The Effect of Smoking on Physical Activity:

An Instrumental Variable Estimation Approach

by

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Contents

1 Introduction

The World Health Organization identifies smoking and physical inactivity as two of the top three largest modifiable risk factors for premature death and chronic disease in the developed world (World Health Organization, 2005). Medical research over the past two decades deems smoking as the major cause of lung cancer and chronic obstruction pulmonary disease; moreover, smoking is also strongly linked to heart disease, strokes, and several other types of cancer (Eriksen and Mackay, 2002). Studies show that regular participation in physical activity (PA) leads to an enhanced ability to perform daily tasks and reduces anxiety and depression, while inactivity leads to a greater prevalence of obesity, diabetes and cardiovascular disease (US Department of Health and Human Resources, 1996). Yet despite the health issues associated with smoking and physical inactivity, approximately 18% of Canadians over the age of 15 smoke, and two-thirds of Canadians age 20 and older do not meet the physically active standards set by Canada's Physical Activity Guide (Health Canada, 2008; Public Health Agency of Canada, 2006).

In a literature review of academic publications on the empirical relationship between smoking and PA, Kaczynski et al. (2008) conclude that, in general, previous literature finds that there is a negative correlation between the two. They admittedly state, however, that these studies cannot infer a causal relationship between the two activities; determining whether or not a causal relationship exists between these two activities is the main goal of this paper.

Using data from four cycles of the Canadian Community Health Survey (CCHS), I construct a model with PA as the dependent variable; I assume it is a function of the number of cigarettes smoked per month and various control variables. More specifically, given the likely endogeneity of the number of cigarettes smoked per month in this model, I use the monthly real price of a carton of cigarettes in a province as an instrumental variable (IV) for the number of cigarettes smoked.

To preview, my findings show that the real price of a carton of cigarettes acts as a valid IV for the number of cigarettes smoked per month, and that there is a statistically significant negative and causal relationship between smoking and PA. This causal inference is new to the research in this area and suggests that policies aimed at reducing smoking may have synergistic health effects; not only would there be health benefits from lowered smoking rates, but also from an increase in activity levels caused by these lowering of smoking rates.

The remainder of this paper proceeds as follows: Section 2 gives an overview of the previous literature on empirical PA models, and a brief discussion of the literature on the interaction between smoking and PA. In Section 3, a detailed discussion of the data and methodology are given. Section 4 summarizes the regression results. Finally, Section 5 contains concluding remarks.

2 Literature Review

McInnes and Shinogle (2009) take an innovative approach to this area of research by examining how economic and policy factors affect PA. They use data from the 2000-2005 Behavioural Risk Factor Surveillance System and merge it with state and county

data on "sin taxes" (beer and cigarette taxes), gyms and recreational facilities per capita, unemployment rates, crime rates and the prices of PA goods. In addition, their models include standard control variables, all of which possess coefficient signs and magnitudes that are intuitive and consistent with prior research.[1]

Their most interesting results come from the area-specific and the transportation price variables. They find that gas prices are negatively related and bus prices are positively related to PA. They interpret this unintuitive result for bus prices as suggesting that as bus prices rise, people who frequently use the bus as a mode of transportation may use the bus to go to places to engage in PA rather than use it to go to a more expensive leisure time activity (e.g. play sports outdoors rather than go to a movie). They also find that gyms and parks per capita are associated with more PA.[2] One drawback of their study is the fact that their data does not allow them to account for the time constraints facing men and women, such as the number of children in a household and the number of hours an individual works.

Contrary to the results in McInnes and Shinogle (2009), Ruhm (2005) finds that economic downturns and healthy lifestyles are related. Controlling for individual characteristics, state fixed-effects and month and year dummy variables, he uses a variety of econometric specifications and estimates that a one percent increase in the unemployment rate in the U.S. reduces the prevalence physical inactivity and smoking by 0.7 and 0.6 percent, respectfully. He interprets the physical inactivity result as suggesting

[1] These control variables are education, income, age, age squared, being married, and race.

[2] They do, however, note that the gyms and parks per capita variables may be endogenous because people who tend to engage in PA may be more likely to choose to live in amenity rich areas where opportunities to engage in PA are easily available.

that the opportunity cost of time generally falls during economic downturns and given that producing health is a time-intensive activity, the demand for health and its inputs, such as PA, are likely to rise when the price of time falls. Also, he interprets the smoking results as suggesting that smoking levels may fall during these downturns due to the fact that income declines.

Mullahy and Robert (2008) study the role that time constraints play in the level of PA one engages in. Using the 2005-2006 American Time Use Survey (ATUS), they find that people with more education tend to sleep less, spend less time in non-exercise leisure activity and exercise more, but only on weekends. They explain this weekend-exercise result by suggesting that people with more education generally feel a higher opportunity cost of time during the week and, therefore, spend more time working and less exercising.

Another study examining the link between PA and time constraints is Loh (2009). Using data from the American Health and Retirement Study (HRS), he investigates how a restriction on working hours affects the exercise decisions of working men age 51-61, inclusive. He finds that a working hour lower bound is partly responsible for lower levels of PA for this select set of the population. As a result, he concludes that providing employers with the incentives to relax working hour restrictions could increase exercise levels. A serious drawback of his study is the fact that it is limited only to men in a select age range.

Using cross-sectional data from the 2001 Greece census, Lentzas et al. (2005) regress a binary measure of PA on a vector consisting of sociodemographic and lifestyle characteristics. They infer that people who live healthier lifestyles, such as eating healthy

food and avoid smoking are more likely to engage in PA. At best, however, Lentzas et al. can associate a negative correlation between smoking and PA given that there exists several plausible endogeneity arguments for the smoking variable. For example, it is not random who smokes; people who care about their body and overall fitness level are much less likely to smoke. Additionally, a reverse causality argument could be made; it could be that people who avoid smoking do so because they engage in vigorous PA, implying that PA could also be a function of smoking.

In order to advance the literature on the interaction of smoking and PA it is necessary to determine whether or not a causal relationship exists. One method to decipher if such a relationship exists is through the use of instrumental variables, which is the approach I take in this paper.

The use of cigarette prices as an IV for smoking is not completely new to the health literature. Leigh and Schrembri (2004) use data from the 1996-1997 Community Tracking Study, with physical functioning status as their dependent variable. In their analysis they use the state average price per pack of cigarettes in 1997 as an instrument for the average number of cigarettes a respondent smoked per day over the past 30 days. In their first stage they find that cigarette prices per pack is strongly and negatively associated with cigarettes per day (P=0.002), and for their second stage find that the cigarettes per day variable is also negatively associated with physical functioning index for both their tobit and linear regression models (P=0.021 and P=0.047, respectfully). While they still get statistically significant results in the second stage, the fact that they only have 36 different observations for cigarette prices is not ideal.

In this paper I avoid the endogeneity associated with regressing PA on smoking by using the monthly real price of cigarettes in a respondent's province as an instrumental variable for the number of cigarettes they smoke per month. My results show that the real price of cigarettes is a suitable IV, and that there is a negative, and causal relationship between smoking and PA. This finding is new to the empirical literature and sheds light on the fact that there is more than just a negative correlation between the two activities.

3 Data and Methodology

The main data I use in this study are cycles 1.1, 2.1, 3.1 and 4.1 of the Canadian Community Health Survey (CCHS) confidential files.[3] These surveys contain detailed information on the personal characteristics, lifestyles and the health status of respondents.

The dependent variable I use comes from the physical activity index; it is derived in the CCHS from several questions relating to the PA levels of respondents in the last 3 months. It takes on the ordered outcomes 1=inactive, 2=moderately active and 3=active. Active corresponds to people who average at least 3.0 kilocalories per kilograms per day (kcal/kg/day) of energy expenditure, people who are moderately active average 1.5-2.9 kcal/kg /day and people are inactive if their energy expenditure is less than 1.5 kcal/kg/day (Statistics Canada, 2007). In order to decipher a respondent's total kcal/kg/day, each respondent is asked how many times they engage in a given activity

[3] The CCHS 1.1 covers the years 2000-2001, the 2.1 covers 2003, 3.1 covers 2005-2006 and the 4.1 covers 2007-2008.

during the past 3 months, and how much time on average they spend in that activity on each occasion; each activity is also assigned a specific kcal/kg/hour.[4]

For this analysis I turn this physical activity index into a binary variable by grouping together the outcomes inactive and moderately active, implying that the dependent variable is 1 if the person is active and 0 if they are moderately active or inactive. A linear probability model is chosen over an IV probit model due to computational constraints that arise as a result of the large sample in this study.

The independent variables for this model draw heavily from the previous literature. Education appears as a categorical variable (broken into seven categories: less than high school, high school graduate, some post-secondary, trades diploma, college/CEGEP diploma, bachelor's degree (omitted category) and university degree above bachelor's level).[5] I also include binary variables for whether or not a respondent is married, a student, unemployed, male and foreign born. As well, pregnant women are dropped from the sample because PA recommendations are conditional on prior physical fitness levels (McInnes and Shinogle, 2009).

Additionally, I include variables relating to the time constraint individuals face in the model. These consist of hours worked per week (broken into 9 categories: less than 20, 20-30, 31-35, 36-40, 41-45 (omitted category), 46-50, 51-55, 56-60, and over 60) and separate binary variables for having a child less than 5 and a child between the age of 5

[4] The list of activities are walking, gardening or yard work, swimming, biking, popular or social dance, home exercises, ice hockey, ice skating, rollerblading, jogging or running, golfing, exercise class or aerobics, downhill skiing or snowboarding, bowling, baseball or softball, tennis, weight-training, fishing, volleyball, basketball, soccer and other (Statistics Canada, 2007).

[5] Unlike some of the previous literature, personal income is left out of my model due to its high degree of correlation with education.

and 11. The impact of having children on PA levels has not been studied in the previous research, however, it is important to control for this because having children is likely to significantly decrease the leisure time that parents can allocate to PA.

To control for geographical location I include dummies for the 10 provinces (British Columbia as the omitted province) and for residing in a rural area. As well, I include dummies for the month that the respondent answered the survey (with February as the omitted month). The month is important to control for as it is likely the case that people who respond in the winter months are less likely to be active due to the fact that the winter climate in Canada restricts several types of outdoor PA.

Lastly, I control for the number of cigarettes smoked per month. Several steps are required to derive this variable since the CCHS does not directly have a question with this information. Respondents first answer the question "At the present time, do you smoke cigarettes daily, occasionally or not at all?" If the respondent chose the option "not at all" then I label them as smoking zero cigarettes per month. Respondents who choose the option "occasional smoker" or "regular smoker" are asked how many cigarettes they smoke per day (Statistics Canada, 2010a). I multiply the number of cigarettes they smoke per day by the average days per month, 30.4, to approximate the number of cigarettes a respondent smokes per month. I use monthly cigarettes rather than daily cigarettes in order to coincide with the variable I use to instrument for the number of cigarettes smoked, the real price of cigarettes, which is in monthly terms.

As mentioned above, I use the real price of a carton of cigarettes (in January 2007 dollars) as an IV for cigarettes smoked per month. To construct this variable I use the consumer price indices from Statistics Canada (2010b) and the average price of a carton

of cigarettes in each province on January 1, 2007 from the Smoking and Health Action Foundation (2007). The specific algorithm I use to create this variable is as follows: (i) The provincial monthly cigarette CPI in January 2007 dollars is constructed by dividing each respective provincial monthly cigarette CPI by its cigarette CPI in January 2007, then multiplied by 100. (ii) The provincial monthly CPI for all items excluding tobacco and alcohol products in January 2007 dollars is constructed identically to (i). January 2007 is the base period, that is, the CPI for both tobacco products and all items excluding tobacco and alcohol are equal to 100 in January 2007. (iii) The monthly real price of a carton of cigarettes in January 2007 dollars in a province is constructed by dividing the provincial monthly cigarette CPI in January 2007 dollars by the provincial monthly CPI for all items excluding tobacco and alcohol products in January 2007 dollars, and then multiplying by the average price of a carton of cigarettes in January 2007 in their respective province.

To summarize, the first stage regression, where the endogenous variable is regressed on its instrument and the set of exogenous explanatory variables in the PA equation can be written as follows:

$$(1)\ Cigarettes\ smoked\ per\ month_i = \beta_0 + \beta_1 Real\ price\ of\ cigarettes_i + \beta_2 Age_i + \beta_3 Age^2{}_i + \beta_4 Foreign\ born_i + \beta_5 Married_i + \beta_6 Education_i + \beta_7 Male_i + \beta_8 Unemployed_i + \beta_9 Hours\ worked_i + \beta_{10} Child{<}5_i + \beta_{11} Child\ \varepsilon(5,11)_i + \beta_{12} Province_i + \beta_{13} Rural_i + \beta_{14} Month_i + \mu_i$$

While the second stage regression, which is the primary equation of interest, can be written as:

$$(2)\ PA_i = \beta_0 + \beta_1 Cigarettes\ smoked\ per\ month_i + \beta_2 Age_i + \beta_3 Age^2_i + \beta_4 Foreign\ born_i + \beta_5 Married_i + \beta_6 Education_i + \beta_7 Male_i + \beta_8 Unemployed_i + \beta_9 Hours\ worked_i + \beta_{10} child{<}5_i + \beta_{11} child\ \varepsilon(5,11)_i + \beta_{12} Province_i + \beta_{13} Rural_i + \beta_{14} Month_i + \mu_i$$

Basic weighted summary statistics for the variables in this study from the CCHS for respondents age 19-50 appear in Table 1 below.

Table 1: Descriptive Statistics, CCHS

Physically Active	
Total Sample	0.253
CCHS 1.1	0.238
CCHS 2.1	0.269
CCHS 3.1	0.264
CCHS 4.1	0.256
Smoking	
Proportion of the sample that smoke	0.226
Monthly Cigarettes	112.5
Monthly Cigarettes for those who smoke	393.0
Individual Characteristics	
Age	35.0
Married	0.482
Rural	0.169
Male	0.468
Unemployed	0.128
Student	0.153
Foreign Born	0.158
Kid Less Than 5	0.212
Kid Between 6 and 11	0.232
Level of Education	
Less than High School	0.042

Table 1, continued

High School Graduate	0.110
Some Post-secondary	0.070
College/CEGEP Diploma	0.309
Trades Diploma	0.127
Bachelor's Degree	0.229
University degree above Bachelor's level	0.114
Hours Worked Per Week	
Less Than 20 Hours Worked	0.057
Between 20 and 30 Hours Worked	0.064
Between 31 and 35 Hours Worked	0.107
Between 36 and 40 Hours Worked	0.311
Between 41 and 45 Hours Worked	0.097
Between 46 and 50 Hours Worked	0.098
Between 51 and 55 Hours Worked	0.034
Between 56 and 60 Hours Worked	0.048
Over 60 Hours Worked	0.048
Province	
Prince Edward Island	0.004
Newfoundland and Labrador	0.017
New Brunswick	0.024
Nova Scotia	0.029
Quebec	0.236
Ontario	0.396
Manitoba	0.033
Saskatchewan	0.029
Alberta	0.104
British Columbia	0.128
Month	
January	0.088
February	0.095
March	0.087
April	0.087
May	0.091
June	0.095
July	0.081
August	0.089
September	0.088
October	0.075
November	0.074

Table 1 continued,	
December	0.054
Proportion of sample	
CCHS 1.1	0.259
CCHS 2.1	0.244
CCHS 3.1	0.236
CCHS 4.1	0.261

Notes: The statistics are weighted means. The sample includes adults age 19-50 in the CCHS 1.1-4.1.

Overall, approximately 25.3 percent of the sample is active; the CCHS 1.1 (2000-2001) is the least active with a 23.8 percent active rate, and the CCHS 2.1 (2003) is the most active with an active rate of 26.9 percent. The trend does not seem to show any clear evidence that the level of activity among Canadians is steadily increasing over time as both the CCHS 3.1 (2005-2006) and 4.1 (2007-2008) portray activity levels that are lower than the 2.1 survey.

Approximately 22.6 percent of the sample reported smoking more than one cigarette per day. The mean number of cigarettes smoked per month is 112.5, and the mean number of cigarettes smoked per month for those who smoke is close to 394 (or 13 cigarettes per day).

For the variables that vary across individuals (see individual characteristics in Table 1) the mean age is close to 35, approximately 48.2 percent of the sample is married, 17 percent live in rural areas, 12.8 percent are unemployed, 15.3 percent are current students and 15.8 percent are foreign born. As well, 21.2 percent have a child less than 5 years of age and 23.2 percent report having a child age 5-11.

The level of education category shows that over 11 percent have a degree higher than a bachelor's degree and approximately 53 percent of the sample have either a bachelor's degree or a college/CEGEP certificate as their highest level of education. As

well, close to 13 percent have a trades diploma, 11 percent have a high school diploma and just over 4 percent have less than high school.

Over 31 percent of the sample report working 35-40 hours per week. Approximately 5.7 percent works less than 20 hours, and at the other extreme, 4.8 percent of the sample works more than 60 hours per week.

Ontario, Quebec, British Columbia and Alberta constitute over 86 percent of the sample. The sample is fairly evenly distributed across the months, with the exception of December, which accounts for 5.4 percent of the sample reference period. Lastly, the sample is almost evenly distributed between the four CCHS cycles, and the total sample size is 211,955.

The mean after tax real price of a carton of cigarettes in January 2007 dollars for the 10 provinces from January 2000 to December 2008 is approximately $74. There are 108 observations for each province, implying that there are a total of 1080 cigarette carton price observations. Also, the regressions are clustered by province to correct the standard errors.

Figures 1 through 10 in the Appendix display how the real price of a carton of cigarettes in each province evolves during the 108-month span. In general, we see that the real price increases in every province during this time frame.

The large majority of the variation in the real price of cigarettes is due to variations in excise taxes (Fraser Institute, 2010). The largest increase in the real price in most provinces is from 2001 to 2002; this increase is largely due to the Federal Tobacco Control Strategy (FTCS), which was implemented by the federal government in April 2001. Among other things, the FTCS consisted of a series of monthly tax hikes that first

pushed federal excise tax per carton up from just over $10 in March 2001(in real 2002 dollars) to $15.85 per carton in July 2002. Federal excise taxes have since staggered around this level in real terms (Fraser Institute, 2010).[6]

In addition to federal tobacco tax increases, provinces also followed suit by raising their tax rates on cigarettes as well, however, the magnitudes differed by province. From 2001 to 2008 New Brunswick implemented the smallest tax increase of all the Canadian provinces (from $14.83 to $20.60 in real 2002 Canadian dollars) and Ontario had the largest increase during this same time period ($9.10 to $21.65) (Fraser Institute, 2010).

Between 2000 and 2008, the number of units of cigarettes sold in Canada decreased by 36.4 percent, an average annual decrease of approximately 4.6 percent. The largest annual decrease in sales was approximately 10.7 percent from 2001-2002, which was also the time period of the largest annual increase in the real price of cigarettes for every province during the same 9 year span (Health Canada, 2010).

As of December 2008, Newfoundland and Labrador was the most expensive province to purchase a carton of cigarettes in Canada at $92.02 in real January 2007 dollars and the cheapest price was in Quebec at $71.58. Due to their close proximity to Quebec, both New Brunswick ($81.09) and Ontario ($75.62) kept their provincial excise tax rates relatively low so that their cigarette prices were closer to the Quebec level than the Newfoundland and Labrador level in order to avoid significant tax loses from floods of contraband cigarettes from Quebec (Canadian Non-Smokers' Rights Association,

[6] The Fraser Institute gathered their monthly federal excise tax data on cigarette cartons through a special request from the Department of Finance.

2003). The remaining six Canadian provinces had real cigarette prices closer to Newfoundland and Labrador than Quebec in December 2008.

4 Results

This section will discuss the linear probability two stage least squares model results that appear in Tables 2 and 3. Table 2 contains the first stage regression results, that is, the number of cigarettes smoked per month (the endogenous regressor in the equation of interest) regressed on the set of exogenous regressors and its instrument, the real price of a carton of cigarettes (see Table 2A in the Appendix for the full set of coefficient estimates). In Table 3 the regression results for the second stage are shown (see Table 3A in the Appendix for the full set of coefficient estimates).

Table 2: First Stage Regression Results: Monthly Cigarettes Smoked

Coefficient	***Monthly Cigarettes***
Real Price of Cigarettes (January, 2007)	-0.797***
	[0.290]
Observations	211,955

Notes: Sample includes adults age 19-50 in the CCHS 1.1-4.1. The dependent variable is the number of cigarettes smoked per month. See Table 2A in the appendix for the full set of regression results. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

I begin the discussion of the regression results with an examination of the validity of the IV for the number of cigarettes smoked per month – the real price of a carton of cigarettes. A "good instrument" should be both relevant and valid. A relevant instrument is one that is significantly correlated with the endogenous regressor (Wooldridge, 2006). To determine the relevancy, I examine the first stage regression results in Table 2. The

real price of cigarettes is significant at the 1% significance level; its t-statistic is 2.75 implying that the F-statistics of excluding the real price of cigarettes from the regression in the first stage regression is 7.553,[7] slightly below the common rule of thumb for a relevant instrument of 10, but greater than 5 which is an indication of severe finite-sample bias (Cameron and Trivedi, 2005; Stock et al., 2002). However, Hahn and Hausman (2002) show that the IV bias increases with the number of instruments, and given that I am using one instrument the potential for finite-sample bias is reduced.[8]

The second characteristic of a "good instrument" is its validity, which is satisfied under the assumption that the instrument is orthogonal to the error term in the second stage regression. Unfortunately, this assumption is not directly testable in an exactly identified model (Wooldridge, 2006). In this context, however, this assumption is not a very problematic one as it is difficult to construct a valid argument that the real price of cigarettes would be endogenous in the second stage. More specifically, the price of cigarettes does not affect PA for reasons other than the effect that cigarette prices have on smoking.

The regression results for the first stage in Table 2 show that a one dollar increase in the real price of a carton of cigarettes leads to a decrease of slightly less than one cigarette per month. This appears to be an accurate estimate given the large amount of evidence that cigarettes are a relatively inelastic good (Chaloupka and Warner, 2000).

[7] Since there is one restriction $t^2=F$.
[8] One possibility to reduce the bias is to increase the sample size in the future by adding the next cycle of the CCHS data which should be available in the next few months.

Table 3: Second Stage Regression Results: The Impact of Cigarette Consumption of Physical Activity

Coefficient	***Active***
Monthly Cigarettes/10	-0.019*
	[0.010]
Observations	211,955

Notes: Sample includes adults age 19-50 in the CCHS 1.1-4.1. The dependent variable is a binary variable which is equal to 1 if the respondent is deemed active by the physical activity index in the CCHS. See Table 3A in the Appendix for the full set of regression results. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

The second stage regression estimates appear in Table 3 (see Table 3A in the Appendix for the full set of coefficient estimates). The variable for monthly cigarettes is statistically significant at the ten percent significance level. The model predicts that, *ceteris paribus,* someone who smokes 10 cigarettes per day (or 304 per month) is approximately 56 percent less likely to be active than someone who does not smoke.

While previous studies show that there is generally a negative correlation between PA and smoking, the results in Table 3 suggest that there is in fact a causal relationship between the two. This result highlights the fact that policies which decrease smoking cigarettes could have a synergistic type health effect, that is, population health would not only benefit from the decline in smoking, but also from the increase in PA levels that these results suggest would occur.

The regression results in Table 3A in the appendix clearly show that males are significantly more likely to be active than females. Specifically, males age 19-50 are 11.7 percent more likely to be physically active than females in this age range. These

results are also consistent with the findings of McInnes and Shinogle (2009) and Mullahy and Robert (2008).

The variables for hours worked yield some interesting results. People who work 36-40 hours a week are 2.7 percent less likely to be active than those who work 41-45 hours per week. Table 3A also shows that people who work 56-60 and over 60 hours per week are respectfully 5.19 percent and 6.14 percent more likely to be active than the comparison group, 41-45 hours per week. One reason why people who work more may exercise more is that they likely require high levels of energy, and that this type of energy is sustainable through PA. Another reason why this might be the case is that people who work more are likely accustom to spending little time in sedentary activities and do not require as much motivation and self control to "pick themselves up off the couch", which can be difficult to overcome if an individual is customary to having more leisure time, and spending a significant amount of it sedentary.

People who were interviewed between May and December are statistically significantly more physically active in the past 3 months than people who were interviewed in February. Most notably, people who were interviewed in September are approximately 12.1 percent more likely to be active than those who were interviewed in February. These seasonal results are not surprising given that the climate in Canada restricts several types of outdoor activities that one can engage in during the winter months.

People who live in Newfoundland and Labrador, Quebec and Manitoba are respectfully 7.5 percent, 7 percent and 4.5 percent less likely to be active than individuals who reside in British Columbia (B.C). People who live in the other six Canadian

provinces do not have activity levels that are statistically significantly different than individuals who live in B.C.

Being married is also associated with less PA. Specifically, people who are married are 13.3 percent less likely to be active than someone who is not married. This result may be because when some people get married they may tend to "let themselves go", or potentially have other commitments that do not permit them ample leisure time to allocate to exercise. The direction of this result is also consistent with previous literature (McInnes and Shinogle, 2009; Mullahy and Robert, 2008).

People who are foreign born are 14.8 percent less likely to be active. The large magnitude of this coefficient suggests that there are cultural differences with respect to PA.

Certainly, one would expect that having young children would decrease the amount of free time an individual can allocate to leisure time PA. The regression results in Table 3A further support this intuition. Having a child(s) less than the age of 5 decreases the probability of being active by close to 6 percent, however, having a child(s) age of 5 to 11 does not decrease the probability of being active in this analysis.

People who are unemployed are approximately 4 percent more likely to be active than those who are employed. The sign and magnitude of this finding is also consistent with McInnes and Shinogle (2009).

While the previous literature finds that activity levels increase with educational attainment, my regression results suggest that education does not affect activity levels in a statistically significant manner. An argument that is not addressed in the literature is that educational attainment could be an endogenous variable. It is likely the case that the

amount of education one receives is highly correlated with their "drive", an immeasurable variable that is also likely correlated with activity levels. Education is also likely correlated with another component of the error term for physical activity – how much information an individual possesses about the health benefits of PA.

5 Conclusion

In this paper I use data from the Canadian Community Health Survey (CCHS) from 2000-2008 to examine the effect that smoking has on PA using the real price of a carton of cigarettes as an instrument for the number of cigarettes an individual smoked per month. While previous work on the interaction between smoking and PA finds that there is, generally, a negative correlation between the two, my findings suggest that a negative and causal relationship exists, that is, smoking decreases the probability that someone is physically active. This result indicates that the health benefits from policies that reduce smoking have unforeseen spillovers. More specifically, not only will health improve due to lower smoking levels, but also from increases in activity levels that my findings suggest will accompany reductions in smoking.

There have been several smoking policies put in place over the years in Canada in attempt to reduce smoking levels (Physicians for a Smoke-Free Canada, 2003). One of the main policies was municipal anti-smoking by-laws to reduce public place smoking. While these by-laws impose a social stigma on smoking and increase its overall time cost, Carpenter et al. (2010) find that they do not affect overall smoking levels, however they do reduce exposure to second hand smoke.

Various studies show that the most effective policy to reduce smoking levels (and thus benefit from the health gains discussed above) is to increase the real price that consumers pay through taxation (Guidon et al., 2002; Physicians for a Smoke-Free Canada, 2003; DeCicca et al., 2008). While a recent Canadian study by Gospodinov and Irvine (2009) find that tobacco taxes are regressive, which is generally deemed as an undesirable tax characteristic, it is also true that people with relatively low incomes are the most price sensitive to increases in tobacco taxes (Gruber et al., 2003). Thus, the fact that low-income smokers are relatively price sensitive ameliorates the regressive nature of tobacco taxes (Fraser Institute, 2010). Also, as previously mentioned, the largest annual decline in the units of cigarettes sold in Canada from 2000-2008 was from 2001-2002, which is also the time period that the real price of a carton of cigarettes increased the most, primarily due to a federal excise tax increase of over 55 percent (Fraser Institute, 2010).

While this study has advanced the literature on the interaction between smoking and PA, it does face several drawbacks. Most notably, the PA questions in the CCHS only address leisure time PA – transportation PA, such as those who walk or bike to work or school should also be accounted for. Despite this drawback, the results from this paper show that there is a negative and causal relationship between smoking and PA.

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Appendix

Table 2A: First Stage Regression Results: **Monthly Cigarettes Smoked**

Coefficient	***Monthly Cigarettes***
Real Price of Cigarettes (January, 2007)	-0.797***
	[0.29]
Male	37.54***
	[1.46]
Less Than 20 Hours Worked	-4.3
	[3.48]
Between 20 and 30 Hours Worked	3.62
	[3.56]
Between 31 and 35 Hours Worked	-5.715*
	[3.14]
Between 36 and 40 Hours Worked	-7.314***
	[2.74]
Between 46 and 50 Hours Worked	-2.235
	[3.27]
Between 51 and 55 Hours Worked	-0.904
	[4.53]
Between 56 and 60 Hours Worked	22.10***
	[4.46]
Over 60 Hours Worked	35.10***
	[5.04]
Age	10.030***
	[0.73]
Age^2	-0.113***
	[0.01]
January	-0.752
	[3.38]
March	-5.280*
	[3.18]
April	-3.769
	[3.18]
May	-3.004
	[3.09]
June	-1.734
	[3.27]
July	0.574
	[3.14]

Table 2A continued,

August	-1.198
	[3.23]
September	8.723***
	[3.28]
October	5.671
	[3.46]
November	-0.604
	[3.31]
December	0.852
	[3.19]
Prince Edward Island	28.31***
	[5.43]
Newfoundland and Labrador	25.99***
	[4.44]
New Brunswick	31.09***
	[4.35]
Nova Scotia	39.47***
	[3.99]
Quebec	20.07***
	[5.37]
Ontario	19.41***
	[5.13]
Manitoba	21.06***
	[3.49]
Saskatchewan	24.74***
	[3.29]
Alberta	20.84***
	[2.75]
Married	-60.26***
	[1.80]
Rural	1.19
	[1.91]
Unemployed	13.94***
	[3.75]
Student	-39.10***
	[1.87]
Foreign Born	-38.56***
	[2.03]
Kid Less Than 5	-9.524***
	[1.77]
Kid Between 6 and 11	-7.588***
	[1.78]

Table 2A continued,	
Less than High School	197.4***
	[5.60]
High School Graduate	108.4***
	[2.72]
Some Post-secondary	95.17***
	[3.38]
Trades Diploma	104.2***
	[2.63]
CEGEP or College Diploma	51.63***
	[1.66]
University degree above Bachelor level	-13.46***
	[1.77]
Cycle 2.1	1.955
	[7.54]
Cycle 3.1	1.182
	[8.84]
Cycle 4.1	-1.415
	[9.57]
Observations	211,955

Notes: The dependent variable is the number of cigarettes per month. The sample includes respondents age 19-50 in the CCHS 1.1-4.1. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

Table 3A: Second Stage Regression Results: The Impact of Cigarette Consumption on Physical Activity

Coefficient	***Active***
Monthly Cigarettes/10	-0.019*
	[0.010]
Male	0.117***
	[0.037]
Less Than 20 Hours Worked	-0.001
	[0.011]
Between 20 and 30 Hours Worked	0.017
	[0.010]
Between 31 and 35 Hours Worked	-0.017*
	[0.010]
Between 36 and 40 Hours Worked	-0.027***
	[0.010]
Between 46 and 50 Hours Worked	0.002
	[0.009]
Between 51 and 55 Hours Worked	0.019
	[0.012]
Between 56 and 60 Hours Worked	0.052**
	[0.024]
Over 60 Hours Worked	0.061*
	[0.036]
Age	0.0065
	[0.010]
$Age^2/1000$	-0.084
	[0.110]
January	-0.013
	[0.009]
March	-0.024**
	[0.009]
April	-0.004
	[0.009]
May	0.024***
	[0.009]
June	0.071***
	[0.009]
July	0.095***
	[0.008]
August	0.113***

Table 3A continued,

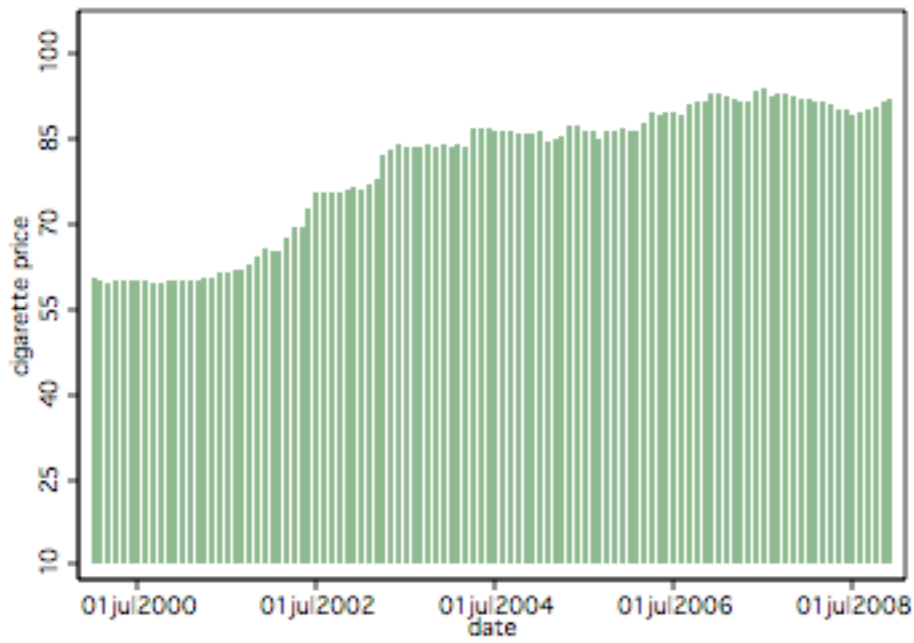
	[0.009]
September	0.121***
	[0.012]
October	0.098***
	[0.010]
November	0.047***
	[0.009]
December	0.038***
	[0.010]
Prince Edward Island	-0.047
	[0.035]
Newfoundland and Labrador	-0.075***
	[0.027]
New Brunswick	-0.058
	[0.038]
Nova Scotia	-0.008
	[0.043]
Quebec	-0.070**
	[0.033]
Ontario	-0.010
	[0.033]
Manitoba	-0.045**
	[0.021]
Saskatchewan	-0.028
	[0.025]
Alberta	0.012
	[0.025]
Married	-0.133**
	[0.060]
Rural	0.007
	[0.005]
Unemployed	0.038**
	[0.017]
Student	-0.038
	[0.039]
Not Born in Canada	-0.148***
	[0.039]
Kid Less Than 5	-0.061***
	[0.010]
Kid Between 6 and 11	-0.007
	[0.009]
Less than High School	0.273

Table 3A continued,

	[0.190]
High School Graduate	0.124
	[0.110]
Some Post-secondary	0.115
	[0.094]
Trades Diploma	0.136
	[0.100]
CEGEP or College Diploma	0.065
	[0.051]
University degree above Bachelor level	-0.003
	[0.015]
Cycle 2.1	0.022
	[0.018]
Cycle 3.1	0.009
	[0.023]
Cycle 4.1	-0.008
	[0.027]
Observations	211,955

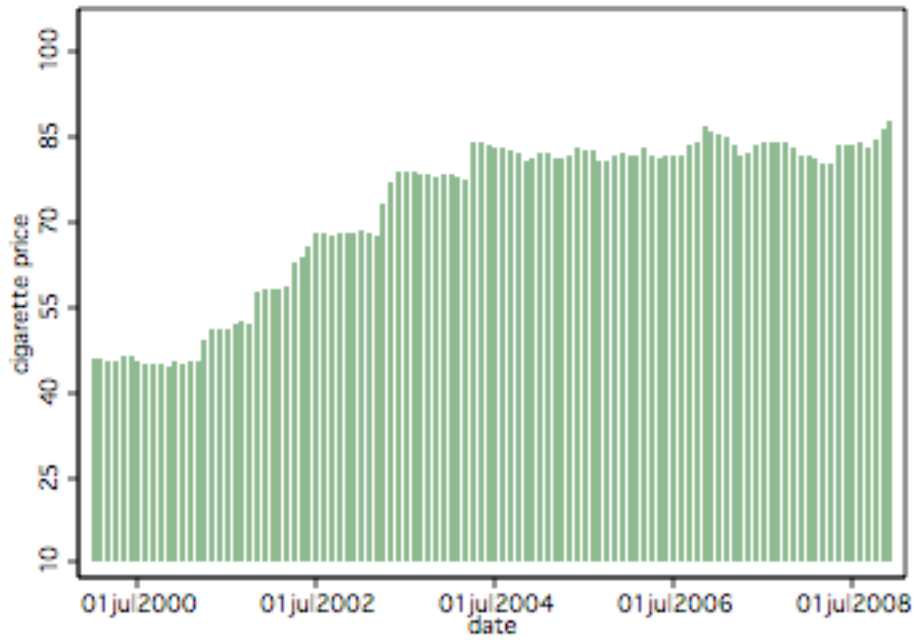
Notes: The dependent variable is a binary variable that is equal to 1 if the respondent is physically active. The sample includes respondents age 19-50 in the CCHS 1.1-4.1. Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Newfoundland and Labrador Real Price of Cigarettes (in January, 2007 Dollars)



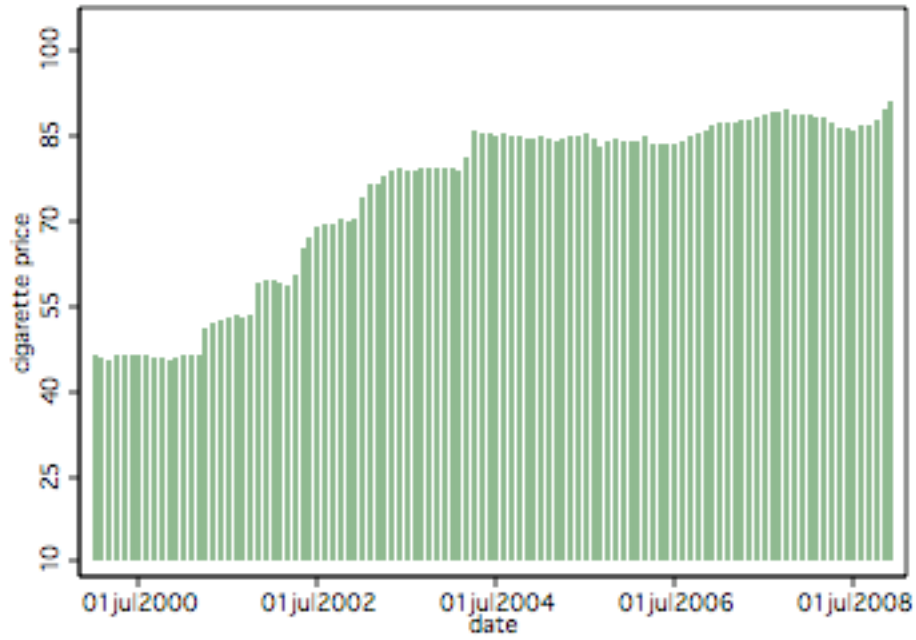
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 2: Prince Edward Island Real Price of Cigarettes (in January, 2007 Dollars)



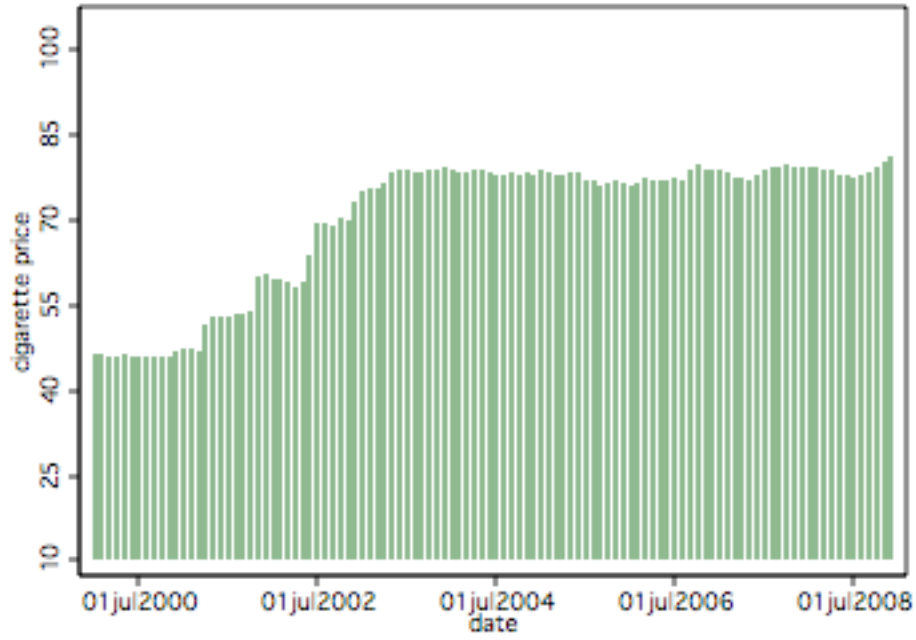
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 3: Nova Scotia Real Price of Cigarettes (in January, 2007 Dollars)



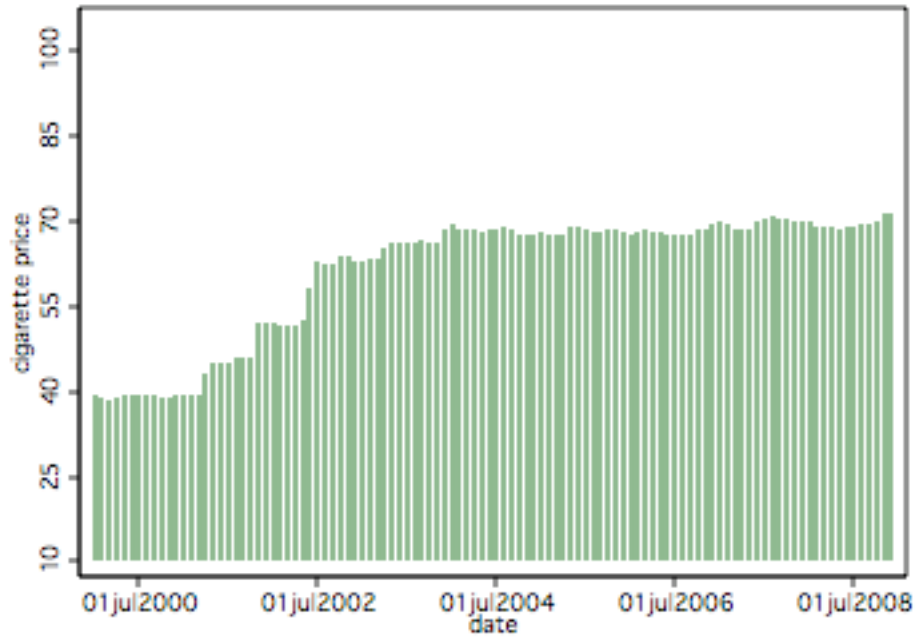
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 4: Nova Brunswick Real Price of Cigarettes (in January, 2007 Dollars)



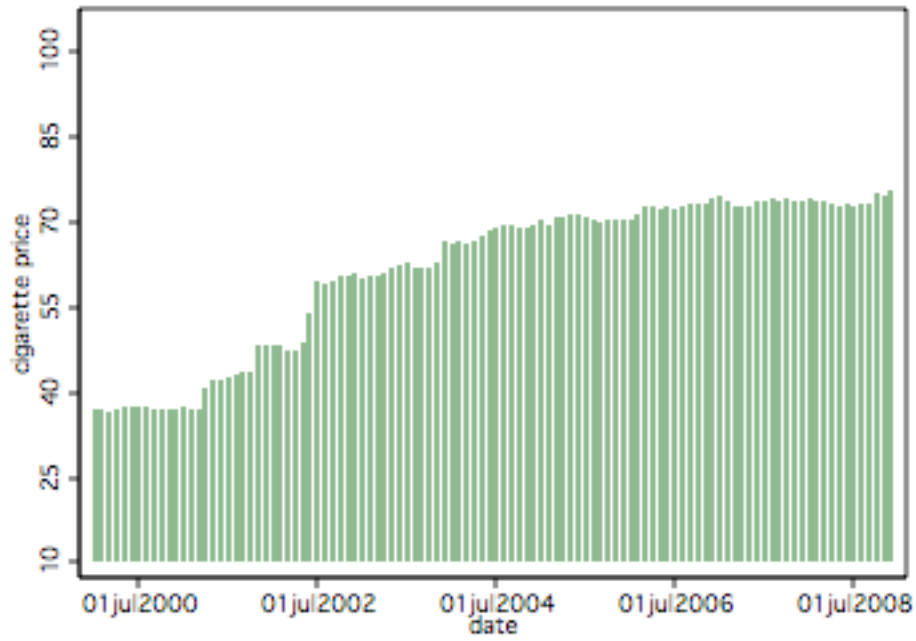
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 5: Quebec Real Price of Cigarettes (in January, 2007 Dollars)



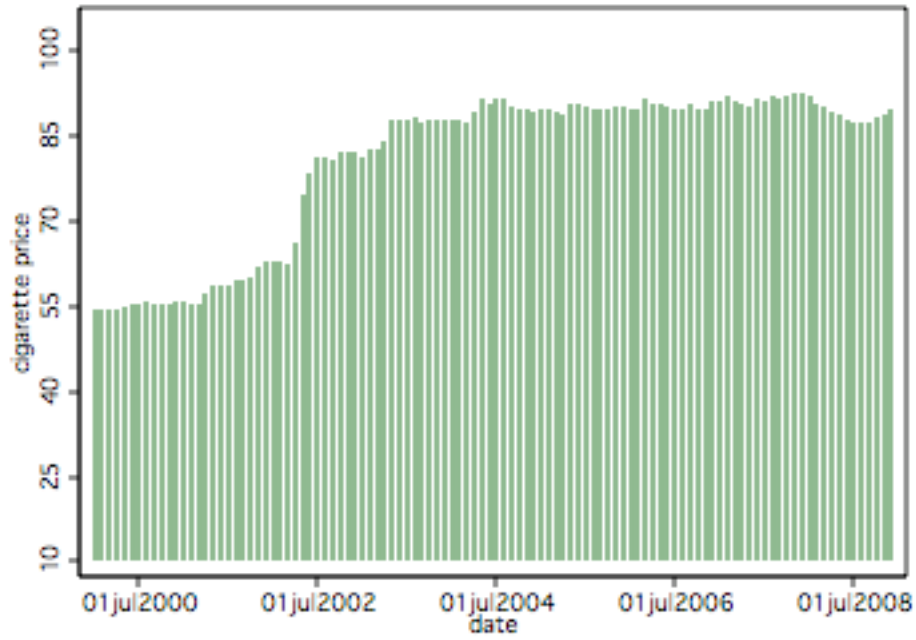
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 6: Ontario Real Price of Cigarettes (in January, 2007 Dollars)



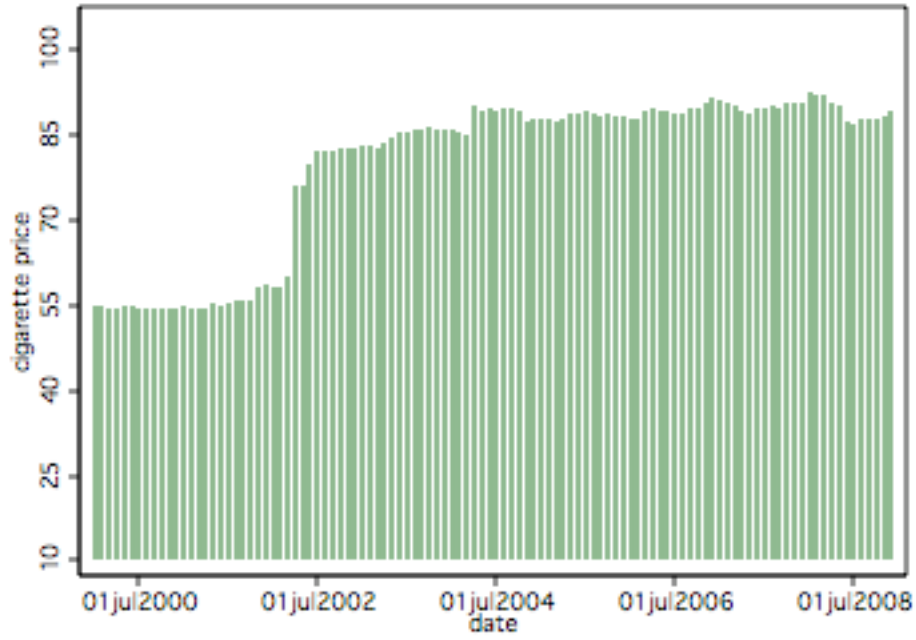
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 7: Manitoba Real Price of Cigarettes (in January, 2007 Dollars)



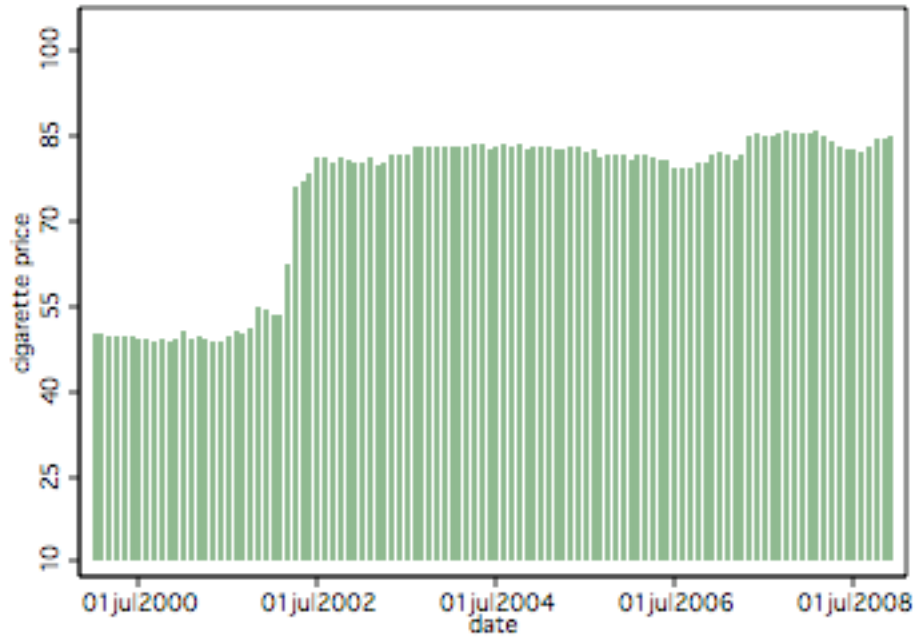
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 8: Saskatchewan Real Price of Cigarettes (in January, 2007 Dollars)



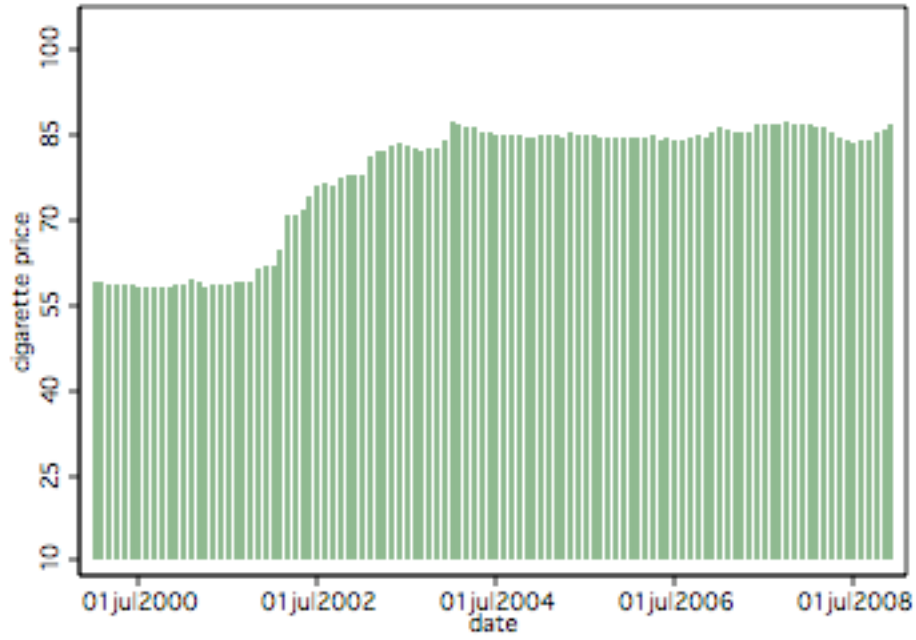
Source: Smoking and Health Action Foundation, Statistics Canada

Figure 9: Alberta Real Price of Cigarettes (in January, 2007 Dollars)



Source: Smoking and Health Action Foundation, Statistics Canada

Figure 10: British Columbia Real Price of Cigarettes (in January, 2007 Dollars)



Source: Smoking and Health Action Foundation, Statistics Canada