vehicle accidents could be related to differences in drinking behaviour at the two types of establishment. For instance, drinkers at clubs and bars may be more likely to use taxis or public transport, whereas drinkers at restaurants and cafes may be more likely to drive following their drinking (Gruenewald *et al.*, 2002).[24] However, it is difficult to reconcile this with the other results as there were no significant associations between outlet density and Friday and Saturday night motor vehicle accidents (although restaurant and cafe density was closest to statistical significance).

We had somewhat disappointing results in terms of health-related variables, with the only significant association being between restaurant and cafe density and alcohol-related hospital admissions. Most studies of health-related impacts make use of natural experiments, but one cross-sectional study showed that outlet density was significantly positively associated with alcohol-related hospitalisations in San Diego (Tatlow *et al*., 2000). Our disappointing results are probably due to recording practices in the health data. The location of an accident and emergency 'event' is usually recorded as the patient's home address, as opposed to the location where the 'event' took place – leading to

[24] Gruenewald *et al.* (2002) found that high variance drinkers (those with a high variance in the quantity consumed in each occasion of drinking) are less likely to drive when they prefer to drink at their own homes or bars, compared with restaurants or at friends' homes. They also found that those who drink more per occasion and have a preference for drinking at bars are less likely to drink while intoxicated, compared with those with other preferred drinking locations.

significant spatial errors. This suggests that any observed association between outlet density and accident and emergency events would be spurious at best. A better source of data for investigating these effects may be ambulance call-outs, if geocoded data are available.

While many of the marginal effects are statistically significant, the size of the estimated marginal effects is in most cases quite small (see Section 5). For instance, an additional liquor outlet is associated with an additional two to four violent offence events. Recall that these events are not apprehensions or prosecutions, but based on all events recorded by New Zealand Police in the CARD database. However, these results may generally be in line with the international literature. For example, Scribner *et al*. (1995) found that an increase in outlet density (whether on-licence or off-licence) was associated with 0.30 to 0.54 additional violent assaults, while Gruenewald *et al*. (2006) found that an increase in off-licence density by one outlet was associated with 1.3 additional hospital discharges for assault. Similarly, while we found an additional liquor outlet was associated with an additional 2.0 to 4.9 motor vehicle accidents per year, Scribner *et al*. (1994) found much lower rates but their study was limited to alcohol-related crashes, and Gruenewald *et al*. (1996) also found lower rates but were limited to single-vehicle night-time crashes.

This analysis is the most wide-ranging analysis of the impacts of liquor outlet density on small areas in New Zealand. However, it should be noted that there are a number of ways in which this study could be improved. First, in the absence of a randomised controlled experiment or even a natural experiment, repeated cross-sectional or panel data should be used to better control for unobserved differences between different CAUs within the study area. Repeated cross-sectional or panel data could then allow the models to be expressed in differences, essentially differencing out any time-invariant differences within each CAU. However, even panel data are still not definitive in terms of causality.

Second, there is the possibility that edge effects may drive some of the results observed in this study. Essentially, this research has assumed that Manukau City is an island, when in fact Auckland City, with a high population density and many liquor outlets, borders the city to the north. Some effects related to liquor outlet density will therefore cross the city borders and cannot be taken into account in an analysis that limits itself to a non-naturally constrained geographical area. A more complete analysis could be conducted across all CAUs in the North Island, if not all of New Zealand, in order to examine these edge effects.

Finally, as noted in Cameron *et al*. (2009), this research has assumed that the relationships between liquor outlet density and alcohol-related harms are constant across all of the study area. This is unlikely to be true.[25] While the directionality variables (*x-centroid* and *y-centroid*) probably proxy somewhat for these varying relationships across space, it may be better to approach future modelling using Bayesian geographically weighted regression or similar techniques (LeSage, 1997; LeSage and Pace, 2009).

We intend to conduct further follow-up research in this area. To this end, we are building a repeated cross-sectional database of liquor outlet density in Manukau City to address the first point above. We

[25] A subsequent preliminary analysis suggests that these relationships do, indeed, vary across Manukau City.

will supplement this by applying Bayesian geographically weighted regression techniques in the analysis in the future.

7 CONCLUSION

This report estimated the impacts of liquor outlet density on a range of indicators in Manukau City, including police events, accident and emergency admissions, and hospital discharges. We applied a range of aspatial and spatial data analysis techniques, finally adopting a preferred specification that utilised SSUR to estimate a system of related cross-sectional equations.

Holding all other variables constant, our preferred specification showed that off-licence density is significantly positively associated with violent offences, sexual offences, and drug and alcohol offences, and significantly negatively associated with family violence; the density of clubs and bars is significantly positively associated with violent offences, drug and alcohol offences, property damage, property abuses, antisocial behaviour, dishonesty offences, and traffic offences; and the density of restaurants and cafes is significantly positively associated with violent offences, family violence, property damage, property abuses, antisocial behaviour, dishonesty offences, traffic offences, and motor vehicle accidents.

The results were robust to alternative specifications of the models and a variety of included control variables. The results were also similar to those found in the international literature, although Cameron *et al*. (2012a) showed that results can be highly context specific. This context specificity is one reason why caution should be taken when considering these results as indicative of the situation in other areas of New Zealand. However, the general approach that was adopted in this research is readily transferable to other settings.

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APPENDIX I

Table A1: Regression results for aspatial single equation models, with total outlet density as a dependent variable

	Total police events (1.1)		Violent offences (1.2)		Family violence (1.3)		Sexual offences (1.4)		Drug and alcohol offences (1.5)		Property damage (1.6)	
Observations	86		86		86		86		86		86	
F(3,82)	24.27		38.03		128.50		5.78		21.05		18.97	
Prob. >F	<0.0001		<0.0001		<0.0001		0.0004		<0.0001		<0.0001	
R-squared	0.5620		0.6140		0.8214		0.2751		0.5022		0.4978	
Root MSE	765.88		44.103		74.286		5.0984		34.686		29.103	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Total outlet density	34.5322	0.036**	2.1380	0.004***	-0.6342	0.222	0.1189	0.141	1.1564	0.004***	0.6496	0.030**
Population density	-0.1166	0.204	0.0042	0.409	-0.0132	0.140	-0.0004	0.513	-0.0010	0.806	-0.0053	0.159
NZ deprivation	6.7592	<0.001***	0.4387	<0.001***	1.4923	<0.001***	0.0244	<0.001***	0.2953	<0.001***	0.2691	<0.001***
Constant	-5,684.5	<0.001***	-405.58	<0.001***	-1,265.1	<0.001***	-19.745	0.002***	-272.89	<0.001***	-220.19	<0.001***
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	2.77	0.006***	1.77	0.076*	6.92	<0.001***	0.89	0.371	0.67	0.506	1.72	0.086*
LM error	5.20	0.023**	1.78	0.182	38.42	<0.001***	0.25	0.614	0.08	0.773	1.64	0.200
LM lag	4.37	0.037**	5.12	0.024**	17.30	<0.001***	0.03	0.856	0.98	0.323	0.03	0.854

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A1 ctd.: Regression results for aspatial single equation models, with total outlet density as a dependent variable

	Property abuses (1.7)		Antisocial behaviour (1.8)		Dishonesty offences (1.9)		Traffic offences (1.10)		All motor vehicle accidents (1.11)		Friday/Saturday night MVAs (1.12)	
Observations	86		86		86		86		86		86	
F(3,82)	18.78		25.80		4.65		7.42		4.07		7.17	
Prob. >F	<0.0001		<0.0001		0.0047		0.0002		0.0096		0.0002	
R-squared	0.4495		0.5687		0.4411		0.4993		0.4172		0.2689	
Root MSE	33.415		187.41		322.46		155.61		91.450		7.071	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Total outlet density	1.2672	0.076*	7.4834	0.019**	15.3326	0.041**	7.0204	0.049**	3.6059	0.089*	0.0886	0.412
Population density	-0.0001	0.983	-0.0133	0.573	-0.0386	0.282	-0.0489	0.004***	-0.0248	0.008***	-0.0028	0.001***
NZ deprivation	0.2308	<0.001***	1.8029	<0.001***	1.3803	<0.001***	0.8255	<0.001***	0.3427	0.003***	0.0288	<0.001***
Constant	-208.33	<0.001***	-1,533.0	<0.001***	-1,144.3	0.007***	-615.46	0.003***	-252.21	0.041**	-16.637	0.040**
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	3.10	0.002***	2.34	0.019**	2.48	0.013**	0.88	0.381	1.28	0.202	1.46	0.144
LM error	6.70	0.010**	3.51	0.061*	4.02	0.045**	0.24	0.626	0.75	0.387	1.09	0.297
LM lag	6.65	0.010**	4.43	0.035**	1.78	0.182	0.17	0.682	0.14	0.710	0.53	0.466

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A1 ctd.: Regression results for aspatial single equation models, with total outlet density as a dependent variable

	Emergency room admissions (1.13)		Friday/Saturday night ER admissions (1.14)		Alcohol-related hospital admissions (1.15)	
Observations	86		86		86	
F(3,82)	49.19		29.04		2.75	
Prob. >F	<0.0001		<0.0001		0.0480	
R-squared	0.4820		0.4321		0.1540	
Root MSE	101.03		10.771		9.03	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Total outlet density	0.0144	0.983	0.0681	0.256	0.2137	0.044**
Population density	-0.0096	0.380	0.0007	0.593	0.0003	0.776
NZ deprivation	0.9269	<0.001***	0.0833	<0.001***	0.0215	0.069*
Constant	-632.31	<0.001***	-67.116	<0.001***	-12.670	0.241
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	0.79	0.431	-0.94	0.349	0.12	0.908
LM error	0.16	0.687	1.51	0.220	0.15	0.817
LM lag	3.12	0.077*	0.10	0.758	0.01	0.942

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

APPENDIX II

Table A2: Regression results for aspatial single equation models, with off-licence density and on-licence density as dependent variables

	Total police events (2.1)		Violent offences (2.2)		Family violence (2.3)		Sexual offences (2.4)		Drug and alcohol offences (2.5)		Property damage (2.6)	
Observations	86		86		86		86		86		86	
F(4,81)	19.20		28.19		115.50		5.31		15.61		16.30	
Prob. >F	<0.0001		<0.0001		<0.0001		0.0008		<0.0001		<0.0001	
R-squared	0.5677		0.6147		0.8316		0.2808		0.5105		0.5270	
Root MSE	765.56		44.333		72.577		5.0785		34.607		28.420	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	10.565	0.689	2.6618	0.083*	-5.5027	0.040**	0.3050	0.070*	2.3853	0.144	-1.2734	0.221
On-licence density	44.106	0.048**	1.9287	0.059*	1.3105	0.179	0.0445	0.696	0.6656	0.161	1.4177	0.003***
Population density	-0.0958	0.296	0.0038	0.467	-0.0090	0.277	-0.0006	0.369	-0.0207	0.562	-0.0037	0.292
NZ deprivation	7.0134	<0.001***	0.4331	<0.001***	1.5439	<0.001***	0.0224	0.001***	0.2822	<0.001***	0.2895	<0.001***
Constant	-5,996.2	<0.001***	-424.87	<0.001***	-1,328.4	<0.001***	-17.325	0.012**	-256.91	<0.001***	-245.20	<0.001***
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	2.58	0.099*	1.82	0.069*	7.16	<0.001***	1.03	0.302	0.81	0.421	1.99	0.046**
LM error	4.53	0.033**	1.97	0.160	41.82	<0.001***	0.44	0.508	0.20	0.655	2.47	0.116
LM lag	4.15	0.042**	5.30	0.021**	17.93	<0.001***	0.09	0.768	1.18	0.278	0.10	0.750

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A2 ctd.: Regression results for aspatial single equation models, with off-licence density and on-licence density as dependent variables

	Property abuses (2.7)		Antisocial behaviour (2.8)		Dishonesty offences (2.9)		Traffic offences (2.10)		All motor vehicle accidents (2.11)		Friday/Saturday night MVAs (2.12)	
Observations	86		86		86		86		86		86	
F(4,81)	14.09		19.70		3.70		5.62		3.29		5.39	
Prob. >F	<0.0001		<0.0001		0.0081		0.0005		0.0150		0.0007	
R-squared	0.4517		0.5704		0.4495		0.5049		0.4193		0.2707	
Root MSE	33.552		188.20		322.00		155.69		91.844		7.1057	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	0.6795	0.558	4.2955	0.556	4.5076	0.652	2.5063	0.589	2.0845	0.577	-0.0083	0.974
On-licence density	1.5020	0.123	8.7568	0.039**	19.657	0.055*	8.8235	0.070*	4.2136	0.157	0.1273	0.426
Population density	0.0004	0.908	-0.0106	0.638	-0.0292	0.436	-0.0449	0.012**	-0.0235	0.011**	-0.0027	0.002***
NZ deprivation	0.2370	<0.001***	1.8367	<0.001***	1.4951	<0.001***	0.8734	<0.001***	0.3589	0.007***	0.0298	0.001***
Constant	-229.71	<0.001***	-1,574.4	<0.001***	-1,285.1	0.006***	-674.16	0.004***	-272.00	0.063*	-17.897	0.067*
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	2.90	0.004***	2.21	0.027**	2.26	0.024**	0.75	0.454	1.18	0.239	1.41	0.158
LM error	5.90	0.015**	3.17	0.075*	3.32	0.069*	0.15	0.695	0.64	0.424	1.04	0.307
LM lag	6.23	0.013**	4.27	0.039**	1.62	0.203	0.16	0.691	0.12	0.724	0.54	0.464

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A2 ctd.: Regression results for aspatial single equation models, with off-licence density and on-licence density as dependent variables

	Emergency room admissions (2.13)		Friday/Saturday night ER admissions (2.14)		Alcohol-related hospital admissions (2.15)	
Observations	86		86		86	
F(4,81)	37.57		21.59		2.78	
Prob. >F	<0.0001		<0.0001		0.0324	
R-squared	0.5016		0.4344		0.1707	
Root MSE	99.714		10.816		8.9997	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	-5.3757	0.109	-0.1172	0.762	-0.1345	0.580
On-licence density	2.1675	0.130	0.1421	0.386	0.3528	0.011**
Population density	-0.0049	0.619	0.0008	0.525	0.0006	0.563
NZ deprivation	0.9841	<0.001***	0.0853	<0.001***	0.0252	0.036**
Constant	-702.40	<0.001***	-69.525	<0.001***	-17.199	0.124
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	0.90	0.368	-0.87	0.382	0.02	0.981
LM error	0.29	0.592	1.31	0.252	0.09	0.769
LM lag	3.65	0.056*	0.08	0.783	0.01	0.930

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

APPENDIX III

Table A3: Regression results for aspatial single equation models, with on-licence density of clubs and bars, on-licence density of restaurants and cafes, and off-licence density as dependent variables

	Total police events (3.1)		Violent offences (3.2)		Family violence (3.3)		Sexual offences (3.4)		Drug and alcohol offences (3.5)		Property damage (3.6)	
Observations	86		86		86		86		86		86	
F(5,80)	15.20		21.66		93.50		4.27		12.39		13.50	
Prob. >F	<0.0001		<0.0001		<0.0001		0.0017		<0.0001		<0.0001	
R-squared	0.5681		0.6161		0.8327		0.2823		0.5170		0.5271	
Root MSE	770.04		44.532		72.787		5.1047		34.590		28.593	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	10.374	0.702	2.6855	0.074*	-5.5564	0.048**	0.3070	0.060*	2.4216	0.126	-1.2776	0.230
Club/bar density	40.426	0.207	2.3835	0.170	0.2765	0.872	0.0855	0.648	1.3652	0.252	1.3369	0.062*
Restaurant/cafe density	45.287	0.061*	1.7828	0.116	1.6422	0.222	0.0314	0.799	0.4411	0.523	1.4436	0.013**
Population density	-0.0983	0.265	0.0041	0.424	-0.0097	0.240	-0.0006	0.388	-0.0016	0.676	-0.0037	0.292
NZ deprivation	7.0209	<0.001***	0.4322	<0.001***	1.5460	<0.001***	0.0224	0.001***	0.2808	<0.001***	0.2896	<0.001***
Constant	-5,988.8	<0.001***	-399.69	<0.001***	-1,326.3	<0.001***	-17.408	0.013**	-258.32	<0.001***	-245.03	<0.001***
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	2.56	0.010**	1.99	0.046**	7.44	<0.001***	1.12	0.264	1.00	0.320	2.04	0.041**
LM error	4.22	0.040**	2.30	0.129	44.28	<0.001***	0.48	0.488	0.33	0.564	2.44	0.118
LM lag	4.16	0.042**	5.39	0.020**	18.35	<0.001***	0.08	0.778	1.10	0.295	0.10	0.749

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A3 ctd.: Regression results for aspatial single equation models, with on-licence density of clubs and bars, on-licence density of restaurants and cafes, and off-licence density as dependent variables

	Property abuses (3.7)		Antisocial behaviour (3.8)		Dishonesty offences (3.9)		Traffic offences (3.10)		All motor vehicle accidents (3.11)		Friday/Saturday night MVAs (3.12)	
Observations	86		86		86		86		86		86	
F(5,80)	11.21		15.42		3.04		4.62		2.97		4.56	
Prob. >F	<0.0001		<0.0001		0.0144		0.0009		0.0163		0.0010	
R-squared	0.4519		0.5715		0.4517		0.5069		0.4234		0.2767	
Root MSE	33.757		189.13		323.34		156.34		92.087		7.1205	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	0.6746	0.570	4.3832	0.541	4.3194	0.679	2.4163	0.615	2.0141	0.594	-0.0142	0.956
Club/bar density	1.4083	0.274	10.445	0.158	16.033	0.228	7.0912	0.267	2.8571	0.444	0.0143	0.952
Restaurant/cafe density	1.5320	0.143	8.2152	0.096*	20.819	0.053*	9.3793	0.067*	4.6488	0.130	0.1635	0.330
Population density	0.0004	0.920	-0.0094	0.675	-0.0317	0.378	-0.0461	0.007***	-0.0245	0.007***	-0.0027	0.001***
NZ deprivation	0.2372	<0.001***	1.8333	<0.001***	1.5025	<0.001***	0.8769	<0.001***	0.3616	0.007***	0.0300	0.001***
Constant	-215.78	<0.001***	-1,577.85	<0.001***	-1,277.7	0.007***	-670.65	<0.001***	-269.25	0.068*	-17.668	0.076*
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	2.93	0.003***	2.39	0.017**	2.07	0.039**	0.60	0.548	1.04	0.297	1.35	0.176
LM error	5.78	0.016**	3.57	0.059*	2.51	0.113	0.04	0.837	0.39	0.534	0.84	0.359
LM lag	6.30	0.012**	4.37	0.037**	1.48	0.223	0.14	0.711	0.11	0.746	0.50	0.478

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A3 ctd.: Regression results for aspatial single equation models, with on-licence density of clubs and bars, on-licence density of restaurants and cafes, and off-licence density as dependent variables

	Emergency room admissions (3.13)		Friday/Saturday night ER admissions (3.14)		Alcohol-related hospital admissions (3.15)	
Observations	86		86		86	
F(5,80)	31.70		17.98		2.29	
Prob. >F	<0.0001		<0.0001		0.0539	
R-squared	0.5132		0.4451		0.1711	
Root MSE	99.154		10.78		9.0534	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	-5.2370	0.136	-0.1036	0.794	-0.1327	0.582
Club/bar density	4.8393	0.022**	0.4035	0.065*	0.3891	0.144
Restaurant/cafe density	1.3104	0.452	0.0582	0.756	0.3412	0.039**
Population density	-0.0030	0.758	0.0010	0.434	0.0006	0.539
NZ deprivation	0.9786	<0.001***	0.0848	<0.001***	0.0251	0.038**
Constant	-707.81	<0.001***	-70.054	<0.001***	-17.272	0.125
	statistic	**p-value**	**statistic**	**p-value**	**statistic**	**p-value**
Moran's I	0.41	0.684	-0.74	0.458	0.07	0.944
LM error	0.00	0.981	1.12	0.289	0.09	0.769
LM lag	2.61	0.106	0.08	0.776	0.01	0.920

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

APPENDIX IV

Table A4: Regression results for spatial Durbin single equation models (SDMs), with total outlet density as a dependent variable

	Total police events (4.1)		**Violent offences (4.2)**		**Family violence (4.3)**		**Sexual offences (4.4)**		**Drug and alcohol offences (4.5)**		**Property damage (4.6)**	
Observations	86		86		86		86		86		86	
Sq. Corr.	0.698		0.741		0.893		0.361		0.602		0.562	
Sigma	619.04		34.61		55.22		4.62		30.28		26.55	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Total outlet density	39.6108	<0.001***	2.4664	<0.001***	-0.3285	0.462	0.1268	0.001***	1.2608	<0.001***	0.6188	0.004***
Population density	-0.1782	0.021**	0.0003	0.941	-0.0146	0.033**	-0.0010	0.090*	-0.0045	0.234	-0.0080	0.015**
NZ deprivation	2.5287	0.063*	0.1521	0.046**	1.4189	<0.001***	0.0120	0.240	0.0845	0.208	0.2844	<0.001***
Lag of total outlet density	13.199	0.334	1.3337	0.085*	-0.5696	0.546	0.0376	0.663	-0.1287	0.824	-0.2953	0.535
Lag of population density	0.4013	0.003***	0.0288	<0.001***	0.0242	0.047**	0.0026	0.014**	0.0151	0.024**	0.0122	0.035**
Lag of NZ deprivation	0.6758	0.748	0.1683	0.178	-0.7946	0.001***	-0.0047	0.767	0.2270	0.029**	-0.1440	0.116
x-centroid	-0.0371	0.078*	-0.0021	0.079*	-0.0005	0.782	-0.0001	0.393	0.0006	0.544	-0.0002	0.828
y-centroid	-0.0924	<0.001***	-0.0054	<0.001***	-0.0077	0.002***	-0.0003	0.032**	-0.0009	0.415	-0.0018	0.058*
Constant	-694,556	<0.001***	40,215	<0.001***	50,558	0.005***	2,518.1	0.044**	3,687.2	0.663	11,822	0.111
Rho	-0.1001	0.531	-0.2360	0.146	0.3313	0.026**	-0.1357	0.425	-0.0238	0.895	0.0097	0.953

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A4 ctd.: Regression results for single equation SDMs, with total outlet density as a dependent variable

	Property abuses (4.7)		Antisocial behaviour (4.8)		Dishonesty offences (4.9)		Traffic offences (4.10)		All motor vehicle accidents (4.11)		Friday/Saturday night MVAs (4.12)	
Observations	86		86		86		86		86		86	
Sq. Corr.	0.579		0.708		0.597		0.583		0.499		0.328	
Sigma	28.52		149.62		266.85		137.75		82.61		6.61	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Total outlet density	1.4587	<0.001***	8.4299	<0.001***	17.640	<0.001***	8.1434	<0.001***	4.0447	<0.001***	0.1145	0.032**
Population density	-0.0006	0.857	-0.0337	0.070*	-0.0575	0.083*	-0.0586	0.001***	-0.0339	0.001***	-0.0031	<0.001***
NZ deprivation	0.0757	0.227	0.6341	0.054*	-0.3071	0.600	0.1978	0.513	0.1109	0.542	0.0164	0.259
Lag of total outlet density	-0.1657	0.777	1.8653	0.565	5.7754	0.322	6.0243	0.042**	3.0258	0.086*	0.0898	0.458
Lag of population density	0.0081	0.209	0.1189	<0.001***	0.1251	0.032**	0.0603	0.045**	0.0450	0.012**	0.0017	0.233
Lag of NZ deprivation	0.0107	0.912	0.6370	0.217	0.0388	0.965	0.1122	0.809	-0.1433	0.605	-0.0143	0.520
x-centroid	-0.0009	0.312	-0.0027	0.587	-0.0231	0.014**	-0.0086	0.056*	-0.0049	0.068*	-0.0004	0.079*
y-centroid	-0.0033	0.004***	-0.0190	0.002***	-0.0361	<0.001***	-0.0139	0.004***	-0.0067	0.018**	-0.0004	0.091*
Constant	23,501	0.007***	128,882	0.007***	295,392	<0.001***	112,597	0.004***	56,643	0.013**	3,444.5	0.053*
Rho	0.0510	0.760	-0.1183	0.485	-0.0954	0.546	-0.1626	0.294	-0.0900	0.578	0.0659	0.692

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A4 ctd.: Regression results for single equation SDMs, with total outlet density as a dependent variable

	Emergency room admissions (4.13)		Friday/Saturday night ER admissions (4.14)		Alcohol-related hospital admissions (4.15)	
Observations	86		86		86	
Sq. Corr.	0.545		0.454		0.306	
Sigma	91.97		10.04		7.96	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Total outlet density	0.6390	0.389	0.0909	0.262	0.2540	<0.001***
Population density	-0.0108	0.342	0.0002	0.898	-0.0005	0.632
NZ deprivation	0.4189	0.038**	0.0457	0.039**	-0.0355	0.043**
Lag of total outlet density	1.8160	0.256	0.1294	0.464	0.0911	0.546
Lag of population density	0.0098	0.624	0.0024	0.272	0.0032	0.066*
Lag of NZ deprivation	0.4922	0.149	0.0842	0.024**	0.0623	0.020**
x-centroid	-0.0044	0.146	0.0002	0.436	-0.0001	0.732
y-centroid	-0.0048	0.111	0.0001	0.752	-0.0002	0.434
Constant	42,367	0.085*	-1,320.1	0.613	1,552.1	0.469
Rho	-0.1060	0.503	-0.2861	0.114	-0.1150	0.512

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

APPENDIX V

Table A5: Regression results for spatial Durbin single equation models (SDMs), with off-licence density and on-licence density as dependent variables

	Total police events (5.1)		Violent offences (5.2)		Family violence (5.3)		Sexual offences (5.4)		Drug and alcohol offences (5.5)		Property damage (5.6)	
Observations	86		86		86		86		86		86	
Sq. Corr.	0.702		0.747		0.900		0.384		0.618		0.586	
Sigma	615.12		34.34		53.20		4.54		29.68		25.82	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	20.063	0.341	3.3440	0.004***	-4.1498	0.023**	0.3776	0.015**	2.5784	0.011**	-0.8649	0.330
On-licence density	47.199	<0.001***	2.1067	<0.001***	1.2055	0.140	0.0277	0.692	0.7313	0.109	1.2125	0.002***
Population density	-0.1652	0.037**	-0.0010	0.830	-0.0104	0.126	-0.0012	0.037**	-0.0062	0.103	-0.0063	0.056*
NZ deprivation	2.8202	0.041**	0.1435	0.063*	1.4656	<0.001***	0.0089	0.386	0.0693	0.302	0.3014	<0.001***
Lag of off-licence density	-22.972	0.645	-0.1779	0.950	0.6028	0.888	0.1124	0.765	-1.7791	0.465	-0.8424	0.684
Lag of on-licence density	25.876	0.233	1.8395	0.122	-1.1123	0.518	0.0161	0.913	0.4352	0.653	-0.7898	0.350
Lag of population density	0.4173	0.003***	0.0306	<0.001***	0.0198	0.105	0.0026	0.011**	0.0173	0.011**	0.0100	0.089*
Lag of NZ deprivation	1.2054	0.582	0.1766	0.157	-0.8317	0.001***	-0.0064	0.689	0.2402	0.023**	-0.1608	0.084*
x-centroid	-0.0343	0.107	-0.0019	0.108	-0.0006	0.744	-0.0001	0.369	0.0008	0.448	-0.0002	0.775
y-centroid	-0.0902	<0.001***	-0.0053	<0.001***	-0.0071	0.003***	-0.0003	0.024**	-0.0008	0.443	-0.0016	0.077*
Constant	-671,692	0.001***	39,354	<0.001***	47,252	0.006***	2,655.2	0.035**	2,928.3	0.730	11,058	0.132
Rho	-0.1072	0.502	-0.2225	0.169	0.3602	0.013**	-0.1252	0.465	0.0079	0.965	0.0488	0.763

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A5 ctd.: Regression results for single equation SDMs, with off-licence density and on-licence density as dependent variables

	Property abuses (5.7)		Antisocial behaviour (5.8)		Dishonesty offences (5.9)		Traffic offences (5.10)		All motor vehicle accidents (5.11)		Friday/Saturday night MVAs (5.12)	
Observations	86		86		86		86		86		86	
Sq. Corr.	0.591		0.712		0.605		0.585		0.499		0.329	
Sigma	28.12		148.70		264.35		137.32		82.58		6.61	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	0.6612	0.498	5.9572	0.242	7.3152	0.420	5.0699	0.281	3.3445	0.237	0.0836	0.712
On-licence density	1.7536	<0.001***	9.3468	<0.001***	21.660	<0.001***	9.3675	<0.001***	4.3196	0.001***	0.1274	0.209
Population density	-0.0006	0.878	-0.0337	0.078*	-0.0504	0.138	-0.0555	0.002***	-0.0333	0.002***	-0.0030	<0.001***
NZ deprivation	0.0904	0.152	0.6818	0.041**	-0.1536	0.796	0.2356	0.445	0.1204	0.517	0.0166	0.263
Lag of off-licence density	-3.5572	0.115	-10.200	0.400	-12.368	0.562	5.7663	0.607	2.3528	0.728	0.2032	0.705
Lag of on-licence density	-1.0759	0.274	6.0218	0.242	12.343	0.189	6.0570	0.199	3.2446	0.248	0.0500	0.815
Lag of population density	0.0107	0.107	0.1270	<0.001***	0.1329	0.026**	0.0581	0.062*	0.0450	0.016**	0.0016	0.287
Lag of NZ deprivation	0.0584	0.558	0.7953	0.137	0.2937	0.751	0.1240	0.798	-0.1330	0.646	-0.0156	0.500
x-centroid	-0.0007	0.473	-0.0017	0.739	-0.0219	0.021**	-0.0085	0.062*	-0.0049	0.078*	-0.0004	0.078*
y-centroid	-0.0032	0.005***	-0.0183	0.003***	-0.0351	0.001***	-0.0137	0.005***	-0.0066	0.021**	-0.0004	0.091*
Constant	22,092	0.011**	121,233	0.012**	285,607	0.001***	111,219	0.005***	55,980	0.016**	3,497.7	0.055*
Rho	0.0248	0.883	-0.1166	0.491	-0.1110	0.482	-0.1651	0.286	-0.0903	0.577	0.0624	0.709

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A5 ctd.: Regression results for single equation SDMs, with off-licence density and on-licence density as dependent variables

	Emergency room admissions (5.13)		Friday/Saturday night ER admissions (5.14)		Alcohol-related hospital admissions (5.15)	
Observations	86		86		86	
Sq. Corr.	0.563		0.461		0.317	
Sigma	90.31		9.97		7.90	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	-3.7217	0.229	0.1231	0.720	-0.0531	0.844
On-licence density	2.3897	0.085*	0.0826	0.590	0.3752	0.002***
Population density	-0.0055	0.633	0.0003	0.811	-0.0002	0.854
NZ deprivation	0.4694	0.021**	0.0441	0.049**	-0.0315	0.076*
Lag of off-licence density	4.7463	0.514	0.9741	0.223	-0.0675	0.916
Lag of on-licence density	0.5662	0.849	-0.1695	0.600	0.1382	0.598
Lag of population density	0.0041	0.840	0.0017	0.448	0.0031	0.084*
Lag of NZ deprivation	0.4353	0.220	0.0729	0.059*	0.0651	0.019**
x-centroid	-0.0045	0.138	0.0001	0.687	-0.0001	0.777
y-centroid	-0.0045	0.131	0.0001	0.842	-0.0002	0.498
Constant	40,628	0.096*	-877.81	0.740	1,329.1	0.539
Rho	-0.0748	0.637	-0.2814	0.120	-0.1167	0.504

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

APPENDIX VI

Table A6: Regression results for spatial Durbin single equation models (SDMs), with on-licence density of clubs and bars, on-licence density of restaurants and cafes, and off-licence density as dependent variables

	Total police events (6.1)		Violent offences (6.2)		Family violence (6.3)		Sexual offences (6.4)		Drug and alcohol offences (6.5)		Property damage (6.6)	
Observations	86		86		86		86		86		86	
Sq. Corr.	0.719		0.753		0.903		0.389		0.624		0.586	
Sigma	596.46		34.03		52.49		4.53		29.41		25.82	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	24.939	0.225	3.4888	0.003***	-4.1587	0.021**	0.3802	0.015**	2.6431	0.009***	-0.8457	0.344
Club/bar density	53.639	0.002***	2.8718	0.004***	-0.7950	0.600	0.1048	0.430	1.6105	0.058*	1.2508	0.095**
Restaurant/cafe density	45.862	<0.001***	1.8891	0.001***	1.7784	0.044**	0.0060	0.938	0.4844	0.329	1.2029	0.006***
Population density	-0.1595	0.039**	-0.0005	0.909	-0.0119	0.080*	-0.0012	0.047**	-0.0056	0.142	-0.0063	0.059*
NZ deprivation	3.2614	0.017**	0.1650	0.035**	1.4349	<0.001***	0.0104	0.325	0.0858	0.207	0.3032	<0.001***
Lag of off-licence density	-40.586	0.417	-1.1278	0.697	1.5877	0.714	0.0532	0.892	-2.4734	0.319	0.7674	0.718
Lag of club/bar density	-31.864	0.341	-0.0846	0.965	-0.5494	0.845	-0.0336	0.892	-0.5199	0.744	-1.0122	0.466
Lag of rest./cafe density	56.668	0.023**	2.6838	0.051*	-1.3030	0.529	0.0364	0.836	0.8731	0.449	-0.6733	0.510
Lag of pop. den.	0.4317	0.002***	0.0298	<0.001***	0.0226	0.065*	0.0026	0.015**	0.0163	0.016**	0.0100	0.091*
Lag of NZ deprivation	1.1506	0.603	0.1479	0.248	-0.7470	0.003***	-0.0093	0.575	0.2099	0.052*	-0.1614	0.092*
x-centroid	-0.0207	0.349	-0.0018	0.175	-0.0005	0.808	-0.0002	0.319	0.0005	0.622	-0.0002	0.831
y-centroid	-0.1004	<0.001***	-0.0055	<0.001***	-0.0072	0.003***	-0.0004	0.025**	-0.0009	0.383	-0.0017	0.076*
Constant	-700,770	<0.001***	39,807	<0.001***	44,678	0.010**	2,749.2	0.030**	4,279.6	0.614	11,186	0.131
Rho	-0.1178	0.472	-0.1911	0.242	0.3602	0.019**	-0.1027	0.558	0.0285	0.873	0.0476	0.771

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A6 ctd.: Regression results for single equation SDMs, with on-licence density of clubs and bars, on-licence density of restaurants and cafes, and off-licence density as dependent variables

	Property abuses (6.7)		Antisocial behaviour (6.8)		Dishonesty offences (6.9)		Traffic offences (6.10)		All motor vehicle accidents (6.11)		Friday/Saturday night MVAs (6.12)	
Observations	86		86		86		86		86		86	
Sq. Corr.	0.616		0.723		0.636		0.606		0.510		0.333	
Sigma	27.23		146.07		253.25		133.15		81.54		6.59	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	0.9125	0.338	6.8717	0.172	9.7538	0.264	6.1286	0.182	3.7194	0.185	0.0967	0.670
Club/bar density	2.3130	0.004***	12.606	0.003***	25.278	0.001***	8.5720	0.029**	3.5095	0.142	0.0855	0.656
Restaurant/cafe density	1.6065	0.001***	8.4761	0.001***	20.892	<0.001***	9.7586	<0.001***	4.6086	0.001***	0.1406	0.206
Population density	-0.0001	0.973	-0.0315	0.095*	-0.0472	0.150	-0.0557	0.001***	-0.0337	0.001***	-0.0031	<0.001***
NZ deprivation	0.1147	0.067*	0.7923	0.018**	0.0754	0.897	0.2930	0.339	0.1323	0.482	0.0169	0.266
Lag of off-licence density	-4.5585	0.043**	-14.901	0.226	-21.483	0.308	3.6751	0.745	1.8823	0.786	0.1892	0.732
Lag of club/bar density	-1.7659	0.248	-5.3860	0.509	-16.837	0.237	-5.0310	0.497	-0.6188	0.892	-0.0868	0.807
Lag of rest./cafe density	2.4571	0.028**	11.407	0.056*	27.963	0.009***	12.5152	0.021**	5.4979	0.094*	0.1246	0.628
Lag of pop. den.	0.0107	0.102	0.1254	<0.001***	0.1395	0.016**	0.0628	0.039**	0.0477	0.010**	0.0017	0.260
Lag of NZ deprivation	0.0435	0.663	0.6904	0.208	0.2370	0.794	0.1947	0.689	-0.0925	0.754	-0.0138	0.563
x-centroid	-0.0001	0.888	-0.0001	0.992	-0.0153	0.111	-0.0048	0.323	-0.0032	0.276	-0.0003	0.181
y-centroid	-0.0035	0.002***	-0.0195	0.002***	-0.0402	<0.001***	-0.0159	0.001***	-0.0074	0.010**	-0.0004	0.078*
Constant	22,947	0.007***	124,608	0.009***	300,996	<0.001***	115,502	0.003***	56,354	0.014**	3,467.0	0.058*
Rho	0.0479	0.778	-0.0907	0.601	-0.1246	0.437	-0.2045	0.201	-0.1141	0.495	0.0557	0.743

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A6 ctd.: Regression results for single equation SDMs, with on-licence density of clubs and bars, on-licence density of restaurants and cafes, and off-licence density as dependent variables

	Emergency room admissions (6.13)		Friday/Saturday night ER admissions (6.14)		Alcohol-related hospital admissions (6.15)	
Observations	86		86		86	
Sq. Corr.	0.608		0.467		0.320	
Sigma	81.00		9.93		7.88	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Off-licence density	-4.8334	0.083*	0.1244	0.717	-0.0688	0.800
Club/bar density	5.2952	0.026**	0.2922	0.308	0.3696	0.104
Restaurant/cafe density	1.3661	0.322*	0.0226	0.893	0.3754	0.005***
Population density	-0.0057	0.588	0.0005	0.720	-0.0002	0.852
NZ deprivation	0.4121	0.027**	0.0474	0.038**	-0.0327	0.071*
Lag of off-licence density	4.9321	0.462	0.8588	0.293	-0.0137	0.983
Lag of club/bar density	14.985	0.002***	-0.2516	0.640	0.3236	0.454
Lag of rest./cafe density	-4.7125	0.135	-0.1367	0.724	0.0469	0.880
Lag of pop. den.	-0.0058	0.755	0.0015	0.523	0.0030	0.093*
Lag of NZ deprivation	0.6692	0.043**	0.0654	0.098*	0.0650	0.022**
x-centroid	-0.0118	<0.001***	0.0000	0.925	-0.0001	0.657
y-centroid	-0.0039	0.149	0.0000	0.885	-0.0002	0.565
Constant	56,177	0.013**	-498.01	0.852	1,319.4	0.546
Rho	-0.4345	0.013**	-0.2753	0.129	-0.1260	0.472

*Significant at the 10% level, **significant at the 5% level, ***significant at the 10% level

APPENDIX VII

Table A7: SSUR results for Model 7

	Violent offences (7.1)		Family violence (7.2)		Sexual offences (7.3)		Drug and alcohol offences (7.4)		Property damage (7.5)		Property abuses (7.6)	
Observations	86		86		86		86		86		86	
R-squared	0.7599		0.8995		0.3903		0.6224		0.5779		0.6167	
RMSE	33.967		54.407		4.5379		29.500		26.054		27.225	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.2574	0.043**	0.0371	0.790	-0.3791	0.047**	-0.1356	0.425	-0.1958	0.143	0.0780	0.593
Off-licence density	3.4802	0.003***	-4.1944	0.025**	0.3750	0.016**	2.6198	0.010**	-0.7156	0.427	0.9416	0.321
Club/bar density	2.8253	0.004***	-1.0115	0.520	0.0666	0.617	1.5477	0.069*	1.1244	0.136	2.3327	0.003***
Restaurant/cafe density	1.9236	0.001***	1.7591	0.055*	0.0121	0.875	0.4938	0.321	1.1946	0.007***	1.5912	0.001***
Pop. density	-0.0003	0.950	-0.0115	0.103	-0.0011	0.050*	-0.0054	0.155	-0.0060	0.076*	-0.0001	0.977
NZ deprivation	0.1638	0.036**	1.4177	<0.001***	0.0072	0.497	0.0920	0.177	0.2972	<0.001***	0.1148	0.067*
Lag of off-licence density	-0.8197	0.774	0.6697	0.881	0.2392	0.544	-1.9548	0.431	0.9345	0.663	-4.5990	0.041**
Lag of club/bar density	0.1589	0.933	-0.7187	0.805	0.0453	0.856	-0.2979	0.852	-0.8235	0.556	-1.8483	0.221
Lag of rest./cafe density	2.8356	0.036**	-0.6415	0.764	0.0298	0.866	0.9832	0.395	-0.4055	0.693	2.3933	0.030**
Lag of pop. den.	0.0307	<0.001***	0.0275	0.029**	0.0029	0.006***	0.0171	0.012**	0.0109	0.068*	0.0103	0.109
Lag of NZDep	0.1636	0.193	-0.3981	0.113	-0.0044	0.790	0.2302	0.033**	-0.1244	0.194	0.0399	0.688
x-centroid	-0.0019	0.131	0.0009	0.663	-0.0002	0.271	0.0004	0.728	-0.0003	0.742	-0.0001	0.895
y-centroid	-0.0058	<0.001***	-0.0107	<0.001***	-0.0004	0.006***	-0.0013	0.212	-0.0022	0.015**	-0.0034	0.001***
Constant	42,302	<0.001***	66,148	<0.001***	3,316.0	0.009***	7,211.4	0.394	15,131	0.038**	22,179	0.007***

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A7 ctd.: SSUR results for Model 7

	Antisocial behaviour (7.7)		Dishonesty offences (7.8)		Traffic offences (7.9)		All motor vehicle accidents (7.10)		Friday/Saturday night MVAs (7.11)		Emergency room admissions (7.12)	
Observations	86		86		86		86		86		86	
R-squared	0.7253		0.6390		0.6176		0.5150		0.3256		0.6613	
RMSE	146.06		253.06		132.79		81.461		6.6313		79.769	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.2607	0.022**	-0.1636	0.150	-0.3383	0.003***	-0.2363	0.060*	-0.1487	0.371	-0.8274	<0.001***
Off-licence density	6.7202	0.182	9.6360	0.269	6.2748	0.170	3.7658	0.180	0.1057	0.644	-5.0422	0.067*
Club/bar density	11.725	0.006***	24.944	0.001***	7.8961	0.041**	3.1919	0.178	0.0491	0.799	6.3927	0.006***
Restaurant/cafe density	8.8220	<0.001***	21.109	<0.001***	10.176	<0.001***	4.8055	0.001***	0.1490	0.183	0.9427	0.487
Pop. density	-0.0301	0.110	-0.0466	0.154	-0.0551	0.001***	-0.0332	0.002***	-0.0031	<0.001***	-0.0073	0.481
NZ deprivation	0.7817	0.020**	0.0730	0.900	0.2750	0.368	0.1180	0.530	0.0158	0.301	0.3898	0.034**
Lag of off-licence density	-12.184	0.315	-20.625	0.324	5.9962	0.589	3.2064	0.639	0.3223	0.562	3.1421	0.634
Lag of club/bar density	-3.1167	0.696	-15.776	0.256	-3.3591	0.643	0.2867	0.949	-0.0282	0.937	19.635	<0.001***
Lag of rest./cafe density	13.189	0.023**	28.930	0.005***	13.852	0.009***	6.1001	0.059*	0.1455	0.574	-4.6087	0.138
Lag of pop. den.	0.1353	<0.001***	0.1412	0.015**	0.0614	0.043**	0.0484	0.009***	0.0014	0.353	-0.0095	0.602
Lag of NZDep	0.8459	0.114	0.2415	0.790	0.2718	0.572	-0.0656	0.823	-0.0104	0.663	1.0224	0.002***
x-centroid	-0.0009	0.872	-0.0160	0.089*	-0.0051	0.288	-0.0035	0.242	-0.0004	0.144	-0.0150	<0.001***
y-centroid	-0.0233	<0.001***	-0.0416	<0.001***	-0.0176	<0.001***	-0.0081	0.004***	-0.0005	0.036**	-0.0049	0.065*
Constant	151,414	0.001***	311,665	<0.001***	127,091	0.001***	61,681	0.006***	4,046.0	0.028**	71,305	<0.001***

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A7 ctd.: SSUR results for Model 7

	Friday/Saturday night ER admissions (7.13)		Alcohol-related hospital admissions (7.14)	
Observations	86		86	
R-squared	0.5010		0.3121	
RMSE	9.8600		7.9550	
	coef.	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.6606	<0.001***	-0.5845	0.002***
Off-licence density	0.1885	0.580	-0.0761	0.781
Club/bar density	0.2454	0.389	0.3680	0.108
Restaurant/cafe density	0.0162	0.923	0.3777	0.005***
Pop. density	0.0004	0.769	-0.0001	0.916
NZ deprivation	0.0436	0.055*	-0.0317	0.083*
Lag of off-licence density	0.9832	0.226	0.1839	0.780
Lag of club/bar density	-0.0656	0.903	0.5685	0.193
Lag of rest./cafe density	-0.0893	0.817	0.1748	0.578
Lag of pop. den.	0.0019	0.399	0.0031	0.092*
Lag of NZDep	0.1013	0.010**	0.0697	0.015**
x-centroid	-0.0001	0.829	-0.0003	0.290
y-centroid	0.0000	0.974	-0.0003	0.252
Constant	16.194	0.995	2,824.2	0.202

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

APPENDIX VIII

Table A8: SSUR results for Model 8

	Violent offences (8.1)		Family violence (8.2)		Sexual offences (8.3)		Drug and alcohol offences (8.4)		Property damage (8.5)		Property abuses (8.6)	
Observations	86		86		86		86		86		86	
R-squared	0.7592		0.9046		0.3914		0.6240		0.5854		0.6167	
RMSE	34.017		53.019		4.5338		29.438		25.821		27.227	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.2020	0.113	0.2383	0.099*	-0.3488	0.073*	-0.0550	0.754	0.0334	0.817	0.1308	0.374
Off-licence density	3.4874	0.003***	-4.1710	0.022**	0.3756	0.016**	2.6312	0.009***	-0.8381	0.348	0.9926	0.295
Club/bar density	2.8642	0.004***	-0.8699	0.570	0.0708	0.595	1.5785	0.064*	1.2434	0.096*	2.3673	0.003***
Restaurant/cafe density	1.8948	0.001***	1.7717	0.047**	0.0114	0.882	0.4891	0.324	1.2024	0.006***	1.5645	0.001***
Pop. density	-0.0005	0.915	-0.0117	0.087*	-0.0011	0.050*	-0.0055	0.148	-0.0063	0.060*	-0.0001	0.984
NZ deprivation	0.1648	0.035**	1.4290	<0.001***	0.0076	0.476	0.0889	0.191	0.3028	<0.001***	0.1149	0.066*
Lag of off-licence density	-1.0772	0.706	1.2703	0.772	0.2188	0.579	-2.2094	0.373	0.7771	0.714	-4.6701	0.038**
Lag of club/bar density	-0.0446	0.981	-0.6080	0.830	0.0366	0.883	-0.4069	0.798	-1.0011	0.470	-1.9925	0.188
Lag of rest./cafe density	2.7087	0.046**	-1.0743	0.607	0.0305	0.863	0.9291	0.420	-0.6577	0.518	2.2818	0.039**
Lag of pop. den.	0.0300	<0.001***	0.0243	0.049**	0.0029	0.007***	0.0167	0.013**	0.0100	0.089*	0.0097	0.134
Lag of NZDep	0.1505	0.231	-0.6264	0.013**	-0.0050	0.765	0.2203	0.041**	-0.1593	0.095*	0.0336	0.735
x-centroid	-0.0018	0.160	0.0006	0.755	-0.0002	0.276	0.0005	0.675	-0.0002	0.825	-0.0001	0.908
y-centroid	-0.0055	<0.001***	-0.0084	0.001***	-0.0004	0.008***	-0.0011	0.288	-0.0017	0.065*	-0.0032	0.003***
Constant	40,217	<0.001***	52,101	0.003***	3,254.0	0.011**	5,772.0	0.496	11,416	0.118	20,834	0.011**

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A8 ctd.: SSUR results for Model 8

	Antisocial behaviour (8.7)		Dishonesty offences (8.8)		Traffic offences (8.9)		All motor vehicle accidents (8.10)		Friday/Saturday night MVAs (8.11)		Alcohol-related hospital adm. (8.12)	
Observations	86		86		86		86		86		86	
R-squared	0.7256		0.6385		0.6173		0.5150		0.3316		0.3152	
RMSE	145.96		253.22		132.84		81.462		6.6020		7.9366	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.1892	0.104	-0.1291	0.258	-0.2913	0.011**	-0.1810	0.155	-0.0389	0.822	-0.5457	0.010**
Off-licence density	6.7839	0.177	9.7402	0.264	6.2234	0.174	3.7448	0.182	0.1009	0.657	-0.0755	0.782
Club/bar density	12.096	0.004***	25.239	0.001***	8.1336	0.036**	3.3357	0.159	0.0687	0.722	0.3681	0.107
Restaurant/cafe density	8.6766	<0.001***	20.917	<0.001***	10.029	<0.001***	4.7164	0.001***	0.1445	0.195	0.3775	0.005***
Pop. density	-0.0307	0.103	-0.0471	0.150	-0.0553	0.001***	-0.0335	0.001***	-0.0031	<0.001***	-0.0001	0.910
NZ deprivation	0.7862	0.019**	0.0751	0.897	0.2813	0.357	0.1245	0.507	0.0164	0.281	-0.0318	0.081*
Lag of off-licence density	-13.327	0.272	-21.386	0.307	5.1806	0.640	2.6071	0.703	0.2508	0.651	0.1672	0.800
Lag of club/bar density	-4.0710	0.609	-16.714	0.229	-3.9466	0.586	-0.1231	0.978	-0.0597	0.867	0.5478	0.213
Lag of rest./cafe density	12.439	0.032**	28.075	0.006***	13.382	0.012**	5.8275	0.072*	0.1342	0.603	0.1640	0.602
Lag of pop. den.	0.1311	<0.001***	0.1397	0.016**	0.0619	0.041**	0.0481	0.010**	0.0016	0.301	0.0031	0.091*
Lag of NZDep	0.7805	0.144	0.2375	0.794	0.2447	0.611	-0.0778	0.791	-0.0122	0.608	0.0693	0.015**
x-centroid	-0.0005	0.922	-0.0154	0.102	-0.0050	0.299	-0.0034	0.256	-0.0003	0.163	-0.0003	0.318
y-centroid	-0.0217	<0.001***	-0.0404	<0.001***	-0.0170	<0.001***	-0.0078	0.006***	-0.0004	0.056*	-0.0003	0.276
Constant	140,142	0.001***	302,232	<0.001***	123,019	0.001***	59,270	0.008***	3,734.8	0.042**	2,697.1	0.228

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

APPENDIX IX

Table A9: SSUR results for Model 9

	Violent offences (9.1)		Family violence (9.2)		Sexual offences (9.3)		Drug and alcohol offences (9.4)		Property damage (9.5)		Property abuses (9.6)	
Observations	86		86		86		86		86		86	
R-squared	0.7591		0.9053		0.3885		0.6230		0.5851		0.6165	
RMSE	34.022		52.806		4.5446		29.474		25.832		27.234	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.1975	0.123	0.2777	0.056*	-0.4189	0.033**	-0.1070	0.545	0.0081	0.956	0.1584	0.287
Off-licence density	3.4880	0.003***	-4.1664	0.022**	0.3743	0.017**	2.6238	0.010**	-0.8246	0.356	1.0192	0.283
Club/bar density	2.8673	0.004***	-0.8421	0.581	0.0611	0.648	1.5586	0.067*	1.2303	0.100	2.3854	0.003***
Restaurant/cafe density	1.8924	0.001***	1.7742	0.046**	0.0130	0.866	0.4921	0.322	1.2015	0.006***	1.5505	0.001***
Pop. density	-0.0005	0.913	-0.0118	0.084*	-0.0011	0.051*	-0.0054	0.152	-0.0062	0.062*	-0.0001	0.988
NZ deprivation	0.1649	0.035**	1.4312	<0.001***	0.0068	0.526	0.0909	0.182	0.3023	<0.001***	0.1150	0.066*
Lag of off-licence density	-1.0981	0.701	1.3879	0.750	0.2660	0.502	-2.0452	0.410	0.7945	0.708	-4.7072	0.036**
Lag of club/bar density	-0.6113	0.974	-0.5863	0.836	0.0566	0.821	-0.3366	0.833	-0.9815	0.479	-2.0679	0.172
Lag of rest./cafe density	2.6984	0.047**	-1.1591	0.578	0.0288	0.871	0.9640	0.404	-0.6299	0.537	2.2235	0.045**
Lag of pop. den.	0.0299	<0.001***	0.0236	0.054*	0.0030	0.006***	0.0170	0.012**	0.0101	0.087*	0.0094	0.148
Lag of NZDep	0.1494	0.235	-0.6711	0.008***	-0.0037	0.823	0.2267	0.036**	-0.1554	0.103	0.0303	0.760
x-centroid	-0.0018	0.163	0.0006	0.775	-0.0002	0.266	0.0004	0.709	-0.0002	0.816	-0.0001	0.914
y-centroid	-0.0055	<0.001***	-0.0080	0.001***	-0.0004	0.005***	-0.0013	0.239	-0.0018	0.057*	-0.0031	0.004***
Constant	40,048	<0.001***	49,350	0.005***	3,397.8	0.008***	6,700.2	0.430	11,826	0.106	20,131	0.014**

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level

Table A9 ctd.: SSUR results for Model 9

	Antisocial behaviour (9.7)		Dishonesty offences (9.8)		Traffic offences (9.9)		All motor vehicle accidents (9.10)		Alcohol-related hospital adm. (9.11)	
Observations	86		86		86		86		86	
R-squared	0.7256		0.6384		0.6153		0.5133		0.3175	
RMSE	145.97		253.27		133.19		81.605		7.9234	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
Lag dependent variable	-0.1558	0.104	-0.1221	0.291	-0.1971	0.123	-0.0828	0.568	-0.5144	0.016**
Off-licence density	6.8136	0.177	9.7615	0.263	6.1206	0.182	3.7075	0.187	-0.0750	0.784
Club/bar density	12.269	0.004***	25.299	0.001***	8.6091	0.027**	3.5911	0.131	0.3682	0.107
Restaurant/cafe density	8.6086	<0.001***	20.878	<0.001***	9.7357	<0.001***	4.5581	0.001***	0.3773	0.005***
Pop. density	-0.0310	0.103	-0.0472	0.149	-0.0557	0.001***	-0.0338	0.001***	-0.0001	0.906
NZ deprivation	0.7883	0.019**	0.0755	0.897	0.2940	0.337	0.1360	0.470	-0.0319	0.080*
Lag of off-licence density	-13.860	0.272	-21.537	0.304	3.5478	0.751	1.5423	0.823	0.1537	0.815
Lag of club/bar density	-4.0710	0.609	-16.906	0.224	-5.1227	0.483	-0.8514	0.853	0.5310	0.226
Lag of rest./cafe density	12.439	0.032**	27.901	0.007***	12.442	0.020**	5.3432	0.101	0.1552	0.621
Lag of pop. den.	0.1311	<0.001***	0.1394	0.016**	0.0629	0.038**	0.0476	0.011**	0.0031	0.091*
Lag of NZDep	0.7805	0.144	0.2367	0.795	0.1904	0.694	-0.0993	0.736	0.0690	0.016**
x-centroid	-0.0005	0.922	-0.0153	0.105	-0.0048	0.324	-0.0032	0.285	-0.0003	0.338
y-centroid	-0.0217	<0.001***	-0.0401	<0.001***	-0.0158	0.001***	-0.0072	0.011**	-0.0003	0.293
Constant	140,142	0.001***	300,305	<0.001***	114,867	0.002***	54,986	0.016**	2,594.4	0.245

*** = significant at 1% level, ** = significant at 5% level, * = significant at 10% level