
Tobacco tax and smoking rate in Canada during the period of Federal
Tobacco Control Strategy (FTCS), 2002-2011

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Abstract: The objective of this paper is to test the effect of tobacco tax on cigarette smoking among Canadian population during the ten years period when Federal Tobacco Control Strategy (FTCS) is implemented. The Federal Tobacco Control Strategy (referred to as either the FTCS or the Strategy throughout the paper) is a comprehensive tobacco control campaign, led by Health Canada which includes various tobacco control interventions, many of them are new to Canada. During the first ten year initiative of FTCS, the tobacco control environment is largely different than before and it maintained at a similar level during the decade, this provide us a natural environment where the tobacco control policies other than taxation can be relatively hold constant.

This study uses the smoking survey data from Canadian Tobacco Use Monitoring Survey (CTUMS) and average annual excise tax data from the Finance of the Nation during 2002-2011. The background being set, this paper estimates the effect of cigarette tax on the smoking participation among Canadian smokers. There are two measures of outcome, daily smokers represents the population who smokes every day and the current smokers represents those either smokes every day and smokes occasionally. I finds that the increase in cigarette tax will significantly reduce the percentage of daily smokers. From a numerical point of view, a 1% increase in cigarette tax will reduce the percentage of daily smokers by 16.1%. However, the increase in tobacco tax will not affect the percentage of current smokers. In the heterogeneity analysis, this paper splits the original sample into the following age groups: "15+", "15-19", "20-24", "25-44", "45+". This paper finds that the increase in cigarette tax will significantly reduce the percentage of daily smokers for age group only in "15+", "25-44", and have no significant effect on other age groups. And the raise of cigarette tax will increase the percentage of current smokers for age group "15-19", but has no significant effect on percentage of current smokers of other age groups. At last, we also analyze the impact of cigarette tax on the percentage of children exposed to second hand smoking at home. I found that the increase in cigarette tax will significantly reduce the percentage of children exposed to tobacco smoking environment at home. From a numerical point of view, a 1% increase in cigarette tax will reduce the percentage of children exposed at home to environmental tobacco smoke by 65.1%.

Key words: cigarette tax; percentage of current smokers; percentage of daily smokers.

1.INTRODUCTION

It is well established that cigarette smoking relates to many serious diseases and causes severe damage to smokers' health. Cigarettes contain more than 7000 chemicals when they are burnt, among them about 70 chemicals are known to cause cancer and many others cause heart and lung diseases (Harmful Chemicals in Tobacco Products, 2017). According to an overview of *Canada's Federal Tobacco Control Strategy* published on the Government of Canada's website, cigarette smoking kills about 37,000 Canadians every year and many of them are preventable deaths (Strong Foundation, Renewed Focus: An Overview of Canada's Federal Tobacco Control Strategy 2012-17, 2012).

We assume smokers in different age groups have different consumption patterns and habits with cigarettes, and may react differently to the change of tobacco tax. According to "*Tobacco Use in Canada: Patterns and Trends, 2017 Edition*", in Canada, both smoking prevalence and cigarette consumption varied largely among different age groups in recent years. In 2017, while smoking is most prevalent among adults who are aged between 45-54, with a prevalence of 19.9%, the younger adults who aged between 15-19 has the lowest prevalence (7.9%) (Reid et al. 2019). There has been a large literature focused on the effect of cigarette tax on tobacco control. Most of them were focused on smoking issues among the youth, given smoking can induce serious damage on health if one smokes from a young age and this is also a critical period to take up addictive habits. However, there has been relatively less attention on the impact of tax on the smoking among older age groups. DeCicca and Mcleod (2008) argues that, the importance of smoking cessation in later stages of life cannot be understated. They listed a collection of scientific evidence from reliable sources indicating that even in one's 40s and 50s smoking cessation can still have an immediate and substantial improvement on one's health. In this respect, I focus on population with age 15 and older, and divide our sample into five different age groups "15+", "15-19", "20-24", "25-44", "45+" and evaluate their reaction to price changes in cigarette respectively.

The main purpose of this study is to find the impact of cigarette tax on smoking prevalence amongst Canadian population and evaluate how sensitive each age groups are to the tax changes. This study focused on empirical analysis during year 2002 to 2011, during this period the Federal Tobacco Control Strategy was implemented. The Federal Tobacco Control Strategy (referred to as either the FTCS or the Strategy throughout the paper) is a campaign launched by Health Canada, in 2002 which includes various interventions to reduce smoking. Smoking prevalence relates not only to cigarettes' price which in large part is related to the it's taxation, but also relates to many other factors such as public health education, smoke free law, the warning label on cigarette pack, etc. many of these social campaigns are under the supervision of FTCS. During the period the strategy is in place, tobacco control efforts have been made at a similar level, thus it provides us a natural environment to test the effect of tax changes holding the other tobacco control interventions at a relatively similar level.

Since early 1960s, after Canada implemented the first tobacco control program to reduce the diseases and death due to tobacco use, various strategies were introduced. Over the time tobacco control strategies undertaken by the Government have evolved and became more comprehensive. Beginning in 2001, FTCS was introduced as the new tobacco control program replacing the previous program. It was initially a 10-year program (2002-2011) aiming at further reducing tobacco consumption and its harm on public health by undertaking some even more comprehensive and up-to-date measures (Federal Tobacco Control Strategy 2001-2011- Horizontal Evaluation, 2012). As a result, a steady decrease in the overall smoking prevalence among Canadians in all age groups can be observed during this ten years period. (Canadian Tobacco Use Monitoring Survey: overview of historical data, 1999 to 2012, 2013) The FTCS entails the most of tobacco control measures but does not include taxation of tobacco product which is under the supervision of Department of Finance (Federal Tobacco Control Strategy 2001-2011- Horizontal Evaluation, 2012). Taxation as a tool of tobacco control has more directly influence on people's consumption of tobacco than FTCS strategies, because it changes the price consumers pay. Based on the consensus that when price increase, consumption will decrease, people normally assume that an increase in tobacco tax which will raise cigarette prices and will eventually decrease the amount of cigarette consumption. And how much the consumption will be reduced depends on each individual's responsiveness to the price. However, given the cigarette is a special kind of good, because it is addictive, people's demand on it may not follow the above consensus which suggests a higher price will decrease the demand. And we also assume people at different ages and with different length of smoking history will respond differently towards the price changes.

I obtained the smoking survey data from Canadian Tobacco Use Monitoring Survey (CTUMS) a survey carried out by Health Canada, and the average annual excise tax data from the Finance of the Nation. The smoking prevalence is presented in two measures, namely the daily smoking rate which is the percentage of people who smokes every day out of the whole population, and the current smoking rate which is percentage of people who either smokes every day or smokes occasionally. I found that tax raised have a significant effect on the reduction of smoking rate, a 1% increment of cigarette tax will cause the daily smoker rate to decrease by 16.1% and the current smoker rate by an approximate 3.2%. This paper is also interested in how the raise of tobacco tax will reduce children's exposure to second-hand smoking at home, the result is surprisingly large, for 1% raise in tobacco tax the percentage of children exposed to second-hand smoking will drop by 65.1%.

2. LITERATURE REVIEW

An article by Phongsack Manivong, Sam Harper and Erin Strump evaluated the impact of excise tax on Canadian youth aged 15-18 during 2002-2012 which is the ten years' period when Federal Tobacco Control Strategy (FTCS) came into effect (Manivong, Harper, and Strump 2017). According to Manivong

et al., (2017) the result of previous studies may no longer suitable for today's circumstances and a more up to date study is necessary. They pointed out three limitations we are facing when using the results of previous studies to make inferences with regard to a Canadian setting today.

The first limitation and also the most intensely discussed one is the change of Canadian tobacco control environment after Federal Tobacco Control Strategy (FTCS) has implemented. FTCS is consisted of two key components, that is the introduction of smoking free laws in many local governments which mainly bans smoking in public space and the Tobacco Act implemented by the federal government which mainly restricts manufacture, sale, access and promotion of tobacco product (Manivong et al. 2017). The establishment of FTCS changed tobacco control environment in Canada in a large degree, before FTCS was introduced tobacco taxes were largely the only contribution to the change in Tobacco consumption, after FTCS was introduced, other forms of tobacco control like Tobacco Act also contribute to the change in tobacco consumption. During the time of FTCS, the effect of FTCS and the effect of taxes coincided, and we do not know how much of the recently decline in tobacco consumption are contributed by tax changes. Thus a new study focusing on the time of FTCS is necessary.

The second limitation of using international studies to estimate in a Canadian setting is the tobacco tax level and tobacco control strategies are different across countries. Tobacco as an addictive product, it's price elasticity is very sensitive to price ranges and the population being studied and people's sentiment toward smoking, thus we cannot adopt international studies to explain what is happening in Canada.

The authors speak the third limitation as the use of average annual provincial taxes as the indicator of tax policy. According to *Statistic Canada*. (2018), in Canada, tobacco taxes are levied at both federal and provincial level, unlike the federal excise tax apply to all tobacco product over Canada, provincial governments have its own autonomy to set its tobacco tax. Provincial excise tax varies largely among provinces, some provinces lowered its tobacco tax as a strategy to fight contraband cigarette and illegal smuggling, while other provinces raised taxes to suppress cigarette consumption. The problem this caused to the study is that the change of tax often occurs during the year, thus the use of average annual tobacco tax as variable are not strictly unbiased. This perspective is supported by Karin (2012) who argues that the inconsistencies in the application of taxes on tobacco makes tracking of the tax amount quite difficult. The reason is because, while at some point the consumption might be low due to the application of the taxes, that might change over the course of a year due to inconsistent changes in the taxes.

Manivong et al., (2017) studied two specific smoking outcomes: the past-week smoking status and smoking frequency among Canadian youth. It extracted smoking related data from Canadian Tobacco Use Monitoring Survey (CTUMS), a semi-annual survey conducted by Health Canada, providing data of smoking prevalence and frequency along with some basic socio demographic information about the participants. The tax data were from the Finances of the Nation report from 2002 to 2012 and the authors

adjusted the taxes by Consumer Price Index (CPI) to offset the effect of inflation (this is doable because excise tax in Canada is a kind of uniform tax, it charges the same amount for every carton of cigarette). With these essential data, the authors run a series of different-in- different regression models. The basic model including smoking outcome as dependent variable, tax per pack cigarette as independent variable and a series control variable. These control variables control the effect of province, year, individual-level characteristics and time-varying provincial-level characteristic.

With the year and province effect fixed in the basic model, the regression results indicates a negative relationship between cigarette tax and smoking outcomes, however, the estimated effect of cigarette tax on both smoking prevalence and frequency are not statistically significant at 95% Confidence level (Manivong, Harper, and Strump 2017). For every one dollar increase in tax per pack of cigarette, smoking prevalence decrease by 0.2%, smoking frequency decrease by 0.3. Individual and provincial-level covariates are proofed not having much effect on smoking. Together these results indicate that after fixed the effect of province and year, cigarette tax has no significant effect of the current decreasing trend of smoking rate among Canadian youth. The findings therefore made by Manivong et al., (2017) in this analysis is consistent with what Phongsack (2017) have expressed that there is possibilities of negative correlation between cigarette tax and smoking outcomes. That is because there are numerous other factors which have to be factored in while conducting such analysis. In addition, taxes might not only be the factor that can influence consumption of tobacco at the same time. In this respect, as much as taxes might be instituted in order to help cub the consumption of tobacco, there are other factors like good economic times which might be in place and offers support for continued consumption of tobacco. Reid (2017) agrees to this perspective by projecting that, good economic times increases the consumption potential of any individual in an economy that is doing well. That is because the incomes are relatively high and the inflation rates are also low. In that respect, instituting taxes on products like tobacco might not have a lot of financial effect on the consumers hence the consumers stand greater chances of continued consumption of the products normally.

The authors explained this result as the effect of other factors like provincial smoke-free law, Tobacco retail display ban and graphic warning labels that were implemented during the same period of time outweigh the effect of changing in tobacco tax (Phongsack Manivong, 2017). This seems a good explanation for why the tax lost its contribution on recent decline in prevalence among young smokers during this time period.

3.2. Philip DeCicca and Logan McLeod, 2008

DeCicca and Mcleod (2008) focused on the effect of cigarette tax on older adult smoking in the U.S. According to DeCicca and Mcleod (2008), this is a scientific proofed fact is quitting smoke can yield substantial health benefit even for older adults who have been smoking for a long time in their life. DeCicca and Mcleod (2008) referred to the U.S. surgeon general's study (USDHHS, 1990) and stated that smoking

cessation benefits older smokers in two ways: it significantly reduces mortality and increase longevity. Population quit smoke not only have an averagely longer life span but also living a healthier than those were not quitting. Together this evidence constructed the motivation of the study of the effect of tax on older smokers.

DeCicca and Mcleod (2008) extracts smoking related data from Behavioral Risk Factor Surveillance System (BRFSS). BRFSS is an U.S. based annual telephone survey collecting smoking related data for adults of 18 years old and older and participants' health status and basic demographic information. The authors extract the individual level data for individuals aged between 45 and 59 during year 2000—2005. Two smoking measures are used as two indicator variables in the basic regression model: Participants were asked whether they smoke on all day or not and whether they smoke on at least some days or not, if answered yes the variable has the value 1 if answered no the variable has the value 0. The cigarette tax data used is cigarette tax of pack of 20 cigarettes, this dollar amount of tax is adjusted based on 2001 dollar to offset the inflation. Cigarette tax used in this study is recorded monthly between the year of 2000 and 2005 this is to identify the effect of change which happen with in the year.

The basic model includes the two smoking measures I mentioned above as dependent variables, cigarette tax of each states recorded monthly as the independent variable and a series of control variables controlling the effect of state, year, month and other smoking regulations that varies across states. After controlling the effects of these variables, the estimate suggests that tax has a significant effect on reducing smoking participation and older smokers are substantial sensitive to cigarette tax. 1-dollar increase in tax lead to 6-8% decline smoking participation among American smokers who age between 45 and 59. In general, the less educated group are more sensitive to cigarette tax than their more educated counterparts. The perspective expressed by DeCicca and Mcleod (2008) is in line with what Karin (2012) projects on regulated smoking or abandoned smoking. *Statistic Canada*. (2018) argues that, regulated or abandoning smoking help to improve the health condition of elderly smokers with a whopping 40% proportion. The case is even better for smokers who are still young. That is because it limits their risk of developing tobacco smoking related health complications by over 70%. In this respect, regulated or abandoning smoking is considered as an important measure that can be taken in helping to ensure that the possible threats that smoking has on the health of the smokers are reversed or prevented. That is both biological and economical. Reason being that by regulating smoking or stopping it an individual stands better chances of limiting the nicotine and other toxins which are damped in their bodies as a result of smoking. In this respect, they limit their potential hazardous exposure to health complications that comes with excessive smoking. On the economic perspective Phongsack (2017) argues that regulated smoking or stopping smoking works to help channel the cost of smoking to other productive initiatives like increased attention to better healthcare as

well as better diet and other health improving activities which would work to improve the health conditions of the individual.

3. DATA

3.1. Smoking data.

This analysis obtained data from Canadian Tobacco Use Monitoring Survey (CTUMS), a smoking survey conducted by Health Canada, which contains smoking related data of Canadian aged 15 and older along with basic demographic information of the participants (Canadian Tobacco Use Monitoring Survey: overview of historical data, 1999 to 2012, 2013). CTUMS began in the year of 1999 and lasted until 2012, between this 14 years' period smoking data were collected semi-annually.

For individual level data is not available for download, this analysis deployed year and province specific data. The province specific data is from 10 provinces, for this survey has not conducted in the 3 territories. The survey is launched in 1999 until 2012, however, this analysis will only use the data between 2002 and 2011, which match the period of Federal Tobacco Control Strategy (FTCS). The reason of doing so is to ensure that we evaluate the impact of tax changes while controlling for the effect of other interventions launched by FTCS. The data set provided this study with two measures of smoking participation, namely the percentage of daily smokers and the percentage of current smokers. The percentage of daily smokers is the percentage of participants who reported to smoke every day out of the total population and the percentage of current smokers is the percentage of participants who reported both to smoke occasionally and to smoke every day. There is total of 100 observations for each measure of smoking participation.

The lack of individual level data restricts the empirical analysis, without individual level data, the regression cannot control individual level characteristic which may have an influence on smoking participation. These individual level characteristics include gender, education level, income level, number of household and so on, all these characteristics are proofed to have association with smoking participation in earlier literature. Fail to identify them may lead to bias results in the regression. According to (Manivong, Harper, and Strump 2017), in which the authors also employed data from CTUMS survey, but has focused on study the younger age group, suggested that individual level covariates have little effect on the smoking participation for youth. However, this cannot say that individual level covariates can be omitted.

3.2 Tax data

This analysis used average annual excise tax data from the Finance of the Nation 2002—2011 reports provided by Canadian Tax Foundation (Treff and Ort 2012). In Canada, cigarette taxes are imposed on both federal and provincial levels (Tobacco Tax, 2018), both Federal and provincial level tax are levied on an ad valorem basis which means the tax is a fixed amount for a certain amount of cigarette. In the report,

cigarette taxes were reported in dollar amount per carton of 200 cigarettes, I converted them into tax per pack of 20 cigarettes.

During the years between 2002 and 2011, cigarette taxes varied largely among provinces. If we look at the tax amount, the federal excise tax remained relatively unchanged during this period, provincial excise tax tends to cause the most variation in the total amount of tax. Provinces had autonomy to adjust their provincial excise tax and adopted different tax policies during this period. In these 10 years, cigarette tax in Prince Edward Island increased at the fastest pace, its tax increased by 71% by 2011, in contrast, the province with the slowest pace is Quebec in where nominal cigarette tax only increased by 11%, these numbers give a sense of how large the variation is among the provincial implemented tobacco tax .

4. SPECIFICATION

The empirical analysis is based on the following equation:

$$\ln pds_{pt} = \alpha_0 + \alpha_1 \ln tax_{pt} + \delta_p + \delta_t + \epsilon_{pt} \quad (1)$$

$$\ln pcs_{pt} = \alpha_0 + \alpha_1 \ln tax_{pt} + \delta_p + \delta_t + \epsilon_{pt} \quad (2)$$

This equation is used to estimate the effect of cigarette tax on the smoking participation on Canadian smokers. On the left side of the equation (1), $\ln pds_{pt}$ is log of average of the percentage of daily smokers. On the left side of the equation (2), $\ln pcs_{pt}$ is log of average of the percentage of current smokers. The small 'p' indicates the province of the smoking data, the small 't' indicates in which year the data is collected. $\ln tax_{pt}$ is the average of real cigarette tax of province 'p' and year 't'. I only use provincial level data levied in each province.

A particular concern is there may be unobserved Provincial level factors, like local tobacco control program or municipal level cigarette restricting law which reflect people's sentiment toward smoking in the particular provinces. These factors could be correlated with cigarette tax level as well have an influence on people's smoking behaviors, fail to identify these factors may lead to omitted variable bias. Omitted variables may also be included in years, in certain years, smokers may smoke more or less than they usually would do, which may be caused by the change of macroeconomic circumstances of that year, I guess. To control these unobserved factors, I included a series of province fixed effect δ_p and year fixed effect δ_t to control the effect of province and year.

5. RESULTS

5.1 Baseline result

Table 1 reports the estimated results of Equation 1 and Equation 2. Column 1 to column 3 present the estimations of the cigarette tax on daily smoking rate and Column 4 to column 6 are that of current smoking

rate. In Column 1 and column 3, the specification is the simplest one, where smoking rate and tax variable will be regressed without the inclusion of dummy variables to control the effect of province and year. In Column 2 and column 4, we further include year fixed effect but not include province fixed effect. In Column 3 and column 6, we include both province and year fixed effect.

Columns 3 and 6 in Table 1 have the highest R-square, this means the models containing the year and provincial fixed effect explained most of the variation in our outcomes than the models without the fixed effects. From the results in column 3, we can conclude that the coefficient of *lntax* is significantly different from 0 at the 10% level. Therefore, the increase in cigarette tax will significantly reduce the percentage of daily smokers. From a numerical point of view, every 1% increase in cigarette tax will reduce the percentage of daily smokers by 16.1%. From the results in column 6, we find that the coefficient of *lntax* is not significant at the 10% level. Therefore, the increase in tobacco tax will not affect the percentage of current smokers.

Table 1: The baseline result

	lnpds			lnpcs		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>lntax</i>	-0.193*** (0.0692)	-0.0432 (0.0720)	-0.161* (0.0910)	-0.150** (0.0588)	-0.0230 (0.0609)	-0.0316 (0.0795)
<i>_cons</i>	3.420*** (0.237)	3.078*** (0.235)	3.453*** (0.291)	3.548*** (0.202)	3.234*** (0.199)	3.262*** (0.254)
Province fixed effect	No	No	Yes	No	No	Yes
Year fixed effect	No	Yes	Yes	No	Yes	Yes
N	100	100	100	100	100	100
<i>R</i> ²	0.074	0.268	0.723	0.063	0.265	0.706

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.2 Heterogeneity analysis

Considering that cigarette tax may have a heterogeneous impact on different age groups, we therefore divide the original data into the following groups according to age according to the characteristics of the data: "15+", "15-19", "20-24", "25-44", "45+".

Table 2 reports the estimated results of Equation 1 and Equation 2 for age is 15 older and we include both province and year fixed effect in each column. From the results in column 1 of table 2, we can conclude that the coefficient of *lntax* is significantly different from 0 at the 5% level. Therefore, the increase in cigarette tax will significantly reduce the percentage of daily smokers for age is 15 older. From a numerical point of view, every 1% increase in cigarette tax will reduce the percentage of daily smokers by 21%. From the results in column 2 of table 2, we find that the coefficient of *lntax* is not significant at the 10% level. Therefore, the increase in tobacco tax will not affect the percentage of current smokers for age is 15 older.

Table 2: The impact of cigarette tax for age "15+"

(1)	(2)
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	lnpds	lnpcs
Intax	-0.210** (0.0913)	-0.102 (0.0778)
_cons	3.567*** (0.292)	3.412*** (0.249)
Province fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
N	100	100
R ²	0.640	0.618

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 reports the estimated results of Equation 1 and Equation 2 for age is between 15 and 19, and we include both province and year fixed effect in each column. From the results of table 3, we can conclude that the coefficient of Intax is not significant on the percentage of daily smokers for age is between 15 and 19. However, the increase in tobacco tax will increase the percentage of current smokers for age is between 15 and 19.

Table 3: The impact of cigarette tax for age “15-19”

	(1) lnpds	(2) lnpcs
Intax	0.286 (0.215)	0.350* (0.178)
_cons	1.849*** (0.687)	1.936*** (0.568)
Province fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
N	94	100
R ²	0.724	0.671

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4 reports the estimated results of Equation 1 and Equation 2 for age is between 20 and 24, and we include both province and year fixed effect in each column. From the results of table 4, we can conclude that the coefficient of Intax is not significant in both column. Therefore, the increase in tobacco tax will not affect the percentage of daily smokers and the percentage of current smokers for age is between 20 and 24.

Table 4: The impact of cigarette tax for age “20-24”

	(1) lnpds	(2) lnpcs
Intax	-0.128 (0.166)	-0.0307 (0.155)
_cons	3.593*** (0.531)	3.555*** (0.494)
Province fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
N	100	100
R ²	0.615	0.489

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 reports the estimated results of Equation 1 and Equation 2 for age is between 25 and 44 and we include both province and year fixed effect in each column. From the results in column 1 of table 5, we can conclude that the coefficient of $\ln tax$ is significantly different from 0 at the 10% level. Therefore, the increase in cigarette tax will significantly reduce the percentage of daily smokers for age is between 25 and 44. From a numerical point of view, every 1% increase in cigarette tax will reduce the percentage of daily smokers by 31.6%. From the results in column 2 of table 5, we find that the coefficient of $\ln tax$ is not significant at the 10% level. Therefore, the increase in tobacco tax will not affect the percentage of current smokers for age is between 25 and 44.

Table 5: The impact of cigarette tax for age “25-44”

	(1) $\ln pds$	(2) $\ln pcs$
$\ln tax$	-0.316* (0.160)	-0.176 (0.131)
$_cons$	4.091*** (0.510)	3.841*** (0.419)
Province fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
N	100	100
R^2	0.461	0.467

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6 reports the estimated results of Equation 1 and Equation 2 for age is 45 older, and we include both province and year fixed effect in each column. From the results of table 6, we can conclude that the coefficient of $\ln tax$ is not significant in both column. Therefore, the increase in tobacco tax will not affect the percentage of daily smokers and the percentage of current smokers for age is 45 older.

Table 6: The impact of cigarette tax for age “45+”

	(1) $\ln pds$	(2) $\ln pcs$
$\ln tax$	-0.192 (0.160)	-0.127 (0.145)
$_cons$	3.275*** (0.513)	3.189*** (0.463)
Province fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
N	100	100
R^2	0.187	0.160

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.3 Further analysis

In this part, we further analysis the impact of cigarette tax on the percentage of children exposed at home to environmental tobacco smoke, abbreviated as “ETS”. Thus, we conduct the following equation:

$$\ln ets_{pt} = \alpha_0 + \alpha_1 \ln tax_{pt} + \delta_p + \delta_t + \epsilon_{pt} \quad (1)$$

On the left side of the equation (1), $\ln ets_{pt}$ is log of the percentage of children exposed at home to environmental tobacco smoke.

Table 7 reports the estimated results of Equation 3. In Column 1, the specification is the simplest one, where ets and tax variable will be regressed without the inclusion of dummy variables to control the effect of province and year. In Column 2, we further include year fixed effect but not include province fixed effect. In Column 3 and column 6, we include both province and year fixed effect.

Table 7: The impact of cigarette tax on ETS

	(1) $\ln _ets$	(2) $\ln _ets$	(3) $\ln _ets$
Intax	-1.268*** (0.206)	-0.685*** (0.184)	-0.651*** (0.196)
_cons	6.446*** (0.705)	4.969*** (0.600)	4.904*** (0.626)
Province fixed effect	No	No	Yes
Year fixed effect	No	Yes	Yes
N	92	92	92
R ²	0.296	0.596	0.947

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Columns 3 in Table 7 have the highest R-square, so their results are the most robust. From the results in column 3, we can conclude that the coefficient of Intax is significantly different from 0 at the 1% level. Therefore, the increase in cigarette tax will significantly reduce the percentage of children exposed at home to environmental tobacco smoke. From a numerical point of view, an 1% increase in cigarette tax will reduce the percentage of children exposed at home to environmental tobacco smoke by 65.1%.

7. CONCLUSION

This paper estimated the impact of 1% raise of tobacco tax on cigarettes on the smoking participation rate among Canadian adults, the smoking participation is measured by both the percentage of daily smokers and that of current smokers. We need to be aware that these participation rates are reflections of how frequent people smoked not how many cigarettes were consumed. Our results are more likely to be a good reflection on how many people are smoking less often or quitting, rather than telling us the change in the actually demand of cigarettes. To sum up, according to the estimation of this paper, tax on cigarettes has a negative effect on the percentage of both every day smokers and occasional smokers among Canadian population who are 15 years old or older. After controlling for the provincial and year fixed effect, for every 1% increase in cigarette tax, the percentage of daily smokers will drops by 16.1%, and the percentage of current smokers will decline by 3.2%. However, the accuracy of this estimation is still subject to further analysis, because it fails to take into account the effect of individual characteristics due to the lack of individual level data, it would be better if we can obtain the individual level data, and control for the effects

of some important personal characteristics like participants' gender, education level and their socio-economics status.

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Data available for use:

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Smoking Population, Age 15+, Canada, 1999 and 2012 Current Smoking Prevalence by Age, Canada, 1985-2012	https://www.canada.ca/en/health-canada/services/publications/healthy-living/canadian-tobacco-use-monitoring-survey-ctums-2012.html
Canadian Tobacco Use Monitoring Survey:	https://www.canada.ca/en/health-

historical tables 1999 to 2011	canada/services/publications/healthy-living/canadian-tobacco-use-monitoring-survey-historical-tables-1999-2011.html
Summary of Annual Results for 2012	https://www.canada.ca/en/health-canada/services/publications/healthy-living/canadian-tobacco-use-monitoring-survey-summary-2012.html
cigarette and fine-cut sales, Canada, 1980–2014	https://www.canada.ca/en/health-canada/services/publications/healthy-living/wholesales-sales-data-cigarette-fine-cut-sales-canada-1980-2014.html
National and provincial/territorial tobacco sales data 2019	https://www.canada.ca/en/health-canada/services/publications/healthy-living/federal-provincial-territorial-tobacco-sales-data.html
(CTUMS) 2012: supplementary tables	https://www.canada.ca/en/health-canada/services/publications/healthy-living/canadian-tobacco-use-monitoring-survey-2012-supplementary-tables.html

Tax data:

The data for cigarette tax is displayed in section 5:10 on each file.	https://www.ctf.ca/CTFWEB/EN/Publications/Finances_of_the_Nation.aspx
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Federal Tobacco Control Strategy 2001-2011-Horizontal Evaluation	https://www.canada.ca/en/health-canada/corporate/about-health-canada/accountability-performance-financial-reporting/evaluation-reports/federal-tobacco-control-strategy-2001-2011-horizontal-evaluation.html#a2
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