Estimating price elasticity for tobacco in Canada's Aboriginal communities*

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Abstract

Exploiting a repeated cross-section created from the 1991 and 2001 waves of the Aboriginal Peoples Survey, I provide the first estimates of tobacco price elasticity for adults in Canada's Aboriginal communities. These communities are small and secluded, presenting a unique opportunity to look at the potential influence of community smoking norms on individual behavior. Specifically, I allow aggregate smoking behavior within the community to influence individual smoking behavior. I distinguish between two price effects: the direct effect, reflecting individual reaction to a price change; and the indirect effect, whereby price influences the individual by changing community smoking behavior. I find the indirect effect doubles the price elasticity over the direct effect alone. I also find the discouraging effect of taxes on smoking to be significantly less than previously hypothesized. A 10 percent increase in prices leads to a 0.73 percentage point decrease in daily smoking, a 1.39 percentage point decrease in occasional smoking, and does not significantly affect smoking intensity among daily smokers. I conclude that taxation is an effective tool for revenue creation but a largely ineffective tool for adult health policy.

Keywords: Aboriginal Canadians, smoking, tobacco tax, social interactions

JEL classification codes: D12, I10, I38

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1 Introduction

Health outcomes in Canada's Aboriginal communities are some of the worst in the country. Male and female life expectancy is well below the Canadian average, the prevalence of diabetes, cancer and cardiovascular disease is significantly higher, and Aboriginal Canadians are disproportionately affected by HIV.[1] These tragic outcomes parallel other differences in behaviors that may be linked to health. For example, the majority of adults and youths in these communities do not receive the recommended daily exercise and more than 70 percent are overweight. Reported use of marijuana among adults is almost twice the Canadian average, and smoking rates are two to three times higher. The fact that these communities are small and secluded means that individual behavior may be strongly influenced by community norms. If so, social interactions will have important implications for the design of policy.

In this paper I analyze the influence that price has on adult smoking behavior in Canada's Aboriginal communities, explicitly accounting for the potential influence of community smoking rates on individual smoking behavior. I address two specific questions: Is taxation an effective tool for reducing adult tobacco use in Aboriginal communities?; and relatedly, How do we account for the effect of social interactions when estimating tobacco price elasticity?

The exemption of Aboriginal communities from provincial sales taxes, which make up between 29 and 50 percent of the final price on tobacco, is often cited to explain high Aboriginal smoking rates. While this is certainly possible, when social interactions are endogenous—in the sense that an individual's smoking is positively influenced by the smoking of others—an increase in the price of tobacco will influence individual smoking through two channels: directly, by making smoking relatively expensive, and indirectly, by decreasing community smoking rates and therefore decreasing the marginal utility of smoking. The indirect effect results in a social multiplier, as each individual simultaneously influences and

[1]For details on these and other health outcomes see the First Nations Regional Longitudinal Health Survey.

is influenced by community smoking rates, and this is important to take into account in estimation.

This is the first study to explicitly test the claim that high smoking rates on Aboriginal reserves are the result of tax exemptions. I find that the discouraging effect of taxes on smoking is significantly less than previously hypothesized. A 10 percent increase in prices will lead to a 0.73 percentage point decrease in daily tobacco use, a 1.39 percentage point decrease in occasional tobacco use, and does not have a significant statistical or economic effect on smoking intensity among daily smokers. Given these low price elasticities I conclude that taxation is largely an ineffective tool for adult health policy, but a very effective tool for revenue creation.

I also provide and compare estimates of the direct and total price elasticities, and show that endogenous social interactions have a significant effect on the impact of a tax. For example, I find the total price elasticity is double the direct price elasticity for daily smoking, and triple for occasional smoking. Clearly social interactions matter, and this implies an important aggregation problem. When only the direct effect is known, the response of population behavior to a price change cannot be determined by aggregating the response of individual behavior to a price change.

Aboriginal communities in Canada provide a unique context for this type of study. Small population and a tight knit communities mean that individuals are likely to be aware of the conspicuous activities, such as smoking, of their fellow community members. This "reference group" assumption is a critical component to incorporating social interactions into estimation (see Manski, 1993, 2000). Unfortunately, data limitations in previous studies have not allowed for the identification of social effects beyond a very small reference group, such as classrooms or households (group sizes range from a minimum of 1 to a maximum of 50). In contrast, my average community size is 965 individuals, and I find a large and significant effect of social interactions. A 10 percent increase in community smoking rates increase the probability an individual smokes by 5.8 percent.

To generate these results I exploit a repeated cross section of 95 communities and 17,720 individuals created from the 1991 and 2001 waves of the Aboriginal Peoples Survey. This gives me a rich panel structure to control for unobservables. For example, I can control for unobservable variation in preferences across communities arising from differences in their historical and spiritual attachment to tobacco. If, as I suspect, this unobservable variation is geographically correlated, then failure to control for these fixed effects will confound my ability to estimate elasticity using provincial price variation.

Since price variation is critical, I build a set of price data that utilizes variation in provincial tax exemptions between provinces and over time, taking careful account of the discrepancy between tobacco prices faced in Aboriginal communities and the rest of Canada. By doing this I capture the relevant variation in tobacco prices across these communities, while providing the first unified documentation of these price changes across the country. I find the resulting price variation is large relative to previous studies, with between period price changes (in constant dollars) as large as 40 percent.

Using this data I estimate price elasticity based on three equations, which allows me to examine the potential bias from failure to account for social effects. I first estimate elasticity assuming that social effects are zero. This gives me a baseline to compare with estimates from equations that incorporate endogenous social effects. Social effect equations are based on the linear-in-means model of social interactions (Manski, 1993.) With the second equation I estimate total price elasticity, accounting for the direct and indirect effect of price on individual behavior. With the third equation I estimate the direct effect of price. These three equations allow me to comment on the influence that social interactions have on estimates of elasticity and any bias that would result if social effects are excluded. Excluding social effects from the estimating equations results in an elasticity estimate for daily smoking that is very close to the total elasticity, but much closer to the direct elasticity for overall and occasional smoking.

My estimates from the social equations are consistent with the predictions of the social model. Specifically, the presence of endogenous social interactions will not impact the estimated effect of variables that influence the smoking behavior of only one individual. For example, say an individual becomes unexpectedly unemployed and increases his smoking in response.[2] This will not significantly influence the mean level of smoking for the community. Therefore, other members of the community should not be directly influenced by this individual's behavioral change and there will not be a social multiplier. Individual level shocks have no community-level effects, and my results are consistent with this hypothesis.

I examine four self-reported outcomes for smoking behavior: respondent smokes cigarettes, respondent smokes cigarettes daily, respondent smokes cigarettes occasionally (conditional on not being a daily smoker), and smoking intensity, measured as the number of cigarettes smoked per day for daily smokers. In addition to providing a robustness check, these outcomes each provide unique information with respect to price changes. From a health policy perspective a tax may be considered more effective if it is discouraging daily, rather than occasional, smoking. It is also interesting from a health perspective to know if a tax influences the smoking intensity for those who remain daily smokers.

The literature looking at social interactions and smoking has largely focused on the identification of endogenous social effects. Several studies have examined how youth smoking is impacted by peer smoking in the same school or classroom (see for example Powell *et al.* (2005), Krauth (2007), Soetevent and Kooreman (2007), Lee *et al.* (2007), and Fletcher (2010).) This research has resulted in a range of estimated endogenous effects for youth,[3] but it is unclear whether these peer effects carry over to the behavior of adults. Cutler and

[2]This is consistent with the idea of smoking being used as a stress coping mechanism (Rahkonen et al., 2005).

[3]A 25 percent increase in peer group tobacco use is found to increase individual tobacco use between 6.3 percentage points (Lee *et al.*, 2007) and 14.5 percentage points (Powell *et al.*, 2005).

Glaeser (2007) find that the probability an adult smokes increases 40 percent if their spouse smokes. When they expand their peer group to individuals in the same metropolitan area, age cohort, and education level there is no significant group affect. These results may suggest that peers are important to youth but not adult smoking.

My focus on adults in Aboriginal communities allows me to extend the literature in several ways. Because these communities are small as secluded I am able to identify a feasible reference group for each individual that is larger than the household or classroom, but smaller than a metropolitan area (an average size of 965). Even with this large reference group I find statistically significant effects that are consistent with those found in smaller peer settings. As well, I show that the social interactions with peers play an important role in adult behavior. Moreover, my estimate of the influence of community smoking rates on adult smoking is similar to those found among youth and their peers. Therefore, my findings suggest that the importance of peer effects on behavior does not go away, or even diminish, in adulthood, nor do they seriously weaken in groups of almost 1,000.

Given the public health concerns, it is not surprising that there is a large literature estimating the importance of price in tobacco use outcomes. Price elasticity estimates typically range between -0.5 and -1.7 for youth initiation (Powell *et al.*, 2009) but are substantially lower in adult populations. Franz (2008), for example, estimates an adult price elasticity of -0.19 and Cutler and Glaeser (2007) find price does not significantly affect adult smoking. Relatively few studies consider how estimated price elasticity is affected by endogenous social interactions. Of those that do, Sen and Wirjanto (2009) find that social interactions do not significantly impact elasticity estimates, while Auld (2005) and Powell *et al.* (2009) find that excluding controls for social interactions from the regression leads to a larger estimate of the price elasticity. This latter finding is consistent with social interactions having multiplier effect on price elasticities.

A shortcoming of many studies is that the direct price elasticity (estimated by controlling for reference group smoking) is compared to an elasticity estimated from a miss-specified model. It is not clear that, for models that exclude social interactions, the total price effect on smoking behavior is accurately estimated. In this respect a significant contribution is made here. By estimating the three models outlined above I am able to account for both the direct and indirect effects in estimating the total price elasticity. By doing this I can then comment on how estimates from models that exclude social effects compare.

The remainder of the paper proceeds as follows. In Section 2, I introduce a simple model of tobacco demand that incorporates tobacco demand of others in the community. This model is used to explicitly show the multiplier effect arising from endogenous social interactions. I then discuss the empirical estimation strategy for the three proposed equations. In Section3, I discuss the data used in the empirical estimation and provide a brief description of the evidence supporting the underlying reference group assumption. The results of the empirical estimation are presented in Section 4, followed by a discussion and concluding remarks in Section 5.

2 A model of tobacco demand

In this study I think about the influence that community smoking has on the smoking decisions of individual community members. There are a number of reasons to think that this is a realistic characterization of behavior. Tobacco use may be an informal mechanism to signal social identity (Akerlof and Kranton, 2010) or group membership. Individuals may inform their opinions on the health consequences of smoking based on observed smoking of others. Addicted smokers may increase the quantity of tobacco they consume, or decrease the desire to quit, when surrounded by other smokers. Alternatively, non-smokers may be offended by tobacco use giving smokers incentive to reduce consumption or initiate efforts to quit. The communities examined here are relatively small in population and have a limited number of locations, such as recreation centers, community halls, or restaurants, for community members to gather outside of the home. For this reason, the observed tobacco use for an individual is likely to be accurately reflected by the mean tobacco use in the community.

With this in mind, individual utility from tobacco use is specified as a function of mean tobacco use in the community. To provide a framework for thinking about how community behavior and prices influence smoking behavior I adopt a quasi-linear utility specification.[4] The utility for individual i is given by:

$$U(C_{igt}, s_{igt}, E_{gt}[s]) = \eta C_{igt} + \left[A_{igt} + \alpha E_{gt}[s] - \frac{1}{2} s_{igt} \right] s_{igt} \tag{1}$$

C_{igt} and s_{igt} are the consumption of a composite commodity and tobacco for individual i in group g at time t. $E_{gt}[s]$ is the mean level of tobacco consumption in community g. The parameter η captures the constant marginal utility from consumption of the composite commodity to individual i. A_{igt} is a function of observable and unobservable determinants of individual smoking behavior. Social interactions are captured by $\alpha E_{gt}[s]$, the marginal utility of s_{igt} attributable to mean smoking rates in the community. Therefore when mean tobacco use in the community increases by one unit, i's marginal utility increases at the constant rate α.

Each community consists of a large number of individuals. Therefore, no single individual's behavior has a significant influence on $E_{gt}[s]$, and all individuals take $E_{gt}[s]$ as given. Each chooses consumption over s_{igt} and C_{igt} to maximize Eq. (1) subject to their budget constraint $C_{igt} + P_{gt} s_{igt} \geq Y_{igt}$, where P_{gt} is the real price of tobacco faced by community g at time t, and Y_{igt} is i's real income. Price of the composite commodity is normalized to 1.

[4] A similar utility specification is used in Glaeser *et al.* (2003).

This results in the following first order condition (focusing on the interior solution):

$$s_{igt} = A_{igt} + \alpha E_{gt}[s] - \eta P_{gt} \tag{2}$$

This condition states that indivdiual i will choose s_{igt} such that the marginal benefit from consuming s_{igt}, $A_{igt} + \alpha E_{gt}[s] + s_{igt}$, is equal to the marginal cost, ηP_{gt}. Notice that ηP_{gt} reflects the utility forgone by consuming P_{gt} fewer units of C for every unit of s.

In equilibrium all individuals choose according to Equation (2). We can solve for $E_{gt}[s]$ by taking expectations on both sides of Equation (2):

$$E_{gt}[s] = \frac{E_{gt}[A]}{(1-\alpha)} - \frac{\eta P_{gt}}{(1-\alpha)},$$

and substituting back into Eq. (2) to solve for the demand based on exogenous variables:

$$\begin{aligned} s^{\star}_{igt} &= A_{igt} + \frac{\alpha E_{gt}[A]}{(1-\alpha)} - \eta P_{gt} - \frac{\alpha \eta P_{gt}}{(1-\alpha)} && (3) \\ &= A_{igt} + \frac{\alpha E_{gt}[A]}{(1-\alpha)} - \frac{\eta P_{gt}}{(1-\alpha)} && (4) \end{aligned}$$

Eq. (3) explicitly shows the two channels through which price influences behavior when endogenous social interactions are non-zero. The third term on the right-hand-side is the direct effect of price on $s^{\star}_{igt}$. A unit increase in P_{gt} increases the marginal (utility) cost of each unit of s_{igt} by η. The fourth term is the indirect effect of price that works through the reference level $E_{gt}[s]$. Because every individual in community g is affected by the price increase $E_{gt}[s]$ declines. This creates a feedback effect as all individuals further decrease s_{igt} in response to the decreases in $E_{gt}[s]$. The equilibrium magnitude of this indirect effect is a $\alpha\eta/(1-\alpha)$ unit decrease in $s^{\star}_{igt}$ for a unit increase in price. The sum of these two effects corresponds to the price coefficient in (4). This highlights the aggregation problem; in the presence of endogenous social interactions the effect of price on group behavior cannot be determined by aggregating the direct effect of price on individual behavior.

2.1 Empirical application

The term A_{igt} from Eq. (4) is specified in terms of observable and unobservable influences on the outcome:

$$\begin{aligned} A_{igt} &= X_{igt}'\beta + E_{gt}\left[X\right]'\theta + \delta_g + \epsilon_{igt} \\ E_{gt}\left[\epsilon_{igt}|X_{igt}, P_{gt}\right] &= 0 \end{aligned} \tag{5}$$

The $1 \times k$ vector X_{igt} includes exogenous characteristics specific to individual i and $E_{gt}\left[X\right]$ is the mean of each of the exogenous characteristics in community g at time t. δ_g captures unobserved factors that influence community preferences for tobacco and ϵ_{igt} captures unobserved factors that influences individual preferences for tobacco. I assume that ϵ_{igt} is independently distributed across and within communities and identically distributed within communities.

Coefficients are interpreted following Manski (1993). The $k \times 1$ vector of coefficients, β, corresponds to the private effect of each exogenous variable on the cigarette consumption of individual i. For example, an individual's age may directly impact their propensity to smoke. In addition to the endogenous social effect, α, there is a second social effect, known as the contextual effect, captured by the $k \times 1$ vector θ. The contextual effect captures the influence that underlying characteristics of other members of the community on an individual's propensity for tobacco use. For example, if older individuals, regardless of their own tobacco use, are more likely to support anti-tobacco programs in the community, then the age distribution in the community will influence individual tobacco use. δ_g is the fixed effect for community g, corresponding to Manski's correlated effects. A correlated effect is present if permanent differences in traditional and spiritual use of tobacco across communities lead to differences in mean smoking behavior.

Two models of tobacco use, resulting in three estimating equations, are used to estimate price elasticity. The first, which I refer to as the *non-social* model, imposes the non-existence of social effects, both endogenous and exogenous. In other words $\alpha = \theta = 0$. Under this specification the existence of group similarities arise only through the correlated effects, captured by δ_g:

$$s_{igt} = X'_{igt}\beta + \eta P_{gt} + \delta_g + \epsilon_{igt}, \tag{6}$$

The second model follows the utility specification in Eq. (1) and allows for the possibility that either either α or θ are non-zero. Substituting Eq. (5) into Eq. (4) yields the following reduced form estimating equation:

$$s_{igt} = X'_{igt}\beta + E_{gt}\left[X\right]' \frac{\alpha\beta + \theta}{1-\alpha} + \frac{\eta P_{gt}}{1-\alpha} + \frac{\delta_g}{1-\alpha} + \epsilon_{igt} \tag{7}$$

Notice that the coefficients for variables that affect the entire group all contain the social multiplier, $1/(1-\alpha)$. As discussed in Manski (1993), we cannot separately identify the endogenous and contextual social effects from this equation. However, a non-zero value for any elements in the vector $(\alpha\beta+\theta)/(1-\alpha)$ indicate that at least one of the two social effects are present.

Direct estimation of the social multiplier has proven to be a considerable challenge in the empirical literature (see Manski, 1993, 2000). However, if no contextual effects are present for some variables in $E_{gt}\left[X\right]$, the strategy suggested by Graham and Hahn (2005) will be valid. This involves using the non-contextual subset of $E_{gt}\left[X\right]$ as excluded instruments to estimate $E_{gt}\left[s\right]$ and using the corespondent predicted values of $\widehat{E_{gt}\left[s\right]}$ to estimate (4) directly. This estimation strategy is specified by the following set of equations:

$$\begin{aligned}
\widehat{E_{gt}[s]} &= E_{gt}[X]' \frac{\beta+\theta}{1-\alpha} + \frac{\eta P_{gt}}{1-\alpha} + \frac{\delta_g}{1-\alpha} \\
s_{igt} &= X'_{igt}\beta + \alpha \widehat{E_{gt}[s]} + E_{gt}[X]'\theta + \eta P_{gt} + \delta_g + \epsilon_{igt},
\end{aligned} \tag{8}$$

where some elements in θ are *a priori* identified as zero.

Notice that the extent to which Eq. (6), Eq. (7) and Eq. (8) yield different estimates of price elasticity depends on the magnitude of α. If $\alpha = 0$ then the coefficients associated with price for each of the three equations should be approximately equivalent (for Eq. (6) this will depend on the correlation between prices and the excluded community means). If $0 < \alpha < 1$, then the price coefficient for Eq. (7) will be strictly larger than the price coefficient for Eq. (8). The two price coefficients will differ by $1/(1-\alpha)$ where α is estimated directly in Eq. (8).

To control for observable factors influencing tobacco consumption X_{igt} includes a quadratic age term, a sex indicator, household size, marital status, family and respondent income (in $100,000 increments), employment status, high-school graduation status, and a community problem index. The community problem index is constructed based on the answers to seven binary response questions regarding whether the respondent thought various social issues where a problem in the community.[5] The index is the proportion of these questions for which an affirmative response is given. Summary statistics for these variables are provided in Table 1.

Sample analogs for $E_{gt}[X]$ are constructed using the population weights provided in the survey and all observations available for each community.[6]

[5]The seven questions ask if the respondent believes *suicide, unemployment, family violence, rape, sexual abuse, drug abuse* or *alcohol abuse* are problems in the community.

[6]The use of sample analogs gives rise to concern about attenuation bias. To see this write Eq. (7) in sample analogs:

$$s_{igt} = X'_{igt}\beta + \bar{X}'_{gt}\frac{\alpha\beta+\theta}{1-\alpha} + \frac{\eta P_{gt}}{1-\alpha} + \frac{\delta_g}{1-\alpha} + u_{igt}$$

Table 1: Demographic, income and labour summary statistics

	1991				2001			
	Mean	SDW	SDB	N	Mean	SDW	SDB	N
Age	34.75	15.97	2.25	11,090	36.09	15.78	2.36	12,920
Males	0.52	0.50	0.05	11,090	0.50	0.50	0.04	12,930
Speaks a trad. language	0.84	0.23	0.21	10,930	0.80	0.31	0.20	12,890
Married	0.88	0.92	0.20	11,090	0.75	0.89	0.18	12,770
Household size	5.55	2.57	0.98	11,090	4.89	2.29	0.84	12,770
High school graduate	0.15	0.34	0.08	9,570	0.23	0.41	0.09	11,390
Highest grade completed	4.43	2.83	0.59	9,312	6.59	2.06	0.72	11,170
Attending School	0.17	0.37	0.05	11,090	0.12	0.33	0.04	12,470
Community problem index	0.51	0.26	0.11	10,680	0.61	0.27	0.10	12,520
Family income	20,875	18,296	8,176	11,090	24,864	23,187	9,373	12,770
Personal income	9,048	10,161	1,957	11,090	12,784	13,429	3,179	12,770
Employment income	5,352	9,505	2,051	11,090	8,218	13,340	3,008	12,770
Government income	2,966	4,135	840	11,090	4,240	5,193	740	12,770
SD community income	10,161		2,120	11,090	13,429		2,823	12,930
Employed	0.31	0.45	0.09	11,030	0.39	0.48	0.10	12,570
Unemployed	0.15	0.35	0.07	11,030	0.12	0.31	0.05	12,570
Not in labour force	0.54	0.48	0.12	11,030	0.49	0.49	0.11	12,570
Hours worked (ref. week)	37.27	12.76	3.26	3,290	38.01	13.72	3.06	4,600
Weeks worked (ref. year)	14.14	19.26	4.51	11,030	16.50	20.50	3.96	12,770

SDW and SDB are standard deviations for within and between communities respectively. 95 communities covered. Population weights used in all calculations. Individual observation count rounded as per confidentiality requirements.

3 Data

The primary data for this study is drawn from the 1991 and 2001 waves of the Aboriginal Peoples Survey (APS), a post-census survey administered by Statistics Canada. The confidential micro-data is accessed through the Statistics Canada's Research Data Center. Communities are identified by unique census sub-division codes. I restrict the sample to communities that are sampled in both the 1991 and 2001 APS and exclude communities

where

$$u_{igt} = \left(E_{gt}[X] - \bar{X}_{gt}\right)\frac{\alpha\beta+\theta}{1-\alpha} + \epsilon_{igt} = e^X_{gt} + \epsilon_{igt}$$

It is assumed that measurement error in the explanatory variables is uncorrelated with the random error component: $E\left[e^X_{gt}, \epsilon_{igt}\right] = 0$. This error-in-variables may lead to an attenuation bias, and under-estimate the coefficients in $\alpha\beta+\theta/1-\alpha$. Further, correlation between individual variables (assumed to be measured without error) and community aggregates may result in estimates of β that are biased in an unspecified direction. In an attempt to address the attenuation bias I implement a split-sample IV estimation approach (as used in Auld (2009)). Unfortunately this strategy resulted in significantly larger standard errors, likely due to the relatively small community samples, and was not included. Coefficient estimates for community aggregates should be assumed to under-estimate the true effect.

with less than 45 observations in each period. The result is a total of 95 aboriginal communities[7] consisting of 24,400 individuals (23 percent coverage based on 2001 populations) from which sample analogs for community means are estimated.[8] For regression estimation, data is restricted to respondents between the ages of 18 and 60. Further, observations missing any outcome or control variables are omitted. The final sample consists of 17,720 individual observations.

Survey participation is voluntary and conditional on Census participation. As many Aboriginal communities do not participate in the Census the APS under-represents communities in Ontario, Quebec and Eastern Canada. All long form (form 2B) 1991 Census respondents who reported at least one Aboriginal origin[9] received the 1991 APS (Statistics Canada, 1995). The response rate is 87 percent, resulting in a 20 percent sample of the Aboriginal Census population. Likewise, long form (form 2D for on-reserve respondents) 2001 Census respondents who either reported Aboriginal ancestry (question 17) or identified themselves as Aboriginal (questions 18, 20 or 21) are targeted for the 2001 wave of the APS with an on-reserve response rate of 87.9 percent (Statistics Canada, 2003). Due to cost considerations, the 2001 survey sampled 50 to 55 percent of the participating communities in each province, beginning with the largest. In the case of British Columbia, where there are many small communities, less than 50 percent of the communities are surveyed. For this reason the APS is not a representative sample of Aboriginal communities in Canada.

3.1 Tobacco use in Aboriginal communities

In Table 2 I present summary statistics for tobacco use in the included communities. As previously reported, smoking rates are very high in these communities relative to non-Aboriginal

[7]A complete list of all communities in the sub-sample can be found in Table A1 in the appendix.

[8]The provided Census sampling weights are used to calculate all sample analogs.

[9]Aboriginal origin is defined as having identified ethnic origin as North American Indian, Metis or Inuit (Census form question 15), or as registered under the Indian Act (Census form question 16.)

Table 2: Tobacco use summary statistics

	1991				2001			
	Mean	SDW	SDB	N	Mean	SDW	SDB	N
Smokers	0.60	0.48	0.10	10,840	0.58	0.48	0.11	12,480
Daily smokers	0.41	0.48	0.11	10,840	0.43	0.48	0.12	12,480
Cig. per day (daily)	14.78	9.26	3.30	4,509	12.07	7.20	2.41	5,320
Cig. per day (occasional)					4.98	3.93	1.28	1,790
Age started					16.05	4.80	1.09	5,240
Age stopped					31.47	13.31	3.39	1,900
Years smoked					17.48	12.45	3.26	5,240
Other smokers in household	0.69	0.45	0.12	10,811				

SDW and SDB are standard deviations for within and between communities respectively. 95 communities covered. Population weights used in all calculations. Individual observation count rounded as per confidentiality requirements.

populations. 60 and 58 percent of respondents indicated that they smoked cigarettes in the 1991 and 2001 surveys. Daily cigarette smoking increased slightly between surveys, from 41 to 43 percent of respondents. Smoking intensity (measured by the number of cigarettes smoked per day) decreased by about two cigarettes per day between 1991 and 2001.

Similar to non-aboriginal communities, age of initiation for tobacco use in these communities is about 16 years. Smokers who successfully quit do so at an average age of 31, and the average daily smoker has been smoking for 17.5 years. Finally, in the 1991 survey, 69 percent of respondents (both smokers and non-smokers) indicate that at least one smoker, other than themselves, lives in their household.

3.2 Community level referencing

A critical assumption in the empirical estimation of social effects is that the reference group for an individual is *a priori* identified (Manski, 1993, 2000). In this study, I assume that an individual's reference group is other individuals in the same community. To show that this is a reasonable assumption, in this section I discuss the geographic, social and economic structure of the communities in this sample. The within-community referencing assumption is based on the fact that these communities are relatively small, secluded, and self-sufficient.

Table 3: Mobility summary statistics

	1991				2001			
	Mean	SDW	SDB	N	Mean	SDW	SDB	N
Lived on reserve entire life	0.46	0.46	0.196	10,829	0.69	0.44	0.131	12,840
Lived off reserve past 5 years	0.10	0.28	0.061	11,081	0.18	0.365	0.098	10,560
Currently works on reserve	0.50	0.37	0.310	5,715	0.78	0.34	0.202	5,710

SDW and SDB are standard deviations for within and between communities respectively. 95 communities covered. Population weights used in all calculations. Individual observation count rounded as per confidentiality requirements.

Migration in and out of the communities is also relatively low.

Many of the communities, particularly those in the North, are located in relatively unpopulated regions of Canada, and a significant distance from major city centers. Likely because of this, these communities are relatively self-sufficient. Based on a 2003 report, 74 percent have schools and recreation centers, 80 percent have health care centers, and 60 and 48 percent have fire and police services.[10] In 1991 50 percent of actively employed respondents worked in the community, a number that increased to 78 percent in 2001 (see Table 3).[11]

The APS data suggests that movement into and out of these communities is low. In Table 3, I display summary statistics concerning the mobility of respondents. The number of respondents reporting having lived in the community their entire life was 46 percent in 1991 and 69 percent in 2001. Only 10 and 18 percent of respondents, for 1991 and 2001, report having lived outside of the community within five year of the survey.

A selection bias will result if aggregate tobacco consumption influences an individual's decision to remain on or move off their reserve. Individual's with strong anti-smoking sentiments may choose to move off a reserve with high smoking rates, but stay on a reserve

[10]The respective infrastructure for each community is reported in the Appendix. All information is found at the Government of Canada's *Aboriginal Canada Portal* web site: http://www.aboriginalcanada.gc.ca/acp/site.nsf/eng/index.html

[11]The increase in on-reserve employment is likely, in part, a response to 1995 changes to income tax exemptions. The changes required that tax-exempt exempt employment take place on reserve.

with low smoking rates. This will lead to a spurious correlation between aggregate tobacco consumption and individual tobacco consumption attributable to endogenous community selection rather than endogenous social effects. My estimation of endogenous social effects assumes that this problem is sufficiently insignificant. This assumption is supported by a relatively constant (or increasing) population size in all reserves over the time period of interest and the low mobility rates reported in Table 3. Further, a study conducted by the Institute of Urban Studies (2003) found that, for families that moved from reserves to the city of Winnipeg, 90 percent of respondents cited family, employment, and education as being their primary reasons for moving. Only 1.3 percent of respondents cited alcohol and substance abuse as the primary motivate for leaving the reserve. Given this, the number of relocations due to tobacco use is likely very small.

3.3 Tobacco taxation in Aboriginal communities

Section 87 of the *Indian Act* exempts all Status Indians from provincial taxes levied on tobacco. To qualify for exemption, tobacco products must be purchased on a reserve, and the purchaser must present proof of Status. Some provinces impose a quota on the amount of tobacco an individual can purchase over a defined period (Physicians for a Smoke Free Canada, 2007). These quotas are large relative to the needs of individual smokers and will not be considered in the analysis.[12] Section 87 does not exempt Status Indians from federal excise taxes on tobacco (Physicians for a Smoke Free Canada, 2007).

Estimated point-of-sale tobacco prices for each year (1991 and 2001) are used to estimate tobacco price elasticity. Exogenous price variation comes from three sources: changes to federal excise taxes, differences in implementation of provincial tax exemptions, and use of the First Nations Tax (FNT). Information regarding tax exemptions and use of the FNT is combined with information on tax and cigarette prices to construct a data set reflecting the

[12] For example, Alberta imposes a 4-carton, or 800 cigarettes, per week per individual quota.

Table 4: Cigarette prices in survey years

Province	1991	2001	% Δ	Communities
NF	35.32	32.42	-8.21	1
PEI	52.08	44.48	-14.59	2
NS	37.50	31.47	-16.08	3
NB	39.36	35.33	-10.24	1
PQ	33.53	26.87	-19.86	3
ON	36.11	28.86	-20.08	7
MN	53.27	51.28	-3.74	14
SK	50.88	30.73	-39.60	30
AB	31.85	28.36	-10.96	12
BC	30.40	28.15	-7.40	21
Kamloops	30.40	30.12	-0.92	1

Prices reflect the real price of 200 cigarettes for Status Indians purchasing on reserve. Nominal prices are adjusted using provincial consumer price index (2001 dollars.)

point-of-sale prices faced in Aboriginal communities. The resulting prices are summarized in Table 4.

The implementation of provincial tax exemptions differs across provinces in two ways. The first is in timing. Relevant to this study, Saskatchewan did not recognize exemptions from provincial tobacco taxes until March 30, 2000 (Saskatchewan Department of Finance, 2010). After this date retailers are reimbursed the provincial sales tax for all tobacco sales to Status Indians. The change in tax policy resulted in a 39 percent decrease in the point-of-sale price of tobacco in Saskatchewan between 1999 and 2000. The second way that tax exemptions differ is in how taxes are reimbursed. In all Manitoba communities, and the Lennox Island reserve on Prince Edward Island (included in the sample), provincial governments reimburse the communities as an alternative to point-of-sale tax exemptions for individual consumers. Taxes are applied at the retail level and reimbursed to local First Nations band councils, less taxes paid by non-Status individuals (Physicians for a Smoke Free Canada, 2007). As the interest of this study is the price paid at the point of sale, these communities are treated as fully reflecting the provincial tobacco tax.

Band councils have the option to implement a FNT in the communities they oversee. In 1998 the Kamloops Band became one of only 11 bands in Canada to implement a FNT on tobacco products[13](Physicians for a Smoke Free Canada, 2007). The FNT levies a 7 percent tax on all tobacco products sold on the Kamloops reserve.[14]

The remaining provinces implemented provincial tax exemptions prior to 1991. In 1987 the Government of British Columbia amended the *Social Services Tax Act* to exempt Status Indians from provincial sales tax (Gardner-O'Toole, 1992). Likewise, in 1991 the Government of Alberta implemented tobacco tax exemptions. Prior to this individuals in British Columbia and Alberta were required to pay the full provincial tobacco tax. Point of sale tax exemptions applied in all Ontario, Quebec, Nova Scotia and New Brunswick communities over the period examined (Gardner-O'Toole, 1992). In these communities, only federal excise taxes apply.

Finally, reductions in federal excise taxes in the early 1990s lead to a decrease in the real price of cigarettes in all provinces between 1991 and 2001. These decreases were larger in the Eastern provinces than the Western provinces.

This results in a significant amount of variation in tobacco prices, summarized in Table 4. Contrast tobacco prices for Saskatchewan communities with communities in Manitoba. Both provinces faced similar prices in 1991 but substantially different prices in 2001, with Saskatchewan falling almost 40 percent and Manitoba falling 3.7 percent. Communities in British Columbia are estimated to have seen a 7.4 percent reduction in cigarette prices, with the exception of the Kamloops reserve in which the 1998 FNT stopped prices from falling.

Because cigarette prices in a given year are constant across all reserves within a province (Kamloops being the exception), I must assume that price changes are uncorrelated with any other unobservable factors that changed at the provincial level and influenced tobacco use. For example, if a decrease in tobacco prices is met with an aggressive Aboriginal tobacco education campaign implemented in a province, I may under-estimate the influence of price

[13]The Kamloops Band is the only band with a reserve included in the sample to implement a FNT.

[14]The sample analyzed in this study contains one of these communities, Kamloops 1. More information on the Kamloops FNT can be found at http://www.cra-arc.gc.ca/E/pub/gi/notice92a/notice92a-e.html.

on smoking behavior.

4 Results

I estimate price elasticity for three binary outcomes: smoking participation, daily smoking, and occasional smoking (conditional on not being a daily smoker). As all models are estimated linearly, binary outcomes are interpreted as linear probability models.[15] I also look at smoking intensity for daily smokers, as reflected by number of cigarettes consumed per day. It should be noted that no adjustment is made for the possibility of a selection bias with smoking intensity. This will affect the results if the smoking intensity of those who quit smoking when prices increase is non-random. Specifically, low-intensity smokers may be more likely to quit, leading to an under-estimation of the effect of prices on mean smoking intensity.

All regressions include community fixed effects and community level clustering of standard errors. For each outcome three equations are estimated: the non-social equation (Eq. (6)), the total elasticity social equation (Eq. (7)), and the direct elasticity social equation (Eq. (8)).

4.1 Non-social equation estimates

In Table 5 I report the results of estimating Eq. (6) for each outcome. These estimates suggest that a number of individual characteristics are significant determinants of adult tobacco use. The age-quadratic indicates that the propensity to smoke for overall and daily smoking increases until age 50 and decreases afterwards. The propensity for occasional smoking ends

[15]By specifying a linear-in-means framework I am able to precisely interpret estimated coefficient from the different equations. Binary outcome models have also been estimated using a probit specification. As expected, estimated marginal effects between the probit and linear estimates are very similar (see Angrist and Pischke (2008, 103–107) for a discussion on this property). As I am only concerned with marginal effects, and the linear-in-means model strictly corresponds to linear estimation, the reported results are for linear estimates. Nonlinear estimates are available from the author upon request.

Table 5: Estimates with no social effects

	Smoke		Smoke Daily		Smoke Occasionally		Cigarettes per Day	
log(Cigarette prices)	-0.066*	(0.026)	-0.076*	(0.037)	-0.040	(0.039)	7.008**	(0.857)
Age	0.011**	(0.002)	0.009**	(0.002)	0.005	(0.003)	0.371**	(0.066)
Age-squared/100	-0.022**	(0.003)	-0.017**	(0.003)	-0.013**	(0.004)	-0.378**	(0.084)
Males	-0.013	(0.009)	-0.017	(0.010)	-0.003	(0.010)	2.337**	(0.209)
Household size	0.005**	(0.002)	0.002	(0.002)	0.007**	(0.002)	-0.038	(0.047)
Divorced/sept./wid.	0.028	(0.016)	0.038*	(0.016)	-0.007	(0.019)	1.379**	(0.443)
Married	-0.080**	(0.010)	-0.057**	(0.009)	-0.074**	(0.013)	0.928**	(0.303)
Family inc./100k	-0.089**	(0.020)	-0.046**	(0.017)	-0.108**	(0.024)	-0.524	(0.606)
Respondent inc./100k	-0.108**	(0.033)	-0.061	(0.035)	-0.093*	(0.037)	-1.240	(1.013)
Employed	0.002	(0.010)	0.001	(0.011)	0.001	(0.013)	0.044	(0.289)
Unemployed	0.045**	(0.011)	0.029**	(0.011)	0.044**	(0.015)	-0.103	(0.354)
Work off reserve	-0.009	(0.013)	0.003	(0.013)	-0.020	(0.015)	0.414	(0.412)
High school grad.	-0.112**	(0.011)	-0.108**	(0.011)	-0.070**	(0.012)	-1.091**	(0.299)
Attending school	-0.018	(0.016)	-0.010	(0.016)	-0.025	(0.022)	-1.062**	(0.334)
Speaks a trad. language	0.023*	(0.010)	0.000	(0.010)	0.042**	(0.013)	-0.769**	(0.253)
Community problem index	0.009	(0.014)	0.042*	(0.017)	-0.023	(0.019)	1.237**	(0.449)
Observations	17,720		17,720		9,590		8,030	
Adjusted R-squared	4.17%		2.10%		3.92%		6.33%	

Robust standard errors adjusted for community level clustering are reported in parenthesis. All regressions include community fixed effects. Family income is net of respondent's income. Cigarette prices reflect the point-of-sale price of 200 cigarettes for Status Indians purchasing on reserve. Nominal monetary variables are adjusted using the provincial consumer price index (2001 dollars.)

much earlier, increasing until age 38 and decreasing thereafter. Controlling for other factors, males do not appear to be significantly different from females in their propensity to smoke, but males who smoke daily consume roughly two cigarettes more per day then their female counterparts. Married individuals are 8.0 percentage points less likely to smoke than individuals never married, but married daily smokers smoke almost a cigarette per day more. The coefficients for household and individual income are negative and statistically significant but economically small. At best, a ten-thousand dollar increase in personal income reduces tobacco use by 1 percentage point. Unemployed individuals are more likely to be smokers than those not in the labour force, and being a high-school graduate, as opposed to leaving high-school without completion, is strongly associated with lower smoking. Individuals who speak a traditional Aboriginal language are about 2.3 percentage points more likely to identify themselves as smokers. However, this significant increase is due to an increase in occasional smoking; individuals who speak a traditional language are not more likely than non-speakers to be daily smokers. This is consistent with the idea that participation in traditional aboriginal culture increases use of tobacco, but not necessarily tobacco abuse (see McKennitt (2005) for a discussion.) Further, daily smokers who speak an aboriginal language consume approximately 0.77 fewer cigarettes per-day (roughly a pack of 20 cigarettes less each month) than their counterparts who do not speak a traditional Aboriginal language. Individuals who perceive their communities as having more social problems, as measured by the community problem index, are more likely to be daily smokers and smoke at a higher intensity.

These results are consistent with previous studies that look at determinants of tobacco use in non-Aboriginal populations. Several studies have found a strong negative relationship between education and tobacco use (de Walque, 2007; Cutler and Glaeser, 2007.) The estimates for demographic characteristics, marital status and income are consistent with those found by Cutler and Glaeser (2007). The positive coefficient for daily smoking and the community problem index, and the positive coefficients for daily and occasional smoking and unemployment, are consistent with the theory that tobacco may be used as a coping mechanism in stressful circumstances (Rahkonen *et al.*, 2005).

Estimates for tobacco price elasticities are statistically significant and economically non-trivial. A 10 percent increase in the price of tobacco is predicted to decrease overall rates of adult tobacco use by 0.66 percentage points. The estimated elasticity for daily smoking is almost twice the magnitude of the estimated elasticity for occasional smoking. A 10 percent increase in the price of tobacco is predicted to decrease rates of daily adult smoking by 0.76 percentage points and occasional smoking by 0.40 percentage points.

There is a large, positive and statistically significant coefficient associated with the smoking intensity of daily tobacco use. This estimate implies that a one percent increase in tobacco prices will lead to an increase of 7 cigarettes per day for the average daily smoker.

This positive price effect is contrary to expectations. This could be the result of the selection bias discussed earlier. However, given the small magnitudes for participation elasticity it is unlikely that selection bias explains the large effect estimated here. As the estimates for the social model will show, a more plausible explanation is that this is a bias created by model miss-specification.

4.2 Total elasticity equation estimates

Estimates of Eq. (7) are reported in Table 6. The addition of community aggregates does not significantly change the estimates for private effects relative to those in Table 5.

The coefficient estimates associated with many of the community means are statistically insignificant. While this is evidence against the presence of social interactions, it could also be the result of low variation across communities and time leading to imprecise estimates or attenuation bias arising from the use of sample analogs in place of community means. Conditional on own age, an individual in a relatively young community is more likely to smoke occasionally (as opposed to never) than an individual in a relatively old community. Further, daily smokers in younger communities consume more cigarettes per day. A 10 percent increase in traditional language use in the community increases the probability a given individuals will be an occasional smoker by 2.27 percentage points. Indicators of community health, specifically the mean community problem index and the standard deviation of community income, have an interesting interpretation. Conditioning on an individual's community problem index, an increases in the mean community problem index increases the probability a given individual will be a daily smoker. A mean increase of one more problem identified (increasing the index by 0.14) increases the probability of daily tobacco use by 1.89 percentage points. A ten-thousand dollar increase in the standard deviation of community income increases the probability an individual smokes by 7.85 percentage points.

As specified in Eq. (7), the coefficient for the community mean associated with variable

Table 6: Total elasticity estimates with social effects

	Smoke		Smoke Daily		Smoke Occasionally		Cigarettes per Day	
log(Cigarette prices)	-0.118**	(0.040)	-0.073	(0.056)	-0.139*	(0.062)	1.369	(1.325)
Age	0.011**	(0.003)	0.009**	(0.002)	0.005	(0.003)	0.371**	(0.064)
Age-squared/100	-0.022**	(0.003)	-0.017**	(0.003)	-0.014**	(0.004)	-0.401**	(0.082)
Males	-0.014	(0.009)	-0.018	(0.010)	-0.004	(0.010)	2.326**	(0.207)
Household size	0.005**	(0.002)	0.002	(0.002)	0.007**	(0.002)	-0.075	(0.049)
Divorced/sept./wid.	0.026	(0.016)	0.036*	(0.016)	-0.008	(0.019)	1.120**	(0.449)
Married	-0.081**	(0.010)	-0.057**	(0.009)	-0.075**	(0.013)	0.652**	(0.282)
Family income/100,000	-0.090**	(0.021)	-0.048*	(0.018)	-0.108**	(0.024)	-0.293	(0.613)
Respondent income/100,000	-0.104**	(0.033)	-0.060	(0.035)	-0.088*	(0.037)	-0.508	(0.997)
Employed	0.003	(0.010)	0.002	(0.011)	0.002	(0.012)	0.209	(0.286)
Unemployed	0.045**	(0.010)	0.030**	(0.011)	0.043**	(0.015)	-0.116	(0.350)
Work off reserve	-0.009	(0.013)	0.003	(0.013)	-0.020	(0.014)	-0.240	(0.434)
High school grad.	-0.111**	(0.011)	-0.106**	(0.011)	-0.069**	(0.012)	-0.997**	(0.303)
Attending school(not hs grad.)	-0.017	(0.016)	-0.010	(0.016)	-0.023	(0.022)	-1.148**	(0.335)
Speaks a trad. language	0.021*	(0.010)	0.000	(0.010)	0.037**	(0.013)	-0.763**	(0.251)
Community problem index	0.006	(0.014)	0.035*	(0.016)	-0.021	(0.018)	1.453**	(0.472)
Community Aggregates								
Age < 20yrs	0.470	(0.387)	-0.085	(0.500)	1.068*	(0.484)	30.708*	(13.892)
Age 20–29yrs	0.059	(0.320)	-0.257	(0.376)	0.445	(0.410)	32.902**	(12.481)
Age 30–39yrs	0.016	(0.282)	-0.167	(0.317)	0.225	(0.376)	23.565	(13.023)
Age 40–49yrs	0.086	(0.369)	0.006	(0.434)	0.225	(0.418)	3.491	(12.274)
Age 50–59 yrs	-0.081	(0.294)	-0.085	(0.307)	-0.075	(0.350)	22.387	(13.115)
Males	0.240	(0.235)	0.124	(0.305)	0.353	(0.336)	4.075	(9.983)
Household Size	-0.010	(0.015)	-0.002**	(0.020)	-0.026	(0.021)	0.385	(0.599)
Divorced/sept./wid.	0.337	(0.245)	0.227	(0.324)	0.296	(0.303)	12.826	(6.589)
Married	0.251*	(0.114)	0.211	(0.151)	0.218	(0.153)	8.075	(4.316)
Family income/100,000	0.100	(0.198)	0.018	(0.272)	0.172	(0.254)	0.179	(5.992)
Respondent income/100,000	-0.858	(0.521)	-0.811	(0.650)	-0.501	(0.761)	3.330	(13.366)
Employed	0.028	(0.120)	0.126	(0.126)	-0.132	(0.156)	-3.354	(3.687)
Unemployed	-0.153	(0.193)	-0.202	(0.205)	-0.089	(0.215)	-2.175	(5.345)
Work off reserve	0.028	(0.064)	0.121	(0.088)	-0.085	(0.099)	3.283	(2.529)
High school grad.	-0.125	(0.127)	-0.180	(0.149)	-0.055	(0.193)	-1.284	(4.034)
Attending school	-0.229	(0.140)	0.023	(0.200)	-0.504*	(0.205)	1.908	(5.458)
Speaks a trad. language	0.106	(0.069)	-0.005	(0.074)	0.227*	(0.111)	-1.961	(2.530)
Community problem index	0.124	(0.087)	0.189*	(0.090)	0.029	(0.132)	0.504	(2.550)
SD of Community Income/100,000	0.785*	(0.375)	0.815	(0.430)	0.331*	(0.528)	0.550	(9.274)
Observations	17,720		17,720		9,590		8,030	
Adjusted R-squared	4.19%		2.14%		3.96%		7.41%	

Robust standard errors, adjusted for community level clustering, are reported in parenthesis. All regressions include community fixed effects. Family income is net of respondent's income. Cigarette prices reflect the point-of-sale price of 200 cigarettes for Status Indians purchasing on reserve. Nominal monetary variables are adjusted using the provincial consumer price index (2001 dollars.)

k, $(\alpha\beta_k + \theta_k)/(1 - \alpha)$, captures both the endogenous social effect, α, and contextual social effect, θ_k. If the coefficient associated with community mean k is non-zero then there must be a social effect, either α or θ_k or both are non-zero. If the endogenous social effect is positive and the contextual effect is equal to zero then the estimated coefficient will be of the same sign as β_k. To illustrate, the estimates in Table 6 indicate that married individuals are less likely to be smokers than non-married individuals. If endogenous social effects are important then an individual living in a community with a high proportion of married couples will be less likely to smoke than an observationally equivalent individual living in a community with a low proportion of married couples. However, the estimated coefficient for community marriage rates in Table 6 is positive, suggesting the presence of contextual effects.

Estimates for tobacco price elasticities change relative to those presented in Table 5. A 10 percent increase in the price of tobacco is predicted to decrease overall smoking by 1.18 percentage points. This estimate is consistent with tobacco price elasticities estimated for non-aboriginal population (for example see Ding (2004), Sen and Wirjanto (2009) and Franz (2008)). Occasional smokers are now estimated to be more price sensitive than daily smokers; a 10 percent price increases reduces daily smoking by 0.73 percentage points and occational smoking by 1.39 percentage points. This result is consistent with intuition, as occasional smoking is less likely than daily smoking to be associated with addiction. Relative to the non-social model, total price elasticities are double in magnitude for general smoking and triple for occasional smoking. Smoking intensity for daily smokers is still positive but significantly smaller in magnitude than predicted by the non-social model and not statistically different than zero.

4.3 Direct elasticity equation estimates

If no contextual social effects are present, ($\theta_k = 0$ for all k), then community-level means can be used as instruments for community-level tobacco use. To illustrate the strength of this assumption consider the community age distribution. If there is no contextual effect then individual tobacco consumption varies with the age distribution only because age exogenously influences smoking (younger individuals are more likely to be smokers.) This condition is violated if older community members, regardless of their own tobacco use, are more likely to support anti-smoking and tobacco education programs. In this case, estimates will falsely attribute the correlation between individual tobacco use and the community age distribution to endogenous social interactions rather than to the unobserved policy interventions.

With this in mind I estimate Eq. (8) assuming no contextual social effects. I use a two-stage Generalized Method of Moments (GMM) procedure (Stata's XTIVREG2 command), using the community level aggregates, $E[X_{gt}]$, as excluded instruments for community level tobacco consumption. The results are reported in Table 7. Coefficients associated with community level smoking rates and smoking intensity are interpreted as the endogenous social effects, α.

Again, very little changes with respect to the private effect relative to the previous models. This is consistent with the prediction of Eq. (7) and Eq. (8). The estimated endogenous effects are large and significant. A ten percent increase in community smoking rates are estimated to increase an individual's probability of smoking by 5.6 percentage points. This is consistent with endogenous social effects estimated for tobacco use by Cutler and Glaeser (2007) and Powell *et al.* (2005), but larger than those reported in Lee *et al.* (2007) and Krauth (2007). The endogenous effect for daily smoking is a 8.10 percentage point increase for a 10 percent community increase, and for occasional smoking is a 6.42 percentage point increase for a 10 percent community increase.

As predicted, the direct elasticity estimates are less than the total elasticity estimates. A 10 percent price increase is predicted to directly decrease overall smoking by 0.58 percentage points, daily smoking by 0.37 percentage points and occasional smoking by 0.54 percentage points. Smoking intensity is also negatively related to price, although not economically

Table 7: Direct elasticity estimates with social effects

	Smoke		Smoke Daily		Smoke Occasionally		Cigarettes per Day	
log(Cigarette prices)	-0.058**	(0.017)	-0.037*	(0.016)	-0.054*	(0.022)	-0.026	(0.543)
Comm. smoking rate	0.561**	(0.084)						
Comm. smoking rate (daily)			0.810**	(0.101)				
Comm. smoking rate (occ.)					0.642**	(0.109)		
Comm. smoking intensity							1.138**	(0.066)
Age	0.011**	(0.002)	0.009**	(0.002)	0.005	(0.003)	0.389**	(0.063)
Age-squared/100	-0.022**	(0.003)	-0.017**	(0.003)	-0.014**	(0.004)	-0.389**	(0.080)
Males	-0.013	(0.009)	-0.017	(0.009)	-0.004	(0.010)	2.341**	(0.199)
Household size	0.005**	(0.002)	0.002	(0.002)	0.006**	(0.002)	-0.068	(0.047)
Divorced, separated, widowed	0.026	(0.016)	0.036*	(0.016)	-0.008	(0.018)	1.105*	(0.444)
Married	-0.081**	(0.010)	-0.057**	(0.009)	-0.074**	(0.012)	0.681*	(0.274)
Family income/100,000	-0.087**	(0.020)	-0.046**	(0.017)	-0.104**	(0.023)	-0.268	(0.591)
Respondent income/100,000	-0.101**	(0.032)	-0.055	(0.034)	-0.088*	(0.037)	-0.338	(0.966)
Employed	0.003	(0.010)	0.002	(0.011)	0.003	(0.012)	0.218	(0.279)
Unemployed	0.045**	(0.010)	0.029**	(0.010)	0.042**	(0.015)	-0.084	(0.344)
Work off reserve	-0.015	(0.013)	-0.003	(0.012)	0.023	(0.013)	-0.197	(0.408)
High school grad.	-0.110**	(0.011)	-0.105**	(0.011)	-0.068**	(0.012)	-0.990**	(0.297)
Attending school	-0.018	(0.016)	-0.010	(0.016)	-0.023	(0.022)	-1.103**	(0.345)
Speaks a trad. language	0.021*	(0.010)	0.000	(0.010)	0.037**	(0.013)	-0.660**	(0.253)
Community problem index	0.008	(0.013)	0.036*	(0.015)	-0.018*	(0.017)	1.200**	(0.440)
Observations	17,720		17,720		9,590		8,030	
First stage F-stat (p-value)	0.001		0.167		0.017		0.000	
First stage partial R-square	26.88%		17.34%		26.68%		37.77%	
Hansen's J (p-value)	0.14		0.20		0.16		0.07	

Robust standard errors, adjusted for community level clustering, are reported in parenthesis. All regressions include community fixed effects. Family income is net of respondent's income. Cigarette prices reflect the point-of-sale price of 200 cigarettes for Status Indians purchasing on reserve. Nominal monetary variables are adjusted using the provincial consumer price index (2001 dollars.) First stage F-stat and R-square are for excluded instruments.

or statistically significant. The elasticity estimates between Table 6 and Table 7 change predictably given the estimated values of α. The social model of tobacco use states that the difference in prices between Eq. (7) and Eq. (8) should equal $1/(1-\alpha)$. Given the estimates of price elasticity the endogenous social effects can be recovered relatively accurately from the overall smoking and occasional smoking equations, but with less accuracy for daily smoking and smoking intensity.

Estimates of the non-social model (Eq. (6)) deviate from the social model in differing ways depending on which outcome is being examined. It is not clear from these estimates in what direction or to what magnitude omitting social effects will bias elasticity estimates,

Table 8: Robustness test allowing for contextual social effects

	Smoke		**Smoke Daily**		**Smoke Occasionally**		**Cigarettes per Day**	
Model 1, Excluded instruments (aggregate): age, sex, household size, marital status, income, employment, education, language, community problem index.								
log(Cigarette prices)	-0.042*	(0.017)	-0.025	(0.016)	-0.043	(0.024)	-0.038	(0.535)
Comm. smoking rate	0.575**	(0.086)						
Comm. smoking rate (daily)			0.778**	(0.106)				
Comm. smoking rate (occ.)					0.672**	(0.114)		
Comm. smoking intensity							1.097**	(0.072)
First stage F-stat (p-value)	0.001		0.230		0.044		0.000	
First stage partial R-square	26.78%		16.93%		25.44%		32.46%	
Hansen's J p-value	0.0619		0.215		0.0809		0.0564	
Model 2, Excluded instruments (aggregate): age, sex, household size, employment, education, community problem index.								
log(Cigarette prices)	-0.058*	(0.021)	-0.033	(0.019)	-0.054	(0.030)	-0.028	(0.567)
Comm. smoking rate	0.534**	(0.103)						
Comm. smoking rate (daily)			0.761**	(0.110)				
Comm. smoking rate (occ.)					0.628**	(0.110)		
Comm. smoking intensity							1.121**	(0.079)
First stage F-stat (p-value)	0.008		0.133		0.029		0.001	
First stage partial R-square	24.46%		16.73%		21.21%		14.98%	
Hansen's J p-value	0.0532		0.2437		0.030		0.0188	
Model 3, Excluded instruments (aggregate): employment, education.								
log(Cigarette prices)	-0.087*	(0.043)	-0.074	(0.066)	-0.064	(0.042)	-0.873	(0.547)
Comm. smoking rate	0.210	(0.300)						
Comm. smoking rate (daily)			0.032	(0.650)				
Comm. smoking rate (occ.)					0.523*	(0.256)		
Comm. smoking intensity							1.199**	(0.087)
First stage F-stat (p-value)	0.290		0.924		0.077		0.020	
First stage partial R-square	8.09%		2.43%		10.30%		14.98%	
Hansen's J p-value	0.2050		0.9341		0.0588		0.0226	
Observations	17,720		17,720		9,590		8,030	

Robust standard errors, adjusted for community level clustering, are reported in parenthesis. All models include controls for individual quadratic age, sex, household size, marital status, income, employment status, education, speaking of an aboriginal language, community problem index and community fixed effects. All community aggregates are used as either excluded or included instruments. First stage F-stat and R-square are for excluded instruments.

but a bias is present.

As the model is over-identified I use a J-test for the null hypothesis that the exclusionary restrictions are valid (i.e. that contextual effects are in fact zero). Hansen's J statistic (Table 7) fails to reject the null hypothesis that the community means are valid instruments at a p-value of 5 percent. However, failure to reject is not overwhelming in any regression. It is intuitively likely that assumption of no exogenous social effects is not valid. To account for this (although imperfectly) I re-estimate the model relaxing the assumption that all of the contextual effect are zero. Estimated price elasticities and endogenous social effects for three alternative models are reported in Table 8.

In Model 1 of Table 8 the standard deviation of income is included in the second stage regression. Model 2 further adds the community means of marital status, income, and speaking of an aboriginal language, and Model 3 further includes community means for sex, age, household size and the community problem index. The estimated magnitudes for price elasticity and α are fairly stable through this procedure. Daily smoking is the most sensitive to model specification, in Model 3 the estimated α is small and statistically insignificant. The first stage F-stat for the excluded instruments in all models indicate that this specification is better suited for occasional smoking than daily smoking. Further, the J statistic for smoking intensity corresponds to a low p-value for all specifications, indicating that the exclusionary restrictions are not likely to be valid in this context. With this in mind the estimates reported in Table 7 should be interpreted cautiously.

5 Conclusions

Exploiting a repeated cross-section created from the 1991 and 2001 waves of the Aboriginal Peoples Survey, I provide the first estimates of tobacco price elasticity for adults in Canada's Aboriginal communities. Previous policy studies suggest that tobacco taxation is an impor-

Table 9: Counterfactual tobacco taxation in Aboriginal communities.

			Counterfactual 7% Tax		Counterfactual 50% Tax	
	Elasticity	Average cigarettes per day	Implied Δ in smokers per 1,000†	Annual Δ in revenue per 1,000‡	Implied Δ in smokers per 1,000†	Annual Δ in revenue per 1,000‡
Daily Smokers						
Direct price effect	-0.037	12.0	-2.59		-18.50	
	(0.016)		(0.112)		(0.800)	
Social price effect	-0.073	12.0	-5.11	$22,965	-36.50	$164,039
	(0.056)		(0.392)	($22,550, $23,380)	(2.800)	($142,851, $185,226)
Occasional Smokers						
Direct price effect	-0.054	2.1	-3.78		-27.00	
	(0.022)		(0.154)		(1.100)	
Social price effect	-0.139	2.1	-9.73	$1,547	-69.50	$11,049
	(0.062)		(0.434)	($1,464, $1,629)	(3.100)	($6,860, $15,238)

†Change reported reflects number of people per 1,000 who change their smoking status. ‡Revenue calculations are based on $4.57 for a pack of 25 cigarettes. Standard errors and 95% confidence interval reported in parenthesis.

tant instrument to reduce tobacco consumption in Aboriginal communities. For example, Samji and Wardman (2009) hypothesize that a 7 percent First Nations Tax will reduce smoking rates by 2.4 percent and provincial-level tax rates will reduce smoking rates by 22.5 percent. In this study I provide the first test of these hypothesis. The price elasticities I estimate indicate that tax policy will reduce tobacco consumption, but at a magnitude less than half the size of previous hypothesis. Implementing a 7 percent tax will reduce overall smoking rates for Aboriginal adults by about 0.8 percentage points, and implementing a tax at off-reserve provincial rates (50 percent) will lead to a 5.9 percentage point decrease in overall smoking rates. This translates to reductions of 1.4 percent and 10.2 percent from overall smoking rates in 2001. These taxes will have a much greater proportional effect on occasional smoking rather than daily smoking. A 50 percent tax will decrease daily smoking by 8.5 percent and occasional smoking by 46.3 percent from 2001 levels.

In Table 9 I summarize the expected change in smoking rates and community revenue (based on average tobacco use reported in Table 2) for a 7 percent and 50 percent tobacco tax. For every thousand individuals, a 7 percent tax will result in 5.1 daily smokers changing their status to occasional smoker or nonsmoker and 9.7 occasional smokers will become nonsmokers. The corresponding increase in community revenue will be about $25,000 per thousand. For every thousand individuals, a 50 percent tax will result in 36.5 daily smokers changing their status to occasional smoker or nonsmoker and 69.5 occasional smokers will become nonsmokers. This is expected to raise community revenue by about $175,000 per thousand. Because of the low behavioral response, I conclude that tobacco taxes are an effective tool for revenue generation but will make little difference in terms of health policy.

Canada's Aboriginal communities are small and secluded, presenting a unique opportunity to look at the potential influence of community smoking norms on individual behavior. I model and analyze two ways in which price influences individual behavior. First is the direct effect; a price increase causes tobacco to be relatively expensive and individuals consume less in response. Second is the indirect effect; a price increase decreases tobacco use for all members in a community, which decreases the marginal utility associated with tobacco use for each individual in the community. I find that the indirect effect doubles the negative influence of price on adult tobacco use over the direct effect alone (given the results reported in Table 6 and Table 7.) Further, I find that not accounting for social effects may yield bias estimates of price elasticity.

Data availability has restricted previous studies to estimating social effects for tobacco use in classrooms (for youth) or households (for spouses). The ability to identify the community in which individuals live allows me to overcome the major difficulty of identifying a feasible reference group. This is, to my knowledge, the first study to estimate social effects within self contained communities. Although the analysis is weakened by the inability to cleanly identify an instrument for mean community tobacco use, I believe I am able to provide meaningful information about the relationship between policy intervention and social interactions.

The analysis in this study can be extended beyond smoking and will apply to any socially influenced good or behavior. This has an important policy implication. Interventions applied to the community will be much more effective than interventions applied to individuals. For example, this may be important when thinking about how a policy intervention can be used to address obesity and low levels of physical activity. When social interactions are present, the promotion of community level events, such as team sports, will be more effective than educating and encouraging individuals to engage independently in physical activity. Likewise, interventions for drug and alcohol use will be more effective when simultaneously applied to peer groups, rather than to group members individually.

These findings should be of interest to economists and policy makers alike. Unfortunately, detailed control of social effects in empirical work is severely limited by data availability. Questions that allow for the identification of peer groups and peer group behaviors are vital to move this research forward. Given the importance of this information for health policy research, ensuring such information is collected in national data should be high priority.

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Appendix: Communities included in analysis

Census Subdivision	Community Name	Province	Population (2001)	School	Health Center	Police	Recreation Center	Fire
1003801	Samiajij Miawpukek	NF	837	yes	yes	yes	yes	yes
1103035	Lennox Island 1	PEI	261	yes	yes	yes	yes	yes
1208014	Indian Brook 14	NS	932	yes	yes	yes	yes	yes
1210003	Millbrook 27	NS	821	yes	yes	yes	yes	yes
1217020	Eskasoni 3	NS	2741	yes	yes	yes	yes	yes
1310034	Devon 30	NB	692	yes	yes	no	yes	no
2499804	Mistissini	PQ	3125	no	no	no	no	no
2499806	Waskaganish	PQ	1699	no	yes	yes	no	no
2499814	Chisasibi	PQ	3467	no	no	yes	no	no
3543050	Mnjikaning F.N. 32	ON	597	yes	yes	yes	yes	no
3543069	Christian Island 30	ON	515	yes	yes	yes	yes	yes
3558003	Fort William 52	ON	599	no	yes	yes	yes	no
3559063	Couchiching 16A	ON	595	no	yes	yes	yes	yes
3560053	Fort Hope 64	ON	1001	yes	yes	yes	yes	yes
3560070	Deer Lake	ON	756	yes	yes	yes	no	no
3560071	Sandy Lake 88	ON	1704	yes	yes	yes	yes	yes
4606040	Sioux Valley 58	MB	1050	yes	yes	yes	yes	yes
4608069	Sandy Bay 5	MB	2446	yes	yes	yes	yes	yes
4616017	Waywayseecappo F.N.	MB	1135	yes	yes	yes	yes	yes
4617029	Ebb and Flow 52	MB	991	yes	yes	no	yes	yes
4618067	Fairford 50	MB	820	yes	yes	no	yes	yes
4619056	Fisher River 44	MB	867	yes	yes	no	yes	yes
4621029	Chemawawin 2	MB	964	yes	yes	yes	yes	yes
4621043	Opaskwayak Cree Nation 21E	MB	2025	yes	-	-	-	-
4622050	Oxford House 24	MB	1700	yes	yes	no	yes	yes
4622051	Cross Lake 19	MB	1491	yes	yes	no	yes	no
4622052	Cross Lake 19A	MB	502	-	-	-	-	-
4622058	Norway House 17	MB	3950	no	yes	yes	yes	yes
4622059	Nelson House 170	MB	1710	yes	yes	yes	yes	yes
4622063	Split Lake 171	MB	1581	yes	yes	no	yes	yes
4701808	White Bear 70	SK	536	yes	yes	yes	yes	yes
4705803	Cowessess 73	SK	486	yes	yes	yes	yes	yes
4706809	Piapot 75	SK	503	yes	yes	no	yes	no
4706810	Assiniboine 76	SK	646	yes	yes	yes	yes	yes
4706811	Standing Buffalo 78	SK	454	yes	yes	yes	no	yes
4706816	Peepeekisis 81	SK	396	yes	yes	no	yes	no
4710823	Gordon 86	SK	723	yes	yes	yes	yes	yes
4712830	Mosquito 109	SK	433	yes	yes	no	yes	no
4713835	Poundmaker 114	SK	505	yes	yes	yes	yes	yes

Community facility information and population sizes found at *Aboriginal Canada Portal*: http://www.aboriginalcanada.gc.ca/acp/site.nsf/eng/index.html. F.N. stands for First Nation.

Census Subdivision	Community Name	Province	Population (2001)	School	Health Center	Police	Recreation Center	Fire
4713836	Little Pine 116	SK	567	yes	yes	no	yes	yes
4715849	James Smith 100	SK	624	yes	yes	no	yes	yes
4715853	Montreal Lake 106B	SK	347	-	-	-	-	-
4716856	Sturgeon Lake 101	SK	873	yes	yes	yes	yes	yes
4716858	Big River 118	SK	1225	yes	yes	no	yes	yes
4716860	Ahtahkakoop 104	SK	1099	yes	yes	yes	yes	yes
4717801	Seekaskootch 119	SK	1834	yes	yes	yes	yes	yes
4717802	Makaoo (Part) 120	SK	175	-	-	-	-	-
4717805	Flying Dust F.N. 105	SK	575	yes	yes	yes	yes	no
4717806	Waterhen 130	SK	577	yes	yes	yes	yes	yes
4717807	Makwa Lake 129B	SK	736	-	-	-	-	-
4717809	Ministikwan 161	SK	573	yes	yes	no	yes	yes
4717812	Moosomin 112B	SK	514	yes	yes	yes	yes	yes
4718802	Montreal Lake 106	SK	861	yes	yes	yes	yes	yes
4718809	Lac La Ronge 156	SK	1181	-	-	-	-	-
4718812	Kitsakie 156B	SK	560	-	-	-	-	-
4718814	Wapachewunak 192D	SK	434	yes	yes	yes	yes	yes
4718817	Canoe Lake 165	SK	747	yes	yes	yes	yes	yes
4718818	Buffalo River Dene Nation 193	SK	607	yes	yes	yes	yes	yes
4718828	Chicken 224	SK	1075	yes	yes	yes	yes	yes
4718839	Clearwater River	SK	548	yes	yes	no	yes	yes
4803801	Peigan 147	AB	-	yes	yes	no	yes	yes
4803802	Blood 148	AB	3852	yes	yes	yes	yes	yes
4805802	Siksika 146	AB	2750	yes	yes	yes	yes	yes
4806804	Tsuu T'ina Nation 145	AB	-	-	-	-	-	-
4810805	Makaoo (Part) 120	AB	175	-	-	-	-	-
4811803	Louis Bull 138B	AB	892	yes	yes	yes	yes	yes
4811804	Stony Plain 135	AB	1100	yes	yes	no	yes	yes
4815802	Stoney 142, 143, 144	AB	2173	yes	yes	no	yes	yes
4817819	Wabasca 166A	AB	510	-	-	-	-	-
4817823	Wabasca 166D	AB	860	yes	no	no	no	no
4817824	Utikoomak Lake 155	AB	812	yes	yes	yes	no	yes
4817837	John d'Or Prairie 215	AB	851	-	-	-	-	-
5909832	Seabird Island	BC	535	yes	yes	no	yes	yes
5909839	Chehalis 5	BC	460	yes	yes	no	no	yes
5915803	Musqueam 2	BC	1305	yes	yes	no	yes	no
5915807	Mission 1	BC	550	no	no	no	yes	no
5915808	Capilano 5	BC	2230	-	-	-	-	-
5919804	Chemainus 13	BC	557	yes	yes	no	yes	no
5919807	Cowichan 1	BC	1201	yes	yes	no	yes	no
5923816	Tsahaheh 1	BC	322	yes	yes	no	yes	no
5929803	Sechelt (Part)	BC	-	no	yes	no	no	no
5933880	Kamloops 1	BC	1410	yes	yes	yes	yes	no
5937801	Okanagan (Part) 1	BC	95	no	yes	no	yes	yes
5941801	Alkali Lake 1	BC	396	yes	yes	yes	yes	yes
5941812	Williams Lake 1	BC	273	no	yes	no	yes	yes
5943801	Alert Bay 1	BC	281	-	-	-	-	-
5943802	Alert Bay 1A	BC	411	yes	yes	no	yes	no
5943806	Tsulquate 4	BC	387	no	no	yes	no	no
5949803	Kitamaat 2	BC	511	yes	yes	yes	yes	yes
5949811	Hagwilget 1	BC	237	no	yes	no	yes	yes
5949812	Gitanmaax 1	BC	693	yes	yes	no	yes	yes
5949814	Gitsegukla 1	BC	432	yes	yes	no	yes	yes
5949816	Gitwangak 1	BC	475	yes	yes	no	yes	yes
5955801	East Moberly Lake 169	BC	330	yes	yes	no	no	no
5959806	Fort Nelson 2	BC	390	yes	yes	yes	yes	no

Community facility information and population sizes found at *Aboriginal Canada Portal*: http://www.aboriginalcanada.gc.ca/acp/site.nsf/eng/index.html. F.N. stands for First Nation.