1 Summary

An analysis of the effect of the smoking ban introduced in Victorian gaming venues on 1 September 2002 on gambling expenditure, and numbers of problem gambling counselling and problem gambling financial counselling clients has been conducted.

The analysis shows that for gambling expenditure there was an immediate 18.4% reduction following the smoking ban and an associated decrease in the expenditure level trend over time, from an annual increase in expenditure of 8.8% prior to the smoking bans to an annual increase in expenditure of 3.3% after the smoking bans.

For numbers of problem gambling counselling clients, there also appears to have been a reduction in numbers, although the reduction is less than for expenditure and the estimated effect is relatively more uncertain. Note that there appears to have been a downward trend just prior to the smoking bans, and this should be taken into account when interpreting the findings.

For monthly number of problem gambling counselling clients, the annual trend prior to the smoking bans is estimated to be an increase of 14.0% per annum, while after the smoking bans it is estimated to be 8.8%. The estimate of the stepchange due to the smoking bans is a decrease of 13.7% with a 95% confidence interval ranging from 2.3% to 23.8%. However, if the effect of the smoking bans is modelled as taking effect over a number of months then the long term reduction is estimated to be only 8.1%.

For new problem gambling counselling clients, the annual trend prior to the smoking bans is estimated to be an increase of 8.8% per annum, while after the smoking bans it is estimated to be a decrease of 4.8% per annum. The estimate of the stepchange due to the smoking bans is a decrease of 11.8% with a wide 95% confidence interval ranging from a 29.5% decrease to a 10.3% increase. Part of the reason for the wide confidence interval might be the unusual number of new clients in July 2004, as well as the apparent decreasing trend prior to the smoking bans.

For monthly number of problem gambling financial counselling clients, the annual trend prior to the smoking bans is estimated to be an increase of 142% per annum, while after the smoking bans it is estimated to be an increase of 25.9% per annum. The estimate of the stepchange due to the smoking bans is a decrease of 43.0% with a 95% confidence interval ranging from a 18.5% decrease to a 60.2% decrease. However, given the trend which began before the smoking bans and the small amount of data prior to the smoking bans it is especially difficult to be definitive

on the effect of the smoking bans for this series.

For monthly number of new problem gambling financial counselling clients, the annual trend prior to the smoking bans is estimated to be an increase of 27.6% per annum, while after the smoking bans it is estimated to be an increase of 11.6% per annum. The estimate of the stepchange due to the smoking bans is a decrease of 34.7% with a 95% confidence interval ranging from a 19.6% decrease to a 47.0% decrease. Again it is difficult to be definitive because of the existence of the prior trend and the small amount of data prior to the smoking bans.

2 Introduction

Smoking Bans were introduced in Victorian gaming venues on 1 September 2002. While the primary motivation was related to improving the health of Victorians, it did have a dramatic impact on gaming expenditure, with an immediate approximate 20% decrease.

This reports examines the impact of the smoking bans on problem gambling. One way to measure the impact is study the number of clients utilising problem gambling counselling prior to and after the smoking bans. A similar examination is conducted for problem gambling financial counselling.

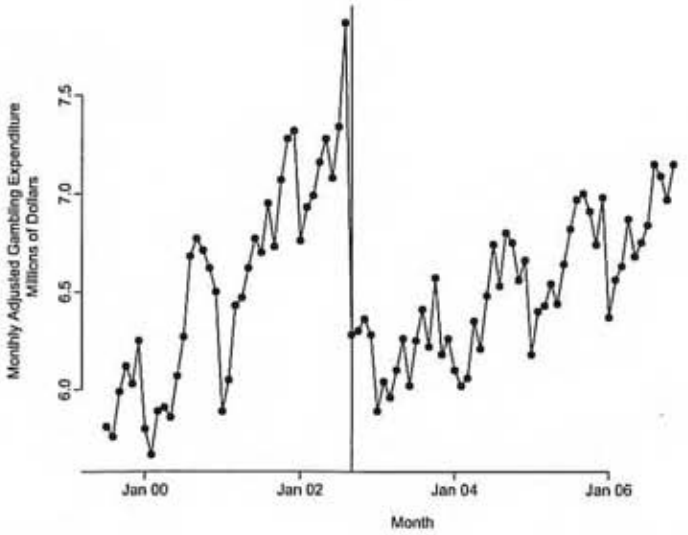
In this report, a re-analysis of the impact of the smoking bans on gambling expenditure will be first undertaken. Following that, similar models will be fitted to the problem gambling counselling data, and then the problem gambling financial counselling data.

3 Gambling Expenditure

Data for monthly gambling expenditure was provided for the period July 1999 to November 2006. The data was standardised by dividing by the number of days in the month.

A graph of the data is given in Figure 1, while the data is tabulated in Table 1. The table shows, for example, that the average Victorian spent \$7.87 on gambling in the month prior to the introduction of the smoking bans and \$6.28 in the month following the introduction of the smoking bans. The data is quite variable from month to month, and shows a strong seasonal pattern and an increasing trend. There is large drop in the average daily expenditure corresponding to the introduction of the smoking bans, and the increasing trend is less pronounced following the smoking bans.

Figure 1: Time series plot for daily gambling expenditure.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999							5.81	5.76	5.99	6.12	6.03	6.25
2000	5.80	5.67	5.89	5.91	5.86	6.07	6.27	6.68	6.77	6.71	6.62	6.50
2001	5.89	6.05	6.43	6.47	6.62	6.77	6.70	6.95	6.73	7.07	7.28	7.32
2002	6.76	6.93	6.99	7.16	7.28	7.08	7.34	7.87	6.28	6.30	6.36	6.28
2003	5.89	6.04	5.96	6.10	6.26	6.02	6.25	6.41	6.22	6.57	6.18	6.26
2004	6.10	6.02	6.06	6.35	6.21	6.48	6.74	6.53	6.80	6.75	6.56	6.66
2005	6.18	6.40	6.43	6.54	6.44	6.64	6.82	6.97	7.00	6.91	6.74	6.98
2006	6.37	6.56	6.63	6.87	6.68	6.75	6.84	7.15	7.09	6.97	7.15	
2007												

Table 1: Monthly average gambling expenditure per day (millions of dollars).

The first analysis conducted was to fit a linear model to the log of the expenditure with a linear trend, a step change for the impact of the smoking bans, a change in slope term, and dummy variables for the months. The model was fitted using the R (R Development Core Team (2008)) statistical package. The results are given in Table 2.

The interpretation of the results in Table 2 is as follows:

- the intercept term corresponds to the log of the gambling expenditure at the beginning of the data period.
- the trend term shows there is an increase of approximately 0.71% per month prior to the smoking bans, corresponding to an annual increase of 8.8%.

Table 2: Summary of fitted gambling expenditure model.

```
> print(summary(smokingbanfit(adjgambexp)))

Call:
lm(formula = log(ds1) ~ trend + stepch + chtrend + DumFeb + DumMar +
    DumApr + DumMay + DumJun + DumJul + DumAug + DumSep + DumOct +
    DumNov + DumDec)

Residuals:
      Min        1Q    Median        3Q       Max
-0.049047 -0.012854  0.004018  0.013343  0.041670

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.6910792  0.0099503 169.953  < 2e-16 ***
trend        0.0070659  0.0003086  22.897  < 2e-16 ***
stepch      -0.2040320  0.0089101 -22.899  < 2e-16 ***
chtrend     -0.0043719  0.0003655 -11.960  < 2e-16 ***
DumFeb       0.0104734  0.0110279   0.950 0.345347
DumMar       0.0225033  0.0110320   2.040 0.044938 *
DumApr       0.0402365  0.0110389   3.645 0.000494 ***
DumMay       0.0344097  0.0110485   3.114 0.002622 **
DumJun       0.0404466  0.0110609   3.657 0.000475 ***
DumJul       0.0618211  0.0107000   5.778 1.68e-07 ***
DumAug       0.0845357  0.0107073   7.895 2.04e-11 ***
DumSep       0.0808283  0.0106908   7.561 8.75e-11 ***
DumOct       0.0867931  0.0106897   8.119 7.70e-12 ***
DumNov       0.0726184  0.0106913   6.792 2.39e-09 ***
DumDec       0.0772982  0.0110279   7.009 9.44e-10 ***
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Signif. codes:  0 Ś***Š 0.001 Ś**Š 0.01 Ś*Š 0.05 Ś.Š 0.1 Ś Š 1

Residual standard error: 0.02063 on 74 degrees of freedom
  (7 observations deleted due to missingness)
Multiple R-squared: 0.9211,Adjusted R-squared: 0.9061
F-statistic: 61.69 on 14 and 74 DF,  p-value: < 2.2e-16
```

- the -0.20 coefficient means there was an approximate 20% decrease in expenditure corresponding to the smoking ban. A better approximation to the reduction is

$$100 \times (1 - \exp(-0.204)) = 18.4\%,$$

  with the 95% confidence interval ranging from 17.0% to 19.9%.

- Corresponding to the smoking bans there was also a decrease in the trend of about 0.44% per month. The estimated annual trend after the smoking bans is 3.3%.

- There is a seasonal pattern in expenditure, with the lowest values in January and February and the highest values in August to October.

All the terms in the model are statistically significant. However, there is some autocorrelation in the residuals, which means that the standard errors may be underestimated. Therefore a time series regression model was fitted, allowing for the autocorrelation between successive observations, and also including an autoregressive seasonal pattern rather than using dummy variables for the months (See, for example, Box, Jenkins, and Reinsel, (1994)). The results are given in Table 3.

This model gives similar results, but the standard errors are more realistic, and in all cases larger. The annual trend prior to the smoking bans is estimated to be 8.9%, while after the smoking

Table 3: Summary of fitted model for adjusted gambling expenditure taking into account autocorrelations.

```
> print(smokingbanarimafit(adjgambexp))

Call:
arima(x = log(ds1), order = c(1, 0, 0), seasonal = list(order = c(1, 0, 0),
    frequency = 12), xreg = cbind(trend, stepch, chtrend))

Coefficients:
         ar1    sar1  intercept   trend   stepch  chtrend
      0.3921  0.5745     1.7428  0.0071  -0.2012  -0.0044
s.e.  0.0991  0.0889     0.0160  0.0006   0.0140   0.0008

sigma^2 estimated as 0.0006088:  log likelihood = 200.71,  aic = -387.42
```

bans it is still estimated to be 3.3%. The step change due to the smoking bans is estimated to be 18.2% with a 95% confidence interval ranging from 15.9% to 21.3%.

A criticism that could be directed at the model is that the trend term is deterministic. To overcome this a structural time series model (See, for example, Harvey (1989)) was fitted to the data, allowing the trend to change through time. The model is given by

$$y_t = a_t + b_t + s_t + \omega z_{1t} + \eta z_{2t} + \varepsilon_t$$

with level, trend, and seasonal terms given by

$$\begin{aligned} a_t &= a_{t-1} + b_{t-1} + \alpha\varepsilon_t \\ b_t &= b_{t-1} + \beta\varepsilon_t \\ s_t &= s_{t-1} + \gamma\varepsilon_t \end{aligned}$$

where ε_t is a normally distributed random error term with mean 0 and standard deviation σ, the dummy variable corresponding to the step change corresponding to the smoking ban is given by

$$z_{1t} = \begin{cases} 0 & \text{Before the Smoking Ban} \\ 1 & \text{After the Smoking Ban} \end{cases}$$

and the dummy variable associated with the slope change is given by

$$z_{2t} = \sum_t z_{1t}.$$

In the model, α gives a measure of the autocorrelation of the results, β gives a measure of the stochastic nature of the trend term, and γ gives a measure of the stochastic nature of the seasonal factors; while ω gives the stepchange associated with the smoking ban, and η gives the change in slope associated with the smoking ban.

Nonlinear least squares (See, for example, Bates and Watts (1988)) was used to fit the model. It was found that the optimal values of β and γ were 0, corresponding to a deterministic slope and fixed seasonal pattern. The effects of the smoking ban were very similar to the results in Table 3.