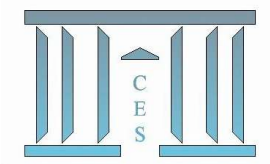
Revisiting an important Canadian natural experiment with new methods: an evaluation of the impact of the 1994 tax decrease on smoking

François Gardes, Philip Merrigan

UNIVERSITÉ PARIS 1 – PANTHÉON - SORBONNE –

Documents de Travail du
Centre d'Economie de la Sorbonne

CES Working Papers



Revisiting an important Canadian natural experiment with new methods: an evaluation of the impact of the 1994 tax decrease on smoking

François GARDES, Philip MERRIGAN

2014.27

Maison des Sciences Économiques, 106-112 boulevard de L'Hôpital, 75647 Paris Cedex 13
http://centredeconomiesorbonne.univ-paris1.fr/
ISSN : 1955-611X

Revisiting an important Canadian natural experiment with new methods: an evaluation of the impact of the 1994 tax decrease on smoking [1]

François Gardes, Paris School of Economics, Université Paris I Panthéon Sorbonne

Philip Merrigan, Université du Québec à Montréal, CIRPEE

March 2014

Abstract

The panel structure of the Survey on Smoking in Canada (1994-5) and novel methods are used to estimate the impact of an important decrease in the levels of taxation of cigarettes occurring in five out of the ten Canadian provinces that intended to eradicate black market sales of cigarettes in the spring of 1994. Given that black market sales have recently increased substantially because of new taxes, a complete and thorough analysis of the 1994 policy is of particular importance for policy makers. We revisit the issue with new econometric methods to address this evaluation problem as well as focus on particular sub-groups in the Canadian population. The large sample permits precise estimation of the impact of the policy by sub-group showing that females, young males, the poorly educated, and separated or divorced individuals were particularly sensitive to these dramatic changes in cigarette prices. We also compute under realistic assumptions a price-elasticity for the probability of smoking and a lower bound on the price-elasticity for the quantities of cigarettes smoked.

[1] Thanks are due to B. Fortin, Laval University, for precious information on the tax cut and its consequences. We take full responsibility for the errors in this paper.

Introduction

In the spring of 1994, in order to eliminate the sales of contraband cigarettes, the governments of 5 Canadian provinces dramatically reduced taxes on cigarettes, lowering the overall price of cigarettes to the level of black market prices. This policy basically eradicated the black market in these areas. Since then, taxes have been increased to their former levels causing the black market to flourish again. In 2005 and 2006, a survey of smokers in Ontario (Luk, Cohen, and Ferrence 2007) estimated that: 37% of current smokers in Ontario report *ever* purchasing cigarettes on native reserves, 26% of current smokers report having bought at least one pack of cigarettes on reserves in the previous six months, 12% of current smokers report *usually* purchasing cigarettes on reserves.

Should the governments adopt the same strategy as in 1994? If they do, it is feasible that this will cause an increase in cigarette consumption and health costs associated with smoking. To add some new light on this important policy issue, we revisit a paper by Hamilton et al (1997) that used a difference in differences method to evaluate the impact of the tax decrease on the prevalence of smoking in the provinces where the policy was implemented. A recent study concludes that the tax change had no impact on tobacco use in the provinces where the tax change occurred (Ouellet 2010). This paper is used by convenience store owners in their lobbying attempts to reduce cigarette taxes as in 1994 (http://www.acda-aqda.ca/, web site of the retailer association). Their own estimates suggest that 50% of cigarettes in 2010 are bought in the black market.

We redo the analysis using new methods proposed by Athey and Inbens (2006) as well as Blundell and Costas-Diaz (2009) and with a larger sample. We find some interesting results showing that the policy had very strong positive effects on the proportion of individuals smoking for particular sub-groups.. We also adjust standard errors for the panel structure in the data. We find much larger effects when we adjust the policy effects for the percentage of individuals who

did not experience a price change as a large proportion of individuals were already buying cigarettes at very low prices. Finally, we use our estimates to derive direct price elasticities which are, for tobacco and alcohol expenditures, generally difficult to estimate using aggregate time-series of prices and quantities because of the collinearity between the price of cigarettes and various trends influencing household expenditures. Furthermore, long-term effects of changes in price may differ from short-term effects: first, because of habit or addiction, second, because of the nature of price variations (permanent or transitory, expected or unexpected). We use in this paper a panel data set that spans 18 months, the Survey on Smoking in Canada (1994-5) publicly available from Statistics Canada, in order to estimate the changes in smoking habits caused by the dramatic decrease in prices due to the decrease of taxes on tobacco goods that occurred in 5 out of the 10 Canadian provinces. From our results, we compute reliable estimates of the price-elasticity of the prevalence of smoking and lower bounds for the price-elasticity of the quantity of cigarettes smoked.

The estimation of price-elasticities of smoking behaviour using the natural experiment of 1994, the availability of panel data, and difference in differences methodologies have several advantages over studies that use regression analysis to estimate the price-elasticity of smoking behavior. First, no instruments are necessary to estimate the price effects of smoking behavior. The price reduction was exogenous and rapidly executed. Second, the variation in confounding explanatory variables such as income will certainly be very small and produce little bias for the estimates as the data covers only 18 months. Third, because the data is longitudinal, fixed individual effects are controlled for by the analysis. Our view is that this experiment and a difference in differences methods will produce more credible estimates of price-elasticities than IV methods based on aggregate provincial data or studies with individual data that do not take into account the endogeneity of price changes in the long-run.

Generally speaking, direct price elasticities for supposed addictive goods have been found to be very small or null in early studies (see Kopp, 2004, p. 45): indeed, Chaloupka's (1991,

p.735) estimates range between – 0.07 and – 0.01 for a non-addictive demand equation estimated with a panel of American individuals. Becker, Grossman and Murphy (1994) challenged this result considering that habits and addiction provoke on the contrary substantial price effects in the long term, because small permanent price variations impart changes in the stock of consumption, which have long term effects on future expenditures. Mullahy (1985) (cited in Becker et al.) showed that the estimates of the direct price elasticity for cigarettes are, for various studies, distributed between -0.4 and -0.5. Becker et al. using macro time series or repeated cross-sections of state level data in the United States, produced estimates for permanent changes in prices of around -.4 for the short-term, and -.7 to -.8 for the long term, rather large values compared to other commodities. Furthermore, temporary price changes also impart important effects on cigarette consumption (elasticity of -.35, Becker et al., Table 5.4). Chaloupka's (1991) estimates are between -.36 and -.27 for the whole population, and even between -.35 and -.48 for current or former smokers. Cook-Tauchen (1982) (cited in Becker et al.) considers that alcohol consumption is even more price elastic (with elasticities between –1.8 and –1). Price effects are also shown to be important for other addictive products, such as heroin or opium (Kopp, p. 46-47).

Recently, in France, taxes on tobacco increased three times between January 2003 and January 2004: first by 11% in January 2003, then by 20% in September and 9% in January 2004. Before this last increase, consumption had already declined by 16%, which corresponds to a direct price elasticity of -.48 for these two years, a figure similar to those obtained in estimations of addiction models with American data. But this elasticity corresponds to short run effects, and moreover is strongly biased by the unknown, but very important, increase of informal markets[2] and aggregate trends.

A meta-analysis of the elasticities of cigarette demand (Gallet and List 2003) finds a mean elasticity of -0.48 and a standard deviation of 0.43 computed with the results from

[2] Also, the price increases have been accompagnied by various changes of the French legislation on drug use, such as public avertising on the medical consequences of smoking.

86 studies, they find also that elasticities from more recent studies are in the low range as well as those in the major journals.

Some recent evidence in the United States by Franks et al (2007) suggests that the price elasticity of cigarettes is now very low for all income groups (estimated with a sample period of 1997 to 2004, the post tobacco Master Settlement Agreement, MSA, years) while it was particularly high for low-income individuals using a sample covering 1984 to 1996. They propose that tobacco tax increases not be undertaken because their main effect would be to increase income inequalities with smoking behavior unchanged. A rebuttal by Farrelly and Engelen (2008), who include the years 2005 and 2006 in a similar analysis, shows a statistically significant effect of price changes only for low-income individuals with the MSA sample period with a low price-elasticity of -.11.

There are also recent studies with Canadian data. Zhang et al. (2002) find a very large price elasticity of -3.36 of smoking initiation for young adults who are 20 to 24 years of age using longitudinal data at the individual level in the National Population Health Survey for Cycles 1 (1994-1995) and 2 (1996-1997) and provincial price variation. Using the same data, but with a sample of 14 to 19 year-olds, Dupont and Ward (2002) find an elasticity for the probability of smoking of -0.914. Finally, Gruber, Sen, and Stabile (2003) compute elasticities for cigarette demand with two data sets. The first contains aggregate provincial level data on cigarette sales, the second uses household level data on annual cigarette expenditures. The find demand elasticities in the range of -.45 and -.47. The authors use several years of data as well as IV methods for estimation.

All these studies prove that the estimated price elasticities depend highly on the specification, static or dynamic, of the demand for cigarettes and on the nature of the datasets: indeed, the effect of price increases on persistent smokers are not disentangled, in these studies, from those which depend on the decision to start or stop smoking. Second, price effects seem to depend on the socio-economic characteristics of individuals. They differ for instance between

low-income agents or the young and the rest of the population. A systematic analysis is thus needed distinguishing these sub-populations, which cannot be accomplished with usual econometric estimation of demand system, using aggregate or semi-aggregate data.

Section 1 presents previous findings using the Survey on Smoking in Canada (1994-5), Section 2 presents methods of estimation and estimates of the price effects due to the tax change, Section 3 constructs estimates of the price elasticities and a final section offers a summary and conclusions.

Section 1. Previous findings using the 1994-95 Canadian panel on smoking habits

In Canada, as mentioned earlier, the federal government as well as 5 provincial governments[3] dramatically decreased tax rates on cigarettes sales in the spring of 1994. Gilmore (2000, p.3) notes that between two surveys made in 1994-95 and 1996-97, 10% of the smokers quit, among those, 6% started to smoke again, and 2% began smoking. This was very different from earlier figures: for instance, between 1985 and 1991, the smoking population decreased by 4.3% (from 35.1 to 30.8%), and did not change between 1991 and 1994-95 (a period during which the black market developed rapidly), while this population decreased once again by 5.8% between 1994-95 and 1999. Various macroeconomic and institutional changes also occurred during these periods, so that an estimation strategy must be defined in order to take into account all the determinants of smoking behavior.

The 1994 Canadian National Survey on Smoking was produced in order to evaluate the consequences of the important federal and provincial tax decrease in 5 provinces on cigarettes consumption. Approximately 15,000 individuals were surveyed in the spring of 1994 and asked to take part in a longitudinal survey. By the end of the survey, 12,338 individuals were involved in the panel. The survey concerned essentially cigarette consumption, particularly among the

[3] A federal tax is the same for all provinces, while province taxes may differ.

young, who were over-represented in the sample. Its objectives were: (1) the measurement of the number of smokers and the volume of consumption, (2) the estimation of the effects of the price change, especially for the young, (3) collecting information on attitudes towards cigarette smoking and more generally tobacco consumption.

The survey is fully described in Gardes, Ghabri, Merrigan (2000) and Statistics Canada, 1995. It contains individual characteristics such as age, sex, education, marital status, but also questions on the existence of other smokers in the family, on the household structure and its income class. Also, people were asked whether they had smoked at least 100 cigarettes during their life, or at least one. The panel structure and the information on the quantities of cigarettes are important features of this data set, individual specific effects (psychological and physiological) certainly play a crucial role determining cigarette consumption.

Gardes, Ghabri, Merrigan (2000) present some descriptive findings using the survey and simple linear regression methods. The probability to smoke as well as the quantity of cigarettes varies with age in an inverse U shape: the proportion of smokers is higher for individuals aged 25 to 34 (40%), and declines to 15% for individuals older than 70 (see additional evidence in Table 4, in this paper, by region where tax cuts occurred). The average quantity of cigarettes smoked for smokers increases continuously until 55-64 for men (45-54 for women), an evolution which would be considered, until this age, as clearly relevant for addiction effects by this theory (note also that the inverse U of quantities is more accentuated for men, which may indicate lower addictive effects compared to women). Both the proportion of smokers and the quantities smoked are higher for men (see Table 3 in this paper). Educated people smoke 5 cigarettes less on average and in a smaller proportion than the uneducated (Table 7). The presence of young children decreases consumption, but only for lone parents. Income effects are not significant (perhaps because of their collinearity with age in the regressions, and also because income is measured with only 7 classes). Some social interaction effects are suggested by large impacts of other smokers in the family on the probability of smoking, and by the higher proportion of smokers in

some provinces (Québec, British Columbia). Separated or divorced individuals compose the demographic group with the largest proportion of smokers (Table 6).

Using the same survey on tobacco use in Canada covering the period of January 1994 to the spring of 1995, Hamilton et al. (1997) presents convincing evidence (details in Section 3) that the reduction in taxes has a positive effect on the prevalence of smoking in the provinces where tax cuts were undertaken in the spring of 1994 but do not perform extensive sub-group analysis nor do they construct price elasticities of smoking behavior.

Section 2. Estimation of the price effects due to the tax change

2.1. Difference in differences, three methods.

With panel data, the well-known difference in differences estimator (DID) of the policy effect is estimated as

$$\hat{\alpha}_{DID} = (P_1^1 - P_0^1) - (P_1^0 - P_0^0) = (n_{10}^1 - n_{01}^1)/n^1 - (n_{10}^0 - n_{01}^0)/n^0,$$

P is for proportion of smokers, the superscripts refer to the "treatment" groups (tax or no tax decrease), 1 for "treatment", 0 for "controls", the indices refer to the time period, 1 for May 1995, and 0 for January 1994, n_{10} is the number of smokers at baseline that stopped smoking in period 2, n_{01} is the number of non-smokers at baseline that start to smoke in period 2. Finally, n^i , i=0,1, is the total number of individuals in the sample.

The variance of the DID estimator is computed as (given the panel nature of the data):

$$\hat{\sigma}_{DID}^2 = Var(P_1^1 - P_0^1) + Var(P_1^0 - P_0^0)$$

with

$$Var\left(P_1^i - P_0^i\right) = P_1^i\left(1 - P_1^i\right) + P_0^i\left(1 - P_0^i\right) + 2(P_{11}^i P_{00}^i - P_{10}^i P_{01}^i).$$

P_{11} is the proportion of smokers who remain smokers between periods 1 and 0, P_{00} is the proportion remaining non-smokers between periods 1 and 0, P_{10} is the proportion switching from smoker to non-smoker, while P_{01} is the opposite.

We present two other estimators. The difference in differences estimator does not take into consideration that the dependent variable is binary and that the probabilities must be between 0 and 1. Athey and Imbens (2006) and Blundell and Costas-Diaz (2009) propose alternative estimators which are consistent with constraints on probabilities. Athey and Imbens also propose bounds for the policy effect (assuming only that unobservable variables that determine smoking are weakly monotonic, but with no conditional independence assumptions), that we also compute with our sample. The Athey and Imbens point-estimator (AI) is given by

$$\hat{\alpha}_{AI} = P_1^1 - \frac{P_1^0}{P_0^0} P_0^1.$$

This estimator is based on the assumption that unobserved variables that determine the choice of smoking is independent of group effects (in this case the group is defined by the region where the tax cut occurred), conditional on the outcome (smoking) and the treatment (the tax cut). This formula is used because the change in the prevalence of smokers in the no tax cut region is negative between the two periods; a different formula is used if this change had been positive. In the words of AI: "When the time trend in the control group is negative, the counterfactual is the probability of successes in the treatment group initial period, adjusted by the proportional change over time in the probability of success in the control group." The standard error of the estimate is computed with the Delta method. We refer the readers to the Imbens and Athey for the procedure that computes the bounds of the policy effect.

Finally, we present the Blundell and Costas-Diaz estimator (BCD) by assuming a probit model with Φ the normal distribution function and obtain, the treatment effect,

$$\hat{\alpha}_{BCD} = P_1^1 - \Phi(\Phi^{-1}(P_1^1) - \hat{\alpha}),$$

where

$$\hat{\alpha} = (\Phi^{-1}(P_1^1) - \Phi^{-1}(P_0^1)) + (\Phi^{-1}(P_1^0) - \Phi^{-1}(P_0^0)).$$

Therefore, the counterfactual in the treatment group in the post-policy period is constructed by subtracting from the observed index in the cumulative in the post-policy period, the difference in differences estimate of the treatment effect on the index function and substituting this result in the cumulative.

2.2 Data and Empirical Results

A number of 15,804 individuals responded in the first wave of the 1994 Canadian National Survey on Smoking in May 1994, they were then re-contacted 3 other times, from Aug. 16 to Sep. 16, 1994, Nov 14. to Dec. 16, 1994, and finally from Feb. 15 to Mar. 16, 1995. In the first wave, respondents were asked whether or not they were smokers on January 1 1994 and if they currently smoked. Hamilton et al. use the January 1 answer as a baseline from which to observe the evolution of smoking prevalence in the Canadian population. We shall also adopt the January 1 answer as baseline. They restrict their analysis to respondents that answer questions on smoking habits for all 4 waves of the survey. Attrition in the sample reduces the number of individuals used in the sample to 11,119 individuals.

Their main finding is that in all provinces the percentage of smokers considerably diminished with a more important drop in provinces with no tax cuts. Using a difference in difference methodology, they estimate that the tax cuts increased smoking by 1.4 percentage points ($p < .001$). In provinces without tax cuts, prevalence decreased by 3.4 percentage points

while it decreased by 2 percentage points in provinces with tax cuts. The authors suggest that the analysis be extended to different demographic sub-groups: the goal of the next sub-section.

We choose a different sample than Hamilton et al in order to increase the number of observations. We sample individuals that respond in both waves 1 and 4, adding 1,219 individuals in the study. Given that individual smokers respond slowly to price changes it is logical to concentrate on differences in smoking between the first and last wave of the survey.

Therefore, our sample is based on 12,338 individuals (78 % of the original sample) that answer to questions in the spring of 1994 and the spring of 1995. Using the same methodology as Hamilton et al., we compute the prevalence of smoking for both periods in provinces with tax cuts and compute the difference in prevalence change between the two periods. Our results are substantially different from that of Hamilton et al. with the larger sample. We also obtain different p values for our tests because we consider the fact that the observations are dependent because of the panel nature of the data.

Using the DID estimator, we estimate the policy effect with the Hamilton sample, obtaining the same point estimates, and find that the p-value is larger and the z statistic is much lower than in their paper (Table 1). Table 2 presents the results from our sample. Because of the substantial over sampling for certain demographic groups, all results are computed using weights provided by Statistics Canada.

Table 1

Proportions of smokers in each region before and after the tax cut and impact of the tax change on the proportion of smokers (Hamilton sample)

	N	P_1	P_2	*Impact*	*z*	*p*
Tax cut						
Yes	5930	0.308	0.283	0.0145	2.81	0.005
No	5189	0.289	0.249			

Table 2

Proportions of smokers in each region before and after the tax cut and impact of the tax change on the proportion of smokers (our sample)

Tax cut	N	P_1	P_0
Yes	6545	0.315	0.285
No	5793	0.287	0.251

DID impact	z	AI impact		BCD impact
0.0099	2.04**	0.0130	2.72*	0.0114

AI Bounds	Lower	Upper
	-0.026	0.315

Note: *significant at the 1% level; ** significant at the 5% level.

The impact with the DID estimator computed with the larger sample in Table 2 is .4 of a percentage point lower than in Hamilton et al., a 28 percent difference, with a substantially lower p value, but remaining statistically significant. The AI estimator is closer to the original estimate of Hamilton et al. The BCD estimate lies between the latter estimates. The AI bounds are not very informative but do point towards a positive effect of the policy. This statement applies to all cases analyzed afterwards in the paper.

The first demographic subgroups analyzed were male and female respondents. Table 3 presents the results for males and females separately. The DID estimator finds no difference between the reaction of males and females to the tax cut, as its impact is almost exactly the same. However the AI estimate is much larger for females and is statistically significant. This is a very important policy result considering the lobby for the reduction of tobacco taxes. Again the BCD

estimate lies between the first two estimates. Turning to different age groups, interesting results are apparent in Table 4.

Table 3

Proportions of smokers in each region before and after the tax cut and impact of the tax change on the proportion of smokers (male and female)

Tax cut	SEX	*N*	P_1	P_0
yes	Male	2961	0.317	0.297
yes	Female	3584	0.306	0.274
no	Male	2666	0.320	0.290
no	Female	3127	0.255	0.213

Sex	DID Impact	*z*	AI impact	z	BCD impact
Male	0.009797	1.412	0.0095	1.436	0.0097
Female	0.010108	1.525	0.0186	2.675*	0.0145

AI Bounds	Lower	Upper
Male	-0,020	0.317
Female	-0.033	0.306

Note:* significant at the 1% level.

Table 4

Proportions of smokers in each region before and after the tax cut and impact of the tax change on the proportion of smokers (age groups)

Tax cut	Age	*N*	P_1	P_0
Yes				
	15-19	1371	0.294	0.267
	20-24	1072	0.405	0.346
	25-34	877	0.357	0.325
	35-44	762	0.361	0.343
	45-54	362	0.305	0.280
	55-64	379	0.264	0.240
	65-69	644	0.228	0.202
	70+	1078	0.128	0.119
No	15-19	1167	0.289	0.241

20-24	854	0.371	0.325
25-34	776	0.349	0.331
35-44	675	0.241	0.222
45-54	407	0.364	0.295
55-64	380	0.253	0.187
65-69	538	0.179	0.140
70+	996	0.139	0.127

Age	DID Impact	z	AI Impact	z	BCD Impact
15-19	0.021	1.44	0.022	1.60	0.215
20-24	-0.013	0.80	-0.010	-0.55	0.012
25-34	-0.014	-0.99	-0.130	-0.97	0.013
35-44	0.002	0.15	0.011	0.79	0.006
45-54	0.044	2,33**	0.033	2,04**	0.038
55-64	0.043	2,46**	0.046	2,76*	0.047
65-69	0.012	1.04	0.023	1.84	0.019
70+	0.004	0.50	0.001	0.39	0.003

Age	AI lower bound	AI upper bound
15-19	-0.027	0.294
20-24	-0.06	0.405
25-34	-0.031	0.357
35-44	-0.017	0.36
45-54	-0.026	0.305
55-64	-0.023	0.267
65-69	-0.026	0.228
70+	-0.009	0.128

Note: :* significant at the 1% level.; ** significant at the 5% level.

The results are similar by method except for the 45-54 age group where the AI estimate is considerably smaller than the DID estimate and the 65-69 age group where the AI estimate is larger and significant at the 10% level. We find that the impact is large for 3 groups, the very young and the middle aged. The fact that the young are affected is worrisome given that almost all individuals report having smoked their first cigarette before 20 years of age. To pursue this result, we measured the impact of the tax cut on the young by sex. We will provide an explanation of the impacts for the middle aged group later with results from other sub-samples.

The results for young individuals by sex are found in Table 5. They show that young males, results being very similar for all three methods, were extremely sensitive to the tax cut whatever the method used for estimation.

Table 5

Proportions of smokers in each region before and after the tax cut and impact of the tax change on the proportion of smokers (male and female, 15-19)

Sex	Tax cut	*N*	P_1	P_0	
M	Yes	684	0.271	0.264	
F	Yes	687	0.317	0.270	
M	No	599	0.283	0.228	
F	No	568	0.295	0.254	
SEX	DID Impact	z	AI Impact	z	BCD Impact
M	0.0479	2.26**	0.0479	2.40**	0.0466
F	-0.007	-0.35	-0.0039	-0.2	

AI Bounds	Lower	Upper
Male	-0.007	0.271
Female	-0.047	0.317

Note: ** significant at the 5% level.

Table 6 presents the results of the tax cuts for the separated or divorced, who are mostly middle aged individuals. As for young males, whichever the method used, separated or divorced individuals are very sensitive to the tax cuts.

The last groups we will analyze are based on education levels as individuals who are poorly educated are more probable smokers. Individuals were separated in 4 groups, (1) no high

school diploma, (2) completed secondary, (3) completed community college, (4) completed university. The results are in Table 7. Only for the lower education group did we find a significant effect, for the other three the effects are very small and far from significant.

Table 6

Proportions of smokers in each region before and after the tax cut and impact of the tax change on the proportion of smokers (separated or divorced)

Tax cut	*N*	P_1	P_0	
Yes	430	0.449	0.434	
No	362	0.449	0.391	
DID Impact	Z	AI Impact	Z	BCD Impact
0.044	2.17**	0.044	2.27**	0.044

Note: **significant at the 5% level.

Table 7

Proportions of smokers in each region before and after the tax cut and impact of the tax change on the proportion of smokers with a low level of education

Tax cut	*N*	P_1	P_0	
Yes	2268	0.319	0.300	
No	1978	0.307	0.255	
DID Impact	z	AI Impact	z	BCD Impact
0.0336	4.10*	0.0356	4.52*	0.0346

AI bounds	lower	upper
	-0,019	0,319

Note: *significant at the 1% level. Because the education level is asked in wave 2, the total number of available observations is less than 12,338 for the analysis as the number of respondents dropped from 15,408 in wave 1 to 13,150 in wave 2. Since we keep respondents that answer in wave 1 and wave 4, we end up with 11402 for the analysis based on education level.

We obtain a strong positive and statistically significant effect for the individuals in the group with the lowest level of education who are from lower income households so that the increase in disposable income after the tax cut is the highest in percentage terms for this group. They are also in a group where smoking is less frowned upon. Also, middle aged groups are cohorts with a larger proportion of less educated individuals. Therefore, since middle aged individuals have many separated or divorced individuals and that they are less educated than the younger cohorts plus the fact that they started to smoke in a period where the dangers of smoking were less known explain why the impact of prices for this group could be larger. Results are very similar across methods.

Of course, the attribution of the changes in smoking to the differential in taxes across regions is correct if differential in smoking trends were not present before the price changes. As mentioned in Hamilton et al, there is no evidence of a stronger negative trend in smoking in the no tax cut areas before the price changes. Second, there must not be any regional specific factor other than the price change after the price affecting smoking for the estimates to be valid. This assumption is plausible given that our panel, spanning only 18 months, is relatively short, so that other major factors affecting smoking could not be regional specific without being observed.

We now compute for these three groups with strong impacts, the percentage who quit, and who continue smoking. Table 8 presents the results for all three groups. In all three cases, the main channel of the price effect is the differences in quit rates which is very similar for the three groups**:** for young males, the quit rate (start rate) is 2.89 (1.89) percentage points lower (higher) in the tax cut region, for separated or divorced, 3.2 (1.16) points lower (higher), and for the low education group, it is 3.19 (.18) lower (higher). The largest effect of starts is for young males. This is not surprising as most individuals start smoking before they are 20 years of age. Hence, the main channel for the positive effect of the tax cuts is its effect on quit rates. The policy discouraged individuals from quitting.

3. Own-price elasticities of the prevalence of smoking and of cigarettes smoked

Our results provide evidence that the decrease in prices had an important effect on smoking behavior in particular for specific demographic sub-groups and a small positive aggregate effect on the prevalence of smokers. These effects hide much larger effects if we assume that the price change was not effective for the whole population. Note that the opportunity to buy cheap cigarettes in the informal economy was not equally shared by all potential consumers, but it certainly concerned an increasing number of households. So the effect of the price decrease, first by smuggling opportunities, then by a change of the official price, is perhaps under-estimated. We try in this section to take into account the change in the proportions of smokers, the resulting changes in the total quantities of cigarettes, in the first quarter and later, and the pervasiveness of the black market in order to compute approximate price elasticities for the proportion who smoked and the quantities smoked.

The mean percentage decrease in the price of cigarettes depends on the accessibility of black market cigarettes. In Quebec, for example, before February 9 1994, date of the tax cut, the price of a carton was 47 $ after tax. After the tax cut, the price dropped to 22.73 $. We postulate that the average price decrease on a carton was 47 minus 22.73, 24.27 dollars, a decrease 51.64%. The post-tax-change price is probably quite close to the black market price as the latter collapsed in a few months. However, according to some researchers who sampled cigarette smokers in Quebec, the price drop concerned in fact only 60% of the population (Fortin 2002). We will use the numbers from Quebec to compute the elasticities of the *proportion of smokers* as the price changes in other provinces were quite similar. Assuming that 50% (because the survey in Fortin

2002 probably underreports the proportion with access to black market cigarettes) of the population has access to black market cigarettes, we compute, first, the elasticities of the proportion of smokers with respect to the price change, computed at the proportion who smoked after the price change. For *young males*, there is a change .048, since the proportion who smoke in the spring of 1995 is .264, our estimated proportion smoking without the price change is .216. Hence the increase in percentage is 18 points. Since we assume that only 50 percent experienced a price change, the effect is of the order of 36.2%. Since the price decrease was 51.64 percent, we obtain an elasticity of .70 which is considerably high. Using the same logic, for *low-education* individuals, the elasticity is .44, while it is .40 for *separated or divorced individuals*. The magnitude of the effects is large, given our reasonable assumptions, and should be of concern for policy makers

Table 8

The percentage of individuals who quit and start smoking for groups with a large impact of the tax cuts

Young Males					
Tax cut	Yes	Percent	Tax cut	No	Percent
Quit		7.34	Quit		10.23
Start		6.63	Start		4.74
Separated or divorced					
tax cut	Yes	Percent	Tax cut	No	Percent
Quit		4.25	Quit		7.45
Start		2.78	Start		1.62
Low level of education					
Tax cut	Yes	Percent	Tax cut	No	Percent
Quit		3.76	Quit		6.95
Start		1.88	Start		1.70

In order to estimate the price elasticity of the *quantities of cigarettes smoked*, since we do not observe the quantity smoked before the price change, but only whether individuals smoked or not, we make two assumptions which produce a lower bound for the estimate:

A1: Individuals who smoke in January 1994 and in the spring of 1995 smoke on average the same number of cigarettes, therefore we assume the price change does not change quantities smoked by these individuals.

A2: Individuals who quit smoking, smoked on average the same amount in January as in the first month of the survey.

Given that we compute the quit rates, the start rates, the mean number of cigarettes smoked in the last wave of the survey for those who started to smoke and the mean number of cigarettes smoked by those who quit smoking before they quit, we can compute the mean increase in cigarettes smoked for both tax regions. Given the mean number of cigarettes smoked in wave 1 of the survey, we can compute the price elasticity of cigarettes smoked.

Table 9

Impact of the tax change on the quantities of cigarettes smoked

	Tax cut	Mean cigarettes Quitters	Quit Rate	Mean cigarettes Starters	Start rate	Change in quantities smoked	Impact
Young males	Yes	11.56	0.073	7.01	0.066	-0.384	0.134
	No	7.47	0.102	5.20	0.047	-0.518	
Separated or	Yes	12.73	0.043	7.16	0.028	-0.342	0.280
Divorced	No	10.56	0.075	10.16	0.016	-0.622	
Low	Yes	14.87	0.038		0.019	-0.559	0.231
Education	No	11.37	0.070		0.017	-0.790	

Note: we do not observe mean quantities smoked for new smokers in the low education group as too few start smoking in this group, however, this does not make much of a difference as the start rates are practically the same in both regions

Assuming that 50% of individuals have access to the black market, the estimated impacts of the price change on quantities smoked are .268 for young males, .560 for the separated or divorced, and .462 for the low educated group. The means for the number of cigarettes smoked for these three groups in the region where tax cuts were effective are respectively, 3.11, 8.29, and 5.59. The elasticities are thus, -.167, -.130 and -.160. Therefore, the unconditional elasticities for the quantities smoked are much smaller than for the probability smoked. Of course, these are lower bounds because the total price elasticities contain also the changes in the quantities smoked by persistent smokers, which we cannot estimate using this survey.

Conclusion

The important price change experienced by Canada in 1994 makes possible the estimation of direct price elasticities of the quantities of cigarettes smoked in terms of the net entries of new smokers as well as the price elasticity of the proportion who smoke. The results for quantities seem robust and confirm early estimates using individual data, between -.2 and -.4. For the proportion who smoke, price elasticities range from -.4 to -.7. The main effect of the price decrease seems to be the discouragement of individuals from quitting, rather than an effect on new smokers. Detailed estimates for sub-populations show stronger price effects for the young, separated individuals and less educated persons. These elasticities add to the effect of the price decrease on the quantities smoked by persistent smokers (note also that the price decrease may result in an increase in the quality of cigarettes as well as increased quantities). These results should be of concern to policy makers as they are lobbied into reducing once more the price of cigarettes[4]. The effect seems to be larger for women than for men, which can indicate stronger addictive behavior, or the fact that less women being smokers, the marginal smokers reacts more to price reductions. Effects on young males are particularly distressing as addiction to smoking

[4] Note that gradual changes may have different consequences than large unique price changes. This can only be analyzed for different types of individuals with a long panel.

starts at a young age. Secondly, the uneducated group is certainly at risk, without smoking, of developing health problems (poor eating habits, obsesity), therefore addition of more risks to this group can be very costly to society. The same can be said of separated or divorced individuals because they are in low-income households and at risk of developing health problems. Furthermore, assuming that 50% of individuals had access to the black market, the treatment on the treated effect (effect on those who actually experience the price change) is double the size of the estimated effects on the whole population.

The evidence in this paper, confirming the results in Hamilton et al. using more modern methods, should be of great concern to policy makers who are tempted to repeat the exercise of 1994. If the trade-off to eradicate the black market is increasing the proportion of young males smoking by 5 percentage points and starting a whole new generation of new smokers, the price seems very high to pay.

References

Athey, Susan, and Guido Imbens (2006) 'Identification and inference in nonlinear difference-in-difference models,' *Econometrica* 74, 431-498.

Becker, Gary S. and Kevin M. Murphy (1988), 'A theory of rational addiction', *Journal of Political Economy, vol.* 96, 675-700.

Becker, Gary S., Michael Grossman, and Kevin M. Murphy (1994) 'An empirical analysis of cigarette addiction,' *American Economic Review* 84, 396-418.

Blundell, Richard, and Monica Costas-Diaz (2009), 'Alternative approaches to evaluation in empirical microeconomics,' *Journal of Human Resources* 44, 565-640.

Chaloupka, Frank J. (1991) 'Rational addictive behavior and cigarette smoking', *Journal of Political Economy* 99, 722-742.

Chalouka, Frank J. (1992) 'Clean indoor air laws, addiction and cigarette smoking,' *Applied Economics* 24, 192-204.

Cook, Philip J., and and George Tauchen (1982) 'The effect of liquor taxes on heavy drinking', *The Bell Journal of Economics* 13, 379-390.

Dupont, Diane P., and Anthony J. Ward (2002) 'The Economic impacts of cigarette tax reductions on youth smoking in Canada,' working paper, Department of Economics, Brock University.

Farrelly, Matthew C., and Mark Engelen (2008) 'Cigarette prices, smoking, and the poor, revisited,' *American Journal of Public Health* 98, 582-583.

Fortin, Bernard (2002) 'Les enjeux de l'économie souterraine,' Séries scientifiques, working paper 2002-s89, CIRANO.

Franks, Peter, Anthony F. Jerant, J. Paul Leigh, Dennis Lee, Alan Chiem, Ilene Lewis, and Sandy Lee (2007) 'Cigarette prices, smoking, and the poor: implications of recent trends`, *American Journal of Public Health* 97, 1873-1877.

Gallet, Craig. A., and John. A. List (2003) 'Cigarette demand: a meta-analysis of elasticities', *Health Economics* 12: 821-835.

Gardes, François, Salah Ghabri, and Philip Merrigan (2000) 'Le Comportement des Fumeurs de Cigarettes Canadiens: une Analyse des Enquêtes sur le Tabagisme (Statistique Canada, 1994-95),' Rapport Inserm sur les comportements des usagers de produits illicites.

Gilmore, Jason (2000) 'Report on cigarettes smoking prevalence in Canada 1985-1999', Statistics Canada, Division des Statistiques sur la Santé, report 82F0077XIF.

Gruber, Jonathan, Sen, Anindya Sen and Mark Stabile (2003) 'Estimating price elasticities when there is smuggling:the sensitivity of smoking to price in Canada,' *Journal of Health Economics* 22, 821–842.

Hamilton, Vivian. , Carey Levington, Yvan St.-Pierre, and Franque Grimard (1997) 'The effect of tobacco tax cuts on cigarette smoking in Canada**,'** *Canadian Medical Association Journal* 156, 187-191.

Kopp, Paul (2004), *Political Economy of Illegal Drugs*, Routledge, London and New-York.

Luk, Rita, Joanna E. Cohen, Ferrence Roberta (2007) 'Contraband cigarettes in Ontario,' The Ontario Tobacco Research Unit.

Mullahy, John (1985), *Cigarette Smoking: Habits, Health Concerns, and Heterogeneous Unobservables in a Micro-Econometric Analysis of Consumer Demand*, Ph.D. Dissertation, University of Virginia, Charlottesville.

Ouellet, Jean François (2010) 'L'échec des politiques de taxation à combattre le tabagisme : les résultats de l'enquête de Statistiques Canada de 1994,' w.p. HEC Montréal.

Zhang, Bo, Joanna Cohen, Roberta Ferrence, and Jürgen Rehm (2006) 'The impact of tobacco tax cuts on smoking initiation among Canadian young adults,' *American Journal of Preventive Medecine* 30, 474-479.