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The effects of public place smoking restrictions on individual smoking behaviour in Australia*

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ABSTRACT

While smoking remains the leading preventable cause of death in Australia, existing policy options, except for bans on smoking at public places, seem to have limited scope for expansion. Eight new smoking bans, introduced in six different Australian jurisdictions over 2003 and 2005, provide a basis for evaluation. The analysis extends a popular two-part model of smoking behaviour by GLM and correlated random effect models. Difference-in-differences estimation using 4 waves of the Household, Income, Labour Dynamics Australia Survey indicates that neither the probability nor the intensity of smoking was affected. The results are robust to alternative specifications and estimation methods.

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I. INTRODUCTION

There has been no lack of epidemiological evidence on the adverse health consequences of smoking and several findings on the impact of passive smoking have come to public attention following the US Surgeon General's Report in 1986. Although estimates differ across surveys, a recent ABS statistic (2006) indicates that in 2004-2005, 26% of men and 23% of women among the Australian adult population did still smoke. The current prevalence level compares well internationally but as of 1998 smoking is still responsible for 15% of all deaths in Australia (ABS, 2006), making it the leading preventable cause of death. In addition, after a decline to roughly one quarter of the post-WWII level by the mid-1990s, the smoking rate for men stabilised as it caught up with women's, which has remained static for more than half a century.

A recent trend analysis commissioned by the Department of Health and Aging (Social Research Centre, 2006) uses a series of comparable surveys and concludes that following a plateau around 20.40% from 1999 to 2002, the smoking prevalence among Australians aged above 17 resumed its downward trend and declined to 18.4% in 2005. Available regulatory information reveals that six different Australian states/territories introduced new bans on smoking at selected places between 2003 and 2005, providing policy variations across jurisdictions and over time. Real cigarette prices remained fairly stable during the same period and there was no other noticeable government intervention.

The primary objective of this paper is to evaluate the effects of the new smoking bans on individual smoking behaviour in Australia, or more specifically an individual's decision to smoke and a smoker's decision of how much to consume. Given that all but two of the regulatory changes covered only public places, they provide an interesting basis for evaluation in two aspects.

First, smoking restrictions at public venues, if found effective, may provide Australian governments with an important policy lever to pull. Under the current regulatory regime in Australia -with the second most expensive cigarette price in the world, indoor smoking bans at private worksites and almost a complete ban on advertising- traditional policy options seem to have a limited scope for expansion.

Public place smoking bans have much room to manoeuvre, as evidenced by Queensland's extension of smoking bans to selected outdoor areas in 2005.

Second, while the empirical literature provides convincing findings on the effectiveness of workplace smoking bans (Evans et al., 1999), evidence on public place bans remains ambiguous. US-based studies on the effects of clean air laws generally conclude that smoking restrictions at worksites *and* public venues discourage smoking as they employ an arbitrary regulation index which cannot disentangle the effects of the two types of restrictions. An available study of public place smoking bans in Australia reports very weak empirical evidence of their effectiveness (Buddelmeyer and Wilkins, 2005) but it fails to consider the relative strictness of regulations across jurisdictions.

This paper examines the effects of public place smoking bans using a differences-in-differences approach and a 4-year panel of Australian individuals from the Household, Income, Labour Dynamics Australia (HILDA) Survey. A conventional two-part model has been estimated along with its generalised linear model and correlated random effects model counterparts. The empirical results indicate that none of the regulatory changes had a statistically detectable impact on the probability and intensity of smoking, and even economically significant policy coefficients have been typically estimated too imprecisely to warrant much confidence in the point estimates.

II. TOBACCO REGULATION IN AUSTRALIA

TOBACCO REGULATION IN AUSTRALIA PRIOR TO 2002

The US Surgeon General's Report in 1964 officially recognised the causal links between smoking and its adverse effects on health, stimulating anti-smoking sentiment internationally. Starting off with mandatory warning labels on cigarette packs in 1972, the Australian government has crafted a regime of stringent tobacco regulations. In the 1980s and early 1990s, the assaults on the informational front were stepped up by the establishment of a cessation advisory service in each state, a series of mass media campaigns and regulations on tobacco advertising. Most notably, The Commonwealth Tobacco Advertising Prohibition Act 1992 phased out virtually all forms of tobacco advertising by 1995. White et al. (2003) state that by 1991, 80% of Australians were covered by advertising bans, and Bardsley and Olekalns (1999) found that the effect of advertising on aggregate tobacco consumption came to nil after 1993.

Taxation has also been an important pillar of tobacco regulation. Bardsley and Olekalans (1999) estimated that the real cigarette price rose by more than 175% over 1962/63 to 1995/96, with various taxes accounting for 65% of cigarette prices at the time when their study was written. In a recent 30-country comparison, Australia is found to have the second highest real cigarette prices (Lal and Scolo, 2002).

In the mid-1980s amid growing concerns over passive smoking, the federal government legislated on smoking bans at its workplaces and Australian airlines. Private businesses also responded to the increasing public demand for smoke-free environment and tightening occupational health regulations by adopting workplace smoking restrictions voluntarily or in compliance with law. While no nationwide tally is available, data from Victoria shows that the percentage of indoor workers covered by total smoking bans increased from 17 to 70% over 1988-1999 (VicHealthCentre for Tobacco Control, 2001). The trend toward smoke-free environments continued into the late 1990s, as a series of State and Territory legislations came into effect, extending smoking bans to enclosed public venues. By 2002, a majority of State and Territories placed formal restrictions on smoking in indoor public venues including restaurants and shops, although the details and relative strictness varied across jurisdictions.

SMOKE-FREE LEGISLATIONS AND REGULATIONS AFTER 2002

Table 1 outlines the new wave of smoke-free laws/regulations which came into effect after 2002 and prior to September 2005. In the absence of Australian government-provided data summarising when relevant smoking bans became effective in each jurisdiction, the construction of the table greatly benefited from information compiled by ASH Australia (2005; 2007), Buddelmyer and Wilkins (2005), Drabsch (2005) and Lewis (2007). All information contained in the table was subsequently confirmed as being true and comprehensive by PhD Frontdesk at the Deparment of Health and Ageing.

It seems reasonable to view the regulatory changes jointly as a natural experiment. Available regulatory data shows that there was no other major government intervention during the relevant period. Insofar as media campaigns are concerned, QuitVictoria's new TV commercials in 2003 and the Cancer Institute NSW's campaigns to inform certain sub-groups in 2004 and 2005 are the more significant ones; both by common sense and on the basis of econometric studies (Chaloupka and Warner, 1999) these items are likely to have had only a negligible impact on smoking behaviour, if any. Since the policy changes were state governments' responses to the Health Department's National Tobacco Strategy that called for the need to reduce exposure to passive smoking, a correlation between regulatory intervention and smoke-related shocks to individuals in a particular state is highly unlikely. Given that regulatory information is not readily available, it is also difficult to imagine that individuals would have invested time in going through Hansard to check on an upcoming smoke-free legislation for the purpose of making an optimal prior adjustment to their smoking behaviour.

In light of the pre-existing regulations sketched above, the effects of Northern Territory's intervention in 2003 and South Australia's in 2004 will be difficult to interpret. They may capture the impact of formalising workplace bans to the extent that occupational health laws alone had provided little incentive to impose smoking bans at worksites. Thus, their proximity to pure public ban effects will depend on the unobserved prior diffusion of voluntary workplace smoking bans in the two jurisdictions.

Table 1: Timeline of newly imposed smoking bans, 2003-2005

2003
January & May *Northern Territory* introduces smoking bans in enclosed public venues including restaurants, shops, dining areas in hotels and bars, and indoor worksites except licensed premises. **July** *New South Wales* implements Phase One of the voluntary 'Share the Air' agreement with the industry; smoking is prohibited at bar or service counters and a non-smoking area should be designated within one bar area.
2004
July *New South Wales* implements Phase Two of the Share the Air agreement; one full smoke-free bar is to be designated in multiple-bar venues and there is a similar provision for recreational and gaming areas. **December** *South Australia* tightens its existing ban, prohibiting smoking in all enclosed public places, workplaces and shared areas; partial smoking bans apply to bars and gaming venues.
2005
January *Queensland* prohibits smoking in several outdoor areas, including sport stadiums, patrolled beaches, and areas in proximity to residential buildings and playgrounds; smoking bans in enclosed venues were tightened, requiring two thirds of licensed premises to be smoke-free before October. *Tasmania* extends smoke-free areas to a nightclub or cabaret, a gaming area and 50% of outdoor dining areas. *Western Australia* bans smoking within a metre of a bar in clubs and hotels, and within five metres of the entrance of government buildings including courts and hospitals. **January & July** *New South Wales* implements a new legislation in January, mainly formalising the Share the Air agreement. From July onwards, smoking is to be permitted in only one bar or gaming area in each premise.

III. LITERATURE REVIEW

Individual-level cigarette consumption data is characterised by a mixed distribution of several zeros and some positive values. A two-part model has been widely applied in the empirical literature to tackle this issue. In part one the probability of participating in smoking is modelled by a binary response model, and in part two the consumption of cigarettes conditional on having participated is linearly estimated.

The earliest form of smoking ban introduced in the latter half of the 1980s targeted private worksites. Evans et al. (1999) provide arguably the most convincing evaluation of workplace bans to date. Using nationally representative individual-level data from the USA, they initially found that workplace bans were associated with 5.7 percentage point decline in smoking participation and 2.5 fewer cigarettes smoked per day by continuing smokers. These findings were robust to using a 2SLS estimator to account for selection bias and could be successfully replicated by employing an alternative dataset. The effects were found to increase in work hours, confirming causality. Based on a cross-section of Japanese workers from Kanto and Kansai, Morozumi and Ii (2006) found that total smoking prohibition was associated with 10 percentage point decrease in the propensity to smoke and 4.11 fewer cigarettes consumed per day, while simple separation of smoking areas affected neither. In Greece, Raptou et al. (2005) report a much weaker result that total prohibition only affected the conditional demand.

In response to findings on the negative health consequences of passive smoking, indoor smoke-free laws in the United States have grown at dramatic rates. Since the effects of smoke-free laws extend to wider segments of the population than current workers, a growing number of studies has analysed their impact on smoking behaviour. A key limitation of the current literature comes from the prevalent use of a ‘regulation index’ which does not permit a meaningful and natural interpretation of the policy impact and drawing distinction between workplace bans and public place bans.

Most of the studies initially intend to include dummy indicators for smoking bans at different venues and use cross sectional variations to estimate the impact of each. As a given state is likely to have different types of bans simultaneously, however, all policy effects tend to be imprecisely estimated. A common practice is to replace the policy dummies by a regulation index similar in spirit to one used in Wasserman et al. (1991), which takes one of five possible values. The highest score, 1, is assigned to states with workplace smoking restrictions and the second highest, 0.75, is given to those with the restriction at restaurants. The remaining positive scores, 0.5 and 0.25, are distributed according to the number of other types of restrictions in force and 0 is reserved for regulation-free states.

In two-part model applications, an increase in the 'index' has been found to be significantly associated with a decline in the adults' probability of smoking and conditional demand (Wasserman et. al., 1991) or only in the conditional demand (Tauras, 2006). Chaloupka and Wechsler (1997) and Czart et al. (2001) find that the index significantly affects the conditional demand by university students, but not the decision to smoke. However, Tauras and Chaloupka (1999), whose work stands out for being a fixed-effects analysis using a panel of young adults, has estimated the impact of the index with statistical precision in both parts. Ohsfeldt et al. (1998) directly address the concern that the effects of smoking bans on the decision to smoke may simply reflect the substitution of smokeless tobacco for cigarettes; while their analysis does not include the second part, they find that an increase in the index leads to a significant decline in both the probability of smoking and of 'snuff' use.

In a micro-level rational addiction model application, Chaloupka (1992) employs a separate dummy for each positive index value and finds evidence against parametric restrictions inherent in the index. He reports that although each dummy is significant, 0.5 and 0.75 groups have the same and biggest impact on the demand while 0.25 and 1.00 groups have smaller effects. (Note: his work ignores the mixed distribution of consumption to incorporate dynamics implied by a reduced form rational addiction equation.)

Economics databases return only a few articles on Australian tobacco consumption. Bardsley and Olekalns (1999) estimated that workplace bans produced a 5% decline in aggregate tobacco consumption between the late 1980s and 1995. Buddelmeyer and Wilkins (2005) estimated the impact of smoke-free laws on the decision to smoke and the decision to quit, using a 3-year panel from the HILDA survey. In their trivariate probit model, a dichotomous intervention variable was found to exert no significant effect on the initiation probability, and to increase the quitting rate marginally for only those aged 14-17 and above 60. Their study is limited by the fact that the same binary variable was used to encompass all changes even though each state's intervention differed with respect to scope and restrictiveness and also that the impact on the conditional demand was left unexamined.

IV. MODELLING FRAMEWORK

BASIC EMPIRICAL APPROACH

The empirical analysis follows the dominant approach in the anti-smoking policy evaluation literature, the two-part model (2PM). This approach assumes the conditional independence of the decision of how much to consume once the participation decision has been made. In the context of medical care expenditure, there has been an unsettled debate over the relative merits of the 2PM and a sample selection model which assumes bivariate normality of disturbances in the two decisions (Jones, 2000, pp.285-289). As Mullahy (1998) states a more relevant question for policy inferences may be, given that the 2PM has been demonstrated to be useful in several contexts, how its coefficients should be interpreted in the presence of the retransformation problem to be discussed below.

In part one, the decision to smoke is modelled by a probit model:

$$\begin{aligned} y_{it}^{*} &= X_{it}^{'}\beta + u_{it} \\ \Pr(c_{it} > 0 \mid X_{it}) &= \Pr(y_{it}^{*} > 0 \mid X_{it}) = \Phi(X_{it}^{'}\beta) \end{aligned} \tag{1}$$

where i and t are individual and time subscripts respectively, c is the level of cigarette consumption, X represents a vector of characteristics and includes 1, u is a standard-normally distributed error term and Φ(.) is the standard-normal cumulative density.

Part two models the demand for cigarettes conditional on being a current smoker. Log transformation provides a convenient way to mitigate heteroskedasticity, moderate the impact of potential outliers, and impose non-negativity constraints on the predicted conditional demand in arithmetic units:

$$
\begin{aligned}
&\log(c_{it} \mid c_{it} > 0) = X_{it}^{'}\gamma + e_{it} \\
&\mathrm{E}[\log(c_{it}) \mid X_{it}, c_{it} > 0] = X_{it}^{'}\gamma
\end{aligned}
\tag{2}
$$

where log(c) is the natural log of c and e is a random error term differing from u. (2) is estimated separately from (1), using an OLS regression of log(c) on X.

For policy analysis, the parameter of primary interest is the impact of policy on the arithmetic mean, E(c_{it} | X_{it}, c_{it}>0). The often-neglected retransformation problem (Manning, 1998; Manning and Mullahy, 2001) arises because e has zero conditional mean in logarithmic, not arithmetic, units. In general,

$$\mathrm{E}(c \mid X, c > 0) = \exp(X'\gamma) \cdot \mathrm{E}(\exp(e) \mid X, c > 0) = \exp(X'\gamma) \cdot \mathrm{r}(X) \neq \exp(X'\gamma) \tag{3}$$

even if E(e | X, c>0) = 0. To correct this bias, a non-parametric smearing estimator of r(X) (Manning, 1998; Tauras, 2005) will be employed. It can be expressed as:

$$\hat{\mathrm{r}}(X) = \hat{\mathrm{r}} = \frac{1}{P}\sum_{p=1}^{P}\exp(\hat{e}_p) \tag{4}$$

where p is the subscript for observations with c > 0, P is the number of such observations, and $\hat{e}$ is the OLS residual from estimating (2). Thus, the expected tobacco consumption estimated from the two-part model can be written as:

$$\hat{\mathrm{E}}(c \mid X) = \hat{\mathrm{P}}\mathrm{r}(c > 0 \mid X) \cdot \hat{\mathrm{E}}(c \mid X, c > 0) = \Phi(X'\hat{\beta}) \cdot \exp(X'\hat{\gamma}) \cdot \frac{1}{P}\sum_{p=1}^{P}\exp(\hat{e}_p) \tag{5}$$

EXTENSIONS

If e_{it} is heteroskedastic its geometric function is no longer constant across X_{it}. (3) and (4) imply that heteroskedasticity not only invalidates OLS standard errors but also biases the retransformed prediction, $\hat{\mathrm{E}}(c \mid X, c > 0)$. The size of bias may be substantial if the error variance, and thus the smearing estimate, is large.

An alternative approach models and estimates the form of heteroskedasticity. Specifically, Manning and Mullahy (2001) propose a simple alternative for part two which bypasses the need for retransformation:

$$\begin{aligned} &\mathrm{E}(c_{it} \mid X_{it}, c_{it} > 0) = \exp(X_{it}^{'}\mu) \\ &\log(\mathrm{E}(c_{it} \mid X_{it}, c_{it} > 0)) = X_{it}^{'}\mu \end{aligned} \tag{6}$$

which can be consistently estimated as a generalised linear model (GLM) with log-link using the quasi-likelihood approach. The GLM requires choosing a heteroskedastic variance function of the form:

$$\mathrm{var}(c_{it} \mid X_{it}, c_{it} > 0) = \kappa \cdot [\exp(X_{it}^{'}\gamma)]^{\lambda}$$

where $\kappa > 0$ and $\lambda \geq 0$. An incorrectly specified variance leads to inefficiency, but not inconsistency. The authors use a modified Park test as a way to form the basis for choosing a suitable variance function:

$$\log((c_{it} - \hat{c}_{it})^2 \mid c_{it} > 0) = \lambda_0 + \lambda_1 \log(\hat{c}_{it}) + v_{it} \tag{7}$$

where $\hat{c}_{it}$ is an initial GLM prediction of c_{it} with any variance function and v_{it} is a random error in the auxiliary linear regression. If $\hat{\lambda}_1 \approx 1$, (6) is re-estimated with the Poisson distribution. $\hat{\lambda}_1 \approx 2$ and $\hat{\lambda}_1 \approx 3$ suggest re-estimation with gamma and inverse Gaussian distributions, respectively. Simulations by Manning and Mullahy (2001) show that GLM estimates can be highly imprecise under certain data generating mechanisms. Accordingly (6) will be estimated as a complement, rather than substitute, to (2).

Another source of bias lies in the presence of unobserved individual heterogeneity, reflecting past experiences or personality traits which may affect an individual's perception of smoking and costs of addiction. Examples include past exposure to certain cultural values, the circle of friends and the self-assessed risk of smoking. These factors may be correlated with observed characteristics but can be reasonably assumed to be constant over a short span of time under this study.

This issue can be addressed by the use of panel data. Specifically, assume that the error terms in (1) and (2) can be decomposed as:

$$\begin{aligned} u_{it} &= a_{i1} + \upsilon_{it} \\ e_{it} &= a_{i2} + \varepsilon_{it} \end{aligned} \tag{8}$$

where υ_{it} and ε_{it} are random disturbances orthogonal to X_{it} and a_{i1} and a_{i2} are time-invariant individual-specific effects possibly correlated with X_{it}. In addition, assume that individual heterogeneity is linearly related to observed characteristics as follows:

$$\begin{aligned} a_{i1} &= \psi_1 + \overline{X}_i^{'}\xi_1 + w_{i1},\ w_{i1} \mid \overline{X}_i \sim N(0,\sigma_a^2) \\ a_{i2} &= \psi_2 + \overline{X}_i^{'}\xi_2 + w_{i2},\ \mathrm{E}(w_{i1} \mid \overline{X}_i) = 0 \end{aligned} \tag{9}$$

where $\overline{X}_i$ is a vector of averages of any time-varying regressors except time dummies for each individual.

Under (9), both parts can be consistently estimated as correlated random-effects models as follows:

$$\Pr(c_{it} > 0 \mid X_{it}, w_{i1}) = \Phi(X_{it}^{'}\beta + \psi_1 + \overline{X}_i^{'}\xi_1 + w_{i1}) \tag{10a}$$

$$\mathrm{E}(\log(c_{it} \mid X_{it}, w_{i2}, c_{it} > 0)) = X_{it}^{'}\gamma + \psi_2 + \overline{X}_i^{'}\xi_2 + w_{i2} \tag{10b}$$

where X no longer includes 1. In other words, the source of bias and inconsistency in (9) is directly controlled for. Once again, both parts will be estimated separately. While fixed-effects models are more flexible in allowing any arbitrary form of correlation, they are not used in this study due to the non-linear nature of the 2PM discussed above.

EVALUATION METHOD

The policy variations across states and over time, coupled with the availability of an individual-level panel spanning the relevant period, provide situations favourable to the use of a natural experiment approach as follows:

$$\begin{aligned} y_{it} &= \mathrm{f}(R_{it}) + X_{it}^{'}\varsigma + \eta_{it} \\ \eta_{it} &= \tau_t + \iota_i + \mu_{it} \end{aligned} \tag{11}$$

where y is a measure of smoking linear in parameters, R is the unobservable stringency index of anti-smoking policy in i's state of residence, f'(R)<0, τ is the common temporal effect, ι is time-invariant individual heterogeneity, and μ is a temporary idiosyncratic zero-mean error.

Abstracting from X and assuming that there are only two periods and two states, the expected changes in outcomes over time can be written as:

$$\mathrm{E}(y_{it+1} - y_{it} \mid S = 1) = [\mathrm{f}(R_{it+1}) - \mathrm{f}(R_{it})] + [\tau_{t+1} - \tau_t] = \delta + \theta \tag{12a}$$

$$\mathrm{E}(y_{it+1} - y_{it} \mid S = 0) = [\tau_{t+1} - \tau_t] = \theta \tag{12b}$$

where S=1 for the state with a new smoking ban (ie an increase in R) and S=0 otherwise.

A difference-in-differences (DID) estimator can be obtained by subtracting (12b) from (12a), thereby isolating $\delta = [\mathrm{f}(R_{it+1}) - \mathrm{f}(R_{it})] < 0$. This identification strategy depends critically on the assumptions that $E(\mu_{it} \mid S = 1) = E(\mu_{it} \mid S = 0)$; that R will remain constant over time if not for the smoking ban; and that $[\tau_{t+1} - \tau_t]$ will be constant across states. In light of the stability in the Australian smoking prevalence during years preceding 2002 and the available regulatory information outlined above, these identifying assumptions appear to be reasonable.

In a linear context, δ can be estimated in a regression model:

$$E(y_{it}) = X_{it}^{'}\varsigma + \alpha S_i + \theta T + \delta(S_i \cdot T) \tag{13}$$

where T=1 for period t+1, X includes 1 and other covariates to reduce the error variance and to control for changing individual characteristics over time. It is straightforward to extend (13) to a multi-period, multi-treatment case as follows:

$$E(y_{it}) = X_{it}^{'}\varsigma + \{\sum_{s=1}^{6}\alpha_s S_{si} + \sum_{h=1}^{3}\theta_h T_h + \sum_{k=1}^{8}\delta_k ST_k\} \tag{14}$$

where T_h=1 at and after period h and $ST_k = S_{si} \cdot T_h$ if state s introduced new smoking bans at h. As outlined in Table 1, six jurisdictions excluding Victoria and Australian Capital Territory introduced new smoking bans over 2003 - 2005 and New South Wales' intervention had been phased in through three different years. Adding terms in {.} to (1) or (2) shows the DID approach assumes that the policy impact takes the form of a permanent shift in the intercept on the latent variable or log of consumption.

One limitation of this evaluation method is that it cannot isolate the impact of a restriction at a particular venue because each treatment ST is a package of different types of smoking restrictions. As discussed previously, available regulatory data is not detailed enough to tabulate what type of ban is in force in which jurisdiction and even if such information is available, multicollinearity among restrictions will make it difficult to identify venue-specific effects. Subject to these limitations, the DID approach is preferable to arbitrary regulation indices used by US-based studies in terms of the ability to clarify what is being measured.

V. DATA DESCRIPTION

DATA SOURCES

The primary data for the empirical analysis comes from the Household, Income, Labour Dynamics Australia (HILDA) Survey General Release 5.1. The HILDA Survey is a large indefinite panel of households across Australia starting from 2001. The Survey is conducted during September of each year. On top of the household-level questionnaire, the Survey administers the person questionnaire (PQ) to household members aged above 14, asking for their personal information. The PQ is supplemented by the self-completion questionnaire (SCQ) which covers more sensitive personal topics, including smoking behaviour.

The analysis is based on waves 2 through 5, spanning 2002 through 2005. Of 46,247 observations who responded to the PQ and SCQ, 511 observations had not identified their current smoking status. After deleting these, 45,736 observations were retained. The baseline analysis, which treats the data as pooled cross sections, uses 44,654 observations with complete information. For the correlated random effect analysis, 28,634 observations which remained in the sample without inter-state migration during the relevant period are used. More information is provided below.

State-specific price data, including tobacco price indices and deflators for nominal variables, come from the Consumer Price Index Standard Data Report: Capital City Index Numbers by Expenditure Class September Quarter (ABS, 2004; ABS, 2005), released by the Australian Bureau of Statistics in late October each year.

DEPENDENT VARIABLES

From wave 2 onwards, the SCQ asks whether respondents smoke cigarettes or other tobacco products. Possible responses include ‘never smoked’, ‘no longer smoke’, ‘smoke daily’, ‘smoke at least weekly’ and ‘smoke less often than weekly’. The frequency of response types are reported in Table 2. SMOKE, which equals 1 for the last three categories and 0 otherwise, was created for part one. Using this variable may overstate the policy impact on tobacco use, to the extent that smokers switch to smoke-less tobacco products.

Self-reported smokers are also asked to state their weekly consumption of tobacco products, in terms of the number of cigarettes. In wave 1, smokers were asked to state their weekly expenditure on tobacco products instead. Given limited price and product information, the two measures cannot be reconciled and wave 1 is not used in the analysis.

Table 2: Smoking status of observations in the HILDA waves 2 – 5

	Estimation sample 1		Estimation sample 2	
Smoking status	No. of obs.	Percent	No. of obs.	Percent
Never smoked	22,131	49.56%	14,173	49.50%
No longer smoke	12,109	27.12%	8,426	29.43%
Smoke daily	8,561	19.17%	4,970	17.36%
Smoke at least weekly (but not daily)	1,045	2.34%	588	2.05%
Smoke less often than weekly	808	1.81%	477	1.67%
Total	44,654	100.00%	28,634	100.00%

For part two, information on the quantity smoked is required. As Table 3 shows, 227 out of 10,414 smokers failed or refused to provide appropriate information. Ideally, the 2PM requires information on consumption decisions of all participants. The observations are retained in the sample, as they still provide valuable information for part one. 55 smokers, 49 of whom smoked less than weekly, reported zero consumption. It seems more natural to view zeros as refusal to respond, rather than indicators of 'social' smokers who do not smoke regularly, given the noise in the data to be discussed below. LN(QTTY) has been created by taking the natural log of the number of cigarettes smoked per week by current smokers who reported positive numbers.

Table 3: The number of cigarettes smoked per week in the HILDA waves 2 – 5; self-reported response types for smokers

	Estimation Sample 1		Estimation Sample 2	
Responses	No. of obs.	Percent[(a)]	No. of obs.	Percent[(a)]
Implausible value	1	0.01%	1	0.02%
Refused/not stated	212	2.09%	102	1.73%
Don't know	14	0.14%	5	0.08%
None	54	0.53%	29	0.49%
Mean positive weekly consumption	10133	82.25	5898	84.06
Total	10414	-	6035	-

(a) A percentage of self-reported smokers who made each inconsistent response or the mean number of cigarettes smoked by smokers who reported positive consumption

Overall, the data on the quantity smoked is less than ideal. As noted by Wasserman et al. (1991), a greater incentive for heavy smokers to underreport their consumption may have implications for the consistency of estimators. The SCQ does not seem immune from underreporting as several daily smokers reported less consumption than less frequent smokers. In addition, the SCQ data fails to adjust for the potential substitution of cigarettes with heavier tobacco contents for lighter ones; the impact of policy intervention may be overestimated consequentially. These problems are common to most of surveys and the extent to which microeconometric findings are invalidated is unknown.

POLICY VARIABLES AND ESTIMATION SAMPLES

The HILDA dataset provides state (*hhstate*) and wave (*wave*) identifiers for each observation. State dummies were created using the former. The time dummy for 200n was set to unity if *wave* ≥ n. Based on Table 1, policy variables were created by multiplying state dummies and relevant year dummies. South Australia's intervention in 2004 took effect in December and hence the South Australia dummy was interacted with the 2005 dummy instead. This is a somewhat rough definition, necessitated by the absence of information on when the SCQ was completed; while wave *n* interviews began in September of 200*n*, the data collection could have been delayed until next year.

In principle the DID approach requires the same individuals be present in each group before and after an intervention, so that individual fixed effects can be cancelled out. Interstate migration is analogous to treatment status changes. Since this study covers 4 years and the HILDA panel is unbalanced, placing such requirements on the sample will lead to the loss of many observations. To maximise the sample size and check for selection bias, the baseline analysis treats the data as pooled cross sections of 44,654 observations. In the evaluation literature, a DID estimator is often applied to *independently* pooled cross sections by assuming that the *expected* individual effect within each group remains constant even though sampled individuals change over time. This assumption is far less restrictive for this study since the dataset still includes a large number of individuals who provided interviews through relevant waves and did not move to other states.

For a sensitivity check and random effects analysis, the estimation sample was restricted to 28,634 observations or 7,169 individuals who 1) remained in the sample from wave 2 until relevant regulations took effect and 2) did not move across states. In effect, the new estimation sample is a balanced panel of individuals from all jurisdictions but Northern Territory; those from Northern Territory were retained so long as they were present in both waves 2 and 3.

CONTROL VARIABLES

The ABS's tobacco price index per state capital was matched with each observation, based on state and wave identifiers. It is based on the quality-adjusted retail price of one cigarette, where quality refers to the amount of tobacco content (Kidd and Hopkins, 2004). For this analysis, each state's tobacco index was deflated by that state's consumer price index and log-transformed to create *LN(PRICE)*. The price data is far less detailed than those used in the US studies which provide within-state variations too. In addition the tobacco prices tended to vary minimally across states and, in real terms, over time as reported in Appendix 1. Given these features the difficulty of estimating the price impact with precision can be expected a priori.

The HILDA survey provides a rich set of socioeconomic characteristics which can be used as control variables. Nominal family disposable loss (*hifin*) was subtracted from family income (*hifip*) to create a real family income variable (*FAMINC)*, in '0,000s of 2002 dollars, using state consumer price indices as deflators. The data on self-reported satisfaction with life (*losat*) was available on a 0-to-10 scale, where 5 corresponds to indifference. Two dummy variables were created from this, indicating dissatisfaction with life or LFDIS = 1 if *losa t* < 4, and satisfaction with life or LFSAT = 1 if *losa t* > 6. Other characteristic variables are relatively generic and a specific discussion is omitted. All variable definitions and summary statistics are reported in Table 4 and Table 5 respectively.

Table 4: Variable definitions

Variable	Source[a]	Description
SMOKE	lssmkf	=1 if smoke; =0 otherwise
QTTY	lstbcn	(positive) number of cigarettes smoked per week by a smoker
LN(QTTY)	lstbcn	natural log of QTTY
FMSIZ	hhpers	number of persons in the household
MJURBAN	hhsos	=1 if resides in a major urban area
RURAL	hhsos	=1 if resides in a rural area
MALE	hgsex	=1 if male
INDIG	anatsi	=1 if of Aboriginal or Torres Strait Islander origin
EMP	esbrd	=1 if currently employed
UNEMP	esbrd	=1 if cureently unemployed
HOSP	jbmind2	=1 if works in the hospitality industry
MARRIED	mrcurr	=1 if currently married legally or de facto
DIVORCED	mrcurr	=1 if currently divorced or separated
WIDOWED	mrcurr	=1 if currently widowed
PSTUGRD	edhigh	=1 if holds higher qualifications than an undergraduate degree
UGRD	edhigh	=1 if holds an undergraduate degree
YR11	edhigh	=1 if the highest qualification is year 11 or below
LFDIS	losat	=1 if dissatisfied with life
LFSAT	losat	=1 if satisfied with life
PHYACT	lspact	=1 if does physical exercise at least once a week
CLUB	lsclub	=1 if an active member of sporting/hobby/community-based associations or clubs
SOCWK	lssocal	=1 if socialises with friends or non-resident family members at least once a week
DRINK	lsdrkf	=1 if drinks
LN(PRICE)	-	logged real tobacco price index for the person's state
AGE	hgage	age as at 30 June each year
AGESQ	-	square of AGE
FAMINC	hifdip,hifdin	real family income in '0,000s of constant 2002 dollars
FAMINCSQ	-	square of FAMINC
YN	wave	=1 if year $\geq 200N$; eg Y4=1 if surveyed in 2004 or 2005
Abbreviated state names	hhstate	=1 if resides in that state or territory; for example, WA=1 if the person lives in Western Australia
NT*Y3	-	NT·Y3 or Nothern Territory's regulatory intervention in 2003; other policy variables are defined similarly

(a) Variables in the HILDA dataset on which the defined variables are based.

Table 5: Summary statistics

	Estimation Sample 1[(a)]				Estimation Sample 2[(b)]			
Name	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
SMOKE	0.233	0.423	0.000	1.000	0.211	0.408	0.000	1.000
QTTY[(c)]	82.248	71.580	1.000	1200.000	84.058	70.637	1.000	600.000
LN(QTTY)[(c)]	3.863	1.286	0.000	7.090	3.887	1.299	0.000	6.397
FMSIZ	2.892	1.452	1.000	13.000	2.828	1.421	1.000	13.000
LN(PRICE)	5.892	0.041	5.791	5.952	5.892	0.042	5.791	5.952
AGE	43.744	17.717	15.000	93.000	45.899	16.605	15.000	93.000
FAMINC	5.596	4.229	-65.650	46.815	5.557	4.121	-65.650	46.815

Estimation Sample 1[(a)(d)]				Estimation Sample 2[(b)(d)]			
Name	Mean	Name	Mean	Name	Mean	Name	Mean
MJURBAN	0.604	PHYACT	0.730	MJURBAN	0.602	PHYACT	0.735
RURAL	0.125	CLUB	0.399	RURAL	0.127	CLUB	0.412
MALE	0.470	SOCWK	0.305	MALE	0.460	SOCWK	0.283
INDIG	0.017	DRINK	0.834	INDIG	0.014	DRINK	0.847
EMP	0.639	Y3	0.749	EMP	0.646	Y3	0.750
UNEMP	0.034	Y4	0.494	UNEMP	0.025	Y4	0.500
HOSP	0.041	Y5	0.246	HOSP	0.037	Y5	0.250
MARRIED	0.633	NSW	0.297	MARRIED	0.681	NSW	0.290
DIVORCED	0.091	QLD	0.203	DIVORCED	0.096	QLD	0.207
WIDOWED	0.048	SA	0.095	WIDOWED	0.046	SA	0.094
PSTUGRD	0.077	WA	0.099	PSTUGRD	0.089	WA	0.099
UGRD	0.122	TAS	0.033	UGRD	0.131	TAS	0.036
YR11	0.372	NT	0.006	YR11	0.346	NT	0.006
LFDIS	0.014	ACT	0.020	LFDIS	0.012	ACT	0.021
LFSAT	0.872			LFSAT	0.882		

(a) No. of observations = 44,654 ; No. of individuals = 15,007
(b) No. of observations = 28,634 ; No. of individuals = 7,169
(c) Summary statistics are calculated over observations with positive consumption in each estimation sample.
(d) All listed variables are binary.

VI. EMPIRICAL FINDINGS

BASELINE CROSS SECTIONAL RESULTS

Table 6 presents the baseline model and its GLM extension. Column (1) lists probit estimates for the participation equation. (2) reports OLS estimates for the conditional log demand equation; the Breusch-Pagan test rejects the null of homosekdasticity at the 1% level and the smearing estimate has a size of 1.672. (3) reports the log of the expected conditional demand, as estimated by the GLM; since the modified Park test yields $\hat{\lambda}_1$ = 1.3 regardless of initial variance functions, the Poisson distribution has been chosen. Suppressed coefficient estimates can be found in Appendix 2. As presented in Table 7, the baseline probit model correctly classifies 72.44% of smokers and 61.41% of non-smokers using the 23-77 criterion that has been chosen to reflect the low sample mean of SMOKE.

Three key findings emerge from the analysis. First, the probit estimates confirm the previous finding by Buddelmeyer and Wilkins (2005) that the Australian smoking bans in 2003 had a statistically insignificant impact on the decision to smoke. The same is the case with additional smoking bans unique to this study, regardless of the relative levels of stringency. Second, as discussed previously, several US-based studies conclude that smoking bans affect the intensity of smoking even when they have no impact on the decision to smoke. The OLS and GLM estimates, however, indicate that the results cannot be generalised to Australia. Finally, the policy coefficient estimates tend to have practically negligible magnitudes and inconsistent signs across regressions. Contextual considerations do not lend support to the effectiveness of smoking bans either. New South Wales' intervention in 2004 (NSW*Y4) was the second phase of an industrial agreement in 2003 (NSW*Y3) and the coefficients on the two variables need to be added up within each column to obtain the overall impact of this policy change. As a result, Western Australia's legislation in 2005 (WA*Y5) is the only regulation which is found to have negative signs across all regressions. It was, however, the least extensive intervention under consideration, prohibiting smoking within a metre of bars and five metres of government buildings. The remainder of this subsection elaborates on the results reported in Table 6.

Table 6: Selected cross sectional analysis results[(a)]

	Participation	Conditional demand	
	Probit	OLS	GLM
	(1)[(b)]	(2)[(c)]	(3)[(d)]
MALE	0.226***(0.014)	0.234***(0.026)	0.208***(0.0173)
HOSP	0.101***(0.033)	-0.129**(0.054)	-0.105***(0.0385)
AGE	0.047***(0.003)	0.065***(0.005)	0.052***(0.003)
AGESQ[(e)]	-0.001***(0.000)	-0.001***(0.000)	-0.001***(0.000)
FAMINC	-0.020***(0.003)	-0.013***(0.005)	-0.005*(0.003)
FAMINCSQ[(f)]	0.000***(0.000)	-0.000(0.000)	-0.000(0.000)
NSW	0.031(0.100)	0.170(0.176)	0.069(0.116)
QLD	-0.001(0.043)	0.251***(0.078)	0.203***(0.051)
SA	0.043(0.030)	0.184***(0.051)	0.083**(0.035)
WA	0.047(0.208)	0.235(0.378)	0.056(0.247)
TAS	0.293(0.223)	0.319(0.402)	0.093(0.264)
NT	0.288(0.214)	0.539*(0.302)	0.136(0.216)
ACT	-0.207*(0.115)	0.201(0.210)	0.136(0.141)
Y3	-0.040(0.034)	-0.071(0.058)	-0.060(0.041)
Y4	-0.023(0.043)	-0.016(0.077)	0.021(0.049)
Y5	-0.010(0.048)	-0.021(0.090)	-0.037(0.059)
NT*Y3	-0.164(0.204)	-0.165(0.284)	0.192(0.191)
NSW*Y3	0.020(0.052)	0.021(0.095)	0.044(0.062)
NSW*Y4	-0.006(0.047)	-0.057(0.083)	-0.083(0.056)
SA*Y5	-0.043(0.063)	-0.046(0.112)	0.018(0.071)
QLD*Y5	0.002(0.047)	-0.006(0.081)	-0.008(0.055)
TAS*Y5	0.091(0.104)	0.043(0.166)	0.022(0.110)
WA*Y5	-0.017(0.096)	-0.063(0.179)	-0.063(0.117)
NSW*Y5	-0.009(0.051)	-0.058(0.094)	0.016(0.064)
Constant	-10.53(12.71)	-4.156(23.06)	4.803(15.00)
Observations	44654	10133	10133

(a) Other coefficients can be found in Appendix 2. ***, **, * indicates statistical significance at 1, 5, 10% levels.
(b) Standard errors in parentheses. Coefficients on probit index. Pseudo-R^2 = 0.111, Log-likelihood = -21571.
(c) Heteroskedasticity-robust standard errors in parentheses. Coefficients on E(ln(QTTY)). R^2 = 0.103.
(d) Sandwich standard errors in parentheses. Coefficients on ln(E(QTTY)). Log pseudo-likelihood = -297722.
(e) Actual entries are -0.00072(0.00003), -0.00062(0.00005) and -0.00051(0.00004) in (1), (2) and (3), respectively.
(f) Actual entries are 0.00030(0.00008), -0.00018(0.00016), and -0.00015(0.00009) in (1), (2) and (3), respectively.

Table 7: Prediction successes from Table 6 (1) using 23:77 criterion

	Actual		
Predicted	1	0	Total
1	7,544	13,212	20,756
0	2,870	21,028	23,898
Total	10,414	34,240	44,654

% of 1s correctly predicted	72.44%
% of 0s correctly predicted	61.41%
% of SMOKE correctly predicted	63.99%

In all columns, the eight policy variables are insignificant at any conventional level, both individually and jointly, while the seven state dummies are jointly significant at the 1% level. Statistical insignificance is not likely to be a consequence of insufficient variations in the policy variables. Working in the hospitality sector (HOSP) has a statistically significant impact at the 1% level across columns, despite its low sample mean of 0.0408, and confirms public health experts' concern that the hospitality workers are more likely to participate in smoking.

To facilitate a discussion of practical significance, marginal effects of covariates on expected outcome variables have been calculated. Given the statistical imprecision, the cumbersome procedure of calculating the average of treatment effects across observations has been avoided. Instead, the policy effects and other selected marginal effects have been evaluated at the typical values of explanatory variables in the sample. A reference individual for this analysis is described as: a 44-year old married woman living in a major urban area in Victoria at 2002, in a family of three earning $56,000 per year, employed, satisfied with life, doing physical exercise, drinking, and facing the log real cigarette price of 5.892. For this reference individual, the marginal effects of the reported personal characteristics are reported in Table 8. The policy impact *at the time of treatment* is reported in Table 9. NT*Y3 and WA*Y5 have been chosen because they can be viewed as the more practically relevant cases, the former in terms of economic significance and the latter in terms of consistent signs.

Table 8 indicates that initial theoretical concerns notwithstanding, inferences from log-linear and GLM estimates are similar. Indeed the conditional demand of the reference individual predicted by OLS and GLM estimates are 65.79 and 70.11 cigarettes per week, respectively. This contrasts with Tauras (2005) whose comparative analysis shows a substantial retransformation bias in the US tobacco consumption data.

The economic significance of WA*Y5 is rather trivial. The impact of NT*Y3 on the participation and the conditional demand is considerable, even though its sign in the GLM equation is counterintuitive. Even after abstracting from statistical imprecision which does not warrant much confidence in the point estimates, the results must be interpreted with caution; NT*Y3 included the formalisation of workplace smoking bans, not only public place bans. Coincidently, NT*Y3's point estimates in the first two columns are similar to what Evans et al. (1999) found in a study of US workplace smoking bans, -5.7 percentage point reduction in participation and 17.5 fewer cigarettes smoked per week.

Table 8: Effects of covariates on expected outcomes

	Participation[a]	**Conditional Demand**[b]	
	Probit E(SMOKE=1)	OLS E(QTTY|QTTY>0)	GLM E(QTTY|QTTY>0)
MALE	0.073	17.346	16.209
HOSP	0.031	-7.963	-6.988
FMINC	-0.005	-0.998	-0.467
AGE	-0.005	0.675	0.497

(a) Changes in the predicted probability of smoking. The base probability = 0.226.
(b) Changes in the predicted number of cigarettes smoked per week by a smoker.
The base conditional demand is 65.793 for OLS and 70.106 for GLM.

Table 9: Effects of smoking bans on expected outcomes

	Participation[a]	**Conditional Demand**[b]	
	Probit E(SMOKE=1)	OLS E(QTTY|QTTY>0)	GLM E(QTTY|QTTY>0)
NT*Y3	-0.057	-19.206	15.427
WA*Y5	-0.006	-6.337	-4.459

(a) Changes in the predicted probability of smoking
(b) Changes in the predicted number of cigarettes smoked per week by a smoker

CORRELATED RANDOM-EFFECTS RESULTS

Table 10 reports estimates from correlated random-effects probit and GLS, where individual heterogeneity is assumed to be linearly related to the within-individual averages of time-varying regressors. Suppressed coefficients are reported in Appendix 5.

In brief, the use of alternative estimators does not alter the main conclusion that there is insufficient evidence to endorse the effectiveness of smoking bans.

In both regressions the time-demeaned averages are jointly significant at the 1% level, rejecting the null of strict exogeneity. The correlated random-effects 2PM has been estimated over the restricted sample of individuals as described in 5.3. When the baseline 2PM was estimated over the same restricted sample, no qualitative change occurred and any difference to be discussed below is not a consequence of using a different sample.

As previously, the eight policy variables are jointly insignificant at any level in both columns. All individual policy effects have been imprecisely estimated in the participation equation. Furthermore, no policy intervention has the expected sign, except for Queensland's regulation in 2005 (QLD*Y5) which is practically negligible (Table 1 indicates that NSW*Y5 cannot be viewed independently from the previous two changes in the same state). The negative and economically significant coefficient on NT*Y3 from the pooled probit appears fragile.

In the conditional demand equation, QLD*Y5 is statistically significant at the 5% level and considerable in magnitude. It also has a negative sign as it does in columns (2) and (3) of Table 6. While this policy intervention had a greater coverage than most others by imposing smoking bans at several selected outdoor areas overemphasis on its statistical significance is not warranted, given that the regression includes a larger number of variables than previously and no other policy coefficient is close to being even marginally significant. Other practically non-trivial interventions with expected signs include NT*Y3 and WA*Y5, same as in the pooled log-linear conditional demand.

For the same reference individual as in 6.3 and each of the three interventions, the policy impact at the time of treatment has been calculated. The smearing estimate is 1.933. The estimated effects of NT*Y3 and WA*Y5 are very similar to the pooled results: 17.0148 and 6.8264 fewer cigarettes smoked per week, respectively. The impact of QLD*Y5 is estimated to be 10.0534 fewer cigarettes smoked.

Table 10: Selected Correlated Random-Effects Analysis Results[a]

	Participation	Conditional demand
	RE Probit	RE GLS
	(1)[b]	(2)[c]
MALE	0.873***(0.110)	0.265***(0.0637)
HOSP	-0.162(0.167)	-0.040(0.082)
AGE	0.133***(0.024)	0.066***(0.011)
AGESQ[e]	-0.002***(0.000)	-0.001***(0.000)
FAMINC	0.031**(0.015)	0.0013(0.004)
FAMINCSQ[f]	-0.000(0.000)	-0.000***(0.000)
Y3	-0.236**(0.096)	-0.072*(0.043)
Y4	-0.089(0.121)	-0.015(0.060)
Y5	-0.177(0.135)	0.011(0.067)
NSW	-0.370(0.481)	0.203(0.261)
QLD	-0.694*(0.388)	0.028(0.234)
SA	0.384(0.541)	-0.043(0.271)
WA	0.821(0.790)	0.086(0.483)
TAS	-0.572(0.885)	0.033(0.448)
NT	-0.268(0.900)	0.080(0.445)
ACT	-0.349(0.532)	0.519(0.320)
NT*Y3	0.315(0.585)	-0.197(0.190)
NSW*Y3	0.085(0.149)	0.058(0.073)
NSW*Y4	0.094(0.134)	-0.084(0.062)
SA*Y5	0.146(0.169)	-0.095(0.084)
QLD*Y5	-0.069(0.132)	-0.156**(0.064)
TAS*Y5	0.283(0.296)	0.008(0.117)
WA*Y5	0.170(0.270)	-0.118(0.137)
NSW*Y5	-0.048(0.146)	-0.050(0.070)
Constant	-66.81(56.08)	-3.341(43.76)
Observations	28634	5898
Individuals	7169	1865
σ_c[d]	4.812	1.142
σ_e[d]	1	0.689

(a) Other coefficients can be found in Appendix 5. ***, **, * indicates statistical significance at 1, 5, 10% levels.
(b) Standard errors in parentheses. Coefficients on probit index. Log-likelihood =-6809.
(c) Standard errors robust to individual clustering in parentheses. Coefficients on E(ln(QTTY)). Overall R^2 = 0.121.
(d) σ_c denotes model standard deviation due to individual heterogeneity, σ_e due to random error.
(e) Actual entries are -0.00215(0.00029) in (1) and -0.00063(0.00012) in (2).
(f) Actual entries are -0.00010(0.00042) in (1) and -0.00028(0.00010) in (2).

Effects of smoking bans on conditional demand[g]

	NT*Y3	QLD*Y5	WA*Y5
E(QTTY | QTTY>0)	-17.015	-10.053	-6.826

(g) Changes in the number of cigarettes smoked per week by a smoker

ROBUSTNESS CHECKS

To ensure that the reported results are not sensitive to subjective choices made in empirical modelling, several alternative specifications, policy variable definitions and estimation samples have been explored. Some examples include:

- interacting each policy variable with 1) drinking, 2) hospitality employment, and 3) weekly socialising indicators as individuals with these characteristics are more frequently or persistently exposed to public place bans.
- estimating the 2PM separately over males and females since women's smoking rate has been more persistent historically.
- estimating the 2PM separately over different age groups.

A more detailed description is available on request. In brief, none of the resulting changes affect the conclusion and it is illustrative to note that a drastic alternative excluding all policy variables produced qualitatively the same set of coefficients as the baseline model.

VII. CONCLUSION

This paper finds no overall evidence that the smoking bans affected either the decision to smoke or the demand for cigarettes by continuing smokers. A big majority of policy coefficients are found to be negligible, both statistically and practically. While Queensland's smoke-free law in 2005 has a significant effect on the conditional demand in the random-effects regression, the result is not robust to alternative estimation methods. In both cross sectional and panel regressions, Western Australia's regulation in 2005 and Northern Territory's intervention in 2003 are found to have induced continuing smokers to smoke 4~7 and 16~19 fewer cigarettes per week; yet the level of statistical imprecision is too high to warrant any confidence in the point estimates because p-values associated with the two policy variables are well above 0.500. The results from alternative model specifications and sub-sample analysis indicate that no particular population sub-group responded to the new smoking bans. Recall that, if anything, using the HILDA or any standard survey data on smoking overestimates policy effects in the presence of substitution between 'smoky' and 'smokeless' tobacco and between heavier and lighter cigarettes.

To reconcile these findings with results from the United States, it may be useful to consider an underlying policy mechanism. Smoking bans are believed to affect individual smoking behaviour by limiting opportunities to smoke directly and/or changing social norms regarding smoking (Levy and Friend, 2003). Since the direct effects of public place bans are likely to be minimal as people spend only so much time at affected areas, the current analysis can be interpreted as evidence against the latter possibility. Given the definition of the 'regulation index', the variable may have been found statistically significant in several US-based studies entirely because of the effects of worksite bans to which employed individuals are exposed for long duration each day. Yet, a study by Ohsfeldt et al. (1998) finds that the index also has a negative effect on the decision to consume smokeless tobacco which is not directly subject to smoking bans.

It is therefore worth reconsidering Chaloupka's (1992) speculation that 'one unmeasured factor which may be being captured by the law indicators is publicity on the negative health consequences of cigarette smoking which accompanies the passage of a clean indoor air law'. In simple, the introduction of smoking bans affects people's risk perception, rather than social norms. As a natural alternative to the 'regulation index', he defined a group dummy for each possible index point. He found that coefficient sizes were not proportional to regulatory stringency, though all dummies were statistically significant. Coincidently, most of existing US-based studies cover years from the late 1980s to the mid-1990s, when the risks of passive smoking and smoke-related lawsuits were coming to public awareness for the first time. During the period under the current analysis, there was no major update on smoke-related health risks.

VIII. APPENDICES

Appendix 1: ABS price indices per state capital 2002-2005

Tobacco Price Index per State Capital as at September of each year

Year	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Weighted Average of 8 Capital Cities
2002	347.50	362.00	370.20	362.00	327.40	328.10	341.90	346.70	354.00
2003	363.60	376.10	382.20	382.50	343.80	339.20	357.60	362.40	369.50
2004	376.40	391.70	399.40	394.70	352.60	355.40	376.20	375.60	383.10
2005	395.60	408.70	417.00	411.10	362.10	364.10	390.20	388.00	399.60

Consumer Price Index per State Capital as at September of each year

Year	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Weighted Average of 8 Capital Cities
2002	139.60	137.80	139.20	140.30	135.80	137.50	135.40	138.10	138.50
2003	142.40	141.80	143.30	145.40	138.60	141.10	137.80	141.90	142.10
2004	146.20	144.20	146.80	149.00	142.00	145.00	140.80	145.50	145.40
2005	150.50	148.60	150.90	153.40	147.80	150.10	144.70	149.70	149.80

Sources: ABS (2004) and ABS (2005)

Appendix 2: Additional cross sectional analysis results

	Participation	Conditional demand	
	Probit	OLS	GLM
	(1)[(a)]	(2)[(b)]	(3)[(c)]
FMSIZ	-0.066***(0.006)	-0.010(0.010)	-0.008(0.007)
MJURBAN	-0.098***(0.016)	-0.197***(0.028)	-0.110***(0.019)
RURAL	-0.124***(0.024)	-0.136***(0.041)	-0.076***(0.028)
INDG	0.471***(0.048)	0.063(0.062)	0.058(0.060)
EMP	-0.064***(0.019)	-0.025(0.032)	-0.029(0.022)
UNEMP	0.280***(0.038)	0.082(0.053)	0.039(0.040)
MARRIED	-0.020(0.022)	0.049(0.035)	0.024(0.025)
DIVORCED	0.330***(0.030)	0.030(0.045)	0.048(0.031)
WIDOWED	0.215***(0.047)	0.135(0.088)	0.096*(0.056)
PSTUGRD	-0.544*(0.032)	-0.612***(0.082)	-0.410***(0.053)
UGRD	-0.376***(0.024)	-0.438***(0.056)	-0.243***(0.036)
YR11	0.155***(0.016)	0.183***(0.026)	0.097***(0.018)
LFDIS	0.158***(0.057)	0.054(0.080)	0.092*(0.051)
LFSAT	-0.272***(0.021)	-0.166***(0.032)	-0.108***(0.022)
PHYACT	-0.158***(0.016)	-0.180***(0.027)	-0.137***(0.018)
CLUB	-0.204***(0.015)	-0.133***(0.028)	-0.054***(0.018)
SOCWK	0.118***(0.016)	0.113***(0.028)	0.064***(0.019)
DRINK	0.422***(0.021)	-0.056(0.036)	-0.002(0.027)
LN(PRICE)	1.632(2.157)	1.164(3.914)	-0.242(2.546)
Observations	44654	10133	10133

(a) Continued from column (1) of Table 6 : Selected cross sectional analysis results
(b) Continued from column (2) of Table 6 : Selected cross sectional analysis results
(c) Continued from column (3) of Table 6 : Selected cross sectional analysis results

Appendix 3: Additional Correlated Random-Effects Analysis Results[(a)]

	Participation	Conditional demand
	RE Probit	RE GLS
	(1)[(b)]	(2)[(c)]
FMSIZ	-0.158***(0.045)	0.043**(0.021)
MJURBAN	-0.168(0.159)	0.062(0.072)
RURAL	-0.428**(0.175)	-0.025(0.079)
INDG	1.658***(0.480)	0.439***(0.156)
EMP	0.310***(0.100)	0.028(0.048)
UNEMP	0.224(0.148)	-0.034(0.061)
MARRIED	0.094(0.148)	0.047(0.072)
DIVORCED	0.586**(0.231)	0.124(0.107)
WIDOWED	1.714***(0.478)	-0.112(0.210)
PSTUGRD	-0.989**(0.476)	-0.172(0.235)
UGRD	-0.430(0.289)	-0.426**(0.211)
YR11	-0.468**(0.193)	-0.463***(0.106)
LFDIS	0.191(0.201)	-0.051(0.073)
LFSAT	0.013(0.082)	-0.037(0.034)
PHYACT	-0.126**(0.063)	-0.022(0.031)
CLUB	0.015(0.068)	-0.042(0.033)
SOCWK	0.060(0.066)	0.088***(0.030)
DRINK	0.439***(0.116)	0.085(0.059)
LN(PRICE)	5.386(6.074)	0.983(3.009)
Observations	28634	5898
Individuals	7169	1865

(a) Coefficients on time-demeaned averages have been suppressed and are available on request.
(b) Continued from column (1) of Table 10: Selected Correlated Random-Effects Analysis Results
(c) Continued from column (2) of Table 10: Selected Correlated Random-Effects Analysis Results

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