The B.E. Journal of Economic Analysis & Policy

Topics

Volume 4, *Issue* 1 2004 *Article* 30

Global Health Warnings on Tobacco Packaging: Evidence from the Canadian Experiment

Nikolay Gospodinov* Ian J. Irvine†

*Concordia University, Montreal, gospodin@alcor.concordia.ca

†Concordia University, Montreal, ieen@sympatico.ca

Recommended Citation
Nikolay Gospodinov and Ian J. Irvine (2004) "Global Health Warnings on Tobacco Packaging: Evidence from the Canadian Experiment," *The B.E. Journal of Economic Analysis & Policy*: Vol. 4: Iss. 1 (Topics), Article 30.
Available at: http://www.bepress.com/bejeap/topics/vol4/iss1/art30

Global Health Warnings on Tobacco Packaging: Evidence from the Canadian Experiment*

Nikolay Gospodinov and Ian J. Irvine

Abstract

New health warnings on tobacco packaging in Canada became mandatory in January 2001. As of that time producers were required to print large-font warning text and graphic images describing the health consequences of using tobacco. This study uses micro data from two waves of Health Canada's Canadian Tobacco Use Monitoring Surveys bordering the legislation to investigate if the introduction of the warnings had any significant impacts on smokers. The recently drafted Framework Convention on Tobacco Control, under the sponsorship of the World Health Assembly, assigns a central role for this type of message. Our findings indicate that the warnings have not had a discernible impact on smoking prevalence. The evidence of their impact on quantity smoked is positive, though only at a relatively low level of confidence.

KEYWORDS: tobacco, health warnings, smoking

---

*We are grateful to two anonymous referees for valuable comments and suggestions, Shelly Xia for excellent research assistance with the data, to Statistics Canada for their Data Liberation Initiative, which provided us with access to the Canadian Tobacco Use Monitoring Survey files, to Ann Golubowski of Concordia University for guiding us to them, and to Elizabeth Majewski of Statistics Canada for helping us in interpretative issues and for comments on an earlier draft. We are grateful to Brian Krauth for comments on a draft that was presented at the annual meetings of the Canadian Economics Association 2003, and to David and Tina Wolfson. Finally, we thank the Social Sciences and Humanities Research Council of Canada for supporting this research.

1. Introduction

The *World Health Assembly* adopted a *Framework Convention on Tobacco Control* (FCTC) in May 2003 that has as its objective the reduction of smoking worldwide. A key ingredient in this framework is the proposal that all signatory countries will mandate the printing of health warnings on tobacco packaging occupying at least 30 percent of the package space, and preferably 50 percent[1]. This element in the *Framework* was supported and promoted by Canada, which was in the unique position of having had such a measure in operation since the end of 2000.

Despite the support expressed by organizations such as the *Canadian Cancer Society* and *Health Canada* for such warnings, until very recently there was no scientific research on their effectiveness. The evaluation of this policy measure forms the subject matter for this paper. We use individual-level data from the *Canadian Tobacco Use Monitoring Survey* (CTUMS) for the period July 2000 – June 2001 to examine if any changes in consumption have materialized. We are particularly interested in analysing whether the measure may have had differing impacts on the various age groups in the population, and accordingly we disaggregate our findings by age group. We also examine the possible differential impacts of the warnings on prevalence and intensity (consumption per person).

Numerous studies have addressed the effectiveness of tobacco-control and 'messaging' policies in recent decades. A key policy problem is the ability to distinguish between the impact of *particular control measures*, and the impact of *consumption reduction measures in the aggregate*, and this is demonstrated very clearly in two recent papers. Nelson (2003) concluded that advertising bans have had no impact on cigarette consumption, using panel data for a cross-section of countries. Farrelly, Pechacek and Chaloupka (2003) however found that, *in the aggregate*, US tobacco-control government expenditures, measured in both stock and flow form, over the period 1981-2000 have been effective in reducing consumption. Their finding is therefore broadly supportive of the array of measures introduced in states such as Arizona, California, Massachusetts and Oregon. While the latter findings are reassuring to both state governments and policy makers, there remains the challenge of trying to distinguish those specific measures that are effective from those that are not. Given the vast array of controls that are available to governments, and given that such measures may have very different associated costs, it is vital to be able to identify those policies that are most effective. 'Carpet-bombing' as a consumption-reduction strategy

[1] Other provisions include action against smuggling, maintaining prices sufficiently high to discourage consumption, protection from second-hand smoke, etc.

may be resource costly, and in addition leave the government vulnerable to legal action on the part of cigarette manufacturers. Indeed Farrelly *et al.* (2003) indicate that 'unfortunately' they did not have tobacco-control expenditure[2] broken out by type of intervention. Our focus is upon an intervention at a particular point in time that came in the form of adding vivid text and visual image warnings to cigarette packaging. A sample of the images is given at Health Canada's website http://www.hc-sc.gc.ca/english/media/photos/tobacco_labelling/.

While the impact of specific messaging campaigns on consumer behaviour may be unsettled from an econometric standpoint, a considerable body of economic theory has been developed in the last few years that sees a useful role for messaging. In contrast to the rational addiction perspective of Becker and Murphy (1988) or Becker, Grossman and Murphy (1994); Laibson (1997), Gruber and Koszegi (2001), O'Donohue and Rabin (1999) and most recently Bernheim and Rangell (2002) have all independently provided rationales for government intervention in the market for 'sin' goods. Laibson proposes that individuals may systematically undervalue the future; Gruber and Koszegi examine the magnitude of taxes that might be required to correct for such 'internalities'; O'Donohue and Rabin propose that individuals may suffer from projection bias – an inaccurate depiction of their future utility. Bernheim and Rangell adopt a neuropsychological approach in which they propose that the neocortex – the control region or command centre of the brain – may make errors. Accordingly a 'cue' can be a socially productive corrective device. Lastly, recent neurological research on the physical development of the teenage brain (e.g. Strauch, 2003) proposes that it may not be sufficiently stabilized, particularly in the neocortex, for teenagers to make the decisions they would make several years later. Even in models of rational addiction, the implicit ineffectiveness of messaging is conditioned upon an assumption of full information. In each of these perspectives therefore, messages or cues are viewed as a means of potentially securing socially superior outcomes in the consumption of sin goods.

Our paper is developed as follows: in the next section we review briefly the recent trends in smoking in Canada among both adults and youth, and reference the numerous ambiguities that attend the available data and beliefs. We also describe the data used in our research. In the subsequent section we summarize the work that supported the health warning initiative in Canada. Finally we present and discuss our findings based on the estimation of prevalence and quantity consumed models. Our conclusion is twofold: first the *Health Canada/Statistics Canada* data do not indicate that prevalence declined in a significant manner following the

[2] See their paper, page 849.

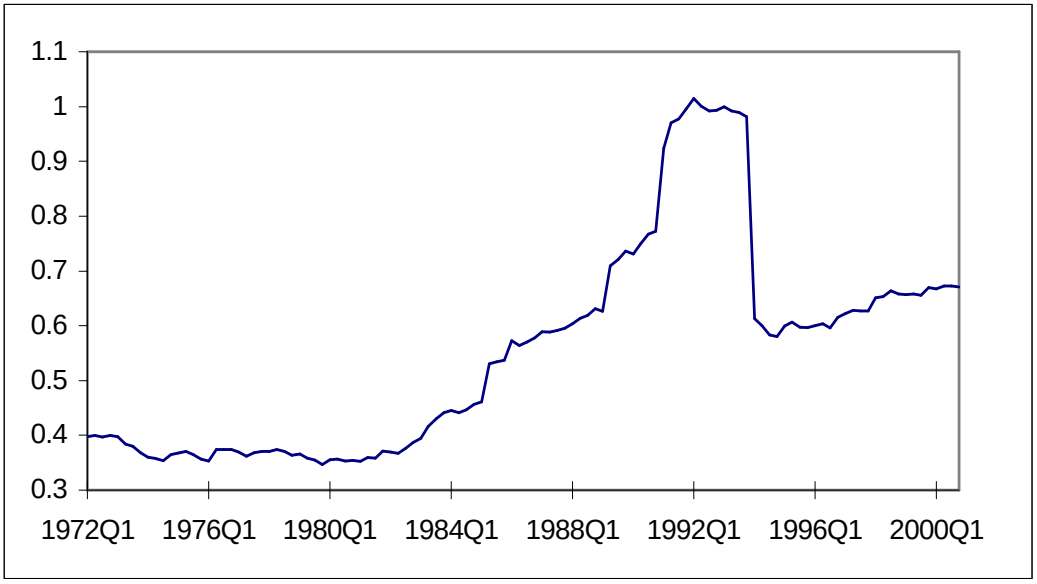
introduction of the health warnings. Second, and in contrast, a substantial decline in intensity is observable, although it is significant at a relatively low confidence level.

2. The economic and policy environment in Canada

2.1 Interpreting recent trends

Taxation policy in Canada since the late nineteen eighties, as it has pertained to tobacco, has been somewhat chaotic. The enormous variation in tax levels at different points in time and across provinces is well documented and is not of prime interest to us here[3].

Figure 1. Real price of cigarettes in Canada.



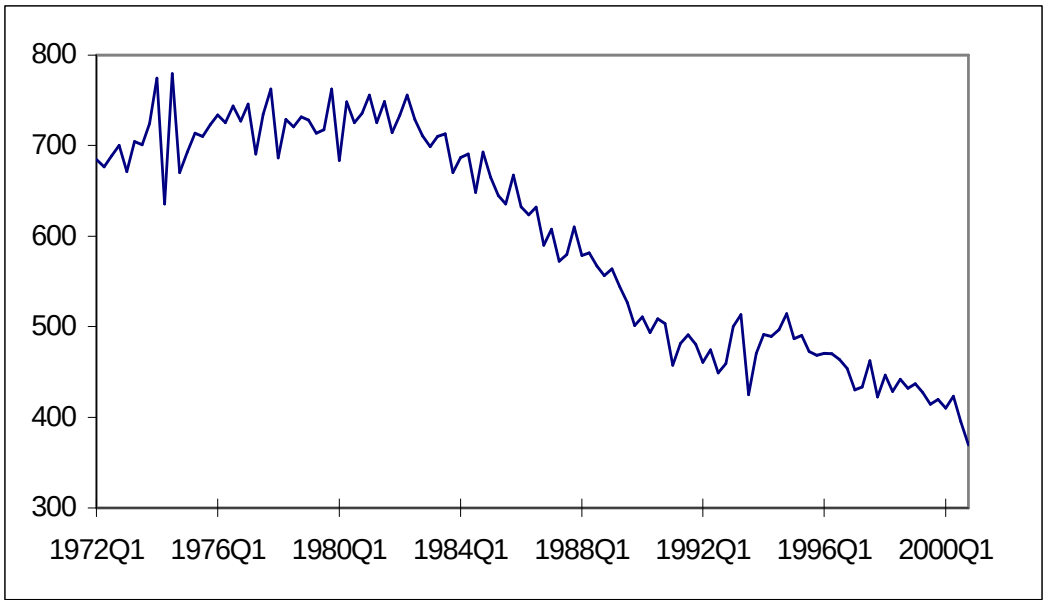
Source: Canadian Socio-economic Information and Management Database (CANSIM).

In contrast, on the regulation side, all levels of government have progressively implemented legislation that has restricted both the use of tobacco and the ability of tobacco manufacturers to market their products through sponsorship and advertising. This has come in the form of limitations on smoking in public places, in work environments, in restaurants and bars, school environs etc. Numerous legal battles have been fought on the constitutionality of these measures, with the tobacco industry arguing that specific elements of this program were ineffective

[3] Most of the price variation is due to tax policy and is illustrated in figure 1.

and also infringed upon their freedom to operate a business. What has emerged over the last two decades, however, is a very strong long-term downward trend in tobacco sales in Canada[4] as indicated in figure 2.

Figure 2. Sales of cigarettes per person in Canada (seasonally adjusted).



Source: Canadian Socio-economic Information and Management Database (CANSIM).

Unlike the clear long-term trend in total sales in Canada, the picture on youth smoking is more complex, and the focus upon youth has been central to the federal government's policy direction in the nineties. Indeed the formation of the continuous tobacco-use surveys now being carried out by *Statistics Canada* for *Health Canada* (CTUMS) was driven in large measure by a concern over youth smoking. The current wisdom is that smoking rates increased in the nineties and only finally began to turn downward at the end of the decade. A similar pattern is observable in the U.S. (Department of Health and Human Services, 2004). This characterization may be too simple however, for a variety of reasons:

- Use patterns for specific age groups must be inferred from surveys rather from total sales data. Surveys on the use of toxic substances suffer from having low response rates, and even then from under-reporting. There are no publicly available longitudinal data at the time of writing.

[4] See also sales figures from Statistics Canada's "The Production and Disposition of Tobacco Products in Canada."

- Unless similar surveys are implemented on a repeated basis, use patterns must be inferred from surveys with differing methodologies, objectives, questionnaires, response rate and rates of under-reporting. In Canada, the use rates from different surveys are frequently non-comparable on account of non-trivial variations in under-reporting rates (Gospodinov & Irvine, 2004)[5]. Therefore the establishment of shorter-term use patterns is problematic. Similar challenges have been described by Pepper (2001) in the interpretation of U.S. data.
- In determining prevalence rates among youth it is necessary to distinguish between the use patterns of different subcategories of user. For example, data from the *Ontario Student Drug Use Survey*[6] indicate that the greater part of the measured reduction in prevalence among teen smokers in the early nineties was in the use rates of twelve and thirteen year olds, who tend to smoke very little, in the face of much more constant rates among older daily teen smokers. Moreover, those grade 7 - 9 students who are more than just samplers tend to smoke less than older students, and therefore there remains greater uncertainty as to whether they will transit to being long-term smokers or not.
- Confidence intervals, as well as reporting rates, may be seriously underestimated in surveys and therefore the comparison of outcomes from adjacent surveys becomes more challenging. For example, since individuals who do respond to surveys typically understate their consumption by 50 percent, then the reported variance may be significantly lower than the true variance of such survey results. Clearly the ability to make comparative statements is compromised.
- Prevalence estimates, if not supported by estimates of amount smoked, may not be reliable predictors of the future behaviour of youth: policy measures may reduce the amount smoked by young smokers without seriously impacting prevalence. But a reduction in the amount smoked among users who are not yet addicted may itself reduce the likelihood of addiction in future time periods. Accordingly, the evaluation of a policy initiative should ideally include an estimate of its impact on quantity consumed in addition to its impact on prevalence.

In the face of these difficulties, and in the absence of longitudinal data, the availability of a series of CTUM survey waves with virtually identical

[5] For example, we have matched sales data with survey results for several years, and it appears that the 1994 Social Survey in Canada and the 1996/97 National Population Health Survey under predict by a smaller amount than several other surveys.
[6] See Adlaf and Paglia (2001).

methodologies, objectives and processing provides a fruitful basis for examining the package-warnings policy intervention.

2.2 Data

The data we use come from the public use files for two waves of the *Statistics Canada/ Health Canada* CTUM survey – one immediately preceding the packaging intervention, one immediately following. The survey has information on a variety of economic, social and demographic covariates, as well as the province of residence and date of interview. We know if the individual is a smoker or not, whether s/he is an occasional or daily smoker, and also how much s/he smoked on each day of the preceding week. This survey is particularly appropriate for our objective, since it over-samples heavily in the lower age groups. Typically, about 25% of each six-month survey wave of 10,000 individuals is for those aged 15-19 and an equal proportion for those aged 20-24. We constructed a dollar price series for tobacco products from the monthly tobacco-price index for each province from CANSIM[7] and dollar prices for cigarettes for November 2001 from the Department of Finance. The presence of province and date variables in the CTUMS data enables us to merge the constructed month- and location-specific tobacco-price series with the survey data.

3. The health warnings

The warnings that currently appear on consumer tobacco packages in Canada are undeniably gruesome. The health warning labels are presented at Health Canada's website http://www.hc-sc.gc.ca/english/media/photos/tobacco_labelling/. They are all characterized by large-font vivid text messages and uncompromising images. Before implementing the warnings *Health Canada* contracted several pieces of research on the most appropriate packaging design. In the Environics studies (1999a,b) individuals were interviewed in 'focus' groups and were questioned on their likely reaction to different messages and graphic images. The reports by Créatec (1999) and Liefeld (1999) are more extensive. The main objective of the Créatec study was to determine the degree to which the size of warnings should have been increased from the then-existing '35% of package area' rule. The report proposed a '50% of area' rule. The Liefeld study used a conjoint method of analysis. This approach attempts to mimic the effect that actual packaging warnings would have on consumers, or potential consumers, through the presentation of a series of pairs of 'whole images' – a combination of

[7] The Canadian Socio-economic Information Management System (CANSIM) II database series V735727 and subsequent series yield the monthly price indices by province for the period in question.

graphic image, message, and font-size/type. Each individual in the study was asked to choose from a series of pairs of packages the ones they found most striking. This *gestalt* process was then disaggregated at the end of the interviews to determine which components of the overall message were key and which were not.

The response of the federal government was to require that manufacturers use an image from those presented at Health Canada's site referenced above in conjunction with large-font warning text that would occupy 50% of the package space. This requirement was perhaps the most ambitious measure contained in the *Tobacco Products Information Regulations* of 2000.

The *Canadian Cancer Society* subsequently commissioned *Environics* to survey Canadians on their reactions to the measures. This survey was done by telephone in September and October 2001, and produced 2,031 usable responses, both smokers and non-smokers, from an initial 40,304 calls[8]. Individuals were asked if they had noted a change in packaging, if they learned anything more about the hazards of smoking, if they had been influenced in their smoking decisions by the presence of the new messages and images, if they were influenced in their attempt to quit, etc. Of those who noticed a change in packaging (62% of the population), about one third felt that they consequently knew either a lot or a little more about the health consequences of smoking; a slightly larger percentage indicated that they were more concerned about the consequences of smoking; 18 % of individuals decided upon one or more occasions not to have a cigarette on account of the messages in an 8-month period; 14 % of people responded that the messages were a major factor in their most recent attempt to quit.

As quantitative assessments of public policy measures, these responses/surveys are of limited value. They fail to provide a quantitative link between the measure and outcomes – in terms of prevalence or conditional quantity smoked. Moreover, it is methodologically more reliable to attempt an observation of actual behavioural responses than to ask the subject for his or her statement of response. Furthermore, data on teens below the age of 18 are not available and, in addition, given the degree of non-response, alternative data sources should be investigated before concluding that the experiment has been successful.

The econometric evidence on the effectiveness of messages/cues is limited. While there exists an enormous literature on the effectiveness of price/taxes as a corrective (see, for example, Gruber and Zinman, 2000), the literature on

[8] The response rate was actually about 1 in 7 once business telephone numbers and other deletions were made from the sample.

regulation, advertising and messaging is less extensive. It also tends to be ambiguous in its findings. In part this is because the impact of some interventions is staggered over time and therefore less easy to identify or isolate (Chaloupka and Warner, 2000, or McGuinness and Cowling, 1975). In contrast, the measure that we investigate is unusually well defined: regulations were implemented on a given date – January 2001, the messages were clear and stark and significantly different from what preceded them, and relatively short time lags can reasonably be anticipated in their likely impact. The effectiveness of such a measure in reducing smoking should be discernible quickly; if consumers can successfully ignore the cue for the first few months of its presence, they will more likely be able to isolate themselves psychologically from it over a longer period. Consequently our focus is upon the five-month period February-June, 2001, which we compare with the period July-December, 2000, while controlling for price changes faced by consumers. We recognize that our tests are strongly conditioned on the timing mechanism. Indeed some psychologists have proposed that interventions initially may simply invoke a period of contemplation, which only subsequently leads to the taking of an action and, perhaps, reaction (for example, Prochaska and DiClemencente, 1983). While our results cannot rule out such lagged impacts, we believe that it would be inaccurate to portray smokers as only entering a state of contemplation on a quit decision when confronted with a particular message in the modern era. Smoking surveys indicate that large percentages of the smoking population are in a constant state of quit contemplation. The real issue is not whether they can begin to think about quitting, it is whether they can be triggered into a state of action.

At the present time there appears to be just one scientific study on the impact of the warnings. Hammond *et al* (2003, 2004) use data from a survey of 413 adults, and conclude that individuals who processed the warnings in depth, or in whom the warnings induced a degree of fear, were more likely to quit, attempt to quit, or reduce consumption than individuals who were less affected by the warnings.

4. Results

4.1 Data samples and variables

The data from the July-December 2000 and the February-June 2001 waves of the CTUM survey were first merged. We then deleted observations where answers to key questions were not recorded. This resulted in a loss in sample size of approximately 2.5%, leaving us with 20,176 individuals, of whom 15,062 are non-smokers. Smokers in this sample are both daily and occasional. One important variable had a significant number of non-responses among this reduced population – income of the household in which the respondent resided. Rather

than delete these records, we imputed[9] the missing values using the weighted hot-deck imputation method[10] (Rubin and Schenker, 1986).

A dollar price series for tobacco products was then merged on a month/location correspondence. We decided against using a set of province-of-residence fixed-effect variables in the main set of results, although we also report on the impact of including such identifiers. While cultural factors that are region-specific may be important, two factors mitigate against their inclusion: first, most of the variation in the price series in this short time period is across regions, and therefore there is a very strong degree of collinearity between the price series and the province dummy variables. But price is a policy variable and it is important to be able to estimate the sensitivity of use to variations in this variable. In the second instance, it is well known that certain identifiable ethnic and language groups have lower smoking propensities than others. For example, until very recently, Quebec (a predominantly francophone province) had the highest smoking rates of all provinces. In addition, the waves of immigrants coming to Canada since the nineteen seventies have been predominantly non-European, and have much lower smoking rates than Canada's European stock. But since these immigrants (and, to a much lesser degree, francophones) are spread throughout the provinces, the language spoken in the household provides a very precise measure of ethnicity and therefore social custom. Accordingly this variable is included in our regressions.

The age variable is augmented by a second series of student variables in our regressions. Students in a given age group tend to be different from non-students in that same group. For example it is well known that high-school dropouts have higher rates of tobacco use than those who stay in school. The youngest three age groups (15-17, 18-19, 20-24) therefore have an additional student identifier dummy variable.

The average smoking prevalence rates and weekly consumption per person in the sample by different (gender, language, education, age and income) groups and time (before and after the introduction of health warnings) periods are reported in table 1. The unconditional analysis reveals a reduction in the quantity smoked for

[9] In an earlier version, we treated the group for whom income data were missing as a separate group by defining a dummy variable for households falling into this class. The numerical results are very similar to those presented below.

[10] This procedure matches the individuals with missing income data to the respondents using several socio- demographic characteristics such age, occupation, education, gender, province and area (large metropolitan or not) of residence, language spoken at home etc. and then randomly selects observed values from the matching group using the weighted Bayesian bootstrap (Rubin and Schenker, 1986).

all groups (except the 55-64 age group). The prevalence rates have also changed, though less convincingly. The next sections investigate if these reductions are statistically significant and if they result from the introduction of the health warnings in 2001. An alternative interpretation of the data is that the very substantive tax-induced price increases in the Spring of 2001 may account for a sizable part of the observed reductions.

Table 1: Average prevalence (in %) and weekly consumption (# of cigarettes per person) by groups.

	Year 2000			Year 2001		
	# obs.	**prevalence**	**quantity**	**# obs.**	**prevalence**	**quantity**
Whole sample	9729	25.0 (0.9)	24.2 (1.1)	10447	23.4 (0.9)	22.1 (1.1)
Male	4512	25.4 (1.3)	28.4 (1.9)	4824	25.0 (1.3)	26.4 (1.8)
Female	5217	24.7 (1.3)	20.1 (1.3)	5623	21.8 (1.2)	17.9 (1.3)
Language Eng	8024	24.7 (1.1)	22.8 (1.2)	8689	24.1 (1.1)	22.0 (1.3)
Language Fr	1186	28.3 (2.0)	31.0 (2.9)	1195	25.7 (1.9)	27.2 (2.6)
Eng & Fr	113	38.1 (8.2)	50.8 (17)	110	17.2 (5.5)	19.4 (7.5)
Lang other	406	15.8 (3.4)	10.9 (4.1)	453	13.3 (2.9)	10.0 (2.6)
Educ< h school	3207	29.2 (1.9)	31.9 (2.8)	3611	27.3 (1.7)	30.3 (2.7)
Educ h school	4248	28.6 (1.4)	26.7 (1.7)	4421	25.9 (1.4)	24.0 (1.7)
Educ college	1052	25.8 (2.7)	22.8 (2.9)	1183	23.2 (2.5)	18.6 (2.5)
Educ university	1222	12.6 (1.5)	11.8 (2.1)	1232	13.6 (1.7)	10.9 (1.7)
Age 15-17	1613	19.8 (1.8)	12.0 (1.6)	1822	19.1 (1.6)	10.9 (1.7)
Age 18-19	1026	31.2 (2.4)	22.2 (2.3)	1053	30.5 (2.5)	21.8 (2.3)
Age 20-24	2183	32.0 (1.6)	26.0 (1.7)	2338	34.0 (1.7)	24.2 (1.6)
Age 25-34	982	29.0 (2.4)	27.0 (2.7)	1086	26.2 (2.4)	22.7 (2.6)
Age 35-44	1259	32.3 (2.3)	32.9 (2.9)	1337	26.0 (2.1)	27.2 (2.8)
Age 45-54	1008	23.8 (2.3)	26.3 (3.1)	1092	24.8 (2.4)	25.5 (2.9)
Age 55-64	707	18.0 (2.6)	20.2 (3.9)	727	17.7 (2.6)	22.4 (4.0)
Age >64	951	11.9 (2.0)	11.6 (2.1)	992	12.2 (1.9)	12.0 (2.6)
Inc low	1703	33.3 (2.5)	30.2 (2.8)	1831	30.0 (2.3)	28.6 (2.7)
Inc low-middle	2257	32.0 (2.1)	34.7 (2.9)	2521	27.0 (1.8)	27.9 (2.7)
Inc middle	1254	27.4 (2.5)	22.7 (2.6)	1384	20.4 (2.2)	21.2 (2.9)
Inc mid-high	563	22.8 (3.2)	20.8 (3.1)	685	22.3 (3.1)	17.8 (2.9)
Inc high	435	15.6 (2.7)	17.2 (3.2)	607	21.9 (3.2)	19.4 (3.5)
Inc unrecorded	3517	18.0 (1.4)	17.1 (1.8)	3419	20.3 (1.6)	17.7 (1.9)

Note: Robust standard errors in parentheses.

For estimation of the smoking prevalence and quantity-consumed equations, we employ the two-part model of Cragg (1971). For a recent application of this model to the effectiveness of some price measures on youth smoking, see Ross and Chaloupka (2003). The first part of the model (smoking participation decision) is estimated by Probit and then the demand equation for smokers is

estimated by an OLS regression of the log of number of cigarettes smoked per week on various determinants. The model is estimated on the pooled 2000-2001 data[11] with a weighting scheme that accounts for the stratified nature of the sample.

4.2 Results on smoking prevalence

The first set of results is based on the Probit estimator and the coefficients presented in table 2 are the marginal effects on the response probability and their standard errors. To test the hypothesis that smoking declined between the two periods as a result of introducing the health warnings, we include a 'year/warnings' dummy variable, taking a value of zero in the first period and a value of one in the second. If smoking prevalence indeed declined we anticipate a negative sign for this variable.

Three broad conclusions emerge from this first estimation: socio-demographic variables are highly significant as a group; the price variable is significant, and the warnings variable is not significant.

The socio-demographic variables indicate that more education, higher income, and a language other than French or English[12] define individuals who are less likely to smoke. The negative signs on the student/age variables likewise indicate that individuals in the younger age groups who attend school are less likely to smoke. It is notable that the household income variable has separate explanatory power beyond the education variable, indicating that social background has an effect independent of the level of education. Smoking clearly decreases among the older age groups (in part because some of the heavy smokers die before reaching old age). The insignificant value on the sex variable indicates that smoking prevalence rates for males and females have converged in the modern era. The negative sign on the 'large metropolitan area' variable is consistent with a pattern

[11] In an earlier version of the paper, we also estimated the prevalence and intensity equations separately using Probit and Tobit estimators. It is well known that the properties of the Probit and Tobit estimators are sensitive to the strict parametric conditions that these models impose on the data. Consistent estimation can be obtained under weaker assumptions such as quantile independence which also allows for heteroskedasticity of unknown form. Results from binary (maximum score and smoothed maximum score of Manski, 1975; Horowitz, 1992; and Kordas, 2002), Tobit and censored (Powell, 1986; Buchinsky and Hahn, 1998) quantile estimation of the prevalence and quantity models are available from the authors upon request.

[12] The language result is consistent with the well-recognized smoking patterns among different ethnic groups: those of Asian, African and Caribbean origin have smoking prevalence rates of less than half those of Northern European origin (*Health Canada*, 1999).

of lower rates in large urban areas, although it is insignificant. The household size variable is picking up the effects of the presence of a spouse and children. We ran the model with a series of family-type dummy variables included, but observed that household size, as a continuous variable, was picking up essentially all of the explanatory power of different family structures.

The price coefficient is significant and its magnitude implies that the participation (prevalence) price elasticity is about -0.57[13]. A substantial body of work on price responsiveness continues to appear. For example, Ross and Chaloupka (2003) find significant price effects, while DeCicca *et al*. (2002) are more sceptical. The latter estimate the impact of price in an age-of-commencement model for youth, as do Kidd and Hopkins (2004), Forster and Jones (2001) and Douglas and Hariharan (1994), with similar outcomes. In this context, our price estimate is consistent with the available evidence from the cross-section, and is a little higher than the time-series estimates (see Gruber et al, 2004, for example).

The one policy measure that appears to be insignificant at this point is the year/warnings dummy. While it is negative, it is not significant and therefore the hypothesis that smoking rates remained the same over the period cannot be rejected on the basis of this specification and this set of results.

[13] After reestimating the model with provincial dummies included, the price effect becomes less significant (t-statistics of –1.67). This is as we anticipated, because much of the price variation in this short time period is cross-sectional. It is also to be noted that the case for introducing fixed effects to a Canadian data base is less convincing than for a US data base: De Cicca *et al*. (2002) point out that market prices (tax inclusive) may be endogenous in some US states. For example, tobacco-producing states, such as Virginia, the Carolinas or Kentucky, may be less inclined to impose excise taxes than more health conscious states such as Oregon or Massachusetts. Consequently, the tax-inclusive price differentials may be picking up unmeasured effects. But Canada has no tobacco-producing provinces, and we believe that cultural effects are well measured by the language variable that we include in our basic specification. In the model with fixed effects, the warnings dummy variable remained insignificant.

Table 2: Results on smoking prevalence and intensity (weekly consumption).

	Smoking Prevalence				Smoking Intensity			
	M Effect	SE	95% CI		M Effect	SE	95% CI	
Warnings dummy	-0.0034	0.013	-0.029	0.021	-2.160	1.50	-5.09	0.790
Large metro area	-0.0047	0.013	-0.029	0.021	-1.356	1.48	-4.18	1.667
Male	0.0195	0.012	-0.005	0.044	6.539	1.16	4.31	8.872
Language Eng	-0.0198	0.053	-0.120	0.084	-4.982	6.83	-16.23	9.765
Language Fr	-0.0273	0.050	-0.138	0.058	-3.431	5.48	-14.52	6.681
Eng & Fr								
Lang Other	-0.1264	0.043	-0.227	-0.061	-23.15	4.96	-33.76	-14.48
Educ< h school	0.2349	0.023	0.188	0.279	30.20	2.44	25.28	34.73
Educ h school	0.1564	0.020	0.118	0.196	18.94	1.96	15.13	22.74
Educ college	0.1205	0.029	0.064	0.178	17.03	3.34	10.04	23.34
Educ univ								
Inc low	0.0613	0.026	0.009	0.109	8.898	2.81	3.35	14.34
Inc low-middle	0.0585	0.024	0.010	0.105	6.534	2.65	1.27	11.62
Inc middle	0.0191	0.026	-0.035	0.067	3.297	2.99	-2.70	8.949
Inc mid-high	0.0263	0.030	-0.034	0.082	2.231	3.47	-4.93	8.864
Inc high								
Age 15-17	0.1730	0.035	0.102	0.241	7.722	4.12	-0.42	15.72
Age 18-19	0.3013	0.032	0.237	0.363	22.61	3.21	16.15	28.79
Age 20-24	0.2898	0.027	0.236	0.342	23.05	2.81	17.47	28.51
Age 25-34	0.2987	0.031	0.239	0.361	27.16	3.18	20.75	33.27
Age 35-44	0.3053	0.031	0.245	0.365	31.88	3.04	25.83	37.64
Age 45-54	0.2489	0.032	0.187	0.311	27.34	3.35	20.76	33.69
Age 55-64	0.1261	0.034	0.057	0.192	16.66	3.78	9.21	23.77
Age >64								
(Age15-17)*stud	-0.1699	0.050	-0.275	-0.077	-25.27	5.86	-37.00	-14.01
(Age 18-19)*stud	-0.1542	0.037	-0.230	-0.087	-19.08	3.91	-26.99	-11.92
(Age 20-24)*stud	-0.1691	0.026	-0.219	-0.119	-22.79	2.75	-28.03	-17.33
Household size	-0.0232	0.006	-0.034	-0.012	-3.595	0.63	-4.79	-2.307
Price	-0.0037	0.001	-0.006	-0.002	-0.356	0.11	-0.57	-0.160

Note: The omitted category is designated by a zero entry in the table. Each coefficient on a dummy variable is then interpretable as the effect of being in one specific category relative to the omitted category. (x)*(y) denotes the interaction of variables x and y. The reported results are from a two-part model (Cragg, 1971). The smoking prevalence equation is estimated by Probit and the smoking intensity (the log of quantity smoked only for smokers) is estimated by OLS. The predicted values in the smoking intensity equation are retransformed into levels using Duan's (1983) smearing estimator. The reported marginal effects are the averages of the marginal effects at each observation. The marginal effects for dummy variables are computed with the dummy

variable turned on and off. The marginal (interaction) effects for the interaction terms are computed as a double difference (see Ai and Norton, 2003). The marginal effects for the intensity (quantity) equation are averages of the sum of the derivative of probability to smoke multiplied by the conditional expectation of quantity smoked and the derivative of smoking intensity multiplied by probability of smoking. The standard errors and 95% confidence intervals (percentile method) are obtained by bootstrap (data resampling) using 1,999 replications. All computations are performed in GAUSS.

4.3 Results for quantity smoked

Despite the lack of support for the hypothesis that the health warnings reduced prevalence, the warnings may still have been effective if they reduced the quantity of cigarettes smoked by smokers. We have used the same set of explanatory variables as in the prevalence model, and similar coefficient patterns emerge on the individual-specific variables. In addition, the price variable is significant (price elasticity is –0.58), and males smoke significantly more than females. The key warnings variable indicates that the typical quantity consumed fell by slightly more than 2 cigarettes per week as of January 2001. This impact (approximately 9%) is large, but is statistically significant only at a low confidence level.

The econometric results provide us with one explanation for the inability of the warnings dummy to provide a convincing explanation for the reductions observed in the raw data: government tax policy drove up prices in the Spring of 2001, and this explains part of the observed reduction in consumption. Two further qualifications should also be kept in mind: first, there has been a secular decline in smoking during the last two decades in Canada. Gospodinov and Irvine (2004) estimate this to be in excess of 3% per annum. Accordingly, about one and one half of the estimated percentage point decline might be trend. Second, there is a possibility that seasonal variation in consumption is at play. Evans *et al*. (1999) found that workplace bans on smoking have reduced consumption in the US. If the very similar restrictions in Canada have had a comparable impact, this implies that individuals may consume more in the summer/vacation months than in the work months. Since the first wave of the data include the vacation months of July and August, and the second wave covers February-June, it is possible that the observed decline may include a vacation/workplace ban effect. When a sufficient number of waves of this survey become available we will be able to test this hypothesis.

4.4 Youth and non-youth estimates

Our next step was to investigate if the warnings may have been successful in reducing the consumption or prevalence of some specific groups. For example, the low significance on the warnings variable might reflect a successful impact

upon one age group, but not on another. Since tobacco policy in Canada has focussed heavily upon youth in the last decade, an analysis by age group might therefore be enlightening. Moreover, if the warnings were effective in reducing youth prevalence or consumption, but not successful in reducing prevalence or consumption among older age groups, this would still signal a longer-term reduction in smoking with attendant health benefits. Accordingly we re-estimated both the prevalence and quantity equations with a new set of dummy variables involving the interaction of the year/warnings dummy with age groups.

Table 3: Results on smoking prevalence and intensity (weekly consumption) by age groups.

	Smoking Prevalence				**Smoking Intensity**			
	ME	SE	95% CI		ME	SE	95% CI	
Warnings dummy	-0.005	0.011	-0.026	0.018	-2.322	1.375	-4.927	0.457
Large metro area	-0.004	0.013	-0.028	0.022	-1.818	1.469	-4.683	1.190
Male	0.021	0.013	-0.004	0.046	6.402	1.225	4.022	8.866
Language English	-0.025	0.052	-0.121	0.079	-6.199	6.992	-18.07	9.011
Language French	-0.032	0.049	-0.142	0.052	-5.113	5.402	-16.24	4.681
English & French								
Language Other	-0.128	0.040	-0.217	-0.063	-22.80	4.770	-33.56	-14.81
Educ < high school	0.218	0.023	0.170	0.263	27.26	2.439	22.24	31.78
Educ high school	0.160	0.020	0.121	0.200	18.05	1.956	14.27	22.00
Educ college	0.133	0.0283	0.076	0.187	17.08	3.320	10.29	23.34
Educ university								
Inc low	0.063	0.025	0.013	0.113	8.178	2.681	2.640	13.44
Inc low-middle	0.060	0.023	0.014	0.106	6.471	2.530	1.425	11.33
Inc middle	0.017	0.025	-0.035	0.065	3.070	2.878	-2.947	8.690
Inc mid-high	0.029	0.030	-0.030	0.087	2.778	3.362	-3.982	9.269
Inc high								
Age Group 15-19	0.066	0.0230	0.022	0.111	2.560	2.631	-2.687	7.792
Age Group 20-64								
Age Group >64	-0.177	0.014	-0.205	-0.151	-17.33	2.303	-21.94	-12.95
(Age 15-19)*student	-0.172	0.025	-0.221	-0.124	-26.95	3.077	-32.96	-20.88
(Age 15-19)*year	0.005	0.026	-0.045	0.053	0.090	3.113	-5.804	6.126
(Age 64>)*year	0.011	0.027	-0.044	0.063	0.795	4.247	-7.239	9.434
Household size	-0.015	0.006	-0.026	-0.004	-3.344	0.636	-4.560	-2.031
Price	-0.004	0.001	-0.005	-0.002	-0.342	0.108	-0.566	-0.140

Note: See Note to Table 2.

In these regressions we collapsed the age groups into three. The first contains teens aged 15-19, the middle group contains those aged 20-64, and the older group those aged 65 and over[14]. The results from the two-part model, reported in table 3, do not reveal any identifiable age effect of the warnings: in both the prevalence and quantity smoked equations the coefficients on the interaction of age and warnings failed to reach a high level of significance for any group[15].

5. Conclusion

The data we have analyzed provide a limited set of answers to the question we posed at the outset: have the 'heavy-duty' warnings on cigarette packages in Canada had a significant impact on the prevalence or intensity of smoking in the period following their introduction? Our two-part estimator indicates that the answer to the first part of this question is negative – we have not been able to detect any significant prevalence effects, much as the unconditional data suggest.

The advocates of the effectiveness of the warnings point to the decline in prevalence among Canadian youth since the late nineteen nineties. However, this observation should be interpreted with care, since the prevalence patterns for teens are not always mirrored in the behaviour of those in the 20-24 age group.

On the intensity side, there is some evidence that the warnings have been influential, though the level of confidence that can be placed in this assertion is not very high. While the coefficient is large in absolute value, the 95% confidence band includes the zero value. At the same time, if such reductions signal a higher quit probability, as suggested by Falba *et al* (2004), then the longer term impact may be greater than the quantity reduction alone implies.

---

[14] We have also estimated separate models for each age group. This allowed us to be more selective in picking covariates for the different age group models. The model for the young group (age 15-19), for instance, does not include college and university education. Given the interest in the price-responsiveness of youth smoking in the recent literature, some interesting findings emerge about the price sensitivity of the three age groups. The prevalence rate of the young group appears to be the least sensitive to price changes (price elasticity is –0.39 with a t-statistic of -1.56). Similar findings have been reported recently by DeCicca *et al*. (2002). The price elasticity for the middle-aged group is -0.49 and highly significant t-statistic of -2.95). Interestingly, the price-responsiveness of the old group is much larger, -1.07 with a t-statistic of –1.74.

[15] Ai and Norton (2003) argue that the magnitude of the interaction effect does not equal the marginal effect of the interaction term. We computed the interaction effect as suggested in Ai and Norton (2003) and the results confirmed the insignificance of the interaction effects. The t-statistics of the interaction term for the young age group, evaluated at all data points, vary between 0 and 0.25 (0 and 0.13) in the prevalence (intensity) equation and 0.1 and 0.6 (0 and 0.37) in the prevalence (intensity) equation for the old group.

On each front, we suggest that the price increase has played some role, that trend factors are likely important, and that seasonality is an as-yet unexplored possibility. The last-mentioned should be testable with the availability of a sufficient number of CTUM survey waves. It is clearly an important issue in view of the importance assigned to warnings in the *Framework Convention for Tobacco Control*.

We also estimated the models in a way that allowed the impact of the warnings to vary by age group. But we could detect no difference in their impact on the young (age 15-19), the old (age>64) and the others (age 20-64).

The possible asymmetry of the warnings also raises interesting questions about the theory underlying the messaging and cues: our intensity results, mild as they are, suggest that the Viscusi view – according to which individuals are very well informed about the consequences of smoking, and therefore benefit little from further messaging – may not be an adequate description of behaviour. At the same time, if prevalence has not been affected, cue theory, projection theory, hyperbolic discounting and the theory of internality correction derive very limited support from our findings.

6. References

Adlaf, E. and A. Paglia (2001) Drug Use Among Ontario Students: Findings from the Ontario Student Drug Use Survey, 1979-2001. *Centre for Addiction and Mental Health*.

Ai, C. and E. Norton (2003) Interaction Terms in Logit and Probit Models. *Economics Letters*, vol. 80, 123 -129.

Becker, G. and K. Murphy (1988) A Theory of Rational Addiction. *Journal of Political Economy*, vol. 96(4), 675-700.

Becker, G., M. Grossman and K. Murphy (1994) An Empirical Analysis of Cigarette Addiction. *American Economic Review*, vol. 84(3), 396-418.

Bernheim, D. and A. Rangell (2002) Addiction, Cognition and the Visceral Brain. *Stanford University*, Department of Economics Working Paper.

Buchinsky, M. and J. Hahn (1998) An Alternative Estimator for the Censored Quantile Regression Model. *Econometrica*, vol. 66, 653-671.

Chaloupka, F. and K. Warner (2000) The Economics of Smoking. In: Cuyler AJ, Newhouse JP, editors, *Handbook of Health Economics*, Elsevier.

Cragg, J.G. (1971) Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods. *Econometrica*, vol. 39, 829-844.

Créatec, Les Études de Marché (1999) Effects of Increasing the Area Occupied by Health Warnings on Cigarette Packages. Report prepared for *Health Canada*, Office of Tobacco Control. Ottawa.

DeCicca, P., D. Kenkel and A. Mathios (2002) Putting out the Fires:Will Higher Taxes Reduce the Onset of Youth Smoking? *Journal of Political Economy*, vol. 110, 144-169.

Department of Health and Human Services (2004) *Morbidity and Mortality Weekly Report*. Centers for Disease Control and Prevention, June 18.

Douglas, S. and G. Hariharan (1994) The Hazard of Starting Smoking: Estimates from a Split-population Duration Model. *Journal of Health Economics*, vol. 13, 213-230.

Duan, N. (1983) Smearing Estimate: A Nonparametric Retransformation Method. *Journal of American Statistical Association*, vol. 78, 605-610.

Environics Research Group Limited (1999a) Focus Group Report Regarding Messages On Cigarette Package Slides and Flip-Tops.

---------- (1999b) Qualitative (Focus Group) Report Regarding Health Warnings Labels and Images On Cigarette Packages. Final Report to *Health Canada*, Ottawa.

---------- (2001) Evaluation of New Warnings on Cigarette Packages. Prepared for *Canadian Cancer Society*.

Evans, W., M. Farrelly and E. Montgomery (1999) Do Workplace Smoking Bans Reduce Smoking? *American Economic Review*, vol. 89, 728-747.

Falba, T., M. Jofre-Bonet, S. Busch, N. Duchovny and J. Sindelar (2004) Reduction in Quantity Smoked Predicts Future Cessation among Smokers. *Addiction*, vol. 99(1),83-92.

Farrelly, M., T. Pechacek and F. Chaloupka (2003) The Impact of Tobacco Control Program Expenditures on Aggregate Cigarette Sales: 1981-2000. *Journal of Health Economics*, vol. 22, 843-859.

Forster, M. and A. Jones (2001) The Role of Tobacco Taxes in Starting and Quitting Smoking: Duration Analysis of British Data. *Journal of the Royal Statistical Society (Series A)*, vol. 164, 517-547.

Gilmore, J. (2000) Report on Smoking Prevalence in Canada, 1985 to 1999. *Statistics Canada* research report 82F0077XIE, Ottawa.

Gospodinov, N. and I. Irvine (2004) A 'Long March' Perspective on Tobacco Use in Canada. *Canadian Journal of Economics*, forthcoming.

Government of Canada (2001) The National Strategy: Moving Forward - The 2001 Federal Provincial Territorial Progress Report on Tobacco Control, Ottawa.

---------- (2000) Tobacco Products Information Regulations, Ottawa.

Gruber, J. and B. Koszegi (2001) Is Addiction 'Rational'? Theory and Evidence. *Quarterly Journal of Economics*, vol. 116(4), 1261-1303.

Gruber, J., A. Sen and M. Stabile (2004) Estimating Price Elasticities when there is Smuggling: the Sensitivity of Smoking to Price in Canada. *Journal of Health Economics*, forthcoming.

Gruber, J., and J. Zinman (2000) Youth Smoking in the US: Evidence and Implications. *National Bureau of Economic Research*, Working Paper 7781.

Hammond, D., G. Fong, P. McDonald, R. Cameron and K. Brown (2003) Impact of Graphic Canadian Warning Labels on Adult Smoking Behaviour. *Tobacco Control*, vol. 12, 391-395.

---------- (2004) Graphic Canadian Cigarette Warning Labels and Adverse Outcomes: Evidence from Canadian Smokers. *American Journal of Public Health*, vol. 94, 1442-1445.

Health Canada (1999) Towards a Healthy Future: A Study based on the *National Population Health Survey*, Ottawa.

Horowitz, J.L. (1992) A Smoothed Maximum Score Estimator for the Binary Response Model. *Econometrica*, vol. 60, 505-531.

Kidd, M. and S. Hopkins (2004) The Hazards of Starting and Quitting Smoking: Some Australian Evidence. *Economic Record*, vol. 80, 177-192.

Kordas, G. (2002) Smoothed Binary Regression Quantiles. Working paper, University of Pennsylvania.

Laibson, D. (1997) Golden Eggs and Hyperbolic Discounting. *Quarterly Journal of Economics*, vol. 112, 443-77.

Liefeld, J. (1999) The Relative Importance of the Size, Content & Pictures On Cigarette Package Warning Messages. Report prepared for *Health Canada, Office of Tobacco Control*, Ottawa.

Manski, C.F. (1975) Maximum Score Estimation of the Stochastic Utility Model of Choice. *Journal of Econometrics*, vol. 3, 205-228.

McGuinness, T. and K. Cowling (1975) Advertising and the Aggregate Demand for Cigarettes. *European Economic Review*, vol. 6, 311-328.

Nelson, J. (2003) Cigarette Demand, Structural Change, and Advertising Bans: International Evidence, 1970-1995. *Contributions to Economic Analysis*, BEPress, vol. 2, no. 1, article 10.

O' Donohue, T. and M. Rabin (1999) Doing it Now or Later. *American Economic Review*, vol. 89(1), 103-124.

Pepper, J.V. (2001) How Do Response Problems Affect Survey Measurement of Trends in Drug Use? Appendix D in *Informing America's Policy on Illegal Drugs: What We Don't Know Keeps Hurting Us* (C. Manski, J. Pepper, and C. Petrie, eds.). National Academy of Sciences, Washington, D.C., 321-348.

Powell, J.S. (1986) Censored Regression Quantiles. *Journal of Econometrics*, vol. 32, 143-155.

Prochaska, J. and C. DiClemencente (1983) Stages in Processes of Self-change of Smoking: Toward an Integrative Model of Change. *Journal of Consulting and Clinical Psychology*, vol. 3, 520-8.

Ross, H. and F. Chaloupka (2003) The Effect of Cigarette Prices on Youth Smoking. *Health Economics*, vol. 12, 217 -230.

Rubin, D. and N. Schenker (1986) Multiple Imputation for Interval Estimation from Simple Random Samples with Ignorable Nonresponse. *Journal of American Statistical Association*, vol. 81, 366- 374.

Statistics Canada. The Production and Disposition of Tobacco Products in Canada. Ottawa.

Strauch, B. (2003) The Primal Teen. Doubleday, New York.