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Do cigarette prices motivate smokers to quit? New evidence from the ITC survey

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Abstract

Aims—To examine the importance of cigarette prices in influencing smoking cessation and the motivation to quit.

Design—We use longitudinal data from three waves of the International Tobacco Control Policy Evaluation Survey (ITC). The study contrasts smoking cessation and motivation to quit among US and Canadian smokers and evaluates how this relationship is modified by cigarette prices, nicotine dependence and health knowledge. Different price measures are used to understand how the ability to purchase cheaper cigarettes may reduce the influence of prices. Our first model examines whether cigarette prices affect motivation to quit smoking using Generalized Estimating Equations to predict cessation stage and a least squares model to predict the change in cessation stage. The second model evaluates quitting behavior over time. The probability of quitting is estimated with Generalized Estimating Equations and a transition model to account for the 'left-truncation' of the data.

Settings—US and Canada.

Participants—4352 smokers at Wave 1, 2000 smokers completing all three waves.

Measurements—Motivation to quit, cigarette prices, nicotine dependence and health knowledge.

Findings—Smokers living in areas with higher cigarette prices are significantly more motivated to quit. There is limited evidence to suggest that price increases over time may also increase quit motivation. Higher cigarette prices increase the likelihood of actual quitting, with the caveat that results are statistically significant in one out of two models. Access to cheaper cigarette sources does not impede cessation although smokers would respond more aggressively (in terms of cessation) to price increases if cheaper cigarette sources were not available.

Conclusions—This research provides a unique opportunity to study smoking cessation among adult smokers and their response to cigarette prices in a market where they are able to avoid tax

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Declarations of interest

None.

increases by purchasing cigarettes from cheaper sources. Higher cigarette prices appear to be associated with greater motivation to stop smoking, an effect which does not appear to be mitigated by cheaper cigarette sources. The paper supports the use of higher prices as a means of encouraging smoking cessation and motivation to quit.

Keywords

Cessation; longitudinal data; prices; smoking; taxation

INTRODUCTION

Empirical research has established the negative relationship between cigarette prices and consumption. Cigarette demand is lowered through cessation, lower per smoker consumption and reduced initiation, but the relative role of those avenues in reducing cigarette use is less clear. In this paper we investigate the impact of cigarette prices on quitting behavior applying behavioral models and using data from three waves of the International Tobacco Control Policy Evaluation (ITC) survey, conducted in the United States and Canada, taking advantage of both within- and across-countries price variation.

The analysis was motivated by data from wave 1 of the ITC survey that indicated that smoking intensity is associated with the purchasing of cheaper cigarettes (i.e. discounted brands or illicit cigarettes) and that the availability of cheaper cigarettes may inhibit cessation [1]. This paper proposes two questions: will cigarette price differences over time, and across regions, influence (i) quit intentions and/or (ii) quitting behavior? We consider different measures of price which allows us to assess if purchasing cheaper cigarettes inhibits quit intentions or cessation. The uniqueness of this paper lies in the use of longitudinal data that allow us to explore the impact of cigarette prices on smoking behavior over time.

Smoking cessation can be studied within the framework of cigarette demand, where the impact of price on consumption is measured by the price elasticity of demand. Estimates of the price elasticity of demand vary depending on types of data and estimation technique. The current consensus is that price elasticity ranges from −0.3 to −0.5 for adult smokers [2]. Several studies have decomposed the effect of price changes into the effect on smoking prevalence rates and the effect on smoking intensity (the quantity of cigarettes smoked per smoker) [3,4]. Generally, half the decrease in consumption results from reductions in prevalence. This is primarily the result of higher cessation rates, as initiation among adults is rare.

There is less consensus among studies that focus specifically upon smoking cessation. Higher prices increase the likelihood of cessation, but the magnitude of the effect varies as many studies struggle with the lack of suitable data.

Douglas [5] and Forster & Jones [6] used cross-sectional data with retrospective information. Douglas [5] found that current and past prices of cigarettes do not have a statistically significant effect on the probability of cessation but that higher future cigarette prices increase quit rates significantly. Forster & Jones [6] reported that cigarette taxes

impact smoking cessation significantly and that a 5% tax increase would reduce smoking duration by approximately 6–9.5 months. Tauras & Chaloupka [7] employed longitudinal data and found that higher cigarette prices increase quitting among young men and women.

The impact of higher cigarette prices upon smoking behavior can be mitigated by the possibility for smokers to engage in compensating behavior such as brand-switching, opting for alternative sources of cigarettes and participating in sale promotions. Loomis *et al*. [8] found a positive relationship between the share of promotional cigarette sales and US state cigarette tax increases between 1994 and 2004. They estimated that cutting the value of the price promotions by half would result in at least a 3.7% decline in cigarette consumption in 2003.

The method of purchase has gained importance with an increase in price and tax variation across and within US states. Hyland *et al*. [9] found that 34% of adult heavy smokers try to reduce their cost of smoking by purchasing cigarettes from cheaper sources. This was more prevalent among smokers who lived near a state border with a lower excise tax or an Indian reservation.

The use of discount or generic cigarettes in the United States is associated positively with higher average cigarette prices [10], higher smoking intensity [9–11] and lower incomes [9–11]. In addition, one study found that access to low-taxed cigarettes inhibited quit attempts and possibly quit rates [12]. Hyland *et al*. [13] studied the differences in the use of low/untaxed cigarettes in Australia, Canada, the United Kingdom and the United States and found that these are driven most probably by the affordability of cigarettes and by the availability of cheaper cigarette sources. Those who reported purchasing from a low/untaxed source were less likely to make a quit attempt [13].

DATA AND METHODOLOGY

Data came from the ITC survey conducted in the United States and Canada among a nationally representative cohort of adult smokers [14]. We used three waves of the survey collected from October to December 2002 (wave 1), May to August 2003 (wave 2) and June to December 2004 (wave 3).

A total of 4352 smokers completed wave 1, although the sample size for the longitudinal sample was reduced to 2000 smokers due to refusal and inability to trace respondents on follow-up. Retainment in the United States was 62.8% and 59.1% in waves 2 and 3, respectively, while retainment in Canada was significantly higher at 75.8% and 71.2% in waves 2 and 3, respectively. The sample was replenished at each wave using the wave 1 design. Demographic characteristics of the sample are comparable to those from other national representative surveys of smokers. Men represented 53.6% and 54.2% in the United States and Canada at wave 1, while the mean age was 41.1 years in both countries. Of the US sample, 78.3% at wave 1 was ‘white’ while 89.8% of the Canadian sample claimed the same racial status. In the United States, 32.4%, 44.7% and 23.0% of the sample at wave 1 were categorized as having low, moderate and high incomes, respectively, while the corresponding data for Canada were 26.8%, 43.0% and 30.2%, respectively. In terms of education, 38.5%, 48.3% and 13.3% of the US sample at wave 1 were categorized as having

low, moderate and high educations, respectively. Similar statistics in Canada were 26.8%, 43.0% and 30.2%, respectively.

We used wave-specific sampling weights to account for uneven representation in any given age/sex/region group, including attrition between recruitment and the main survey. Longitudinal sampling weights corrected for possible bias due to attrition between waves. These weights are recalibrated so that the distribution of smokers in age/sex groups (and race in the United States) agreed with the distribution of adult smokers in each country at wave 1. Both types of weights are scaled to allow an analysis of a sample pooled across countries, as population sizes (and hence the average weights) differ between countries.

Because weighting will not typically remove all non-response biases, we examined whether attrition was related to smoking behavior in the longitudinal sample. A dichotomous variable indicating if a person participated in all three waves was regressed on a set of independent variables (age, gender, marital status, ethnicity, number of cigarettes smoked and the stage of quit motivation) using a Probit model. We found that attrition in both countries is higher among men and younger respondents, and lower among whites and those who were married, but does not depend upon smoking intensity or quit intentions. As the sampling weights correct for attrition related to socio-demographic characteristics, attrition will not bias our analysis. In addition, large differences in response rates have frequently shown only minor effects on key estimates [15,16].

We classified all wave 1 respondents into one of five categories based on the Stages of Change Model [17,18]. A smoker who is not planning to quit belongs to the pre-contemplation stage; a smoker who plans to quit in the future, or a smoker who does not report quit intentions but had a quit attempt within the last 12 months, is assigned to the contemplation stage; a smoker who plans to quit within the next month and tried to quit within the past 12 months belongs to the preparation stage; a smoker who has quit smoking and remained so for up to 6 months is in the action stage; and a smoker who has quit and remained so for more than 6 months is in the maintenance stage.

The distribution of respondents across the five stages of quit behavior at wave 1 shows 21.0% of respondents in pre-contemplation, 68.1% in contemplation, 8.7% in preparation and 1.4% in action (0.8% are missing; none are in the maintenance stage at wave 1 as all respondents were smokers). A significantly greater number of US smokers are in the pre-contemplation stage and significantly fewer in the contemplation stage than their Canadian counterparts.

Model I

Our first set of models examines whether cigarette prices affect motivation to quit smoking.

We used two measures of the strength of quit behavior. The first collapses the five stages of change described above into three cessation stages, which equals 0 if a smoker is in the pre-contemplation stage (22.0%), 1 if in the contemplation or preparation stages (77.4%) and 2 if in the action or maintenance stages (0.6%). The second measure builds upon the original

five-stage quit variable and equals the difference between cessation stage at wave 3 and wave 1, thus capturing the progress toward cessation over time.

In equation 1 we apply the generalized estimating equations (GEE) method. This is an extension of the quasi-likelihood approach which adjusts for the correlation between observations from the same respondent implicitly through the robust variance estimator (i.e. the sandwich variance estimator). A negative binomial distribution with the residual process specified as first-order autoregressive correlation is employed as well as the 'force' option of the 'xtgee' Stata command, because some observations are not spaced equally in time. This is a cross-sectional model, while the subsequent models employ the longitudinal data set.

$$SC_{ist}=\beta_0+\beta_1 P_{st}+\beta_2 X_{ist}+\beta_3 A_{ist}+\beta_4 H_{ist}+\beta_5 CAN+\varepsilon_{is} \quad (1)$$

where SC_{ist} is the cessation stage of an individual (i) living in state/province (s) at wave t; P_{st} is the price for a pack of cigarettes; X_{ist} is a vector of socio-demographic characteristics; A_{ist} is the level of nicotine dependence measured by an index which increases in the number of cigarettes per day and decreases in the time before the first cigarette after waking up (each of those measures have four categories and the index is the sum of the two); H_{ist} is a self-reported indicator of the knowledge of health risks of smoking (respondents indicated if they believe smoking causes heart disease, stoke, male impotence and lung cancer among smokers and non-smokers; binary variables were created for each and their sum represents the level of smoker's knowledge of the health risks of smoking); and *CAN* is a dichotomous indicator for Canada.

The smoker's progress towards cessation over time is modeled in equation 2 applying the least-squares model on the longitudinal sample (equation 2). The values of the demographic and socio-economic variables are from wave 1, as many do not change over time (i.e. sex and race) and others do not change significantly over time (i.e. education and income).

$$\otimes SC_{is}=\beta_0+\beta_1 \otimes P_s+\beta_2 X_{is}+\beta_3 A_{is}+\beta_4 \otimes H_{is}+\beta_5 CAN+\varepsilon_s \quad (2)$$

where DSC_{is} is the difference in cessation stages between waves 3 and 1 for an individual (i) living in state/province (s), DP_s is the difference in cigarette price between waves 3 and 1, A_{is} represents the level of nicotine dependence at wave 1 and DH_{is} is the change in a smoker's knowledge of the health risks of smoking.

Model II

The second model evaluates quitting behavior among smokers over time. We use two approaches. First, we employ the GEE method using the panel data to estimate the probability of quitting, which is defined as the mean probability in a population with the same covariates (equation 3). The coefficients thus represent expected differences within a population, given a change in every-one's covariate from one value to another, and not have the usual 'other factors being constant' interpretation. The estimated coefficients are therefore population-averaged effects rather than individual effects.

$$Q_{ist}=\beta_0+\beta_1 P_{st}+\beta_2 X_{ist}+\beta_3 H_{ist}+\beta_4 CAN+\varepsilon_{is} \quad (3)$$

where Q_{ist} represents the probability of quitting for an individual *i* living in state/province *s* at wave *t*. Model II cannot control for nicotine dependence, as the dependent variable also includes those who have quit and have no value for the dependence index.

The second approach to study cessation employs a transition model—an extension of the generalized linear model. This model is chosen (over a discrete-time hazard model) as it accounts for the 'left-truncation' of the data. At wave 1, respondents must have been smokers to be recruited and as such have been at 'risk' of quitting for an unknown period of time. Therefore, they have a lower 'risk' of quitting than the 'average' smoker because those smokers with a higher 'risk' of quitting may have chosen to quit prior to wave 1. Failure to account for this left-truncation would result in bias. The transition model is based upon the conditional distribution of each response being an explicit function of past response (the smoking status of a past wave) and covariates. The general form of the model assumes that the effects of explanatory variables will differ depending on the previous status. To test this hypothesis, we include interaction terms of all covariates and smoking status (smoking versus quitting) of the past wave. We found that only gender has a significantly different effect on past smoking status. Therefore, we keep the gender interaction term and drop the other interaction terms. Because the dependent variable is binary, we applied a logit link that comprises a first-order Markov chain to estimate the transition model in equation 4.

$$Q_{ist}=\beta_0+\beta_1 \otimes P_{st}+\beta_2 X_{ist}+\beta_3 Q_{st-1}+\beta_4 H_{ist}+\beta_4 CAN+\varepsilon_{is} \quad (4)$$

where DP_{st} = P_{st} - P_{st-1} and Q_{ist-1} is the quit status at wave *t-1*.

The ITC survey includes a self-reported price for a pack of 20 cigarettes. To address the endogeneity of this price measure, we created an alternative measure—an average state/province cigarette price (ITC price) based on the self-reported price of Marlboro (United States) and Du Maurier (Canada), the most popular brands. In both waves 2 and 3, there were two states with no Marlboro smokers and one province with no Du Maurier smokers. For the missing observations we imputed values of self-reported Marlboro prices by multiplying the wave 1 price by a state/province-specific cigarette price change index.

Figure 1 describes the population weighted average ITC prices across the three waves. Cigarettes are significantly cheaper in the United States than Canada. US cigarette prices declined from wave 1 to wave 2 and remained steady between wave 2 and wave 3. The overall decrease between wave 1 and wave 3 was 19 cents. As the average US state tax increased in real terms in this period (the federal tax remained unchanged in nominal terms [19,20]), US smokers must, to avoid taxes, either shop around for cheaper sources of their preferred brand as tobacco companies introduce sale promotions, or purchase illicit cigarettes, or both. Cigarette prices in Canada increased by 22 US cents following increases in both province and federal taxes [21,22].

In addition to the price measures based on self-reported prices, we merged the data with two external price measures. In the United States these are based upon information published by the Tobacco Institute (TI) [23]. One price measure (TI price) is the weighted average of single pack, carton and vending machine cigarette prices in a state, including both branded and generic cigarettes. This price includes all excise taxes. The second measure is the state tax on a cigarette pack.

In Canada, one external price measure is derived from the monthly Consumer Price Index (CPI) for cigarettes for all provinces and province-level cigarette prices for 2004. The other price measure is the province-level cigarette tax per pack.

All price measures were adjusted for inflation and purchasing power parity.

Figure 2 compares three different price measures in the United States over the three waves. All are population weighted to show the national average and are adjusted for inflation. The ITC prices are lower than the TI prices during all waves as the TI prices do not reflect price promotions, discounts or purchases of illicit cigarettes. Both prices declined over time, but the average state tax increased slightly.

RESULTS

Model I

Table 1 reports results for equation 1, where the dependent variable is the cessation stage of an individual (collapsed into three stages). The first model (model A) includes only the demographic and socio-economic variables as independent variables in addition to the price variables, while the second and third models control for the knowledge of the health risks of smoking (model B) and the level of nicotine dependence (model C). The results show that higher cigarette prices and taxes, independent of the measure used, increase significantly the probability of a smoker moving to a later cessation stage (with the exception of the external price in model C). Older smokers are less likely to progress towards cessation, but smokers with moderate and higher education (with the exception of model C) are more likely to do so. Income does not play a statistically significant role in progress towards cessation, nor is there significant difference between smokers in the United States and Canada (with the exception of external price in model B). Smokers with greater health knowledge have stronger quit intentions, and those who exhibit greater nicotine dependence are less likely to progress toward cessation.

Results from equation 2 are presented in Table 2, where the dependent variable is the difference in cessation stage of an individual between waves 3 and 1. Models A and B control for nicotine dependence by including the number of cigarettes smoked per day at wave 1 while model C uses the dependence index as an alternative. Model B controls for the change in health knowledge. The changes in cigarette prices and taxes are a positive, but not a statistically significant, predictor of the progress toward cessation. Because cigarette prices did not vary greatly over the three waves, smokers may not be motivated to quit or progress toward cessation. Older smokers, those with moderate income and those with greater nicotine dependence are significantly less likely to progress toward quitting while smokers

with greater education increase consideration for quitting over time. Gaining more health knowledge over time intensifies significantly the motivation to quit.

Model II

Results in Table 3 are based on equation 3, using the probability of quitting over time as the dependent variable. Higher cigarette prices and taxes increase the probability that a smoker will quit although the estimated coefficients are only statistically significant when using the external prices. Age is associated negatively with the likelihood of quitting in model A while higher education increases the likelihood of smoking cessation in both models. The self-reported knowledge of the risks of smoking (model B) increases the likelihood of quitting, but controlling for health knowledge does not change the impact of price. The coefficient of the Canadian dummy variable is negative, but only statistically significant in the model with the external price. To investigate this further, we added an interaction term between price and the Canadian dummy variable. The coefficient of the interaction term is positive, and again only statistically significant when using the external price measure, meaning that cigarette prices are potentially more important in determining smoking cessation in Canada than the United States.

Table 4 shows the coefficients from the transition model (equation 4), which also uses the probability of quitting as the dependent variable. An increase in cigarette prices over time increases the probability of smoking cessation and this impact is statistically significant for both internal and external prices. Quitting at the past wave increases the probability of remaining quit at the current wave. Similar to the results of equation 3, age is associated negatively with the likelihood of quitting, while high education is associated positively with the probability of quitting. Health knowledge (model B) increases the probability of quitting over time, and including this variable into the model does not change the impact of the other independent variables.

DISCUSSION AND CONCLUSION

This paper evaluates the impact of cigarette prices and taxes on cessation behavior using data from a longitudinal survey in the United States and Canada. We study both the motivation to quit smoking and actual quitting behavior over time.

We find that smokers living in areas with higher cigarette prices and taxes are significantly more motivated to quit. Price/tax increases over time may also increase quit motivation, although the results are not statistically significant, due most probably to the lack of significant price changes during the period of interest. Furthermore, higher cigarette prices increase the likelihood of actual quitting, with the caveat that results are not statistically significant in all the models.

Canadian and US smokers are similar with regard to the impact of cigarette prices and taxes on quit behaviour, with some evidence of greater price sensitivity among Canadians. Knowledge of the risks of smoking increases significantly both the quit motivation and the likelihood of quitting among current cigarette users. Older age lowers both the probability of

cessation intention and actual cessation. Those with greater nicotine dependence are less likely to progress towards cessation.

Using three different measures of price/tax allows us to speculate upon the impact of brand-specific price choices on smoking cessation. Although the external price measures and the ITC price performed similarly in models of cessation motivation (model I), the coefficients of the external price are consistently greater, in absolute terms, than the ITC price. This suggests that smokers would respond more aggressively to price if they were unable to take advantage of lower prices from cheaper cigarette sources. A more detailed analysis of this issue is recommended as an avenue for future research.

Only the external price is statistically significant in equation 3 of model II and has a larger coefficient in equation 4. Again, this suggests that smokers would be more inclined to quit if they were unable to find cheaper sources for their cigarettes. The impact of cigarette taxes on quitting behavior is not statistically significant, but changes in taxes do not necessarily result in changes to prices due to price promotions and tax avoidance.

This study is unique, as it examines the impact of price on adult smoking cessation using longitudinal data. The results support the notion that higher cigarette prices are able to increase cessation as well as motivate smokers to quit. The impact of higher prices persists despite the existence of cheaper cigarette sources, although they seem to reduce the magnitude of the price effect. As our study was limited by the lack of variation in prices/taxes during the period of the surveys, future research should examine smokers' cessation behavior over a longer period of time. In addiction, the Stages of Change model has been criticized in the literature (see West [18] for a comprehensive critique). The most significant concern is the arbitrary differentiation between stages, although we attempt to mitigate this concern by collapsing the five stages into three (see the next section for further details). Another significant concern is that the use of the model's results can lead to a situation when an effective intervention is not offered to smokers who would have responded to it. This is an appropriate concern during a clinical intervention, but not necessarily so when a population-wide price intervention is considered, particularly when the intervention is not fixed in magnitude. Furthermore, it is not clear that an alternative model including a price-based intervention can be tested given the data at hand. Thus the results should be viewed in the context of these concerns.

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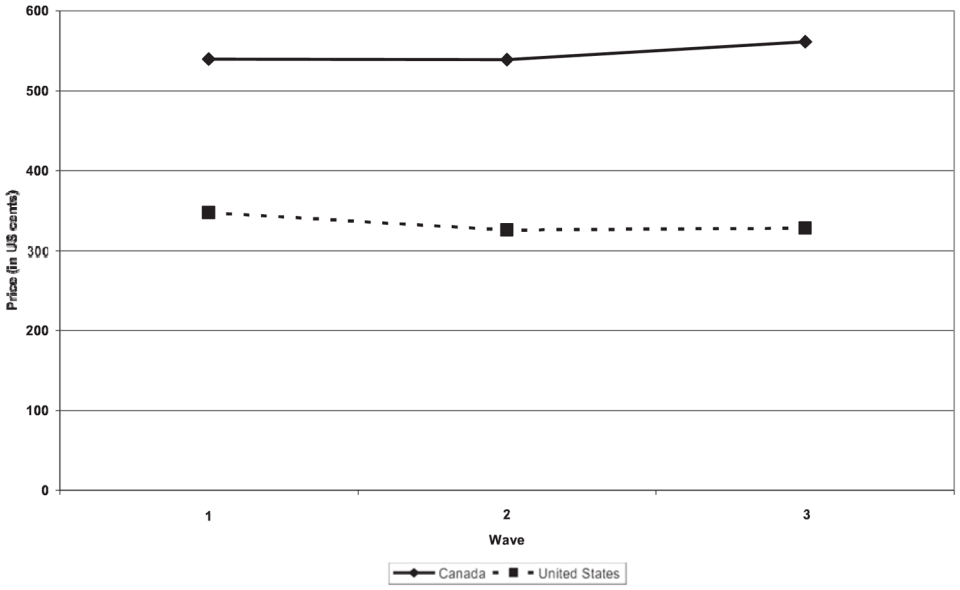

Figure 1.

Weighted average International Tobacco Control (ITC) prices for United States (Marlboro) and Canada (Du Maurier). Note: Prices are adjusted for inflation (base = wave 1), purchasing power parity for each year

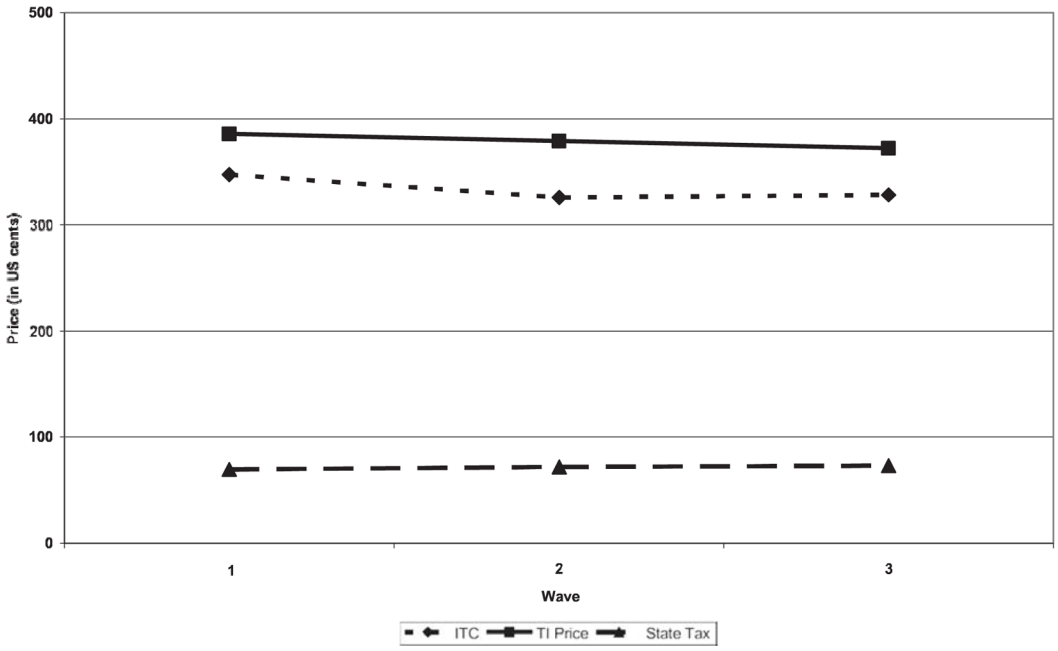

Figure 2.
Comparison of International Tobacco Control (ITC) and TI price and state taxes in the United States. Note: prices are adjusted for inflation. TI: Tobacco Institute

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Table 1

Generalized estimating equations model for cessation stages—model I.

	Model A			***Model B***			***Model C***		
ITC price	0.0003* (0.0002)			0.0003* (0.0002)			0.0004** (0.0002)		
External price		0.0008*** (0.0001)			0.0007*** (0.0001)			0.0002 (0.0001)	
Tax			0.0005** (0.0002)			0.0005** (0.0002)			0.0004** (0.0002)
Male	0.003 (0.023)	0.004 (0.024)	0.004 (0.023)	0.010 (0.023)	0.010 0.023)	0.010 (0.023)	0.007 (0.023)	0.006 (0.023)	0.007 (0.023)
Age	−0.007*** (0.001)	−0.007*** (0.001)	−0.007*** (0.001)	−0.006*** (0.001)	−0.006*** (0.001)	−0.006*** (0.001)	−0.007*** (0.001)	−0.007*** (0.001)	−0.007*** (0.001)
Married	0.022 (0.025)	0.024 (0.025)	0.022 (0.025)	0.014 (0.025)	0.015 (0.025)	0.014 (0.025)	0.018 (0.025)	0.019 (0.025)	0.019 (0.025)
White	−0.020 (0.036)	−0.012 (0.036)	−0.019 (0.036)	−0.021 (0.035)	−0.013 (0.036)	−0.020 (0.035)	0.010 (0.035)	0.007 (0.036)	0.008 (0.036)
Moderate education	0.079*** (0.026)	0.080*** (0.026)	0.080*** (0.026)	0.070*** (0.026)	0.071*** (0.026)	0.070*** (0.026)	0.068*** (0.024)	0.068*** (0.024)	0.068*** (0.024)
High education	0.103*** (0.036)	0.103*** (0.036)	0.103*** (0.036)	0.082** (0.035)	0.083** (0.035)	0.083** (0.036)	0.033 (0.038)	0.036 (0.038)	0.035 (0.038)
Moderate income	0.029 (0.029)	0.025 (0.029)	0.028 (0.029)	0.024 (0.029)	0.021 (0.029)	0.024 (0.029)	0.030 (0.027)	0.030 (0.027)	0.030 (0.027)
High income	0.031 (0.033)	0.027 (0.033)	0.030 (0.033)	0.023 (0.033)	0.019 (0.033)	0.022 (0.033)	0.009 (0.032)	0.010 (0.032)	0.009 (0.032)
Canada	0.003 (0.045)	−0.039 (0.031)	0.011 (0.035)	−0.027 (0.044)	−0.065** (0.030)	−0.020 (0.035)	−0.010 (0.048)	0.047 (0.032)	0.027 (0.034)
Health knowledge				0.082*** (0.011)	0.080*** (0.011)	0.082*** (0.011)			
Nicotine dependence							−0.033*** (0.007)	−0.033*** (0.007)	−0.033*** (0.007)
Constant	−0.079 (0.083)	−0.265*** (0.080)	−0.006 (0.059)	−0.332*** (0.090)	−0.493*** (0.086)	−0.267*** (0.069)	−0.140* (0.084)	−0.080 (0.077)	−0.032 (0.057)
Observations	5932	5932	5932	5900	5900	5900	5304	5304	5304
Number of smokers	1990	1990	1990	1985	1985	1985	1874	1874	1874

Standard errors in parentheses.

* Significant at 10%;

** significant at 5%;

*** significant at 1%.

In general, all coefficients and standard errors have been rounded off to three decimal places but due to the small magnitude of the coefficients on the price variables we have included a fourth decimal place for this variable. This table represents the estimates of Equation 1. Dependent variable: cessation stage of an individual. ITC: International Tobacco Control.

Table 2

Ordinary least- squares model for change in cessation stage over time—model I.

	Model A			*Model B*			*Model C*		
Change in ITC price	0.0009 (0.0010)			0.0009 (0.0010)			0.0009 (0.0010)		
Change in external price		0.0014 (0.0016)			0.0013 (0.0016)			0.0015 (0.0016)	
Change in tax			0.0007 (0.0017)			0.0005 (0.0018)			0.0007 (0.0017)
Male	0.053 (0.061)	0.052 (0.060)	0.050 (0.061)	0.040 (0.061)	0.039 (0.061)	0.037 (0.061)	0.039 (0.060)	0.038 (0.060)	0.036 (0.060)
Age	−0.00 * (0.002)	−0.004* (0.002)	−0.004* (0.002)	−0.004* (0.002)	−0.004* (0.002)	−0.00 * (0.002)	−0.00 * (0.002)	−0.00 * (0.002)	−0.004* (0.002)
Married	0.034 (0.065)	0.032 (0.066)	0.033 (0.065)	0.039 (0.066)	0.037 (0.066)	0.038 (0.066)	0.040 (0.065)	0.038 (0.065)	0.039 (0.065)
White	0.079 (0.096)	0.087 (0.098)	0.087 (0.098)	0.073 (0.095)	0.082 (0.097)	0.082 (0.097)	0.105 (0.095)	0.113 (0.097)	0.113 (0.097)
Moderate education	0.030 (0.065)	0.032 (0.064)	0.031 (0.064)	0.032 (0.065)	0.033 (0.065)	0.033 (0.064)	0.016 (0.065)	0.017 (0.064)	0.017 (0.065)
High education	0.304*** (0.109)	0.304*** (0.111)	0.301*** (0.111)	0.304*** (0.109)	0.304*** (0.111)	0.300*** (0.111)	0.295*** (0.108)	0.296*** (0.110)	0.292*** (0.110)
Moderate income	−0.134* (0.076)	−0.137* (0.076)	−0.136* (0.077)	−0.135* (0.077)	−0.138* (0.077)	−0.13 * (0.077)	−0.14 * (0.077)	−0.14 * (0.077)	−0.148* (0.077)
High income	−0.052 (0.088)	−0.060 (0.088)	−0.054 (0.088)	−0.064 (0.089)	−0.070 (0.088)	−0.06 (0.089)	−0.08 (0.088)	−0.09 (0.087)	−0.086 (0.088)
Cigarettes per day	−0.008** (0.003)	−0.008** (0.003)	−0.008** (0.003)	−0.008** (0.003)	−0.007** (0.003)	−0.00 ** (0.003)			
Canada	−0.024 (0.074)	−0.130 (0.176)	0.007 (0.066)	−0.017 (0.074)	−0.104 (0.177)	0.017 (0.066)	−0.01 (0.073)	−0.12 (0.175)	0.014 (0.066)
Change in health knowledge				0.053** (0.027)	0.052* (0.027)	0.054** (0.027)			
Nicotinedependence at wave 1							−0.06 *** (0.021)	−0.06 *** (0.021)	−0.065* * (0.021)
Constant	0.572*** (0.151)	0.567*** (0.152)	0.545*** (0.150)	0.557*** (0.150)	0.548*** (0.152)	0.530*** (0.150)	0.604*** (0.154)	0.599*** (0.155)	0.577*** (0.153)
Observations	1969	1967	1969	1951	1949	1951	1957	1955	1957
R-squared	0.022	0.022	0.021	0.024	0.024	0.023	0.025	0.025	0.024

Standard errors in parentheses.

*Significant at 10%;

**significant at 5%;

***significant at 1%.

The demographic and socio-economic covariates are those from wave 1. In general, all coefficients and standard errors have been rounded off to three decimal places but due to the small magnitude of the coefficients on the price variables we have included a fourth decimal place for this variable. This table represents the estimates of Equation 2. Dependent variable: difference in cessation stage of an individual between waves 3 and 1. ITC: International Tobacco Control.

Table 3

Generalized estimating equations models for smoking cessation—model II.

	Model A			***Model B***		
ITC price	0.0007 (0.0011)			0.0007 (0.0011)		
External price		0.0044*** (0.0007)			0.0043*** (0.0007)	
Tax			0.0011 (0.0011)			0.0010 (0.0011)
Male	0.084 (0.126)	0.088 (0.128)	0.084 (0.126)	0.096 (0.128)	0.099 (0.130)	0.096 (0.128)
Age	−0.010** (0.005)	−0.011** (0.005)	−0.010** (0.005)	−0.006 (0.005)	−0.007 (0.005)	−0.006 (0.005)
Married	−0.006 (0.139)	0.007 (0.141)	−0.004 (0.139)	−0.035 (0.142)	−0.023 (0.143)	−0.033 (0.141)
White	−0.055 (0.171)	0.018 (0.175)	−0.053 (0.172)	−0.083 (0.172)	−0.008 (0.176)	−0.081 (0.173)
Moderate education	0.201 (0.151)	0.209 (0.152)	0.202 (0.150)	0.160 (0.152)	0.168 (0.154)	0.161 (0.152)
High education	0.616*** (0.172)	0.622*** (0.175)	0.617*** (0.172)	0.553*** (0.174)	0.562*** (0.177)	0.554*** (0.174)
Moderate income	0.094 (0.168)	0.075 (0.170)	0.092 (0.168)	0.084 (0.170)	0.070 (0.173)	0.083 (0.171)
High income	0.238 (0.189)	0.221 (0.190)	0.236 (0.189)	0.212 (0.191)	0.199 (0.193)	0.210 (0.191)
Canada	−0.085 (0.261)	−0.535*** (0.150)	−0.058 (0.194)	−0.178 (0.265)	−0.623*** (0.156)	−0.151 (0.198)
Health knowledge				0.235*** (0.060)	0.220*** (0.061)	0.235*** (0.060)
Constant	−2.586*** (0.463)	−4.060*** (0.413)	−2.419*** (0.295)	−3.336*** (0.519)	−4.757*** (0.466)	−3.181*** (0.360)
Observations	5973	5973	5973	5940	5940	5940
Number of smokers	1991	1991	1991	1987	1987	1987

Standard errors in parentheses;

** significant at 5%;

*** significant at 1%.

Each model controls for sex, age, marital status, race, education and income, and an indicator for Canada. In general all coefficients and standard errors have been rounded off to three decimal places but due to the small magnitude of the coefficients on the price variables we have included a fourth decimal place for this variable. This table represents the estimates of Equation 3. Dependent variable: probability of quitting of an individual. ITC: International Tobacco Control.

Table 4

Transition model for smoking cessation—model II.

	Model A			***Model B***		
Change in ITC price between two waves	0.0043*** (0.0016)			0.0042*** (0.0016)		
Change in external price between two waves		0.0066* (0.0038)			0.0064* (0.0038)	
Change in tax between two waves			0.0041 (0.0047)			0.0036 (0.0046)
Male	0.007 (0.129)	0.005 (0.129)	0.002 (0.129)	0.002 (0.130)	0.001 (0.129)	−0.003 (0.130)
Age	−0.016*** (0.004)	−0.015*** (0.005)	−0.016*** (0.005)	−0.013** (0.005)	−0.013** (0.005)	−0.013** (0.005)
Married	0.075 (0.134)	0.079 (0.135)	0.079 (0.135)	0.061 (0.135)	0.064 (0.135)	0.064 (0.136)
White	−0.057 (0.177)	−0.026 (0.182)	−0.027 (0.181)	−0.075 (0.176)	−0.044 (0.181)	−0.044 (0.180)
Moderate education	0.161 (0.140)	0.168 (0.139)	0.165 (0.139)	0.135 (0.140)	0.141 (0.139)	0.138 (0.139)
High education	0.572*** (0.174)	0.564*** (0.177)	0.557*** (0.177)	0.525*** (0.176)	0.516*** (0.180)	0.507*** (0.180)
Moderate income	0.058 (0.159)	0.044 (0.158)	0.046 (0.159)	0.057 (0.160)	0.042 (0.159)	0.044 (0.160)
High income	0.196 (0.176)	0.172 (0.174)	0.190 (0.176)	0.175 (0.177)	0.151 (0.175)	0.169 (0.177)
Canada	−0.030 (0.130)	−0.256 (0.227)	0.041 (0.128)	−0.072 (0.131)	−0.294 (0.225)	−0.005 (0.129)
Health knowledge				0.134** (0.060)	0.138** (0.060)	0.139** (0.060)
Male ¥ quit at past wave	0.626* (0.366)	0.620* (0.376)	0.577 (0.374)	0.642* (0.370)	0.636* (0.378)	0.594 (0.376)
Quit at past wave	2.095*** (0.232)	2.191*** (0.238)	2.126*** (0.235)	2.073*** (0.232)	2.165*** (0.237)	2.105*** (0.235)
Constant	−1.802*** (0.296)	−1.837*** (0.298)	−1.864*** (0.297)	−2.260*** (0.370)	−2.309*** (0.371)	−2.341*** (0.371)
Observations	3982	3982	3982	3961	3961	3961

Standard errors in parentheses;

* Significant at 10%;

** significant at 5%;

*** significant at 1%.

In general, all coefficients and standard errors have been rounded off to three decimal places but due to the small magnitude of the coefficients on the price variables we have included a fourth decimal place for this variable. This table represents the estimates of Equation 4. Dependent variable: probability of quitting of an individual. ITC: International Tobacco Control.