Decision-making under risk – the case of adolescent smoking

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

Abstract

This thesis examines decision-making about risks under conditions of uncertainty. Research specifically studies adolescents and smoking to uncover which information sources play influential roles in forming smoking risk perceptions. Findings aim to offer policy-related, theoretical and methodological meaning

This study looks at two key issues. First, it links risk perceptions to smoking decisions to highlight the motivation for understanding the predictors of risk perceptions. Second, research investigates how individuals use information sources (ex. parents, doctors, peers, health warning messages) employing a Bayesian decision-making model.

This thesis performs empirical analysis using The Canadian Youth Smoking Survey (2002) (19,018 respondents, 10-15 years) and The U.S. National Survey on Drug Use and Health (2004) (18,294 respondents, 12-17 years). Across both datasets, adolescents' risk perceptions and likelihood of having never smoking a cigarette were found to be positively related. However, smoking behaviors were never found to significantly predict risk perceptions once controlling for endogeneity between risk perceptions and behaviors. This suggests that adolescents rely on exogenous information sources about smoking risks rather than personal experiences to form perceptions of smoking risks.

From a policy perspective, medical professionals talking with adolescent patients about smoking, parents' smoking, societal smoking prevalence (more than peers' smoking), awareness of tobacco package warning labels and knowledge of school smoking rules (but not the rules themselves) were found to predict adolescents' risk perceptions.

From a theoretical perspective, this thesis alters the Bayesian model to include environmental and social effects. It also finds support for the role of affect heuristics in decision making involving risks. Findings also point to evidence of principal-agency relationships between medical professionals and adolescents. Analysis also highlights how spatial proximity impacts the credibility adolescents attach to behavioral examples and opinions regarding smoking.

From a methodological standpoint, evidence suggests that adolescents' expressions of their assessment of risk depend upon elicitation methodology used and that work focusing on predictors of risk perceptions should include direct (ex. parents discussing risks) and indirect (ex. societal smoking prevalence) sources of information.

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Chapter 1. Introduction

In spite of the popular identification of smoking's epidemiological risks, the behavioral preference to smoke clearly persists, and even appears to be on the rise among the young and especially among girls. This thesis examines adolescents' decisions about smoking. In this context, the decision-maker has limited information or simply faces uncertainty about the future because of limited personal experience with smoking. Therefore, this research particularly focuses on information acquisition in a situation of incompletely formed preferences. Although this thesis focuses on smoking, findings aim to speak beyond the realm of smoking and into risk perceptions research in general by bringing behavioral economics thinking into the public health realm.

An individual's setting, especially at the time of likely exposure to new information, proves consequential to preference-setting. Therefore, in order to capture a group with incompletely developed preferences, this research specifically examines the case of adolescents to uncover what kinds of information sources and actors play the most influential role in adolescents' risk perception formulation. This decision to analyze only adolescents was motivated by the hypothesis that because of adolescents' initial lack of experience with smoking they rely on outside sources, both individual and collective in nature to develop their own perceptions of risk. Therefore, if individuals' risk perceptions about smoking are impacted by their direct and indirect experience with smoking and other information sources, the degree to which any of these influences matters depends on the weight individuals attach to these information sources. The questions answered highlight the role of information acquisition in health-related decision-making, an area to which

economists and health economists have conferred significant attention in the last two decades.

1.1. Research setting

The hope of risk perceptions research lies in closely aligning apparent risks to the real risks associated with pursuing a specific behavioral decision. This ideal defines the paradigm of 'perfect information,' in which the rational decision-maker would always select the economically efficient decision as a result of their robust understanding of actual risks. Neoclassical consumer theory assumes decision-making occurs within the setting of perfect information and posits that individuals are the best judges of their own welfare. The assumption then follows that with perfect information, consumers act rationally. According to standard classical decision-making theory as expounded by von Neumann and Morgenstern (1944), individuals estimate the expected utility of different courses of action following some accepted axioms. Included among these governing assumptions, individuals' preferences ought to be independent, continuous, complete and transitive such that the ordering of preferences is constant.

However, the final pay-off of such decisions highly depends on perceptions of the subjective probability of loss as well as expected losses themselves. When loss refers to lasting health damages, the burden of communicating real probabilities attached to risk laden scenarios becomes acute, since, unlike in other risk assessment scenarios, life and death really are immediately at stake.

The ability of individuals to develop precise and accurate notions of costs and benefits depends greatly upon their access to and depth of information sources, along with the

presence of cognitive biases. Therefore, examining the effect of alternative information sources on the construction of risk perceptions and how individuals process information from these sources begins an evaluation of the extent to which risk communication can ever be effective.

Understanding the psychological context around decision-making by no means fully rejects neoclassical economics but instead redefines the validity of certain behavioral goals under the relaxation of some key assumptions such as that of perfect information. Imperfect information implies that individuals govern their behavior on the basis of subjectively formed expectations. Therefore, having a more realistic understanding of psychological foundations strengthens the explanatory power of certain economic explanations of risk-related behaviors . One can then tailor information dissemination based upon how these fundamental axioms of preferences might no longer appear applicable.

Existing literature on risks perceptions suggests that individuals are subject to cognitive biases ((Kahneman and Tversky 1979; Slovic 1987) such that perceived risks are often inconsistent with objective risk information provided to individuals. If research into choices and judgments demonstrates systematic deviances from rationality in a predicable fashion then what appear to be anomalies against rationality can be used to understand and better inform efforts to alter decision-making. In this way, decision-making can be more closely aligned with 'real' risks than subjective ones.

This research will combine elements of previous work from the fields of economics, public health and psychology while including the growing field of behavioral economics to offer

insight into risk perceptions about tobacco use and how it relates to smoking behaviors.[1] The conceptual framework guiding this thesis examines how individuals formulate their risk perceptions and then make decisions based upon those perceptions of risks. I assume that adolescents enter into a risk-taking scenario with an existing level of information. They then would draw upon their personal experiences to update their risk perceptions but because of limited experience with smoking they rely on new information from exogenous sources such as parents' and peers' behaviors and smoking warning labels to assess risks. The uptake of this new information alters existing perceptions of risks, which then impacts behavioral choices.

1.2. Research questions

This research will focus on two central questions:

(1) Do perceptions of risk inform adolescents' decisions to smoke? (Chapter 5)

This work will add to the literature on risk perceptions translating into behavioral choices in order to establish the importance of examining risk perceptions when thinking about health-related decisions. This work highlights why efforts to alter risk-taking behaviors should more closely take into account the determinants of risk beliefs since perceptions play such an integral role in behavioral outcomes, which leads to the second research question.

[1] This research does not foray into the influence of taxation on smoking choices, the impact of tobacco advertising on prevalence rates, the choices individuals make regarding 'light' or normal cigarettes or the effect of public awareness in altering smoking behaviors. Albeit interesting, these topics have been well-researched and do not specifically look at the formulation of risk perceptions at younger ages and the influence of context.

(2) Which sources of information do adolescents rely on to inform their perceptions of risks? (Chapters 6-8)

This thesis uses the term 'information sources' to describe a wide range of individuals, groups of people and policies that offer advice on risk evaluation either through example of their actions, verbal discussions about risks or material consumed visually by reading or looking at photographs. Information sources assessed will include those which are individual (medical professionals, parents) and collective (peers, tobacco package warning messages, school-setting). Although there is significant work, mainly from the public health realm regarding the impact of various information sources on smoking decisions, there is limited work comparing information sources against each other in risk perception formulation. While all of these information sources may influence behaviors, some may be particularly important for altering risk perceptions; therefore, providing the empirical basis to focus policy efforts on those individual or collective sources most affecting risk formulation.

1.3. What this thesis adds to existing literature

For the first research question about the determinants of adolescents' smoking behaviors, analysis builds on previous work looking at the Bayesian updating process in adults' (Antoñanzas et al., 2000; Costa-Font and Rovira 2005; Liu and Hsieh 1995;Viscusi 1990, 1991) and adolescents' (Lundborg 2007; Lundborg and Lindgren 2004) perceptions of smoking risks by extending the Bayesian framework to include the impact of social effect. However, this thesis research is also unique because the sample size is much larger for almost all analysis performed in this thesis than anything in the existing risk literature focusing on adolescents. It also differs from previous work by using instruments to address

the endogenous relationship between smoking and risk perceptions for an adolescent population. It also tests the robustness of findings by investigating how the inclusion of various information sources in a model predicting smoking behavior can increase or decrease the determinative power of risk perceptions on smoking behaviors. Finally, it also employs two measures of risk perception elicitation (one qualitative and one quantitative) from the same dataset thus allowing for methodological findings about how to adequately capture adolescents' risk perceptions. A productive debate thrives among researchers regarding the most suitable method for measuring risk perceptions (Slovic 2000; Viscusi 1992) but this issue has not been examined with adolescent respondents. This methodological debate is of importance because elicitation method strength influences the robustness of conclusions that can be made from any analysis including a measure of risk perceptions.

For the second research question about the determinants of risk perceptions, an even smaller body of literature exists. Only one study of which I am aware has looked at the weights teenagers attach to various information sources in developing their risk perceptions; however, this study takes a very narrow definition of an 'information source' excluding the influence of others' behaviors as sources of information (Lundborg 2007). Here, the definition of an information source includes not only disseminating facts about the dangers and risks of smoking but also acting as a source of information through behavioral example and environmental influence. In general, previous research has been focused on the determinative power of information sources with regards to smoking behaviors but not risk perceptions. This work takes a step back in the decision-making process and fills that gap.

1.4. Methods to answer research questions

Quantitative methods will be used to answer the research questions posed above. This work will involve multivariate OLS regression, probit and ordered logit modeling on cross-sectional data[2] with tests for endogeneity and other potential concerns such as sample selection. The empirical methodology will also include the use of interactive variables and instruments where appropriate.

This thesis will employ the following two sets of survey data to answer the posed research questions. The Canadian Youth Smoking (2002) run by Statistics Canada with Health Canada has 19,018 observations of adolescents aged 10-15 years. This survey has the youngest sample of any work looking at adolescents' risk perceptions, which is helpful because these respondents are even less likely to have personal experience and thus rely on indirect experience from others and exogenous information sources to form preferences. The U.S. National Survey on Drug Use and Health (2004) sponsored by the Office of Applied Statistics within the Department of Health and Human Services' Substance Abuse and Mental Health Services Administration (SAMHSA) has 18,294 respondents aged 12-17 years.

1.5. The theoretical, methodological and policy relevance of the research

This research intends to offer theoretical, methodological and policy-related findings. From a theoretical standpoint, this thesis aims to speak to the relevance of the Bayesian learning model for depicting the information acquisition process about smoking risks, the

[2] Ideally, this research would have used panel data to capture adolescents from a young age and follow the cohort to see at which stages risk perceptions about smoking change and how information sources might change with age. In the absence of available panel data to answer the posed questions, models will look at risk perception development at one moment in time and not be able to depict the information acquisition and risk perception development processes as dynamic ones.

role of intuitive feelings and affect heuristics in this context, the degree to which the principal-agent relationship applies to the role of parents, doctors and dentists in influencing adolescents' risk perceptions and any insights from spatial proximity theory that may add to an understanding of adolescent risk perception formulation.

Methodological objectives stem largely from aiming to add to the literature on risk perception elicitation methods by examining quantitative versus qualitative measures of risk perceptions, using appropriate instruments to control for endogeneity in the relationship between risk perceptions and smoking behaviors, expanding the definition of information sources to include both direct information transfer and indirect information transfer through behavioral example and applying this analysis to a young population sample with limited personal experience with smoking.

For the purposes of informing policy, this thesis intends to use empirical evidence to provide an evidence base for deciding which policy approaches would be most effective in reaching desired behavioral outcomes based upon how much credibility is attached to available conduits of information.

To accomplish these objectives, the thesis proceeds as follows:

Chapter 2 – *literature review I* – sets this research within the previous work on theories on risk perceptions and information processing

Chapter 3 – *literature review II* - sets this research within the previous work on adolescent smoking

Chapter 4– *methods* – discusses data sources and survey elicitation methods

Chapter 5 – *empirical analysis I* –tests risk perceptions as a determinant of smoking behavior

Chapter 6 – *empirical analysis II* – tests impact of parents, doctors and dentists as information sources on risk perceptions

Chapter 7 – *empirical analysis III* – tests impact of peers as information sources on risk perceptions

Chapter 8– *empirical analysis IV* – tests impact of health warning messages on cigarette packages and public health programs in school as information sources on risk perceptions

Chapter 9 – *discussion and conclusion* - discusses results in light of theoretical, methodology and policy findings

Chapter 2. Theories on risk perceptions and information processing – a literature review

This literature review starts with setting the research undertaken in this thesis within a review of applicable theories related to risk perceptions research including prospect theory and related work, cognitive biases, rational addiction theories, the role of information in decision-making theory and cases of inaccurate risk evaluation. The second section sets out the theoretical framework motivating the empirical analysis that follows. It reviews the literature on the uptake of information in decision-making contexts namely the Bayesian learning framework, the principal-agent relationship and the importance of spatial proximity. This chapter concludes with the construction of the conceptual framework guiding this thesis.

2.1. Introduction

Humans sometimes make choices resulting in unambiguously poorer outcomes, such as smoking that leads to a myriad health concerns over ones that hold unambiguously better outcomes, such as not smoking that reduces the chances of multiple conditions such as cancer, emphysema and coronary heart disease. The causal link between lung cancer and tobacco use was established over fifty years ago (Doll and Hill 1950; Wynder and Graham 1950; Levin et al. 1950; Mills and Porter 1950; Schrek et al. 1950). Cancer Research UK (2004) estimates that smoking causes 30 percent of cancer deaths in developed countries. While smoking prevalence dropped rapidly from 1972 until 1992 for both women and men in most EU-25 countries, prevalence appears to have reached a plateau in 1992 and since then has remained roughly the same, decreased at a lower rate or even increased in some states (Forey et al. 2002). Given the overwhelming evidence that smoking will greatly

increase one's likelihood to develop cancer and potentially die as a result, individuals' decisions to use tobacco present great concern over humans' risk assessment abilities.

The chief reason risk perceptions are of increasing interest in the economics literature is that compared to studies looking only at 'actual risks,' often it is the perception of risk that is most 'determinant' in influencing behavior, as individuals appear to make decisions based upon their unique mental models for assessing the actual risk of an action. Individuals examine available information and select only that which they believe to be relevant. This selected information provides the basis to determine the hazard a given risk poses to their health. Individuals' risks perceptions rather than actual risks determine health related behavior, and consequently the dissemination of risk information is closely dependent on risk information sources. The following section lays out the theoretical context of risk perceptions research to frame how we should think about the risk perceptions development process.

2.2. Theoretical context of risk perceptions research

Acknowledging the importance of psychology in economics is not a novel topic. Camerer and Loewenstein (2004) note that that many of the preeminent individuals from the emergence of economics as a distinct discipline incorporated psychological behavior into their findings. For example, Adam Smith's *Theory of Moral Sentiments* discusses individual behavior in psychological terms and includes statements about loss aversion. The birth of neoclassical economics resulted in the construction of an account of human behavior that expunged itself of what was at the time, the less scientific field of psychology (Camerer and Loewenstein 2004).

Individuals questioned the bounds of humans' rationality throughout the second half of the twentieth century but the work of Allais (1953) and Ellsberg (1961) pointed out a series of anomalies in neoclassical economists' depictions of decision making bringing these issues to the forefront of decision research and having important policy implications for information provision. The critique introduced in the mid-twentieth century and continuing currently focuses on examining economists' normative assumptions and predictions about human decision-making. This questioning of economic theory highlights the need for models of individual behavior incorporating a fuller understanding of cognitive processes as they occur in real-life.

Standard classical decision-making theory states that individuals make decisions based on the goal of maximizing their expected utility and therefore weight alternative courses of action based on their respective probabilities of occurrence (von Neumann and Morgenstern 1944). The assumption that individuals have independent, continuous and complete preferences underlies this theory.

Savage's work brought together the concepts of expected utility and expected probabilities (1954). This theory states that individuals make decisions based upon the utility attached to possible outcomes and that the choices one makes depend upon what one believes the subjective probability of each outcome occurring is likely to be. Subjective expected utility then becomes one's expected value of utility. An individual chooses one decision over another based upon whether the subjective expected utility of that choice is higher. Therefore, each individual makes a unique decision depending on his set of beliefs about the likelihood of each possible outcome. A major limitation to Savage's theory requires that

preferences be independent at the moment of decision-making (1954) , which was demonstrated by Allais (1953) to not be in the case.

Evidence from a remarkable number of studies unambiguously demonstrates that individuals do not necessarily follow all of the axioms which form part of von Neumann and Morgenstern's (1944) or Savage's (1954) work in their decision-making processes therefore expected utility theory does not appear representatively valid (Bleichrodt and Pinto 2002; Gonzalez-Vallejo and Wallsten 1992; Holt 1986; Lichtenstein and Slovic 1973; Oliver 2003*a*; Tversky and Kahneman 1981). A significant number of biases and behavioral anomalies question the normative and descriptive validity of such a theory of expected utility estimation. Individuals do not perceive risks in what would appear to be an ordered decision-making process, instead using mental strategies, or heuristics, to inject certainty around things about which the mind is unsure (Tversky and Kahneman 1974). Individuals are subject to well-known biases such as the overestimation of small, known, accepted and publicized risks (Hurley and Shogren 2005; Kahneman and Tversky 1979; Viscusi 1992*a*). This understanding of the realities of decision-making has lead to the development of prospect reference theory and the application of Bayesian decision-making frameworks to explain how individuals update their risk perceptions (Kahneman and Tversky 1979; Viscusi 1989; Viscusi and Evans 2006).

2.2.1. Relevance of prospect theory and subsequent developments

Kahneman and Tversky (1979) developed prospect theory to explain the series of anomalies in human decision-making that violate expected utility theory. Kahneman and Tversky ran a series of experiments to test loss aversion and found individuals' responses to not be internally consistent across gambles and that respondents had a propensity

towards loss aversion. In other words, the disutility of losing an outcome of value *y* appeared greater than the utility attached to gaining an outcome of value *y*.

Work prior to and following this original development of prospect theory demonstrated, that any model like Kahneman and Tversky's allowing for the violation of dominance could be entirely flawed (Oliver 2003*b*). Individuals violate dominance when they fail to prefer unambiguously better outcomes to unambiguously poorer outcomes in decision-making contexts. Tversky and Kahneman (1992) later expanded their work on prospect theory to cumulative prospect theory, which no longer permitted the violation of dominance by borrowing from rank dependent theory to adjust probability weighting for dominant outcomes. Rank-dependent expected utility theory allows for preferences to be non-linear in probability (Quiggin 1982). Therefore, individuals will overweight only those outcomes which they perceive the probability of occurring to be very low as opposed to all outcomes which are unlikely to occur. Cumulative prospect theory allows for the weighting of individual probabilities cumulatively based upon the utility attached to each type of outcome (gain or loss) and further supported prior findings on loss aversion and diminishing sensitivity.

Viscusi (1989) examined prospective reference theory and found that individuals use risk information alongside of prior beliefs in a Bayesian manner to attach utilities to alternate courses of action. Viscusi further developed Kahneman and Tversky's model, suggesting that in those cases where probabilities are identical for all outcomes, individuals employ biases and affective heuristics such as overweighting low probability events to make decisions.

Other amendments to expected utility theory have been proposed such as Yaari's (1987) dual theory of choice under risk altering the expected utility axiom of independence by replacing the axiom of independence with the axiom of dual independence..

Prospect theory and its further incarnations find importance in this study because they highlight that although people might make decisions based upon weighing the risks and benefits of courses of action, in some cases costs are weighted with greater importance than benefits as a result of loss aversion and other biases entering into the decision-making process. Time-related elements become especially important in the smoking decision. Smokers receive benefits immediately but experience costs later in the future. This characteristic of smoking suggests that those individuals who choose to smoke weigh benefits in the near term more heavily than costs in the future or have higher discount rates that those who do not smoke (Khwaja et al. 2006*b*). Individuals make choices based upon perceived utility today as opposed to how this choice might impact the utility gained from activities in the future (Rabin 1998).

The development of prospect theory demonstrates that risk perceptions are sometimes inconsistent with objective risk information. There are several potential justifications in the literature for the seeming mismatch between available information and established preferences and perceptions. These include the presence of cognitive biases or affect heuristics in formulating risk perceptions.

2.2.2. Risk assessment with intuitive feelings (cognitive biases or affect heuristics)

A wide range of evidence exists to support claims that individuals use affective heuristics or cognitive biases in cases of decision-making where outcomes and/or information seem

unclear. The term 'heuristic' describes the thought processes or cognitive biases individuals employ in order to understand potential courses of actions about which they do not feel fully informed enough to make a decision (Kahneman et al. 1982). The means by which individuals process their own understanding of information in what ends up being an incorrect manner leads to judgments that are perhaps overconfident (Slovic 1987). These biases can lead to systematic misjudgments such as overestimation or underestimation of risks or the incorporation of biased information sources as fact. Tversky and Kahneman (1987) describe the use of heuristics, biases and framings as 'too widespread to be ignored, too systematic to be dismissed as random error, and too fundamental to be accommodated by relaxing the normative system.' These systematic errors to the neoclassical economic decision-making model vary in nature from errors in processing new information to responses depending on preference elicitation mode.

The means by which individuals process information to mold risk perceptions comes in two differing forms: one being more intuitive and feeling-related versus the other taking an analytical or rational approach (Epstein 1994). The psychology literature argues that individuals make decisions based more upon affective heuristics or association-based preferences than analytical processes (Loewenstein et al. 2001). While in many decisions, both analytical and affective reasoning play crucial roles, evidence demonstrates that across decisional contexts, affect-related variables trump analytics in their influence on risk perceptions but both types of variables remain important (Holtgrave and Weber 1993; Barett and Salovey 2002; Johnson and Tversky 1983; Loewenstein 1996; Slovic et al. 2002). Blamey (1998) found that in situations where individuals express non-decisiveness about an issue and the issue evokes emotive responses such as an environmental topic, value-laden elements dominate individuals' decision-making structures.

The phenomenon of incorporating 'affect' or feelings into decisions appears with particular prevalence in risk contexts (Finucane et al. 2000). The mind's interpretation of intuitive feelings varies depending on type of risk and the level of understanding and availability of information about the risk at the time of decision-making (Slovic et al. 2004). For example, when looking at an adolescent's decision to smoke, the act of experimenting with smoking is accompanied by little evaluation of risks and instead is driven primarily by affect. When Slovic (2001) asked smokers, 'If you had to do it all over again, would you start smoking?", 85% of adults and 80% of adolescents (14-22 years) responded 'no.' This result highlights the difference between the utility one experiences at the moment of actually making a decision versus at a later time.

Sjoberg (2006) downplays the veracity of claims linking emotion to risk perception found in studies such as Fischhoff et al. (1978) and Finucane et al. (2000) by stating that the definition of affect or emotion used in these studies is too broad. Sjoberg (2000) asserts that Fischhoff et al. (1978) equates dread with emotion while Finucane et al. (2000) conflates emotion towards something and liking something into the same activity. Instead, Sjoberg asserts that liking something or having a favorable disposition towards it determines risk perceptions and because liking also can mean affect then the literature implies that affect is emotion. In this thesis's view, Sjoberg's argument hinges on definitional semantics. Whether we call it affect or how someone likes something or how they feel about it, emotion/affect/beliefs all have been shown to influence individuals' risk perceptions and how they conduct themselves in settings of risk.

The following section continues on the topic of unexpected behaviors by looking at rational addiction, or the idea that individuals choose to maximize their utility in a way that appears surprising at first glance.

2.2.3. Rational addiction models

Theories of addiction are of principal importance when examining how behavioral economics literature aids in looking at risk perceptions regarding smoking. Discussions about addiction fall into two major groups: one thinks about addiction as an issue of self-control while the other looks at addiction as being a rationally chosen consumption decision. Thaler and Shefrin (1981) and Schelling (1984) argue that if an individual elects his short-term preferences over what appears best for his long-term interests then he is likely to suffer from addictive tendencies. This type of model assumes that individuals have inconsistent but stable short-run and long-run preferences and the myopic smoker constantly thwarts efforts of the long-run non-smoker to enter in smoking cessation efforts (Schelling 1978). This approach requires individuals to exercise intertemporal rationality in making decisions to avoid entering into addictive behaviors (Viscusi 1992*b*).

The other school of thought, rational addiction theory, depicts individuals as much stronger in their ability to direct their own behavior as consumption decisions for good x hinge upon past utility gained from consumption of good x (Becker and Murphy 1988). The rational addiction model espoused by Becker and Murphy does not claim that individuals' analyses about utility derived from consuming various goods is actually rational but that individuals use their past utility experiences to derive how their utility curves look going forward. Becker and Murphy's (1988) model does not incorporate the disutility of quitting costs or other consequences from partaking in behavior that lead to long-term costs. The model

also assumes that individuals can correctly calculate how their lifetime utility curve appears at the instant they make a decision about partaking in addictive behaviors and they will face no future regret over these determinations. While these assumptions and shortfalls of this model limit its explanatory power, the concept of rational addiction plays an important role in decision theory. The model demonstrates how those individuals who discount the future are more likely to be involved in addictive behavior and acknowledges how outside factors such as job losses or prices of goods can also affect addiction likelihood.

Suranovic et al. (1999) took Becker and Murphy's (1988) model of rational addiction theory and removed some of its assumptions to expand its predictive power in what is called the 'bounded rationality' model. Suranovic et al.'s (1999) model assumes that individuals can only make decisions about today without future preferences playing a role but future consequences will result from decisions made today. It also allows for individuals to change the level of utility derived from an action without the sort of exogenous shock requisite in Becker and Murphy's model such as drastic changes in income. A chief downside of Suranovic et al.'s (1999) model arises from the fact that all consequences from decisions come at the end of a person's life, which is not necessarily the case but it takes steps forward in explaining why individuals might want to stop partaking in an addictive behavior but be unable to quit. Further to this concept of rational aspects of the smoking decision in the presence of knowledge about the consequences of smoking, the next section discusses the use of information to actually promote what appears to be irrational decision-making.

2.2.4. Injection of information into decision-making frameworks

Individuals employ available information to either support rational decisions or some endogenously designed decisions that otherwise appear irrational. Akerlof and Dicken's (1982) theory of cognitive dissonance supports the existence of irrationality in decision making processes. When individuals are cognitively dissonant, they express a belief that they would like to be true with limited regard to exogenously procured information even in the face of perhaps knowing that alternatives not chosen may have positive attributes (Fishbein and Azjen 1975). In the case of adolescents and smoking, cognitive dissonance is of limited concern because of this population group's limited personal experience with smoking and thus minimal likelihood of attempting to defend views they already hold since their existing views are limited. The adult decision-making process is more one where existing beliefs would be subject to cognitive dissonance because of years of personal experience and information about smoking.

Rational irrationality differs from rational ignorance in that an ignorant decision-maker does not have an opinion about alternate choices. A rationally ignorant decision-maker perceives the benefits of gaining new information as minimal and thus employs minimal amounts of information in his formulation of perceptions (Downs 1957). Caplan (2001) describes some religious believers as being rationally ignorant because of their limited desire to acquire more information about their religion or that of others but maintaining strong beliefs regardless.

Theories of bounded rationality, rational addiction and any other approaches to decision-making where individuals weigh the risks and benefits associated with alternative actions

implicitly require adequate information to make these assessments. In many cases, however, as discussed above with evidence about the use of affective heuristics, decision-making takes place in the absence of full or unbiased information. Viscusi (1997) finds that alarmist decisions and thus overreaction to risks can arise due to government and industry methods of excessively weighting worst case scenarios and over-advertising certain risks. Although information proves integral for economic decision-making, the potential benefits of increased levels of information do not always generate more soundly made decisions. The next section discusses how even in the presence of information about a risk, individuals have a tendency to develop inaccurate risk perceptions in practice and why this matters from a policy perspective.

2.2.5. Inaccurate risk estimation in a setting of available and accessible information

Findings suggest that individuals tend to underestimate or overestimate the actual risks attached to a course of action rather than accurately judge risks. A wide range of literature has concluded that people overestimate low risks and underestimate high probability risks (Hurley and Shogren 2005; Kahneman and Tversky 1979; Viscusi 1992*a*). Armantier (2006) found this to be the case for risks ranging as widely as infectious diseases such as cholera to fireworks, floods, lightning, childbirth, firearms accidents, lung cancer, diabetes and heart disease. There is also evidence of gender-specific nuances to this finding as women overestimate low probability events by less than men but underestimate those of high probability by more than men (Hurley and Shogren 2005). A discussion of the literature about the underestimation and overestimation of smoking risks appears in Chapter 3.

From a policy standpoint, risk overestimation and underestimation present difficulties. Individuals who overestimate a risk could find themselves needlessly living in a state of heightened concern while if information sources such as the government or media overestimate risks then they lose credibility. Additionally, in a litigious setting, individuals deemed to overestimate the risks of a behavior perceive themselves as knowledgeable about the risks they have taken and therefore assume liability for the consequences of their own actions. Government could also find risk overestimation costly because some measures put in place to mitigate concerns would be unnecessary.

On the other hand, risk underestimation could lead to individuals no longer showing the needed concern over a risky situation and governments and other information sources failing to pay enough attention (Fischhoff et al. 1993). Underestimation also implies lack of knowledge leading to individuals perhaps undertaking an activity about which they are not fully informed. This situation places more liability on players such as the tobacco, firearms and alcohol industries that produce products carrying risks.

In order to move individuals' risk perceptions to a level of greater accuracy in either direction from under or overestimation, information sources of all types play a key role. While affect and feelings play a significant role in forming risk perceptions, the availability of adequate information to contribute to the decision-making process remains crucial. The next section provides the theoretical basis from which this research performs empirical analysis about the roles of these information sources starting with the Bayesian learning framework, moving on to the principal-agent model and concluding with an examination of the contribution of spatial econometrics in highlighting the importance of information source proximity.

2.3. Theories underpinning roles of information sources

2.3.1. Bayesian learning framework

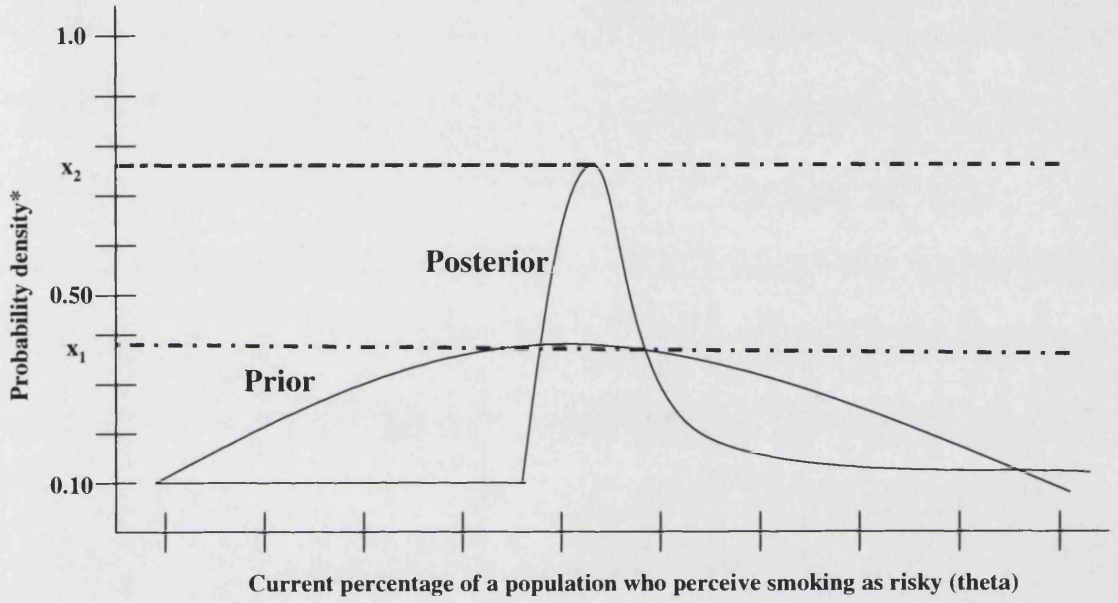
The way this analysis models the learning process regarding risks employs the Bayesian learning model (Viscusi 1992*b*). The Bayesian decision-making model offers a robust construct for explaining how individuals incorporate new information into decision-making processes in order to fill gaps in their current knowledge by updating past understanding.

In a Bayesian learning model the formation of subjective beliefs, according to the different types of information sources individuals face joins a prior set of beliefs or what is called 'the prior.' The model assumes that information concerning the risks and benefits of smoking is constrained by the existence of multiple information channels from which we can distinguish private or individual (e.g., parents, friends) and public or collective (e.g., government-related public health efforts, school education programs) sources. Due to likely existing information about smoking risks, individuals mentally form a subjective probability on the likely effects of smoking. Direct and indirect experiences with risk incorporate such aspects as gender, age and partaking in other risk-taking behaviors as these elements all can relate to experience with risk-taking settings. The technical development of the Bayesian decision-making framework based on the work of Viscusi (1992*a*; 1992*b*) as it applies in this thesis can be read in Appendix 2A.

Depending on the credibility individuals attach to each information sources, they update their 'prior' perceptions of risks based upon this new information to develop a 'posterior'

perception of risk (Viscusi 1991). Figure 1 demonstrates how individuals move towards having more certainty about a risk.

Figure 1. Bayesian approach to how risk perceptions change upon the receipt of new information



***The probability that theta is equal to x_n**

The x-axis of this figure measures the accuracy of an individual's perceptions of smoking risks while the y-axis measures the probability density or likelihood that the value of the x-axis is actually equal to the mean. The variance in an adolescent's perceptions falls from the level present in the prior to a narrower curve in the posterior position. This demonstrates an increased level of certainty about risks. Therefore, we assume that new information gives individuals greater certainty about their perceptions of risks so long as they attach enough credibility to that information source.

In more simple terms but still maintaining the Bayesian learning construct, the risk formulation process used in this thesis looks like the following equation adapted from Viscusi (1991):

$$RISK = \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 \qquad (2.1)$$

where γ_n represent the weights attached to each type of information source (X) where X_1 represents prior risk perception level or what the person thought about smoking prior to gaining new information (endowments), X_2 direct and indirect experience (ex. seeing parents smoke) and X_3 exogenous sources of information (ex. public health classroom lecture or a doctor speaking to the individual about smoking risks). This function for risk perception formulation implies that X_2 and X_3 can only influence *RISK* if the weights attached to them (γ_2 and γ_3) are sufficiently large in comparison to the weight attached to the prior risk perception level (γ_1). As the size of γ_2 and γ_3 increase, then new sources of information alter risk perceptions to a greater extent than the endowments. As the population sample in this research is young and enters into the risk development process with limited endowments or prior opinions about smoking, findings expect to reflect that the weights of direct and indirect experience (γ_2) and exogenous information sources (γ_3) will prove more important in the risk perception development process than prior evaluations of risk perceptions (γ_1).

The Bayesian framework garners support in the risk literature as the assumption holds when tested that individuals do not look at new information about probabilities as fully informative but add this new information to existing opinions about risks to guide future action (Viscusi and Evans 2006). Smith and Johnson (1988) looked at households in Maine

and found that their responses to the risk of radon concentrations in their homes and water supplies support the Bayesian model as survey respondents processed information to alter their risk perceptions.

The Bayesian model also allows for the presence of cognitive biases as discussed in section 2.2.2 but the presence of cognitive biases can undermine the appropriateness of the Bayesian model. Viscusi (1985) suggests that the employment of cognitive biases in decision-making where individuals do not feel fully informed follows this Bayesian learning process. Although decisions formulating risk perceptions may not always be accurate, the way in which individuals employ new information about a risk is predicted within the Bayesian framework (Viscusi 1985). However, Viscusi (1997) found that individuals do not follow the Bayesian model in cases where they are not fully informed and place more weight on a source of information that delivers a higher risk assessment given two information sources about the same topic. This work demonstrates the special care necessary when disseminating risk information in order not to misinform. Viscusi (1992*a*) also suggests that individuals do not fulfill the Bayesian method of processing new information when they fail to understand the meaning of probabilities for possible outcomes.

Where the Bayesian model fails to accurately depict the uptake of new information, an alternative construct would be useful. However, alternatives to the Bayesian model, such as assuming individuals are completely irrational would not allow for quantitative testing and only would serve as theoretical background. The Bayesian model allows for undertaking empirical analysis regarding questions of information uptake and has been

shown to appropriately suit the scenario of smoking risk perceptions and behavior (Liu and Hsieh 1995; Lundborg and Lindgren 2004; Viscusi 1991).

In the case of smoking, the Bayesian framework provides a view on how information uptake differs with age. In general, as people are more exposed to smoking risks, risk perceptions decline. At younger ages, individuals have less personal experience with smoking, therefore the importance of indirect experience (parents and peers in their social setting) and exogenous sources of risk information (warning labels, public health programs, media) would prove more important than in later years. For this reason, the incorporation of information about smoking risks by adolescents might look very different than that done by adults since adolescents appear to rely much more on external factors to formulate perceptions of risk.

While this work employs the Bayesian model as a framework for setting out how individuals make choices about which information sources they deem credible, this process is a dynamic, learning one best depicted with data capturing how information uptake changes over time. This thesis is limited in its application of the Bayesian model because of the use of cross-sectional data. At the time of this analysis, no panel or time series data was available covering risk perceptions of adolescents regarding smoking. While the Bayesian decision making framework is a dynamic one, this research takes a snapshot of the decision-making process adolescents make about risks and which information sources matter most at that discrete time. In order to counter the inability to depict a dynamic process in the analysis because of the use of cross-sectional data, some empirical chapters include models cutting the respondent population into sub-groups based upon age. These

models attempt to show how similar adolescent populations may attach varying weights to different information sources over time .

While the Bayesian framework of incorporating new information does not always depict reality, it offers a useful model by which to analyze risk perception formulation especially around the assimilation of new information. This thesis extends the Bayesian model by incorporating the importance of social interactions as an element by which individuals may update their prior stock of information.

Of additional use to the theoretical basis for this empirical work is an understanding of principal-agent relationships as they affect the uptake of information.

2.3.2. The principal-agent relationship in information processing

When adolescents, individuals are just gaining experience with smoking through their own behavior and/or that of others. Without much prior experience, individuals lean on the indirect experience gleaned from others and information delivered through exogenous sources. Those with whom adolescents have already established relationships, especially where some level of trust is involved would be the most likely candidates to individually influence adolescents' perceptions.[3] Adolescents would presumably have some level of trust in their parents as well as if not trust, then respect for doctors and dentists as information sources. For this reason, these three groups of adult figures might play a role in shaping adolescents' perceptions of smoking risks. Therefore, these individuals could therefore be described as entering into a principal-agent relationship with adolescents

[3] Peers play a more collective influencing role in risk perception development and are discussed in section 3.3.4 of Chapter 3 and empirically examined in Chapter 7.

within their proximity of influence.[4] The particular principal-agent relationships examined here differs from principal-agent theory in that the principal and agent do not necessarily have differing objectives. Principal-agency theory applies when the principal and agent have divergent interests (Besley 1989). If adolescents wish to acquire information about smoking risks and doctors or parents wish to provide this information, then the principal and agent's interests are aligned. This analysis uses this term to describe the informational asymmetry regarding smoking experience and/or smoking risks that may exist between individuals in an adolescent's life such as parents and medical professionals and the adolescent himself or herself. Because of this informational asymmetry, adolescents would rely on these agents to provide them with information.

Economics employs the principal-agent theory to describe interactions between two parties where the agent acts on behalf of a principal. Because of differing levels of information between the two parties and potentially perverse incentive structures, this arrangement does not always lead to the optimal outcome for either the principal or the agent. The outcome is especially poor for the principal, however, as the cost of monitoring the agent's actions can be high and as in the case of parents, principals do not always have choice in their agent. The principal-agent theory is often used in the corporate (manager/employee) or political context (politician/constituent). In the health care setting, this model can describe the relationship between medical doctors and their patients where patients lack information regarding the timing of health care needs and seek physician advice regarding condition diagnosis and prognosis (Arrow 1963; McGuire 2000).

[4] For more information proximity of influence, see the next section (2.3.3) on spatial econometrics and proximal influence.

The principal-agent literature increasingly recognizes this model's limits within the medical setting as patients become more aware of treatment options and the information asymmetry characterized in the principal-agent model exists to a lesser extent (Bryan et al. 2006). Because this thesis focuses solely on adolescence, this informational asymmetry limitation does not exist. Adolescents still rely heavily on the medical profession for information and the process of information sharing is not as two-sided as in the case of adults. Doctors and dentists still have largely exclusive access to high cost information due to their educational and training backgrounds thus contributing to their roles as credible disseminators of information.

The doctor-patient and parent-child relationship have similarities, as historically, these agents have been figures on which their corresponding principals rely for advice. Parents have a customary role of watching over their children. However, the principal-agent relationship has been applied within the family setting only to a limited extent (Munro 1999).

Within the family/household setting, the principal-agent is one where the adolescent is incapable or too inexperienced to define his/her own interests and what is best for them, therefore he/she relies on parents and other figures acting as agents to establish the utility associated with various behavioral choices such as smoking. Those figures in the agent position would be those whom adolescents perceive to be more knowledgeable about smoking risks than themselves. Additionally, adolescents might perceive their parents and peers to be more knowledgeable about the risks of smoking and look to them for guidance and more likely, their example. Parents can provide information through their own behaviors, directly discussing the risks of smoking with their children and also by evidence

of health shocks occurring within the household. This study has no data on parents or grandparents' health shocks but previous literature would suggest that health shocks play an important role in altering behaviors and perceptions of risk (Sloan et al. 2003). These health events would contribute to how parents attenuate the information asymmetry between themselves and their adolescent children as even if adolescents have already started smoking, they are unlikely to have had a resulting health shock or even related negative health outcome such as shortness of breath.

According to this model, the utility an agent (parent, doctor, dentist) attaches to smoking would be taken on by the principal (adolescent). Evidence from the literature suggests that adolescents might perceive their parents to be knowledgeable about risky behaviors and mimic their behaviors while the respected/feared role of doctors and dentists in the minds of adolescents would also contribute gravitas to the epidemiological and medical experience and advice they convey to patients.

As for adolescents, the intermediate influence of parents mediates this influence of healthcare professionals creating a form of 'mediated or two step agency.' Agency relationships between doctors/ dentists and parents as well as parents to children are coupled with some direct or mediated effect from doctors to children. Doctors and dentists could exert a direct effect through discussing risks with patients and/or a mediated effect of strengthening the information given by parents and other agents such as school teachers to children on the potential risks of smoking and its addictive nature. Doctors and dentists also can work through the agency relationship between parents and their children by influencing parents' perceptions of risks such that parents might alter their behaviors and thus influence how children perceive risks through seeing their parents' behaviors.

In the Bayesian model discussed in section 2.3.1, the role of the parent, doctor or dentist comes in both X_2 and X_3 of the risk equation as they influence risk perceptions through offering indirect experience and providing new information about smoking risks. These actors could also serve as a mediating factor for the weight attached to other exogenous information sources (X_3) as disseminators of risk levels through the indirect experience variable (X_2). For example, if an adolescent evaluates the importance of health warnings in light of the experience of their parents' smoking and living to old age with no visible smoking-related health effects, then the weight attached to health warnings will be lower than in the absence of such an experience (Sloan et al. 2003). Therefore, the actions of these actors as well as any information they convey matter in the value attached to them as information sources.

Of additional importance to this principal-agent model is the variation in closeness of the relationships between parents, doctors and dentists. The importance of peers or other figures might change and even replace the role of the parent(s) in the principal-agent model if household structure lacks such figures. Therefore, a spatial element exists in depicting the nature of the principal-agent relationship. The next section examines how spatial econometrics offers a theoretical framework to capture the importance of proximity in relationships.

2.3.3. Spatial proximity and its influence on relationships

Studies examining how physical distance in relationships impacts behaviors provides insight into how the importance of information sources with varying degrees of relational closeness may differ. This applies when comparing the roles of parents, peers, doctors and

dentists. One would expect that when either one or both parents are physically around their child for significant amounts of time, then their behaviors and influence would be of great importance to their child. Conversely, those figures with which adolescents have a more spatially distant relationship such as a doctor would have less influence attached to their interactions. The impact of peers could also be looked at as having a spatial element since adolescents spend a lot of time at school and outside of school with their friends. This peer relationship could be even stronger in the case of a weak parental relationship where parents are not physically around as much thus changing the principal-agent model as discussed above.

Lower social distances as a component of relationships promote trust and cooperation (Glaeser et al. 2002*a*). Across many contexts from an urban setting to individuals in a single apartment building, physical proximity matters for the likelihood of meaningful social exchange. Glaeser and Sacerdote (1999) found that across urban environments, individuals living in apartments are more likely to socialize with their neighbors than those living in houses. Festinger et al. (1950) looked at the random assignment of individuals within the same apartment building and found that those physically living farther apart within the same building are less likely to have a social connection. These findings about spatial proximity are not surprising as those living closer to others are more likely to meet others. However, there are implications here for research on how relationships influence risk perceptions. Just as research on criminal behavior has found that spatial proximity matters for crime rates even when adjusting for socio-economic characteristics (Morenoff et al. 2001), the same could be true for risk perceptions about smoking and thus offer an explanation of why those individuals who are closest to an adolescent in proximity, parents

and siblings in some cases and peers in others, would have the most influence on risk perceptions.

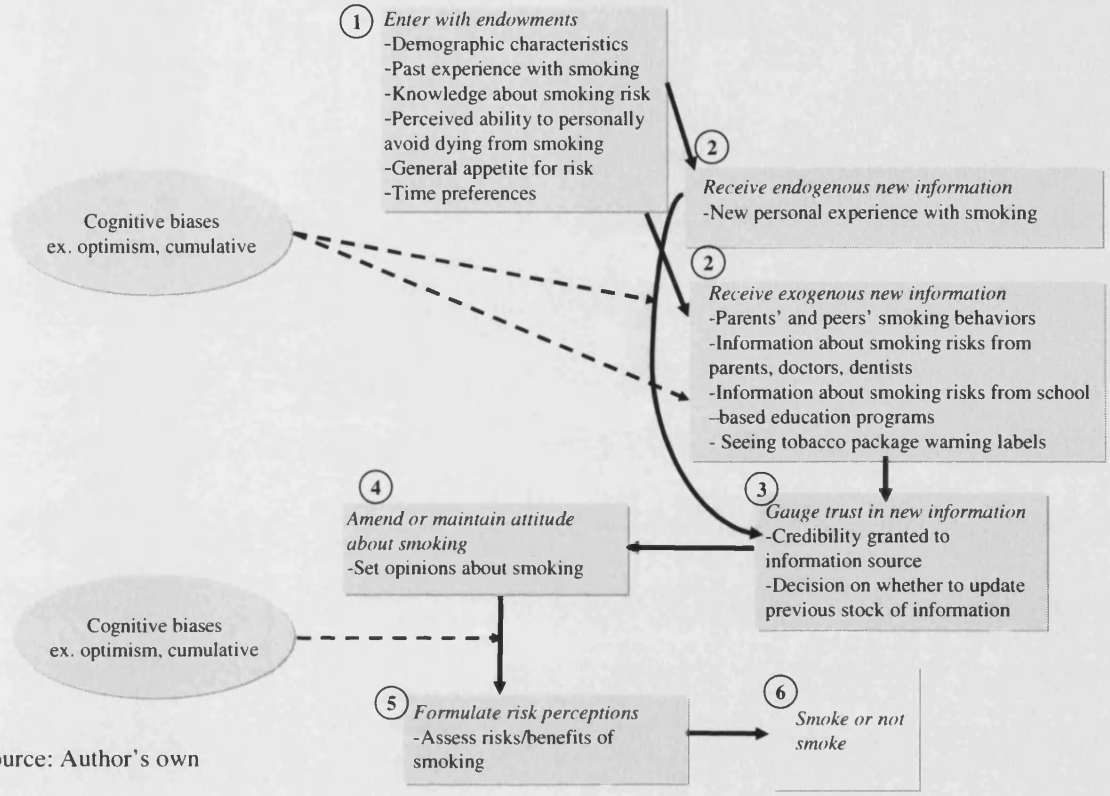
On the other hand, too much physical closeness does increase interaction but can cause individuals to lose clarity in the way they behave. Work on how interpersonal distance impacts individuals' behavioral choices demonstrates that as interpersonal distance diminishes, individual creativity in thinking also falls (Aiello et al. 1977). This could explain peer effects on smoking risk perceptions as individuals who spend a lot of time with their peers think less about decisions themselves but instead rely even more on others to make decisions demonstrating a 'herding' effect.

Having discussed these theories of information exchange – Bayesian learning, principal-agent theory and the role of spatial proximity a guiding conceptual framework for this thesis emerges.

2.4. Conceptual framework

Figure 2 graphically demonstrates the formulation of risk perceptions by showing the roles of information, credibility effects and cognitive biases or affective heuristics throughout this process.

Figure 2. Formulation of risk perceptions about smoking with the influence of new information



Source: Author's own

The way in which adolescents use information to formulate risk perceptions about smoking can be conceptualized as follows. Each individual starts with a set of endowments (*step 1*). These endowments are information that the adolescent already knows and characteristics of the adolescent which may influence not only behavior but also the way he/she perceives new information. One's endowment of knowledge and existing opinion can be mediated by demographic and socioeconomic characteristics such as gender, age, household structure, race and social class. Previous personal smoking experience and/or observation of others' smoking also act as endowments because of their influence on individuals' stocks of prior knowledge about smoking risks. In addition, one's perceived ability to avoid the negative outcomes associated with smoking (exhibiting optimism bias) as well as the extent to which an adolescent is risk averse all inform the set of endowments to which he/she enters into the

smoking decision. An individual's overall attitude towards risks and attitudes towards risks that have nothing to do with smoking would impact how individuals assess smoking risks. Preferences for timing also impact the endowments with which individuals enter into the smoking decision. Adolescents have been found to be relatively near-term focused in expressing their attitudes towards smoking decisions as the risks seem so far away from the time of smoking initiation (O'Donoghue and Rabin 2000).

Individuals then gain and assimilate new information to their set of prior beliefs from a variety of sources according to the Bayesian construct (Viscusi 1985; Viscusi 1989). Both endogenous and exogenous factors can act as information sources (*step 2*). Endogenous new information comes from personal experience resulting from smoking or trying smoking for the first time. Exogenous new information comes both from indirect experience with smoking by seeing behavioral examples of society, parents', household and peers' smoking as well as conveyance of information about smoking risks from medical professionals, parents and public-health related means such as tobacco warning labels and school-based educational programs. While the general public may use both endogenous and exogenous sources of information, younger individuals including respondents aged 10-17 would be less likely to have the personal experience with smoking thus relying much more on exogenous sources of information. Empirical analysis tests if this is true by examining whether adolescents' smoking behaviors predict their perceptions of risks.

The degree to which each of these information sources alter the way an individual's endowments alone would lead them to perceive risk and then make a behavioral choice depend upon the credibility attached to each of these information sources as well as the extent to which an agency relationship and spatial proximity play a role in altering

credibility levels (*step 3*). The Bayesian learning framework depicts the information uptake process as dependent on the weights attached to each source of information so the degree to which each is deemed credible limits the level of influence each exerts over perceptions of risks (Viscusi 1985). The strength of agency relationships between parents and their adolescent children as well as medical professionals such as doctors and dentists and their adolescent patients also is expected to influence the credibility attached to these information sources (Munro 1999). In additional, spatial proximity, or the social distances between individuals may also influence the extent to which adolescents trust in new information sources (Glaeser et al. 2002*a*).

Individuals who display rational ignorance would not uptake additional information because of the perception that incremental gains in information would not be of benefit (Downs 1957). While new information about smoking risks may update individuals' stocks of knowledge it may not result in individuals actually being more informed as they may either still maintain inaccurate risk estimations (Kahneman and Tversky 1979; Viscusi 1992*a*; Viscusi 1997) or suffer from information overload.

Upon updating one's previous stock of information one forms a new attitude about smoking (*step 4*). This attitude is not entirely new but rather an updated version of previous attitudes about smoking. In the case where an individual gives no credibility to any additional information source acquired, the state of the previous attitude does not change.

These attitudes then inform perceptions of risk by attaching some understanding of the consequences involved with deciding to smoke (*step 5*). In theory, the development of risk perceptions involves weighing the risks and benefits of a behavioral choice but in reality,

the influence of affect and cognitive biases such as optimism and available biases impact this process (Arnett 2000; Finucane et al. 2000; Slovic 1998; Slovic et al. 2004).

Based upon this attitude and its subsequence transformation into risk perceptions an adolescent either takes up smoking or abstains (*step 6*). The relationship between risk perceptions and behaviors has often been described as recursive such that risk perceptions may influence behavior and behavior may influence risk perceptions but the order is unclear. Therefore the process can be depicted as a dynamic one. For this reason, this thesis endeavors to investigate this ordering by looking at the endogenous relationship between risk perceptions and behaviors to gain some clarity around the direction of influence. I hypothesize that risk perceptions will influence behavioral choice more prominently than the reverse order because of the young age of this respondent population and their limited personal experience with smoking. In addition, previous literature focusing on adolescents predicts the directionality as posed in this conceptual framework with risk perceptions influencing behaviors but behaviors not influencing perceptions once using instruments to control for endogeneity (Lundborg 2007; Lundborg and Andersson 2007). For adult populations, the answer would differ as more personal experience with smoking would allow for smoking behavior to influence risk perceptions to a greater extent than in the case of adolescents (Viscusi 1991; Liu and Hsieh 1995). However, since this thesis focuses on adolescents, the directionality of influence remains with risk perceptions contributing to the smoking decision but not the other way around.

At largely any stage of this process, the influence of cognitive biases can be felt in the way individuals interpret numbers, facts and new information (Tversky and Kahneman 1987; Viscusi 1985). For example, the way in which information about smoking risks may be

presented to adolescents in a school setting such as phrasing the risks in terms of likelihood of dying or not dying from smoking may influence the degree to which that information source alters perceptions of risk. In additional, where individuals fail to understand any statistical information given about risks, they would not process new information in the way depicted by the Bayesian learning model where information sources have credibility attached to them because of a lack of understanding of this new information (Viscusi 1992*a*)

This is the conceptual framework for where this research starts. Prior to undertaking empirical analysis examining the two key research questions posed in Chapter 1, a review of previous literature on risk perceptions and smoking as well as the influence of the information sources examined here is necessary to inform how this research fills existing gaps in our understanding of these issues.

Chapter 3. Risk perceptions of tobacco use among adolescents – a literature review

While the previous chapter has set out the theories which guide the empirical analysis of this thesis, this chapter examines the literature specifically about smoking and risk perceptions in order to highlight where this thesis answers outstanding questions. This chapter also discusses what the existing literature has found about the roles of potential information sources examined in this thesis (parents, doctors, dentists, peers and public health programs both through school and from warning labels on cigarette packages) in determining adolescents' risk perceptions about smoking and to a lesser extent adolescent smoking behaviors.[5] The final section discusses the policy settings in which the empirical analysis of this thesis takes place, Canada and the US.

3.1. The wide literature on smoking

Research and analysis about tobacco use is of great depth in many fields such as economics, sociology, psychology, political science and public health. It is important to acknowledge the previous work from these fields as sources of insight into risk perceptions about tobacco use.

Economists discuss tobacco consumption and its associated risks and benefits from many angles including the direct and indirect economic costs of smoking to health systems (Jha et al. 2000; World Bank 1992), the externalities resulting from tobacco use (BMA 2002; Manning and RAND 1991; Viscusi 2002), the effectiveness of tobacco taxes on reducing consumption (Evans and Ringel 1999; Lewit and Coate 1982; Moore 1995; World Bank 1999) and the impact of tobacco advertising on prevalence rates (Viscusi 1992*b*; Calfee 1985). While this work does not directly apply to the focus of this research, it enables

[5] Where there is limited literature on any of these information sources predicting risk perceptions, the review draws from literature on the determinants of smoking.

interesting comparisons of policy approaches, and could provide an idea of the expected effects of different communication strategies on health-related behavior. For example, Sloan et al. (2003) found that cigarette use could drop by 11 to 15 percent if smokers were informed about the quality of life at the end of their lives as a result of smoking. A 40 to 50 percent increase in cigarette prices for the same group of smokers would be necessary to achieve an equivalent drop in cigarette consumption.

Public health literature and research has focused on issues such as risks to personal health (Murray and Lopez 1996; Peto 1986; WHO 1999), the need for pertinent public awareness campaigns (Levshin and Droggachih 1999; National Cancer Policy Board 1998; WHO 1997) and the appropriate role of government intervention in tobacco markets (Jha et al. 2000; Van der Merwe 1998).

Behavioral economists and social psychologists tend to focus on topics such as the addiction aspects of tobacco use (Becker and Murphy 1988), society's willingness to actively restrict smoking (Viscusi 1992*b*) and the social aspects around smoking such as likelihood of children smoking if parents do (Cancer Research UK 2004; Murray et al. 1983) or if smoking is allowed in the home (Viscusi 2002).

These fields play contributory roles but often focus on prevalence rates and public health concerns and not how these issues are related to the formulation and employment of risk perceptions in decision-making. The next section demonstrates how even for a topic such as smoking where the epidemiological risks are well established and significant public health efforts have been aimed at curbing smoking rates, individuals still exhibit inaccurate risk perceptions.

3.2. Risk perceptions as a determinant of smoking behavior

The first pieces of research examining the relationship between risk perceptions and smoking behaviors were performed by Viscusi (1990, 1991) on an adult US population. He found that not only non-smokers but also former smokers and current smokers overestimated the perceived likelihood of smokers receiving lung cancer from smoking (Viscusi 1990). Further work examining the formation of risk perceptions supported Bayesian learning models for information processing that suggest individuals incorporate new information as an additive process on top of previous risk assessment (Viscusi 1991) and the importance of risk information depends upon the credibility attached to information sources. Therefore, new information on risk probabilities is not typically viewed as fully informative but instead as additional information to fill existing knowledge gaps (Viscusi and Evans 2006).

Liu and Hsieh (1995) followed the same model as Viscusi's earlier work and found overestimation of smoking risks as well as a negative relationship between risk perceptions and smoking behavior. Lundborg and Lindgren (2004) also based their work on that of Viscusi (1990, 1991) to find that adolescent smokers and nonsmokers overestimate smoking risks and that risk perceptions are negatively related to age. Although they found it less common for smokers to have higher risk perceptions. Lundborg (2007) introduced in the equation an additional control for perceptions of addictiveness and information sources. It still revealed risks to be overestimated and significant variability regarding the determinative power of different information sources predicting risk perceptions.

The smoking literature has a wealth of work on whether adults and adolescents overestimate or underestimate the risks of smoking. Viscusi has been the most vocal of researchers about finding that adults and adolescents overestimate their risk perceptions of smoking cigarettes (1990, 1991, 1992*b* and 2000), however, others have also reached similar conclusions regarding adults (Antoñanzas et al. 2000) and adolescents (Lundborg and Lindgren 2004) or that adolescents correctly estimate or overestimate risks (Lundborg 2007). Viscusi attributes risk overestimation to the media and government conveying volumes of information about smoking risks (1992*b*).

On the whole, however, the majority of research finds that both adults (Hammar and Johannson-Stenman 2004; Slovic 2000*a*; Weinstein et al. 2004; Weinstein et al. 2005) and adolescents (Johnson et al. 2002; Luce and Merrell 1995, Portillo and Antoñanzas 2002; Slovic 1998) underestimate the risks of smoking. Degree of underestimation appears to depend on context. Degree of underestimation of smoking risks might depend upon how heavy a smoker someone is (Romer and Jamieson 2001; Schoenbaum 1997). Extent of underestimation might also be a function of whether one is referring to the risk of contracting a disease like lung cancer or the risk of dying from the disease (Jamieson and Romer 2001; Romer and Jamieson 2001) since individuals may not fully grasp the severity of a behavior's negative consequence. In other words, they may not be completely knowledgeable about what having lung cancer means in terms of morbidity and pain.

Much of the discussion around risk overestimation and underestimation hinges on question framing and elicitation modes. Studies vary in questions used to ask individuals about their risk perceptions and definitions of smoking risks, which results in incongruent findings about overestimation or underestimation of risks (Weinstein 1998). Issues related to risk

perception elicitation will be further discussed in Chapter 4 and empirically explored in Chapter 5.

The next section examines the literature on each of the information sources this thesis will test as being predictors of smoking risk perceptions. Sections include a review of the literature on how parents, doctors, dentists, peers and government public health programs both in school and through warning labels on cigarette packages impact adolescents' risk perceptions.

3.3. Roles of potential information sources for adolescents' risk perceptions

Understanding how individuals come to value what they do, which in the health arena implies understanding how preferences for smoking, eating unhealthy food or avoiding physical activity apply stands integral to this process (Bowles 1998). Upon knowing more about how utilities get attached to various behaviors, we can better depict the formation of preferences about risks. Understanding preference formation about risks has important consequences for health policy evaluation given that preferences for health-related activities are likely to be both influenced and to influence health outcomes.

3.3.1. Parents' roles in adolescents' risk perceptions

Parents play a role in shaping what their child's decision-making and utility curves will look like by their genetic make-up, actions such as their own smoking (intentionally or unintentionally) or eating behaviors and active efforts to influence their child's behavior. Additionally, strong support exists to suggest that differences in smoking and other health-related behaviors can be traced to genetics alongside of situational influences (Cutler and Glaeser 2005).

Parents play a critical role as informational sources in adolescents' propensity to smoke. A survey of over 6,500 adolescents by the Commonwealth Fund found that adolescents consider their parents and health care providers to be key sources of information about health-related topics (Ackard and Neumark-Sztainer 2001). Parents or parental figures can serve as a support system for adolescents by setting an example with their behavior and discussing risk-related activities with their children such as sex, drugs, alcohol and tobacco use. They also can play a role in setting disincentives for smoking such as reducing or withholding allowance or reducing other privileges in the case of child smoking. Where a child is rebellious, however, these disincentives may only encourage the behavior as a child may see smoking as a way to assert his independence (Benthin et al. 1993).

Many studies have presented a link between parental smoking behaviors and likelihood of adolescent smoking with findings that parents' smoking influences their child's smoking habits (Bricker et al. 2006; Madarasova Geckova et al. 2005; Peterson et al. 2006; Scragg et al. 2003; Wen et al. 2005). Tyas and Pederson (1998)'s literature review of the psychosocial factors related to adolescents' smoking found twice as many studies supporting this result versus non-significant findings regarding parental behavior's impact. Smoking parents might also influence the choices in friends that their children make as adolescents whose parents smoke are more likely to have friends that smoke (Engels et al. 2004). Parents' smoking also increases the likelihood that an adolescent has seen their parents suffer a health-related risk due to smoking. Previous research (Carbone et al., 2005; Coleman et al., 2003; Khwaja et al., 2006; Sloan et al., 2003; Smith et al., 2001) has pointed to health events such as heart attacks and strokes being the most clear way individuals can acquire information about health risks. Therefore, adolescents can acquire information about the risks of smoking from their parents' behavior and the resulting

consequences of that behavior even if it is not a dramatic health event but instead conditions such as shortness of breath or chronic coughing.

Studies have also found the strength of parental behavior's influence to be mediated by other factors such as parental attitude toward smoking and the household environment, including parenting style (Biglan et al. 1995) and time of children in self care (Richardson et al. 1989; Farrell et al. 1992). Studies that have split up parents by gender when performing analysis have met mixed results (Quine and Stephenson 1990). Some research has found that parents only have significant effect on adolescent smoking in the case of girls and not boys (Charlton and Blair 1989; Oakley et al. 1992; Swan et al. 1990). While on the other hand, a poor relationship between mother and child has been found to be a predictor of smoking among boys and girls while a poor father/child relationship has only been significant for girls (Oakley et al. 1992). Eiser et al. (1989) posit that parental opposition to smoking is actually a more important factor than parental smoking behavior in predicting a child's actions. Hersch (1998) finds that parents who smoke can influence the chances that their child smokes by placing restrictions on smoking in the home. However, experience shows that parents are not well informed enough about their child's smoking status to even know if such restrictions need to be stated (Hersch 1998).

Parents also set an example for their children regarding appetite towards risk. Dohmen et al. (2005) examined parents' and their children's attitudes towards taking risks in multiple contexts (driving cars, finances, sports, career and health) and found evidence of intergenerational transmission of risk attitudes specific to each type of risk. The literature on cultural transmission of practices such as religion, charitable donation and choosing of a spouse support the theory that parents both actively and passively transmit their own

attitudes and preferences to their children with the result being similar behaviors of parents and their children (Fernandez and Fogli 2005). Much like in the principal-agent model, parents transmit their preferences to their dependents in what can be viewed as a form of paternalistic altruism where parents attach utility payoffs to having certain preferences (Bisin and Veridier 2001). This type of model can be used to explain the preferences that lead to persistence of socioeconomic status across generations but also preferences integral to decisions in settings involving risk.

Apart from some limited pieces of research (Dohmen et al. 2005; Dohmen et al. 2008), there has been much less work on how successfully the transmission of utility setting with regards to risk perceptions occurs. Although this study cannot examine parents' risk perceptions given survey limitations, it can analyze how the intergenerational passage of behavioral norms influences risk perceptions. For the case of parents' influences on smoking risk perceptions, the utility setting process occurs in the household but is mediated by cultural and social influences of the place and society in which adolescents live as well as the strength of the principal-agent relationship between parents and their children. Similar to the Bayesian construct discussed in Chapter 2, evidence has shown that adolescents may attach different weights to the risk of smoke from various sources of secondhand smoke. Halpern-Felsher and Rubinstein (2005) asked adolescents about their perceptions of risks of secondhand smoke from their parents, workplace or friends and found that parental secondhand smoke was perceived most risky relative to workplace exposure and friend exposure. This finding could be tapping into the gravity adolescents attach to their parents' actions or the affect heuristics they associate with the home setting as being perhaps a 'safe' place where the entry of any kind of risk is heightened relative to the workplace and being with friends.

The literature still has a significant lack of studies examining the impact of parental actions on adolescents' risk perceptions including not only smoking behaviors but also rules about smoking in the home (spatial proximity to risky behaviors) and marital/household status.

3.3.2. Doctors' roles in adolescents' risk perceptions

The family doctor or GP (general practitioner) plays a key role in the delivery of information in the smoking context because the GP often diagnoses and sometimes manages the plethora of health problems that can result from smoking. The family doctor also has a consistent, trust-building role with adolescents as they see the doctor for well and sick visits multiple times a year thus laying the underpinnings for a principal-agent relationship where the adolescent relies on the doctor for information. There is probably also some fear attached to doctors for many, especially younger adolescents which may make the doctors' words more likely to be absorbed. They view their doctor with trust in particular, as they are more likely to adhere to physician advice than that from parents or teachers (U.S. Department of Health and Human Services 1994) pointing to a strong principal-agency relationship between doctors and adolescents. Adolescents appear open to advice from physicians as they find it useful and claim to take it into consideration regarding their health practices (Klein 1995).

Physicians also have a good position to disseminate risk information because of adolescents' likely lack of knowledge about their smoking behaviors whereas adolescents certainly know more about their parents' smoking habits and because they are around their teachers more, probably know about their behaviors as well. The potential for hypocrisy in message versus action is much lower for physicians as for example, about 3% of US

physicians smoke, while the same figure is higher for parents and teachers (Nelson et al. 1994).

Doctors' involvement as a disseminator of information about smoking can come in a variety of forms including simply having a conversation about smoking as a preventative measure, screening for smoking behaviors or advising on means of quitting a habit. The uptake of each type of measure varies with counseling and preventive actions much less common than simple screening for smoking behavior (Klein 1995; Thorndike et al. 1999; Vokes et al. 2006). A study of Delaware (US) physicians demonstrated that while most doctors speak to patients about their smoking habits and advise quitting, they do not treat patients to the extent expected by national guidelines (Gill et al. 2004). Physicians' adherence to clinical guidelines regarding delivery of smoking prevention and cessation services to adolescents requires knowledge of or familiarity of these guidelines, which is not always a correct assumption (Klein et al. 2001).

Existing research does link physicians' efforts to screen and counsel patients regarding their smoking habits to adults' smoking behaviors (Demers et al. 1990; Fiore et al. 1996; Li et al. 1984; Russell et al. 1979) but there has been less work examining the impact physicians can have on adolescent smoking behavior. Most studies on adolescents focus on what types of methods doctors use to treat adolescents with potential and apparent smoking habits as well as how successful doctors are in altering behaviors but not risk perceptions.

There has been some work on doctors' role in altering adult patient risk perceptions but sample size is limited (Bock et al. 2000; Bock et al. 2001). Bock et al. (2001) found that those who received a physician intervention for smoking had higher risk perceptions than

other respondents suggesting that physicians can alter patients' risk perceptions. To my knowledge, this thesis will be the first to examine how doctors may impact adolescents' risk perceptions about smoking. Lundborg (2007), who looks at the determinative role of various information sources on adolescents' risk perceptions, does not include doctors, dentists or any other kind of medical professional in his models.

3.3.3. Dentists' roles in adolescents' risk perceptions

As the dentist plays a role in diagnosing and sometimes treating the dental health diseases related to smoking, he also is well-positioned to inform of the dangers of these smoking-related conditions. Governments and public health agencies worldwide have recommended that dentists take a greater role in smoking prevention efforts (EU Working Group on Tobacco and Oral Health 1998; Glynn et al 1991). In the United States, 33% of dentists ask all patients if they smoke, 66% recommend quitting to smokers that are patients and 29% advise patients on cessation strategies (Dolan et al. 1997). In Alberta, a province in Canada, most dentists offer advice about the risks and benefits of smoking but do not offer advice about quitting strategies (Campbell et al. 1999). Strategies more common in dentists' offering of information to adolescents focus on the cosmetic and health effects of smoking such as showing pictures of a smoker's teeth and simultaneously allowing the patients to look at their own teeth with a mirror (Kentala et al. 1999).

The majority of studies on the impact dentists can have on smoking behavior focus on adult populations but these findings still speak to the ability of dentists to influence patients. A meta-analysis of 29 such studies found that dental health professionals can impact adult smoking behavior (Warnakulasuriya 2002). Studies particularly looking at adolescent populations do not point to dentist counseling about smoking risks having a strong impact

on smoking behavior instead finding no significant change in behavior related to dentist counseling (Hovell et al 1996) and no statistically significant drop in smoking of patients receiving information (Kentala et al. 1999). Sears and Hayes (2005) suggest that while orthodontists can play a significant role in altering adolescents' use of tobacco, they act as underused resources because of lack of training.

Shelley el al. (2005) examined the 2000 National Youth Tobacco Survey from the US to find that adolescents reported physician and dentist advice about quitting and cessation among smokers to occur much less than recommended by guidelines. Work on how dentists' advice change adolescents' risk perceptions about smoking is limited. This research aims to fill that gap and proposes that dentists' discussions with patients about their smoking habits may influence adolescents' risk perceptions.

3.3.4. Peers' roles in adolescents' risk perceptions

A significant portion of studies on adolescent smoking have focused on the impact of social influences such as peer pressure and friend groups. This work has been developed by researchers across multiple disciplines but has mainly lain in the realms of psychology and social psychology. Economists have traditionally discounted the role of social interactions because they do not occur in the market setting where consumers make consumption decisions and set utility curves. However, economists have recently conferred significant attention to peer effects regarding risk behavior and the importance of 'non-market interactions' more generally (Glaeser and Scheinkman 2000). Prior to examining these findings about peer effects, it is important to lay down the theoretical framework guiding this thesis' analysis of peers' influence on risk perceptions.

3.3.4.1. The theory behind peer effects

Individuals tend to follow the social norms of their environment by manifesting them in their behavior (Elster 1989). The idea of interdependent preferences has been continually examined in economics. However, Becker's (1974) work on social interactions stands out in its acknowledgement of the household head's crucial role in interactions with household members as a type of social interaction. The theoretical grounding of this kind of study looking at how individuals depend on each others' behavior in the learning process became firmly established with the work of Pollack (1976) introducing interdependent preferences.

Manski (2000) classifies three ways in which individuals can affect the actions of others - constraints, expectations and preferences interactions. First, constraints interactions apply when decision-makers face limited budgets and behave in ways to collectively influence prices. This is less applicable for the case of smoking than both expectations and preferences interactions.

Second, expectations interactions occur when we assume that agents make decisions based on the utility they expect to follow from making that decision. In relation to peer group effects, expectations interactions assume that individuals look at others' behaviors based upon the assumption that others have more information than themselves about a decision and thus have a better understanding of the utility attached to a behavior. Expectations interactions would be especially attractive to adolescents with limited knowledge about smoking risks because they would pick information up from others based on viewing their experiences.

Third, preference interactions occur when an individual forms his preferences based on the actions of others. Therefore, utilities individuals attach to a choice depend upon the actions others choose. Feelings motivate these decisions more than information. While it may be difficult to delineate between expectation and preference interactions, they have valuable policy implications as expectation interactions focus on the role of information and preference interactions on the assessment of any stigma or cache associated with smoking and the feelings they create in the decision-maker. This framework plays an important role in setting out how individuals use others to make their own decisions.

Similarly, Becker (1996) employs the concept of 'social capital' meaning one's own choices and those of one's peers form an element of the adolescents' utility function. This thesis' examination of peer effects follows Becker and Manski's stances on the influence of peers hypothesizing that they play an instrumental role in adolescents' utility curve construction and amendment with regards to smoking.

As a construct to find out why individuals in the same group behave in a similar way, Manski offers two possible reasons (1993). First, an adolescent's actions can be influenced by exogenous characteristics of the youth's peer group such as the smoking prevalence of the parents of youths in an adolescent's reference group. Second, the actions of the peer group can appear similar because of a shared set of unobserved characteristics or 'correlated effects.' An example would be if parents move to areas with better schools in order to pay for improved peer influence on their children. When this kind of phenomenon takes place, the influence of peer group becomes positively skewed and perhaps overestimated because of the difficultly splitting out the endogenous effects of parental decision-making.

Glaeser and Sunstein (2007) draw attention to individuals who overweight the views of others and inadequately alter their views based upon the unique characteristics of their environment calling them 'credulous Bayesians'. Glaeser and Sunstein (2007) look at this phenomenon within the context of extremist views, however, it can also apply to updating information about smoking, especially whereas overall society is deeming in increasingly less acceptable. Therefore, this social learning model suggests that individuals engage in the Bayesian updating process as discussed in Chapter 2 while rationally interpreting information from exogenous information sources to obtain approval and fit in with their group.

Another important theoretical framework depicting how individuals acquire information from others' previous stocks of knowledge is Glaeser et al.'s (2002*b*) and Glaeser and Scheinkman's (2000) 'social multiplier.' The social multiplier expresses how an individual's likelihood of being involved in a behavior increases as the percent of friends being involved in that behavior rises. The social multiplier diminishes if the impact of friends' likelihood of smoking is due to exogenous factors such as parental characteristics and not how many friends smoke. Therefore, one person's action depends on the average actions of a group and the marginal utility of one person undertaking an action increases with the number of peers undertaking that same action. It also demonstrates how results found at the individual level may differ when examined at the aggregate level thus pointing out how aggregate level results may be more imprecise than those found at the individual level (Glaeser et al., 2002) As in literature on the economics of fashion and fads, the time at which the multiplier starts can appear unclear and thus is well served to be portrayed as a cascading effect of information. 'An information cascade occurs when it is optimal for an

individual, having observed the actions of those ahead of him, to follow the behavior of the preceding individual without regard to his own information' (Bikhchandani et al. 1992).

Glaeser et al. (2002*b*) have found evidence of the social multiplier across many contexts including college students' behavior at the individual, room, floor and dorm level, crime rates at the county, state and national level and wages at the individual and state level. The social multiplier has not been in the tested in the context of adolescent smoking.

From a policy standpoint, the social multiplier model provides an important framework because finding the existence of this effect would mean that policy aimed at influencing changes in the behavior of just a few would actually impact many more in the presence of a social multiplier. Therefore, in settings where a high social multiplier exists, public spending could lead to a larger outcome than initially expected.

3.3.4.2. Peer effects in practice

Many studies have demonstrated increased likelihood of smoking if one's peer group does. Leatherdale and Manske (2005) found students in Ontario, Canada to be more likely to smoke if they see students smoking near their school. Additionally, the data showed that smoking is more likely to occur in a school with a higher proportion of more senior students smoking (Leatherdale and Manske 2005). This demonstrates that perhaps younger students look up to the older students much in the way that Manksi (2000) describes by imagining them to be more informed and therefore have made a decision that should be emulated.

Snow and Bruce (2003) surveyed adolescent females in Australia and found support for theories that smoking enhances self-perceptions of reputation among an adolescent's peer group. Findings include that smokers wish to be viewed as 'non-conforming' and gain more utility from being part of a social group. Van den Eijnden et al. (2006) found that among Dutch 12-13 years olds, adolescents who view smoking peers as more sociable engage more often in smoking. Peer influence has also been found to be effective in both starting risky behaviors such as smoking and alcohol use and then in stopping them (Maxwell 2002). Peer effects can also occur within the household through the influence of siblings' smoking behaviors (Harris and Lopez-Valcarel 2008). Nakajima (2007) found that peer effects are even greater within groups of the same gender. While there is plenty more evidence for the influence of peers on smoking behaviors (Chaloupka and Warner 2000; Piko et al 2005), the impact of peers on risk perceptions about smoking, especially for adolescents has been less well researched.

Adults' risk perceptions regarding smoking appear to be mediated by social interactions and settings as social settings influence communications and opinions about risky events (Kasperson et al. 1988). Smoking has been found to be accepted where accommodating smoking is a social norm (Poutvaara and Siemers 2007). This study will investigate if the same holds true for adolescents. Lundborg (2006) found evidence of endogeneity bias or adolescents' behavior being influenced by the prevalence of that behavior in one's peer group with regards to smoking and binge drinking. This is consistent with Gaviria and Raphael's (2001) work on perceived risks of alcoholism and lung cancer showing a negative relationship between risk perceptions and probability of partaking in smoking or binge drinking. However, Lundborg (2006) points out that risk perceptions may be endogenous because of unmeasured variables contributing to both risk perceptions and

behaviors. Lundborg (2007) included 'information from friends' as a determinant in a regression predicting adolescents' risk perceptions and found this explanatory variable to be insignificant.

3.3.4.3. Methodological issues with examining peer effects

Two major issues complicate empirical analysis of peer effects. The first is endogeneity prevalent in peer choice where peer choice and individual choice simultaneously evolve. The identification of endogenous effects in social interactions remains difficult to tease out. Difficulties ensue when trying to determine if the behavior of a group reflects the preferences of an individual within that group (Manski 1993) or if the group's behavior influences that of an individual.

The process of individuals and groups defining each other's behaviors appears to be a continuously dynamic one. The weight placed on peer opinion is a well established influence on adolescents' propensity to take risks (Baumrind 1987; Jessor and Jessor 1975; Valente et al. 2005). In the case of peer behaviors, psychological effects such as a desire to fit-in and using smoking as a coping mechanism in social situations have also been shown to play an important role (Snow and Bruce 2003). Adolescents who partake in risky behaviors report greater perceived support from friends regarding this risk taking and having more friends who also take the same risk (Jessor and Jessor 1975).

Perceptions of peer group smoking behavior as well as actual smoking behavior represent an additional stream of peer influence. Leventhal et al. (1987) found that adolescents overestimate the prevalence of both adult and peer smoking suggesting that perception of other's behaviors could influence an individual's actions as much as actual behavior.

De Vries et al. (2006) offer support of this concept of simultaneity between friends' smoking and friend selection as those individuals who smoke or associate higher utilities to smoking than non-smoking will try to find friends who have similar feelings about smoking. Some studies deal with this 'sorting' problem by looking at peer groups based upon the class or school setting because adolescents have less influence over this decision than who their friends are (Lundborg 2006). Norton et al. (1998) attempted to control for the endogeneity of adolescents choosing their peer group through instrumental variables and found that peer influence was of greater determinative influence than peer selection.

The second major empirical issue is overestimation of peer effects because of third party characteristics that influence decision-making such as cultural characteristics prevalent in a school. This follows along Manski's (1993) concept of correlated effects. School selection made by parents, parental behaviors of peers and risk tolerance possibly being an innate characteristic of smokers with regards to any health behavior all act as examples of such effects. A possible solution here is examining students in the school setting to limit the impact of spurious effects on peer influences that could arise in a neighborhood setting where children have more direct interaction with their friend's parents and family background (Gaviria and Raphael 2001). However, the influence of classmates' parents still may permeate into the behavior of an individuals' peer group.

An understanding of endogenous and exogenous impacts on adolescent behavior provides a primary grounding for Gaviria and Raphael (2001)'s study of whether peer behavior regarding a risk affects an individual's decision to partake in that activity. The authors tested the impact of peer group behavior on respondent behavior in connection with using

drugs, drinking alcohol, smoking cigarettes, attending church and dropping out of school. Findings demonstrate endogeneity bias for drug use and drinking alcohol and find evidence of peer group effects for all five behaviors. This study supports the idea that social capital plays a role in utility curve formation and consumption decisions. It also demonstrates that informational externalities matter as the utility of staying in school is impacted by one's friend dropping out therefore individuals measure one's own decision to stay in school based upon the decision of a peer to leave. Gaviria and Raphael's study does not, however, capture risk perceptions, only behavioral choices. If we hypothesis that risk perceptions play a crucial part in behavioral decisions then a look at the impact of endogeneity in risk perceptions will result in an even more precise understanding of how peer influence impacts beliefs about risk. The continuation of this work on peer effects at the empirical level takes place in Chapter 7.

3.3.5. Role of government - public health warning label campaigns and school education programs - on adolescents' risk perceptions

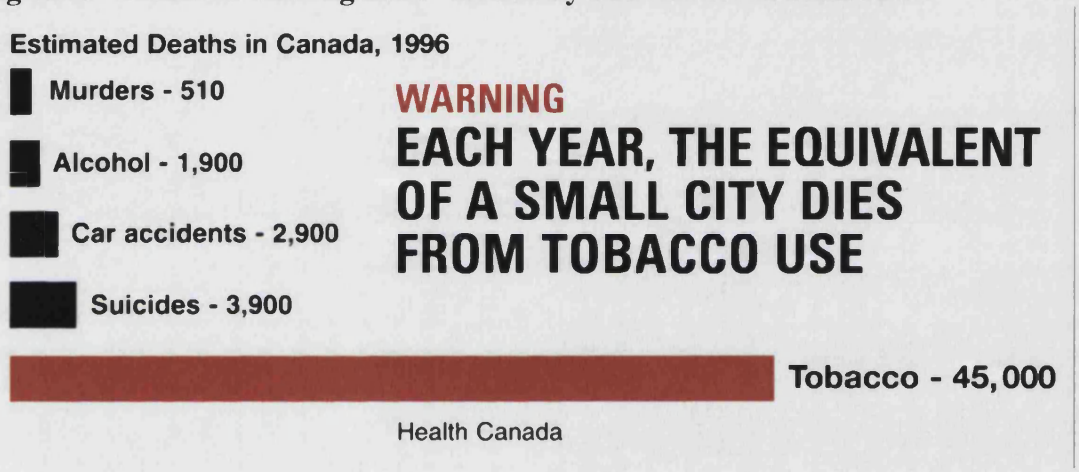
A final set of information sources this thesis aims to examine as determinants of adolescents' risk perceptions about smoking are public health-related – warning labels and school education programs. There has been work on both of these public health measures' impacts on smoking behavior but much less on their roles in altering risk perceptions. This sections starts with warning labels and moves to school-based tobacco education programs.

3.3.5.1. Warning labels

In 2000, Canada became the first country to enact strong regulation requiring tobacco manufacturers to display graphic health warnings on packaging according to strict specifications such as the text not being altered upon opening the package (Health Canada 2000; Mahood 1999). Topics covered in warnings include the impact of parent smoking on

children, the dangers of smoking while pregnant, impotence related to smoking, the dangers of second-hand smoke to the general public and specific disease-related dangers of smoking such as oral and lung cancer. Canada requires warnings that cover the top half of the front and back of cigarette packages and include photographs of smoking-related health problems such as a brain after a stroke, a damaged heart and a lung tumor (Physicians for a Smoke Free Canada 2006). The following are examples of warning labels appearing on cigarette packages in Canada.

Figure 3. Canadian warning label – Mortality risk relative to other risks



Source: Health Canada (2007*c*)

This label is of particular interest because one of the risk perceptions questions used in the Youth Smoking Survey (YSS) asks respondents to choose whether smoking causes more deaths per year in Canada than murders, alcohol, car accidents suicides (as well as AIDS). Because we know that this information is part of the rotation of warning labels in Canada, respondents, especially smokers are more likely to have accurate information about the answer to this question than if there had been no warning label covering this specific subject. Viscusi (1992*b*) suggested that most information given to the US public about

health risks does not offer any specific information on the size or probability of risks. Canada leads in its efforts to offer such finite information on its labels.

Another warning label on rotation conveys the addictive power of cigarette smoking and relates to a question in the YSS whose responses are included in the models used in Chapters 6-8.

Figure 4. Canadian warning label – Addictive nature of cigarettes

Source: Health Canada (2007*c*)

A final example of current warning labels in Canada highlights the cumulative nature of cigarette smoking risks.

Figure 5. Canadian warning label – Cumulative nature of smoking risk

Source: Health Canada (2007*c*)

Since 1965, the US has required warning labels on cigarette packages. The original Federal Cigarette Labeling and Advertising Act required that 'Caution: Cigarette Smoking May Be Hazardous to Your Health' be placed on one of the side panels of cigarette packages (US Department of Health and Human Services 2000). Since this initial ruling, the words appearing on package labels have changed but the US has consistently had less prominent and strong warning labels than those found in other developed countries. US labels simply have black and white writing appearing down the side of the pack with a rotation of four warnings. Figure 6 compares the US warning labels to those in Canada with many more on rotation and a higher portion of the package covered with a color warning.

Figure 6. Cigarette package warning labels from Canada and the US

Canada (2001)
–16 rotating warnings
–50% of pack face
–colour pictures

US (1984)
–4 warnings
–side of pack
–black/white

Source: Adapted from Hammond et al. (2006)

Labels in the US have not been changed since 1984 contrary to evidence that keeping labels up to date and building upon previous knowledge about which kinds of labels have most

impact would benefit the effectiveness of labels. Warning labels in the US appearing only in English also prohibits the substantial Spanish-only speaking portion of the population as well as other non-English speaking groups from benefiting from these labels (Browne et al. 2007). 1 in 20 American adults would not be considered having basic English literacy (National Center for Education Statistics 2003). This language barrier poses a particularly significant problem because warnings are not accompanied with graphics either.

Studies examining the impact of warning labels on individuals' risk perceptions about smoking using adult populations as survey samples have found a positive relationship between seeing warning labels and risk perceptions (Ayanian and Cleary 1999; Liu and Hsieh 1995; Magat et al. 1988; Viscusi and Magat 1987; Willemsen 2005)) but their success remains contingent on whether individuals believe what they read on the cigarette packages.

Warning label design and the particular message included on warning labels appear to matter for their effectiveness among all population groups. Characteristics such as pictures placed alongside of or instead of text health warnings have been shown to augment the effectiveness of warning label campaigns (Nilsson et al. 1999; O'Hegarty et al. 2006; O'Hegarty et al. 2007). Previous work analyzing the impact of Canada's graphic warning labels system both on individuals' knowledge about the risks of smoking (Hammond et al. 2006; Hammond et al. 2007; Koval et al. 2005) and in promoting a downward shift in initiation rates and upward move in quit attempts (Peters et al. 2007) have found that graphic warning labels prove most effective in achieving public health aims than the alternative of text-only warnings.

Lundborg and Lindgren (2004) suggest that their finding of age being negatively related to risk perceptions could have something to do with warning label effectiveness in that public information about smoking plays a significant part in younger individuals' development of risk perceptions related to smoking but this link diminishes with age. Health warnings on tobacco packages have been found to deter smoking among adolescents but only if they are appropriately sized and well-designed with a relevant message (often including graphics and text) (Crawford et al. 2002; Koval et al. 2005; O'Hegarty et al. 2006; O'Hegarty et al. 2007).

Koval et al. (2005) examined Canadian adolescents' views about warning labels and found that current smokers were less likely than ex-smokers to believe warning labels. Similarly, Portillo and Antoñanzas (2002) found that warnings heighten risk perceptions but have less influence on adolescent smokers than non-smokers. These findings could have a psychological explanation such as smokers exercising cognitive dissonance upon viewing the warning or smokers having some sort of endogenous characteristic that would make them disregard such a warning or find other sources of information more meaningful. Alternatively, this finding could be explained from more of a policy communications point of view by suggesting that the warnings used may not actually convey the correct sort of information needed in order to alter behaviors for this specific population group.

3.3.5.2. School-based education programs

The literature on public health campaigns in schools suggests that they are not as effective as hoped in altering behaviors. Factors such as program design, delivery and messaging matter greatly in supporting or conflicting with this finding. Bruvold's (1993) meta-analysis of school-based education program to prevent adolescent smoking found that

programs focusing more on social norms by promoting alternatives to smoking such as being involved in physical activities, social reinforcement by aiding adolescents to acknowledge and be aware of social pressures as well as developmental elements by increasing self-esteem would be more successful on altering smoking behavior outcomes than simply information-based programs.

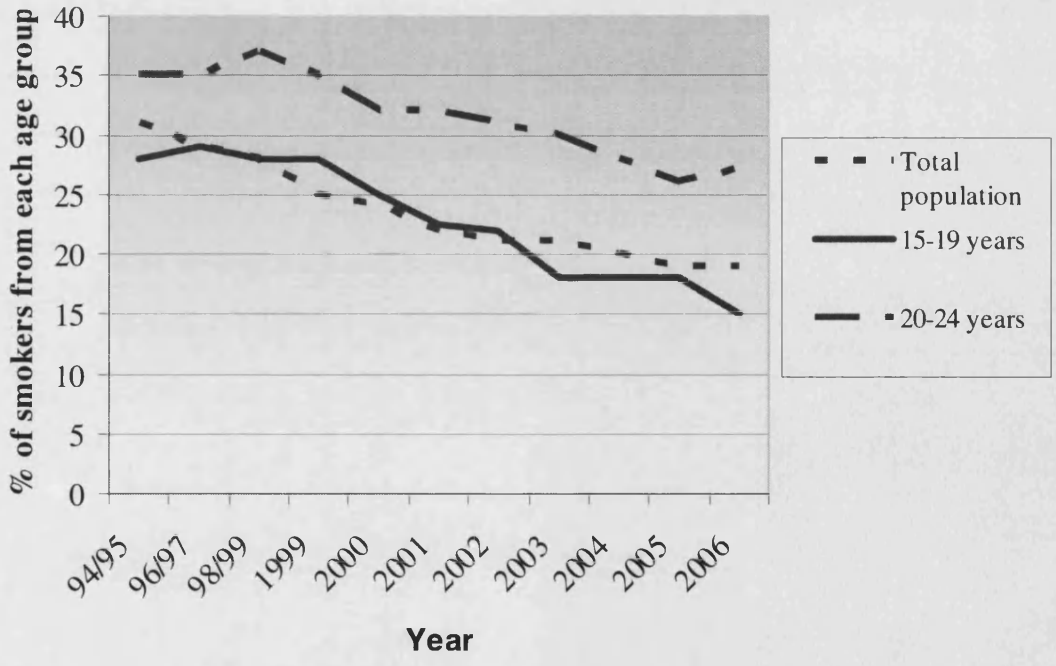
The strength of homogeneous behavioral preferences among school students can clearly be mediated by school smoking policies and public health education curriculums to which students have been exposed. Findings reached regarding the impact of educational programs on smoking risk perceptions have been few. Part of the argument stating that educational curriculum is not as effective in reducing risks centers around findings that adolescents actually overestimate the risks attached to smoking therefore information campaigns actually lower the level of perceived risk from prior beliefs (Lundborg and Lindgren 2004). Lower risk perceptions stemming from public health education could be a function of poor communication of information or adolescents not attaching much credence to the material taught. Lundborg's (2007) examination of teachers and any other types of adults at school disseminating information about smoking risks met mixed results with teachers disseminating information being associated with higher risk perceptions and other adults at school being the conduits of information being associated with lower risk perceptions. Findings suggest that smoking risk education programs performed in the school setting often appear ineffective (Bruvold 1993). Bruvold posits that attitude change stands as a precursor to behavioral change and the newer, more rationally based education approaches capture this element of smoking behaviors more than previous methods. This analysis will add to the paucity of findings regarding any impact school-based education programs have on altering adolescents' risk perceptions.

Prior to concluding this chapter, a brief outline of the current tobacco policy environment in Canada and the US gives some context for the settings in which this thesis' analysis takes place.

3.4. Current policy environment in Canada

Canada has long been a global leader in anti-tobacco efforts. The country's public health tobacco control initiatives have moved beyond the economic (taxation)-focused plans that many countries follow. Canada has made great achievements in reducing smoking prevalence among the adolescent population, however, progress has slowed in recent years. Figure 7 below highlights the drop in smoking for 15 to 19 year olds from 28 percent in 1994/95 to 15 percent in 2006 and for 20 to 24 year olds from 35 percent to 27 percent in 2006.

Figure 7. Smoking prevalence rate* for 15-24 year olds in Canada



Sources: 1994/95-1998/99, National Population Health Survey
1996-2006, Canadian Tobacco Use Monitoring Survey (CTUMS)

* smoking prevalence defined as the number of daily smokers and non-daily smokers (also known as occasional smokers) in a specified group, divided by the total population of that group, expressed as a percentage.

Since 2001, Canada has been implementing the Federal Tobacco Control Strategy (FTCS) aimed at reducing tobacco-related death and diseases for ten years from the strategy's commencement. The original goal for reducing smoking prevalence in Canada was met prior to the end of the strategy (31 March 2011). The strategy's goals are set out in Table 1 below.

Table 1. Goals of the Federal Tobacco Control Strategy

1. Reduce smoking prevalence to 20% by 2011 from 25% in 1999
2. Reduce the number of cigarettes sold by 30%
3. Increase retailer compliance regarding youth access to tobacco from 69% to 80%
4. Reduce the number of people exposed to environmental tobacco smoke in enclosed public places
5. Explore how to mandate changes to tobacco products to reduce health hazards

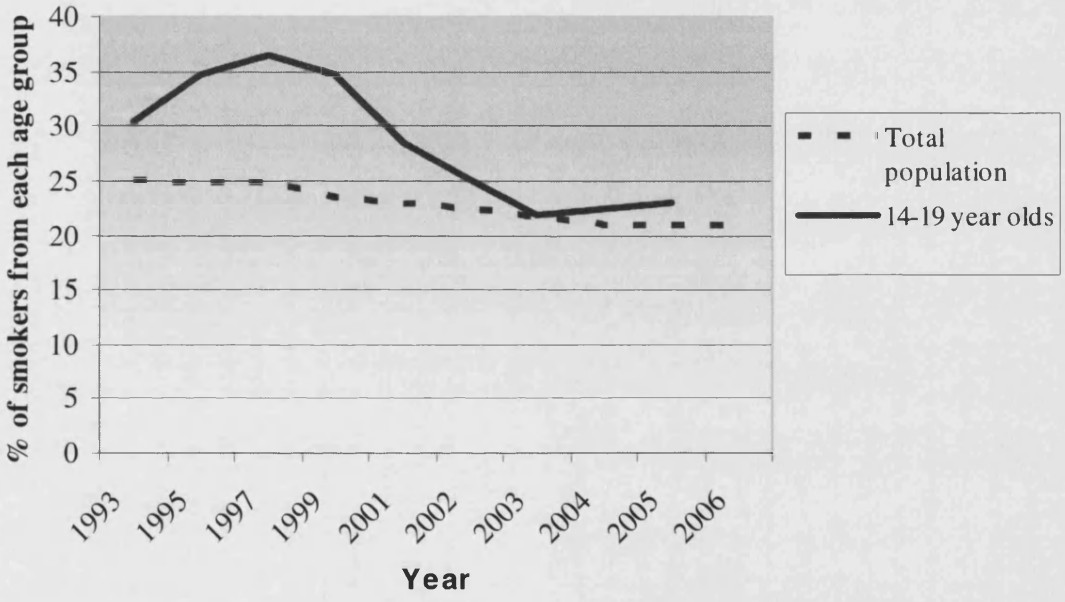
Source: Health Canada (2007*a*)

The first goal was then reset to reduce smoking prevalence to 19% in 2006, which has now been accomplished and has again been reset to 12% by 2011. For adolescents aged 15-17 years, the goal is now to reduce smoking prevalence from 15 percent in 2006 to 9 percent by 2011. The strategy also aims to reduce the percentage of the population exposed to second-hand smoke from 28 percent in 2006 to 20 percent by 2011 (Health Canada 2007*b*). Although the FTCS holds a mission that encompasses all Canadians, it particularly focuses on youths and young adults. Additional information on Canada's public health policy towards curbing smoking, especially among adolescents can be found in Appendix 3A.

3.5. Current policy environment in the US

The US has made significant strides in reducing overall population smoking prevalence and especially that of youths in the past fifty years, however, the rate of decrease among both population groups appears to be stalling and is actually reaching a stable flat line. Figure 8 illustrates how cigarette smoking prevalence among the total population and high school students has changed in the past almost fifteen years.

Figure 8. Smoking prevalence rate* for 14-19 year olds in the US



Sources: For total population, 1993, 1995, 1997, 1999, 2001-4, 2006, National Health Interview Survey
For 14-19 year olds (grades 9-12), 1993, 1995, 1997, 1999, 2001, 2003, 2005, Youth Risk Behavior Surveillance System
*For adults – smokers defined as those who have smoked at least 100 cigarettes in their lifetime and currently smoke (at least one cigarette in the past 30 days)
For youths – smokers defined as smoked at least one cigarette in the past 30 days
Note: for those years without a figure where the other datasets had a figure, an average of the year before and after were taken in order to create a line (adults – 2005, youths – 2002, 2004)

The Centers for Disease Control and Prevention (CDC) coordinates national efforts against tobacco-related morbidity and death through the National Tobacco Control Program started in 1999. Often this coordination includes pulling together and assessing results from previous state or local-run programs to produce evidence-based guidelines on how best to

run new programs focused on particular initiatives such as youth tobacco use cessation. It also involves publishing data on the extent of tobacco use. The US runs an extensive amount of surveys to keep track of adult and youth smoking prevalence.[6] The goals of the National Tobacco Control Program are set out in Table 2 below.

Table 2. Goals of the National Strategy to Reduce Tobacco-Related Disease and Deaths

1. End exposure to environmental tobacco smoke
2. Help current adult and youth smokers quit
3. Prevent youth starting to use tobacco
4. Identify and reduce disparities among population segments

Source: CDC (2007*a*)

Additional information on the United States' public health policy efforts to reduce smoking, especially among adolescents can be found in Appendix 3B..

3.6. Conclusion

This literature review demonstrates the wealth of work already performed covering the topic of adolescents and smoking behaviors and to a much smaller extent, adolescents and their risk perceptions about smoking. While fields from all corners of the social sciences have weighed in on discussions about adolescent smoking, gaps in understanding of adolescents' risk perceptions remain. The theoretical framework set out at the end of Chapter 2 sets up the conceptual guidance for empirical analysis while the literature discussed in this chapter highlights the gaps in work examining the role of risk perceptions

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[6] These surveys include the National Youth Tobacco Survey, the Youth Tobacco Survey, the American Indian/ Alaska Native Adult (State) Tobacco Survey, the National Interview Survey, Behavior Risk Factor Surveillance System, Youth Risk Behavior Surveillance System, Monitoring the Future Survey, National Health and Nutrition Examination Survey, the National Survey on Drug Use and Health (used here), the Current Population Survey.

in determining adolescent smoking behavior and which information sources are most effective in altering these perceptions of risk.

The next chapter, Chapter 4, introduces the datasets used in this thesis' empirical analysis and continues the discussion started in this chapter about the methodological issues with measuring risk perceptions. The chapter also covers survey elicitation concerns when surveying adolescent populations and using different elicitation modes. It concludes with generally outlining the empirical methods used to answer this study's research questions.

Chapter 4. Methodology

This chapter explains the various methodological considerations playing a major part in the empirical work undertaken in this thesis. Four sections follow. The first introduces the two surveys used discussing the individual aspects of each survey including where each has limitations. It also covers why these particular surveys were chosen. This section will serve as the overall reference point for information on the surveys for the rest of the thesis therefore survey details will not be discussed in the results chapters that follow (Chapters 5-8). The second deals with general issues relating to the use of survey data including choice of elicitation method, cross-section versus panel data and specific elicitation issues arising when performing surveys with adolescent respondents. The third examines aspects of question choice and survey design playing a prominent role in the use of surveys for empirical research. Within risk perceptions research in particular, the phrasing of questions can introduce certain cognitive biases dictating responses therefore this section is important in highlighting what kinds of questions open themselves up to such respondent biases. Finally, the fourth broadly discusses the empirical methods used to examine the survey data. Details of empirical specifications used for individual analyses are contained in each results chapter.

4.1. Data sources

In order to find appropriate surveys to that would offer the necessary information to answer the two key research questions posed in this thesis, there were many criteria. Sample size, survey methodology and whether a risk perception question is part of the survey and then what type of risk perception question were the main issues determining whether a survey could be used. Of additional importance were how much information each survey contained about how respondents had gained information about smoking risks and

household characteristics such as parental smoking. The final two major points about risk perception questions turned out being most important as many surveys cover adolescent smoking but the presence of a question about risk perceptions as well as one that was deemed an adequate measure of risk and not attitudes or beliefs proved most difficult. In choosing which surveys best suit this study's purposes, smoking behaviors are well-documented and some countries such as the United Kingdom even perform an annual survey on this topic; however, these surveys lack risk assessments from respondents, thereby limiting the extent to which they can be used to study risk perceptions. In order to be used for risk perceptions work, surveys must include questions such as 'How many people do you think die per year in Country A from smoking?,' 'Of 100 lifelong smokers, how many do you think will have lung cancer at some point in their life' or 'What is the average life expectancy of a smoker in Country A and non-smoker in Country A?' These questions all offer quantifiable results. In an acceptable but non-quantitative risk question, respondents could also be asked how risky they believe smoking to be and answer on a Likert scale of 'not risky at all' to 'very risky.'

This thesis uses two separate cross-sectional surveys from Canada and the USA to answer posed research questions. This thesis elects to use the Canadian Youth Smoking Survey (YSS) from 2002 (Statistics Canada 2002) and the U.S. National Survey on Drug Use and Health (NSDUH) from 2004 (U.S. Department of Health and Human Services 2004). These were the latest publicly available editions of these data sets at the time of undertaking this research. Although the question phrasing and elicitation mode of each survey differs, both cover the same topics of perceived risk and smoking behaviors. Sometimes one of the surveys covers additional topics, namely, the NSDUH including a plethora of information about substance abuse and mental health but only those questions

on risk and smoking are considered in this analysis. In each empirical chapter, both datasets are exploited using all applicable survey data except in Chapter 8 where the NSDUH does not have any information about respondents' experiences with school-taught public health programs that specifically cover smoking or respondents' acknowledging, remembering or offering opinions about the credibility of cigarette warning labels. Table 3 offers summary descriptions of each survey including which data sources each chapter uses.

Table 3. Currently available datasets provide the necessary information to answer research questions

Country	Name of Survey	Sponsoring Agency	Year	Number of Observations	Age Groups	Empirical chapters data used in
Canada	Canadian Youth Smoking Survey	Statistics Canada with Health Canada	2002	19,018	10-15	• Chapter 5 • Chapter 6 • Chapter 7 • Chapter 8
USA	The National Survey on Drug Use and Health	Department of Health and Human Services National Institutes of Health (NIH)	2004	18,294*	12-17	• Chapter 5 • Chapter 6 • Chapter 7

* Survey includes respondents aged 12-65 but this research elects to use only those respondents up to age 17

Having data from two countries allows results to be tested across country context where policy measures differ. Because Canada and the USA have some commonalities in that they are both developed countries with broadly similar levels of attention paid to smoking risks at the policy level, the results gleaned from each population survey will act as further support or dissention with results found for the other country. This thesis is concerned about individual-level risk perceptions and behavior. Conclusions will not be drawn to suggest that any results are valid on the national level. Instead, analysis examines how individual behaviors and perceptions of risk differ within countries and across countries. Of crucial importance is any difference in which information sources matter most in each country.

Making any cross-country comparisons will always be shrouded in the caveats of each survey employing a different elicitation method and question phrasing, especially when gauging risk perceptions. Therefore, direct comparisons between countries will not be possible but findings will still highlight how the experience and decision- making process about smoking risks differ between settings. Even with differences in survey methodology and exact question wording, having results from two surveys offers a more complete understanding of the research questions at hand.

Of principle advantage in using multiple datasets designed by independent bodies is that they are not subject to biases introduced by the researcher designing his own survey. In this way, question wording would not be construed so as to achieve a specific answer. They also were administered independently by experienced statistics professionals. In the case of the Canadian YSS, Statistics Canada ran the same school-based survey in 1994 so any issues to be worked out from the original survey where ameliorated by the 2002 data collection. The US NSDUH has been run by the United States Department of Health and Human Services, Substance Abuse and Mental Health Services Administration (SAMHSA) in the Office of Applied Studies since 1979 until 1991 every three years and then annually until present. The survey used to be called the National Household Survey on Drug Abuse (NSHDA) but the name was changed in 2002.

The reasons for selecting these two particular surveys can be divided into three groups: questions selection, sampling processes and elicitation modes and methods used to prevent avoidable errors. First, as discussed above, many surveys covering youth smoking look at smoking behaviors and prevalence rates, but this research requires information regarding

risk perceptions about smoking behaviors. Surveys can even ask respondents about their awareness of or knowledge about smoking risks but this does not constitute an appropriate 'risk question' in the field of risk research as it tells us more about risk knowledge than perceptions. An example of an existing survey asking about smoking but not risk is The National Longitudinal Survey of Children and Youth started in 1994 by Statistics Canada. It does not serve the purposes of this research well since the survey only collects limited information on smoking behaviors. The Canadian Community Health Survey looks at smoking behaviors of children from age 12 and older, but it focuses more on prevalence and quitting behaviors without any questions on attitudes and beliefs about smoking risks. On the other hand, the YSS offers a quantitative risk question asking about perceptions of smoking-related mortality and six qualitative risk questions asking individuals to compare mortality from other risks with smoking-related mortality.

The US runs multiple surveys covering adolescent tobacco use including two school-based surveys, the Monitoring the Future survey and the Youth Risk Behavior Survey. These surveys do not offer risk perceptions questions in the manner discussed above and instead focus more on knowledge about smoking risks. The NSDUH is particularly interesting because it contains questions about respondents' attitudes towards risks in general and not simply smoking-related. This allows for an understanding of an individual's overall level of risk aversion in general and with reference to specific risks such as wearing a seatbelt.

Second, both surveys employ robust sample designs and population selections as a result of their methods of vetting individual sampling units. In the YSS only 2.3% of the target population of Canadian residents aged 10-15 enrolled in private and public schools could not be represented either because the small size of their classes or the remoteness of their

locale (Statistics Canada 2002). Respondent school board selections were based upon random selection proportional across provinces depending on the number of students enrolled under each board's jurisdiction. The response rate about boards was 94% (CBPRE 2007). Likewise, within school boards, schools were selected based upon school size in order to ensure proportionality. 327 school board, 982 schools and 1070 classrooms were used in the 2002 survey (Health Canada 2007*d*). Schools failing to consent to the survey process were replaced by others similar in enrollment size and grades. The school level response rate was 95% while the response rate among eligible students was 82% for all of Canada. Among those students submitting usable questionnaires, the response rate for the country as a whole was 93%. The Canadian YSS is representative of the target population of individuals in grades five through nine in ten Canadian provinces (Health Canada 2007*d*).

The NSDUH used multistage random sampling and included respondents from all 50 states and the District of Columbia. The sample was stratified on many levels starting with the state level then field interviewer region, and then small geographic areas made up of blocks called segments. Individuals then visited each segment and listed all housing unit addresses in a set order. Then systematic sampling chose the addresses from within each segment. The individual to be interviewed within each address was chosen at random using a computer according to allocation targets in five age groups of 12-17, 18-25, 26-34, 35-49 and 50 years and older such that there would be an equal number of respondents in the 12-17, 18-25 and 26 and older age groups (US Dept. of Health and Human Services 2004). The weighted interview response rate for the NSDUH 2004 was 77%. The US NSDUH is a nationally representative survey of the civilian, non-institutionalized population of the US aged 12 and older.

Third, all survey administrators and designers took appropriate steps to ensure that once surveys were given, response rates would be reasonably high and answers would not be subject to avoidable errors. All surveys were tested prior to their final administration. In the case of the YSS, the questionnaire was specifically designed for the young age group being tested. For the NDSUH, while the survey population included adults, many of the questions used in this analysis were only asked of the adolescent sub-sample and were thus designed with this population group in mind. This reduces the chance of questions being misunderstood by respondents and increases the veracity of answers in the final survey results. It also serves to ensure that the questionnaire is of appropriate length.

Additionally, survey administrators took particular steps to avoid systematic biases in responses and non-sampling errors. For example, in the YSS, a classroom-based survey, interviewers were trained regarding survey procedures and were expected to note any respondent issues understanding instructions. For the NSDUH, a computer-assisted personal interview (CAPI) and audio computer-assisted self interview (ACASI) survey, administrators were given specific script to read to all respondents explaining the survey, the privacy of answers and the informed consent clauses. They were also given a specific guide titled 'steps to maximize data quality' that included important aspects such as making sure to find a private place for conducting the interview, not rushing respondents and not reading the questions out loud to respondents but instead allowing the respondents to use headphones to hear better and have a greater sense of privacy (US DHHS 2004). More on survey elicitation modes such as classroom-based versus interview will be covered below.

Both surveys do have limitations that require recognition. Because the surveys were designed by independent bodies, some of the exact specifications are not ideal for the purposes of this research and questionnaire design limits research that can be performed using these surveys.

For all surveys, a serious limitation throughout this thesis comes as a function of using secondary, not primary data sources. Therefore, analysis faces limits based on the questions posed by the two agencies that wrote and undertook the surveys. In many cases, it is not simply the lack of a particular question that thwarts analysis but question phrasing. For example, the Canadian YSS asks respondents to compare the mortality risks of smoking versus risks of other risky behaviors but this use of a reference point in the form of the other risky behaviors compared to smoking could be confusing the clarity of survey responses reflecting on respondents' perceptions of smoking risks. This point will be discussed at great length in section 4.2.3 about risk perception question phrasing and in Chapter 5 when analyzing the veracity of the two measures of risk perceptions used in the YSS. Despite these limitations always faced by researchers using secondary data sources, these particular surveys were chosen because of the topics covered, quality of their questions and robustness of elicitation methods.

The cross-sectional nature of both surveys precludes an understanding of any temporal relationships amongst the variables. This limits the ability to establish causal relationships and more specifically to test how policy changes over time have altered the importance of any given information sources such as tobacco warning labels on risk perceptions. Using cross-sectional data precludes this analysis from understanding issues such as whether adolescents think about risks and benefits of smoking before actually smoking or once they

have already smoked (Halpern-Felsher et al. 2004). Analysis can simply come to conclusions such as an individual that has high risk perceptions being less likely to have smoked. The timing of risk understanding and behavioral choices remains unclear without adequate time series data. At the time of this analysis, time series data to answer the posed research questions for an adolescent population was unavailable and to date no panel data on adolescent sub-population regarding smoking risks is available.[7]

Additionally, surveying adolescents as a population sub-group also raises issues unique to this age group in comparison to an adult survey population. Specific to each survey, limitations and difficulties stem from two main topics: elicitation method and question phrasing. The following section addresses these subjects in turn.

4.2. Using survey data

In order to capture adolescents' risk perceptions regarding smoking in any large number, their opinions have to be elicited through surveys. Alternative methods of researching risk perceptions such as small discussion groups resulting in a more qualitative understanding of respondents' opinions do not fit the objectives of this research. Not only would they be subject to group behavior biases, especially with adolescents who are known to be influenced by peer effects and may suffer from being nervous but also gathering the type of respondent numbers desired for this study would be costly and time-consuming. Additionally, when surveying adolescents about risk-taking behaviors an issue arises in that the behavior is likely either illegal at their age or they know their parents would disprove of it. Therefore, they have little incentive to be truthful when their anonymity is at stake through verbal response in visual sight of others.

[7] More on data-related limitations to this research can be found in Chapter 9.

Subjective probabilities of risk perceptions can be elicited from survey responses that obtain subjective survival probabilities (Gan et al. 2003; Hamermesh and Hamermesh 1985; Hurd and McGarry 2002) and as in this study, specific hazard-related risk perceptions (Viscusi 1990, 1992*b*) and risk perceptions about the likelihood of mortality (Hakes and Viscusi 2004). Although some studies question probabilistic thinking on cross-cultural grounds (Wright and Phillips 1980), this analysis is set on the premise that existing evidence provides a reasonable account of an individual's capacity to make subjective judgments and evaluations of risks. Subjective probabilities used to develop risk perceptions are based upon individual learning and information updating, which in turn are affected by systematic biases, such as an overestimation of small, involuntarily taken and widely publicized risks as discussed in Chapter 2. These assessments of risks are not always consistent across individuals with different levels of information and experience because of the influence of cognitive biases and affect heuristics. However, the subjective probabilities of survival appear to be consistent with life tables (Hurd and McGarry 1995).[8] Hurd and McGarry (2002) find that individuals modify their subjective probabilities of survival in response to new information (for example, the onset of a new illness).[9] This is also the assumption that this thesis takes in that adolescents update their perceptions of risk based upon new information from a variety of sources. The same is found in other studies

[8] However, Walley (1991) reviews cases in which individuals consistently respond in the lower and upper ends of the probability tails when asked probability-based questions suggesting that numerical probabilities elicited in surveys may be consistently biased toward the extremes. Although answers for the quantitative risk perception question in the YSS were not stated as probabilities, findings exhibited a bias towards only the upward extreme with 19.2 percent of respondents electing that over 100,000 Canadians die each year from smoking-related disease. With the NSDUH measure of risk perceptions, responses were also biased towards the upward extreme, which happens also to be the correct answer (great risk to smoking one or packs of cigarettes per day). Survey design can also lend itself towards upward extreme bias by placing an answer such as 'over 100,000' among a list of responses.

[9] Estimates were affected by focal responses whereby some individuals reported either a 0% or 100% chance of a future event. The same applies to Gan et al. (2003), who uses a Bayesian updating model to account for problems associated with focal responses.

taking risk factors into account (Schoenbaum 1997) or controlling for information acquisition (ex. schooling) and individually-specific determinants (Hurd and McGarry 2002).[10]

In general, one cannot assume that survey results exactly depict reality. The act of actually participating in a survey about risks might make people feel more worried about those hazards mentioned in the survey while responding to the questions than they would be outside the research setting. This could be because the survey actually makes them think about issues to which they have given little time prior to formulating their response. Despite their general limitations, surveys represent the closest approximation to reality available for analysis of large groups of people's risk perceptions.

Surveys provide a wealth of data but their ability to be meaningful depends upon many factors. First, running an effective survey on an adolescent sub-population requires special attention to certain issues. Second, choice of elicitation method can either alleviate the chances of certain biases in responses or heighten the likelihood of their occurrence. Overall survey design elements such as length and order of questions as well as the particular phrasing of questions asked also figures greatly in the usefulness of data from a survey. Third, the field of risk perceptions has an ongoing lively debate about the effectiveness of various means of measuring risk perceptions therefore the choice of risk perceptions questions also plays an important role in analyzing survey data. The first two issues will be addressed in this section and the third will be discussed in a section on question choices and phrasing that follows.

[10] Current health is found to determine subjective probability of survival in Hurd and McGarry (2002).

4.2.1. Particular issues with adolescent surveys

Surveying adolescents presents some unique challenges that have to be addressed and/or acknowledged in order to offer any meaningful findings with regards to this age group. With adolescents, the effects of what someone else might think of their responses be it their peers or an adult figure such as a parent could sway survey responses. The degree to which this effect occurs depends upon elicitation mode. As mentioned in Chapter 3 as a means for others to influence the perceptions of adolescents, evidence suggests that adolescents are influenced by perceptions of the benefits of partaking in an activity. For example, adolescents who smoke are more likely to overestimate the prevalence of smoking among their peers and adults than non-smoking adolescents (Leventhal et al. 1987). Therefore, this issue of perception of action could result in respondents knowingly responding in a false manner to survey questions about smoking behaviors. The likelihood of this kind of false response would be much higher in a classroom-based survey, like the YSS because respondents take the survey together with their peers and thus could think that others see their answers and would want to be seen doing what they perceive their peers to think is a 'cool' behavior.

Confirming that classroom-based surveys elicit upward pressure on smoking prevalence rates and interview or home-based surveys result in underestimates of smoking rates is difficult. The Center for Disease Control in the US tested and re-tested results from a study over a two-week period and found stable answers (Brener et al. 2006) but overall found that findings regarding overestimation in school-based surveys due to desires to project a propensity to take risks remain unclear. Other studies testing this tendency to over-report

smoking and other substance abuses in the classroom survey setting have not found strong evidence of this either (Single et al. 1975; Zanes and Matsoukas 1979).

Instead of perhaps overestimating smoking prevalence, concern over parent knowledge of smoking behaviors could create a downward pressure on survey results about smoking rates for an adolescent population. Currivan et al. (2004) found that respondents were more likely to report smoking behavior in a confidential form of telephone interviewing (telephone audio computer-assisted self-interviewing) than in a less private elicitation mode where an interviewer administers the survey, especially if they were concerned about what their parents thought about their smoking. In general, the more private the elicitation mode, the more likely adolescents are to report their own smoking behaviors (Supple et al. 1999; Tourangeau and Smith 1996).

A final point to note regarding surveying adolescents is that although survey length can be a problem with any respondent population, adolescents would be a particularly bad group to give a very long survey. Perhaps offering payment, as in the case of the NSDUH might make a difference in maintaining attention span, but in general, later questions in a long questionnaire could suffer from less careful reading and thought given to them than earlier questions.

4.2.2. Elicitation method

Much of the research on adolescent risk behaviors takes place by conducting classroom-based surveys, especially when sample size is small but telephone-based surveys are also common. The YSS survey is classroom-based while the NSDUH survey is a home-based computer-assisted interview, which in the case of adolescents, elicitation setting could

make a difference in results as explained above. Each of these methods has their advantages and disadvantages and no elicitation method has been deemed a 'gold standard' for this kind of research.

Elicitation mode has been shown to exert a strong effect on survey responses regarding behaviors considered unacceptable (Aquilino 1994). Currivan et al. (2004) compared adolescents' answers regarding smoking behavior using telephone audio computer-assisted self-interviewing (T-ACASI) and interviewer-administered telephone interviews to find that privacy appears to matter more for girls than boys as girls were more likely to say they smoke if this involves pressing a button rather than saying this out loud. In fact, these findings suggest that traditional telephone-based interviews could underestimate smoking prevalence by up to 50 percent out of fear of parental disapproval. Similarly, a study comparing school pencil and paper interviewing versus computer interviewing found that those completing computer interviews had higher odds of reporting health risk behaviors than those using a paper test (Brener et al. 2006). These examples demonstrate how elicitation mode really can matter for survey findings. This section specifically discusses the two elicitation modes used in the survey data for this thesis: classroom-based and home-based surveys.

4.2.2.1. Classroom-based surveys

Research on adolescent risk behaviors often takes place by conducting classroom-based surveys. This elicitation mode offers a relatively cheap means to gather a large survey sample. However, surveys in the classroom can still present difficulties. Classroom-based surveys typically have higher non-response rates than other types of surveys. They introduce two types of non-responses – school non-response and student non-response.

The reasons for school non-response vary widely but often have to do with event scheduling problems and too much curriculum that the teacher already has to go through without taking time out for a survey. While schools that refuse to participate in a survey are typically replaced with ones of similar regional, ethnic and economic characteristics, without information on the characteristics of refusing schools, it is difficult to know how much bias this introduces into results.

Student non-response rates are due to students missing school. These absentees can present biases of varying degrees to survey results. Guttmacher et al. (2002) found that individuals who were chronically absent were more likely to be smokers than those who attend school regularly (Pirie et al. 1988). However, the intense means it took to elicit opinions from absent students was not worth the minor improvements in risk estimates that could be manufactured through weighting the data. In general, chronically absent students are more likely to engage in risky behaviors therefore, school-based surveys can underestimate the prevalence of these behaviors by excluding these portions of the population (Kandel 1975; Michaud et al. 1998; Rainone et al. 1993). On the other hand, home-based and telephone-based surveys would be more likely to pick up this wider group.

Weitzman et al. (2003) examined data from New York City high school and found respondents from low-response rate high schools to be more likely to be female, African-American and from single parent or no-parent households. When data from this survey was not weighted for absences and low-response schools were excluded from analysis, estimates of risk behavior were underestimated. Given the correlation between individual absenteeism and risky behaviors and schools with higher rates of absenteeism and higher prevalence of substance abuse, the authors suggest that perhaps classroom-based surveys

are not the most appropriate means of assessing adolescents' undertaking of risky behaviors.

While classroom-based surveys miss those adolescents who have dropped out of school and those who have poor attendance histories, they do avoid concerns about parents hearing adolescents' answers. In addition, classroom-based surveys avoid any issues that might arise from face-to-face interviews where anonymity is not so obviously clear. Elicitation mode can impact the way in which cognitive biases play a role in survey response. Weinstein et al. (2005) cite numerous studies where self-administered surveys usually found optimism bias while phone and face to face did not. This finding was deemed to suggest that answers elicited in a private manner were more likely to be honest because they were void of any desires for social approval or heirs of self presentation. Weinstein et al. (2005) make the assertion that individuals asked by an interviewer about their own risks versus the risks faced by others in the same situation would be less likely to deem themselves as facing less risk for fear that the interviewer might ask them to explain themselves. Although face-to-face interview is not of the elicitation techniques used in this thesis, the impact of social desirability could still influence responses across the survey response modes employed. This would especially be the case with other peers during school-based surveys, as discussed and with an interviewer, presumably in the home during home-based surveys even if the survey is performed on a computer.

4.2.2.2. Home-based surveys

Home-based surveys have an advantage over classroom-based surveys in that they allow the entire population to be included in a survey sample and not simply those who attend school (Currivan et al 2004). Regular school attendees would be less likely to pursue

illegal and risky behaviors; therefore, results from a classroom-based study would reflect this bias. Home-based surveys also usually have higher response rates than school-base surveys because of higher refusal rates in schools (Gfroerer et al. 1997).

The use of audio computer assisted self-interviewing (A-CASI), as used in the NSDUH, has been shown to exhibit more frequently consistent results regarding substance abuse and other sensitive questions (Turner et al. 1992; Turner et al. 1998). The US NSDUH starts with an interviewer clarifying the objectives of the survey and conveying crucial information such as the confidentiality of responses and then has the respondent work through a computer-based survey.

When surveying adolescents, home-based interview surveys have been thought of as less accurate at gauging tobacco use levels than classroom-based surveys because they usually reveal lower tobacco use estimates. This potential underestimation in smoking rates often attributed to adolescents having concerns about parental knowledge of their smoking behaviors. For example, the National Household Survey on Drug Use (NHSDA) (now called the National Survey on Drug Use and Health (NSDUH)), an in-home interview-based survey, found that 24 percent of tenth and twelfth grade students had smoked cigarettes whereas the responses were 30 percent and 35 percent for two school-based self-administered surveys, Monitoring the Future (MTF) and the Youth Risk Behavior Survey (YRBS) (Fowler and Stringfellow 2001). In general, self-reported levels of involvement in sensitive behaviors are lower when confidentiality and privacy are in question (Horm et al. 1996; Turner et al. 1996)

The difference in smoking behaviors adolescents express in at-home versus in-school surveys can be attributed to fear that parents would see or hear survey responses at home whereas they have fewer concerns like this regarding classroom-based surveys. It could also be attributed to a third-party relation between individuals who go to school actually being more likely to be smokers potentially due to the heightened influence of peer effects in the school environment.

4.2.3. Question choices and phrasing

Question choices and wording have a crucial role in determining the usefulness of a survey and interpreting results. Especially within the field of risk research, the way that a question about risk is phrased can make a major difference in response. Question phrasing in general can introduce a variety of biases into survey responses by including elements such as reference points or asking respondents about 'people in general' or 'yourself.' Question format also constitutes an issue of importance with risk questions as responses can differ widely depending on question framing. Open-ended versus multiple choice responses (Romer and Jamieson 2001) and questions asking respondents to assess relative risks (Weinstein 1999) have been shown to create difficulties of all kinds for respondents regardless of age.

4.2.3.1. Definition of smoking risk

Risk perceptions can be thought of as many things depending on the perspective one brings to this kind of analysis. Risk perceptions are often discussed in the psychology literature as being influenced by affect, emotion, and dread (Slovic et al. 1982; Slovic et al. 2000). They are also depicted as the likelihood or probability that an event will occur. An individual faces a risk when outcomes are uncertain but probability is known (Connolly et al, 2000). This thesis depicts risk perceptions based upon the subjective probability

individuals have of the risk occurring. Therefore, the risk perception is different than the actual probability of a risk occurring as it captures what the individual perceives to be the actual risk. In reality, however, the perceived risk could be either an overestimation or underestimation of the true risk but it is this risk perception that influence behaviour and not the actual risk probability. The risk outcome examined depends upon the risk measure. For the Canadian YSS, the risk attached to smoking is death (both from the quantitative and qualitative risk measures discussed below) and for the American NSDUH, the risk attached to smoking is less specific and aimed at capturing how respondents perceive the physical and other risks resulting from smoking. The 'other' (non-physical) types of risk related to smoking were not defined in the survey and left to the respondent to recall.

4.2.3.2. Risk perceptions questions

A lively and productive debate thrives among researchers of risk perceptions regarding the optimal method for measuring risk perceptions. The two major categorical distinctions between means of measuring risk are quantitative methods and qualitative methods. Within each of these methods, many variations on question type exist. This thesis includes analysis involving multiple types of risk perceptions questions in order to contribute to this debate about the most accurate method for measuring respondents' risk perceptions. In particular, one of the research questions examined in Chapter 5 aims to answer if the two measures of risk perceptions included in the YSS, one quantitative and the other qualitative are measuring the same information from respondents.

Quantitative measures of risk would be those questions involving numbers, percentages or any other form of statistics. For example, a question might ask respondents what they expect life expectancy of smokers versus non-smokers to be or how many smokers out of

100 they expect to get lung cancer or die from smoking. Another example would be asking respondents the chances they would get lung cancer or heart disease from smoking with a scale of 0% to 100%. The YSS includes a quantitative risk perception question asking how many Canadians per year respondents think will die from smoking-related causes.

Quantitative measures of risk have been found to create difficulties for respondents stemming from the general population's aversion to numbers and especially percentages as well as their difficulty in understanding orders of numerical magnitude (Baron 1997; Kahneman and Tversky 1973). These issues with numbers and percentages manifest themselves in survey responses through tendencies towards end aversion or end of scale biases (Torrance et al. 2001), difficulty in separating probabilities of low and very low levels when percentages are used (Lichtenstein et al. 1978; Manu et al. 1984) and simply giving answers that do not make sense when probabilities are included in a question (i.e. probabilities over 100%) (Borland 1997). Fischhoff and MacGregor (1983) examine how risk perception question framing impacts estimates of lethality of a risk depending on response mode. For example, when questions asked respondents how many people died of a disease while introducing an anchoring point of the number of people who had the disease that year or asked individuals to estimate how many survived that disease, both the information given in the question and the question framing around mortality or survival were found to influence responses. This takes us back to the behavioral economic bias of framing in terms of gains or losses (Camerer and Loewenstein 2004). Fischhoff and MacGregor's (1983) work underlines how biases come into play when individuals answer questions about topics involving affect and/or about which they are uncertain.

Qualitative questions would consist of either Likert response scales or comparisons between multiple risks either directly one against another or using a ranking method. An example of a Likert response would be asking respondents to choose a response category between strongly agree and disagree to a statement such as 'Smoking increases the risk for medical problems such as reproductive problems, respiratory problems or heart disease.' The USNDUH uses a Likert-scale risk perception elicitation method. Comparing risks directly against each other would be something like asking respondents whether smoking or AIDS kills more people per year. This kind of risk elicitation method is used in the YSS. Ranking risks would mean giving respondents a list of risks and asking them to number them 1 to 10 from the greatest risk to the least risk.

The key debate, which analysis from Chapter 5 aims to contribute to is that between Viscusi and Slovic. Viscusi (1992*b*, 2000) has championed the use of quantitative risk perception assessment measures framed as 'how many smokers out of 100 would be likely to develop...lung cancer/heart disease/throat cancer/etc because they smoke.' On the other hand, Slovic (2000*a*) takes issue with quantitative risk measures calling them unreliable and instead preferring qualitative measures. Slovic (2000*a*) cites evidence from Tversky and Koehler (1994) that when respondents are asked to focus on a particular topic such as an outcome, they are more likely to overestimate that single outcome. Therefore, assessments about probabilities are subject to sensitivities emerging from the way the question is described. Fundamentally, Slovic questions the underlying premise of Viscusi's use of quantitative instruments because the general public does not have probabilities or numerical values they attach to a given topic available for appropriately answering a quantitative risk perception question. Also coming down on the side of Slovic's argument against quantitative measures of risk is Weinstein (1999) asserting that asking people how

likely it is that they will live to a certain age or the number of smokers out of 100 that develop lung cancer does not provide meaningful or reliable measure of risk understanding.

Method of measuring risk also plays a role in determining how risk perceptions are deemed to impact smoking behavior. While quantitative risk questions run the risk of being jeopardized by the established inability of the general population to cope with numbers, qualitative risk questions present difficulties in ascertaining valid measures of risk perceptions. Kahneman et al.'s (2006) focusing illusion captures well the issues facing risk perception elicitation in any format. The authors found that when people are asked to assess the impact of a single item on their well-being, they tend to overestimate or exaggerate the importance of that one factor.

Gaba and Viscusi (1998)'s study of quantitative and qualitative measures of risk perceptions in an occupation hazard setting found that assessment of qualitative risk differed depending upon education group and worker-type (white-collar, blue-collar). The authors suggest the importance of using both quantitative and qualitative measures of risk in order to get a fuller picture of risk perceptions.

It is not simply the measurement of risk perceptions that creates difficulty when examining adolescents' behaviors in the face of health risks. Systematic and observable biases have also been found when assessing adolescents' responses to questions about their peers' risk-taking behaviors. For example, studies on adolescent tobacco and alcohol consumption have found that those individuals who partake in either of these behaviors are more likely to overestimate the extent to which their peers also smoke or drink relative to their peers who do not. This tendency for individuals to project their own behavioral decisions onto

others (Norton et al. 2003) forms a type of cognitive bias as discussed in Chapter 2. This clearly creates difficulty for empirical research as any variable expressing peer smoking or drinking habits is endogenously constructed via the respondent's behaviors. If this question is asked of close friends, as is done in the YSS, then the effect of projecting one's behaviors on others is less than if the group is defined as the population in general. Additionally, respondents would actually have more factual knowledge of their close friends' behaviors than those of their overall peer group suggesting that their statements might align more with reality.

Particular to the debate about risk assessment accuracy, some results speak to significant methodological difficulty. Costa-Font and Rovira (2005) looked at a survey of the Spanish population and found that a proportion overestimated the mortality risks associated with smoking but once providing respondents with mortality estimates, a large part of the sample underestimated risks. The way probabilities are structured also determines whether findings support the overestimation hypotheses. For example, Kristiansen et al. (1983) asked respondents about characteristics of two people: a person who died of lung cancer and a smoker. Respondents overestimated the probability of lung cancer given that a person is a smoker or a nonsmoker but underestimated the probability of smoking given lung cancer. These results support earlier evidence that individuals tend to attach greater weight to causal data (probability of effect given cause) than diagnostic data (likelihood of cause, given effect) although they convey the same information (Tversky and Kahneman 1980). Jamieson and Romer (2001) found that a survey of 14-22 years olds exhibited overestimation of lung cancer risk in isolation but underestimation when asked different questions about years of life lost due to smoking and the amount of deaths due to smoking

relative to other causes of death such as gunshots, car accidents and alcohol. This finding highlights the importance of elicitation mode and context in researching risk perceptions.

Adolescents' misunderstandings about smoking risks are not simply related to the mortality they attach to the behavior but also the side effects of smoking. For example, young people overwhelmingly agree that smoking is addictive. However, they also believe smokers can quit anytime they want (Arnett 2000; Romer and Jamison 2001) thus exhibiting some form of cognitive dissonance. The same individuals that frequently overestimate by two to three times the number of people killed annually by smoking also think that smoking kills fewer people than alcohol, guns, AIDS, drugs or motor-vehicle accidents, despite the fact that smoking kills five times more people each year than all of these causes of death combined (Romer and Jamison 2001). The information adolescents receive about tobacco use and the ways in which they interpret this information appears to be incomplete, imprecise and inconsistent supporting assertions made in Chapter 2 to include the influence cognitive biases and affect heuristics in this thesis' conceptual framework.

4.2.3.3. Canadian YSS – quantitative and qualitative measures of risk

The Canadian YSS uses two measures to capture the risk perceptions of survey respondents. First, the quantitative question was posed as 'which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' The survey gave respondents a list of eight possible responses, '1,000,' '5,000,' '15,000,' '25,000,' '45,000,' '75,000,' '100,000' and 'more than 100,000.' Therefore, there were four choices below the accurate figure (45,000) and three above, including a more open-ended response of 'more than 100,000.'

This measure of risk perceptions is similar to that used by Viscusi (1990) but Viscusi asked about lung cancer mortality and not overall mortality and he allowed respondents to make up their own number of individuals who die of lung cancer out of 100. Viscusi asked respondents, 'Among 100 cigarette smokers, how many of them do you think will get lung cancer because they smoke?' Unlike Viscusi giving respondents a base population reference, the Canadian Youth Smoking Survey operates under the assumption that students know roughly how many people who live in Canada smoke and then could surmise how many die a year as result of smoking.

A preferable question would have given the respondents an anchor figure for how many people smoke in Canada or the size of Canada's population and then allowed them to choose a response. However, the lack of an anchor avoided any form of anchoring bias around a provided figure. Since the respondents had multiple choice answers and did not have to come up with a response value themselves, the potential for anchoring bias would have been diminished. For example, Lichtenstein et al. (1978) gave subjects the number of deaths per year from one cause of death to provide an order-of-magnitude in reference to the other causes of death asked about as they found that individuals do not necessarily have a good idea about how many people live or die in a country in an average year. However, given that these respondents are in school and students learn this kind of geographical information in school at that age, we expect that these respondents will have less of a problem with that concept than the general population. None of these solutions, however, alleviate the issues individuals have when faced with number-based questions that are inherent in any quantitative means of eliciting risk perceptions (Grimes and Snively 1999; Woloshin et al. 1999).

An additional point to note with this question is its introduction of optimism bias. Optimism bias occurs when an individual views his own chances of suffering the negative outcome of a risk lower than those of the general population suffering the same negative outcome attached to the same risk. Because the question is phrased in terms of risks to society rather than the respondent himself, responses are subject to this well-established bias (Arnett 2000; Cohn et al. 1995; Hansen and Malotte 1985; Leventhal et al. 1987; Slovic 1998). Another way of phrasing this issue is to say that this measure of risk perception asks for facts about smoking rather than how respondents would perceive risks for themselves (Sloan et al. 2003). Despite evidence of optimism bias with regards to smoking, evidence also exists to support the claim of little (Benthin et al. 1993) or no optimism bias in this risk-taking setting (Lundborg and Lindgren 2004; Quadrel et al. 1993). Viscusi (2000) dismisses the concept of optimism bias when asking individuals about risks of smoking because of work demonstrating the link between perceived risks and smoking behaviors thus implying that individuals act on the basis of their risk perceptions with undertaking behavioral choices. This thesis does not empirically examine the topic of optimism bias because of a lack of data to do so, the interpretation of the usefulness of this measure of risk is, of course, subject to an understanding of the fact that question phrasing can be introducing this bias. However, because of the thesis' findings in Chapter 5 regarding the relationship between risk perceptions and behavioral choices, the view this work takes on optimism bias would fall in line with that of Viscusi (2000).

Another criticism of this measure of risk perceptions is its alleged inability to appropriately capture the time dimensions of risk perceptions (Slovic 2000*a*). Viscusi (1992*b*) as well as others such as Lundborg and Lindgren (2004) argue that if a risk question asks about the lifetime risks of smoking (mortality-related to smoking) then the measure captures whether

adolescents think about smoking risks as being long term. Slovic (2000*a*) points to findings about individuals not fully grasping the cumulative nature of smoking risks as individuals' preferences about smoking change over time by their making efforts to quit and regretting the decision to start smoking. This thesis views this measure of risk perceptions as adequately capturing the nature of smoking risks since the nature of smoking risks are cumulative and not stemming from an individual smoking one cigarette.

The question does lend itself to comparing responses to quantitative evidence regarding the likelihood of dying from smoking-related illness. Just as in Viscusi's (1990) question about how many smokers will get lung cancer, this quantitative measure of risk perceptions actually has a 'correct' answer around which responses can be classified as overestimating or underestimating risks.

The second measure of risk perceptions comes from a series of six questions asking respondents to agree, disagree or state that they don't know regarding the number of deaths in Canada due to smoking versus various other causes. The questions are phrased as follows: 'Cigarette smoking causes more deaths each year than....alcohol, illegal drugs, car accidents, AIDS, suicides, murders.' This risk perceptions measure takes a relative risk approach. For all causes of death listed in the survey, cigarette smoking causes more deaths and therefore 'agree' is always the correct answer. As discussed above, the inclusion of alcohol or AIDS could be acting as a reference point for respondents thus introducing a systematic bias of focus on the compared mortality cause rather than smoking. Each of these questions measuring relative risk perceptions was included separately in their own model as the distinct variable measuring risks.

The significant body of literature on the use of reference points (Kahneman and Tversky 1979; Tversky and Kahneman 1992) to frame how individuals perceive an event applies here. The entrance of reference points can add to the likelihood of cognitive biases and affect as discussed in Chapter 2 into the risk assessment process. As the qualitative risk measures used in this study compare smoking to a variety of other preventable causes of mortality such as AIDS and suicide, individuals could be responding to these questions more based upon how they perceive the risk attached to the event compared to smoking rather than the relative risk of the two causes of mortality. This could especially be true given the survey design where respondents are asked six relative risk perceptions in a row with only the risk compared to smoking changed in each question. The respondent would then focus more on the risk compared to smoking rather than the relative risk between smoking and the other cause of mortality compared.

Another way of assessing how individuals understand the risks of smoking relative to other activities is by asking the same question such as 'on average, of the 1,000 20 year olds in Britain who smoke cigarettes regularly, and who carry on smoking, how many do you think will be murdered? How many do you think will be killed on the roads? And how many do you think will be killed by smoking by the age of 70?' (Sutton 1998). This kind of relative risk question differs from the one used in the YSS in two key ways. One, it uses quantitative responses such that each response can be compared with others. Second, the questions are constructed so that comparison does not occur in the respondent's mind when answering the question. Instead, analysis of responses allows for understanding respondents' relative risk perceptions after questions have been answered thus reducing the influence of reference points. However, these questions introduce other methodological issues in that respondents have to generate a number between 0 and 1,000 to respond.

Respondents may then elect to just pick a number in the middle or at either end of the response scale in the case of being unsure.

If one were using this question to gauge how accurate individuals' risk perceptions are about smoking in isolation, this type of question would not be helpful as Sutton (1998) found that even if a range of within 100 of the 'correct' answer was defined as being 'correct,' 84.5% of respondents gave an incorrect answer to the question about smoking posed in the paragraph above. This finding highlights why giving respondents' choices for quantitative responses appears a better strategy in order to reduce the chances of order of magnitude problems and other numerate literacy issues the general population faces.

The predictive power of both of these measures of risk perceptions in relation to smoking will be assessed in Chapter 5. In addition, the same analysis will be run for the following qualitative risk perception measure included in the NSDUH, however, the survey only includes one risk perception elicitation method.

4.2.3.4. US NSDUH – qualitative measure of risk

The US NSDUH asks respondents about the risks they perceive from smoking using a qualitative approach. The Likert scale question is phrased 'How much do people risk harming themselves physically and in other ways when they smoke one or more packs of cigarettes per day?' with potential responses of 'No risk,' 'Slight risk,' 'Moderate risk,' 'Great risk,' 'Don't Know,' 'Refused,' and 'Blank (No answer).'

This question is such a popular one because its format and the question phrasing prove accessible for many age groups and educational backgrounds. No prior knowledge or

specific facts about risk perceptions prove necessary to answer this question as it simply relies on the individual risk respondents attach to smoking. With no other risks being used in this question as points of comparison or numbers or probabilities being used, the simplicity of this question proves one of its greatest strengths.

While this kind of question is one of the more popular ways of phrasing a question to elicit risk perceptions (Ma et al. 2006), it creates great difficulty as every individual's unique definition of what constitutes a 'great' or 'moderate' risk influences their response. Each individual has his own threshold for risk and responses according to his individual conception of risk (Gaba and Viscusi 1998), deeming responses to such questions incomparable across individuals (Viscusi 2000). Additional, this kind of risk question does not permit comparison against a 'real' notion of the risks of smoking stemming from the scientific literature. Viscusi (2000) notes that it also fails to fully capture the severity of the negative health-related consequences of smoking. There is also no 'correct' answer against which responses can be classified.

Empirically, a method of eliciting risk perceptions such as this one requires assigning a quantitative value to each response (ex. no risk=1 and great risk=4) as was done by Slovic (2000*a*) when he asked respondents to respond whether they strongly agreed, agreed, disagreed or strongly disagreed to whether 'every single cigarette smokes causes a little bit of harm.' Viscusi (2000) critiques assigning a numeric value to each of these responses, as was done with the NSDUH measure of risk because it implies that the difference between 'no' and 'slight' degree of risk attached to smoking and 'slight' and 'moderate' are quantitatively the same. Because of the differences in what the definition of different levels of risk are to each individual, attaching a quantitative level of risk to each response

becomes difficult. However, in order to use this risk measure in this thesis' analysis an assumption had to make about the quantitative value of each response and about the relative difference in responses. In preparing the NSDUH risk perceptions variable for analysis, this analysis followed Slovic's (2000*a*) previous practice of putting in place a numerical scale on the qualitative data from one to four. However, in running robustness checks of models presented, analysis also included a different calculation of the Likert scale on a scale from zero to one.[11]

4.3. Empirical methods

This section will describe the empirical strategy used for analyzing the YSS and NSDUH survey data and the motivations for making these choices. First, however, a note about comparability of models and results across countries. Both of these surveys ask questions about adolescents' risk perceptions and include demographic characteristics, however, direct cross-country comparison is not be possible because each survey poses different, and consequently incomparable questions. On the other hand, findings will be compared on a more general level such as the relationships between demographic variables (age, gender), peer smoking (even if expressed slightly differently through survey questions) and smoking behavior and risk perceptions to inform whether adolescents in both countries have similar experiences.

4.3.1. Model choices

This thesis uses discrete choice models to represent preferences in order to estimate the utility or value individuals place on various choices and what factors they utilize to determine these choices and perceptions. The choice of specific model is contingent upon the dependent variable and whether all independent variables are treated as exogenous. The

[11] See Appendices 6G and 7F.

following two tables display the type of model used for each dataset depending on two items: the dependent variable and whether all independent variables were treated as exogenous.

Table 4. Model choices for analysis using the YSS

	Dependent variable	
	Smoking behavior	*Risk perceptions - quantitative*
All variables considered exogenous	Probit	Ordinary least squares (OLS)
Smoking or risk treated as endogenous (two-stage model))	Cdsimeq*	Two-stage OLS with instrumentation (IVREG*)

* STATA command

Table 5. Model choices for analysis using the NSDUH

	Dependent variable	
	Smoking behavior	*Risk perceptions - qualitative*
All variables considered exogenous	Probit	Ordered logit
Smoking or risk treated as endogenous (two-stage model)	Cdsimeq*	Two-stage OLS with instrumentation (IVREG*)

* STATA command

For analysis of the YSS, specification choices of the models treating all variables as exogenous were driven by the format of the survey question providing a binary response in the case of smoking behavior and a numbered response in the case of risk perceptions. The risk perceptions responses were converted into a logarithmic format because of the non-linear nature of responses. The CDSIMEQ program (Keshk 2003) was chosen because it is a two-staged probit model allowing for a binary dependent variable (smoking behavior) and a continuous endogenous variable (risk perceptions). An IVPROBIT model does not allow for a continuous endogenous variable instead assuming that both the dependent and endogenous variables are binary in form. The two-stage model treating smoking behavior as endogenous and risk perceptions as the dependent variable used IVREG, the two-stage ordinary-least squares (OLS) model provided in STATA 9. This model allows for continuous dependent and endogenous variables.

Like with the YSS models, all specifications using the NSDUH were elected based upon dependent variable format. Discrete choice techniques were used for the sets of models treating all variables as exogenous and the same reasoning as above for the YSS stands for electing to use the CDSIMEQ program when treating risk perceptions as endogenous. The ordered logit format of the risk perceptions variable used in the NSDUH created a challenge for employing a two-stage model. STATA 9, as well as the larger publicly available STATA programming network did not provide a two-stage ordered logit model. For this reason, this thesis elected to treat the risk perceptions variable as continuous when running models to treat for endogeneity with the instrumented OLS specification. While this certainly augments issues surrounding whether the value attached to each response of a Likert scale adequately captures differences in respondent opinion (Viscusi 2000), methodological limitations prohibited this analysis from having another choice. These models were tested using multiple specifications. In all cases where robustness checks were run, the original instrumented OLS model came up with the same findings thus highlighting the acceptability of the decision to move on without a two-stage ordered logit program.[12]

While the general model used to test which information sources play determinative roles in influencing adolescents' risk perceptions remains the same throughout the thesis, I run three separate groups of models when answering specific research questions about each group of information sources; adolescents' agents (parents, medical professionals), peers/society and public health measures. Part of the reason for running three groups of

[12] See Appendix 6G affiliated with Chapter 6 and Appendix 7F affiliated with Chapter 7 to examine robustness checks, which included (1) an OLS regression model with the dependent variable (risk perceptions) converted into a continuous variable from 0 to 1 from the Likert scale, (2) an instrumented probit model classifying risk perceptions as either 1 if great or moderate or 0 if no or slight risk attached to smoking one pack of cigarettes per day and (3) an OLS regression model with a predicted value for the smoking behaviour variable that was also treated as endogenous.

models is for ease of explanation and discussing findings as each group of models still includes controls for other potential information sources but allows for distinct robustness checks and additional analysis unique to the set of research questions asked regarding the three classifications of information sources. These three separate groups of models allowed for testing specific constraints around individual research questions to do two things. First it allows for very particular testing of and expanding upon the robustness of findings and second, it allows for sub-group analysis on particular points of interest.

On the first point regarding testing and expanding upon the robustness of findings, in some cases, specific additional variables allowed for honing more precisely into the significance of the explanatory variables on which the research questions focus. For example, when testing the roles of parents in American adolescents' risk perceptions, I include eight variables controlling for the nature of relationship respondents have with their parents. The inclusion of these variables in order to control more specifically for parents' feelings about smoking did not add much to the model in terms of picking up more variation (increasing the R2) and therefore did not need to be included in further models testing other research questions such as peer effects. However, they do provide more confidence that the specific relationship between parents as information sources about smoking and adolescents' perceptions of risks is being picked up as just that and not broader characteristics of how the respondent interacts with his/her parents.

The second way in which running three groups of the same general model aid in analysis is the ability to do sub-group analysis. For example, when investigating the impact of peers' smoking behaviors on risk perceptions, the analysis hypothesizes that the point at which respondents start to rely on their peers to inform them about the risks of smoking requires

more of their peers to start smoking. Therefore, I would assume that as respondents get older, they would rely on their peers more. However, this same assumption is not the case for parents as their credibility would not change over time in such a pronounced way. Therefore, Chapter 7 includes sub-group analysis of age.

4.3.2. The use of instruments

The entirety of the empirical analysis of this thesis had to be mindful of the potential simultaneity problem existing in risk perceptions research. The directional relationship between risk perceptions and smoking behaviors could have been either recursive such that both informed each other or a third external characteristic could influence both risks and smoking. Therefore, all models were tested for endogeneity by examining whether the error terms on a regression predicting the potentially endogenous variable was significant in the main model. Endogeneity was found to exist in all models (both with behavior and risk perceptions as the dependent variables) using the NSDUH data and using the YSS quantitative risk perceptions question. The endogenous relationships found between smoking and risk perceptions stems from the fact that risk perceptions are not independent of unobserved variables that affect smoking behavior such as time preferences. The qualitative risk perception questions from the YSS were not found to have an endogenous relationship with smoking behaviors. The reason for this is hypothesized to be that the use of a relative risk perception elicitation format confused respondents away from simply responding with reference to how they perceive the risks of smoking and instead the response includes perceptions of risk held by respondents about the comparator risk.

In order to correct for endogeneity, instrumented two stage models were used. The use of two-stage models to specifically handle the simultaneous relationship between smoking and

risk perceptions has been done in the previous literature approaching the subject from an econometric point of view (Antoñanzas et al. 2000; Liu and Hsieh 1995; Lundborg and Lindgren 2004; Lundborg 2007; Viscusi 1990; Viscusi 1991). The empirical chapters goes into detail with regards to which tests were used to verify the robustness of instruments used but in general, this study relied on the Hausman test, F-statistic and the Hansen J statistic. The Hansen J statistic was used to test for over identifying restrictions much like the Sargan test does. However, over identification tests like the Sargan and Hansen J can create a problem in that they assume that all instruments are valid such that those included in the model are valid enough to specify the equation adequately (Murray 2006). Because of the painstaking process taken in this thesis to ensure the validity of each instrument used in this thesis, results for over identification tests presented here would not be likely to be subject to this bias.

Choices of instruments were limited by those questions asked in each dataset and in the case of risk perceptions being the dependent variable, represent a first attempt at finding suitable instruments and addressing the endogenous relationship with smoking behavior. Instruments were also chosen only if they predicted the endogenous regressor and had no significant determinative power in predicting the dependent variable in the main model. This was accomplished by using only one other regressor in the model employed for testing an instrument's significance with the thinking that if the instrument is not significant in a model with only one other regressor then it will not be significant in a larger model where the data's variance can be picked up by other regressors. Table 6 displays the instruments used in this thesis for each type of model.

Table 6. Instruments used for each model type

	Dependent variable	
	*Smoking behavior**	*Risk perceptions***
Canadian YSS	(1) Take part in sports or physical activities *without* a coach or an instructor (2) Think smokers can quit anytime they want	(1) Take part in clubs or groups such as scouts, community or church groups at least weekly (2) Read for fun at least monthly
US NSDUH	(1) Risk respondents attach to using *LSD* once or twice a week (2) Risk respondents attach to using *cocaine* once a month	(1) Received treatment from *a pediatrician or family doctor* about emotional or behavioral problems not caused by alcohol or drugs (2) Have been home-schooled in the past 12 months *Weak* (3) Received treatment from *mental health center* about emotional or behavioral problems not caused by alcohol or drugs

* Predict risk perceptions but not smoking behavior
** Predict smoking behavior but not risk perceptions

While all of the instruments employed in this thesis' models are empirically strong based upon the criteria discussed above, some make more intuitive sense than others. For example, adolescents taking part in activities such as clubs and groups, which may be substitutive activities for smoking would be logical predictors of smoking but not risk perceptions about smoking. On the other hand, receiving treatment from a mental health center for emotional or behavioral problems not related to drugs or alcohol would not be an obvious predictor of smoking behavior but it is related to the instrument used about seeing a pediatrician regarding emotional or behavioral problems not related to alcohol or drugs. Also, some instrument choices came from findings in the previous literature such as the use of a risk belief to instrument risk perceptions with the YSS as was done by Viscusi et al. (2000).

Because each survey was written to cover different topics with the NSDUH focusing on many more youth health issues than smoking such as mental health and drug use, the choice of useable instruments was not similar between the surveys. The empirical chapters include

the logic behind the use of each instrument. However, laying out the instruments used in this table highlights the fact that instruments used to control for endogeneity in the risk perceptions variable when smoking behavior is the dependent variable all capture some qualities about respondents that have to do with risk taking and risk perceptions but not necessarily about smoking behaviors.

4.4. Conclusion

This chapter highlights and discusses the methodological issues permeating throughout the empirical analysis that follows in this thesis. The topics discussed in this chapter inform the interpretation of all empirical analysis that follows since the methods by which surveys elicit responses constantly play a part in empirical findings. In particular, the discussion in this chapter about risk perception question phrasing continues in Chapter 5 with an empirical analysis of three different risk perception elicitation measures.

Chapter 5. Risk perceptions and their relationship with adolescents' smoking behavior

The previous three chapters have set up the theoretical and methodological groundwork for the empirical analysis that follows. This chapter aims to answer the first research question posed in Chapter 1:

①	**Do perceptions of risk inform adolescents' decisions to smoke?**

Therefore, this chapter establishes the role of risk perceptions in determining smoking behaviors placing the research from Chapter 6-8 into a meaningful context.

5.1. Introduction and research questions

Many studies have also found that the perceived risks of smoking play a significant role in the smoking decision (Costa-Font and Rovira 2005; Lundborg 2006; McCoy et al. 1992; Viscusi 1990). Past research has looked less extensively at how risk perceptions impact the behavior of adolescents. The pertinent concern is not simply whether these adolescents understand smoking risks but more importantly, whether this understanding of risks in some way influences behavioral choices.

The examination of survey data to answer questions about the impact of adolescents' risk perceptions on behavior has already been performed, but in general, these sample sizes have been more limited than the surveys to be dissected for this study. Furthermore, current risk research on smoking and adolescents relies exclusively on Swedish populations (Lundborg and Lindgren 2004; Lundborg 2007), while this analysis will examine surveys from both the US and Canada.

The disparity in findings with regards to accuracy of risk estimation often stems from differences in risk perception elicitation methodologies. Within the existing literature on smoking risk perceptions, considerable debate has posed the question as to whether qualitative or quantitative questions more accurately depict the perceptions individuals attach to smoking risks (Ma 2006; Viscusi 1992*b*; Weinstein 1999). This debate has been reviewed in Chapter 4.

By looking at multiple measures of risk perceptions (quantitative - mortality risk and qualitative - relative risk versus other preventable causes of death and Likert-scale responses to risk of smoking), this analysis examines the consistency of these methodologies in predicting similar responses to smoking risks for an individual. I am unaware of any other study regarding adolescents' risk perceptions about smoking and smoking behaviors that uses multiple measures of risk perceptions on the same respondent population.

On the basis of prior research and the discussion posed above and in Chapter 4 about risk perception elicitation methods, this chapter focuses on the following three research questions.

RQ1. Do risk perceptions influence adolescent smoking behavior as it has been found in previous studies (Lundborg 2007; Lundborg and Lindgren 2004; Viscusi 1990, 1992*b*) irrespective of the controls introduced?

RQ2. Do qualitative measures of risk perceptions prove less consistently important factors in determining smoking behaviors than quantitative measures of risk perceptions? (Antoñanzas et al. 2000; Viscusi et al. 1997; Viscusi and Hakes 2003).

RQ3. Do environmental and social effects such as peer smoking and parental smoking diminish the importance of risk perceptions in determining adolescent smoking behavior because of their significance in predicting adolescent behaviors? (de Vries et al. 2003; Gaviria and Raphael 2001; Tyas and Pederson 1998).

5.2. Data and Methods

5.2.1. Data sources

Two surveys covering adolescent risk perceptions and smoking provide ample data to answer these research questions. The different smoking behavior and risk questions available in each survey have been summarized in Table 7 below. Shaded smoking behavior questions were the ones used in this study in a descriptive way or in multivariate regressions.

Table 7. Comparing available smoking behavior and risk perceptions questions for all studies

Canadian Youth Smoking Survey	US National Survey on Drug Use and Health
Smoking behavior	
Ever tried smoking	Ever smoked a cigarette
Smoked a whole cigarette	Time since last smoked part or all of a cigarette
Smoked 100 or more cigarettes in life	Smoked 100 or more cigarettes in life
Smoked every day for 7 days in a row	Number of cigarettes smoked during past 30 days
Number of days in last 30 smoked a cigarette	Number of days in last 30 smoked a cigarette
	Smoked every day for 30 days in a row
Risk perceptions	
Quantitative measure - Number of Canadians that die each year as a result of smoking cigarettes *(1,000, 5,000, 15,000, 25,000, 45,000, 75,000, 100,000 and more than 100,000)*	*Qualitative measure* - Risk smoking one more packs of cigarettes per day (*no risk, slight risk, moderate risk, great risk*)
Qualitative measure - Cigarette smoking causes more deaths each year than…alcohol, illegal drugs, car accidents, AIDS, suicides, murders (*agree, disagree, I don't know*)	

Further discussion of the risk perceptions questions used in the YSS survey can be found in Appendix 5A and from a methodological standpoint in section 4.2.3.2. of Chapter 4. However, it is important to note that in readying the quantitative risk perceptions variable from the YSS for empirical analysis, the response to this risk question was divided by the smoking population of Canada (7 million) (Statistics Canada 2006) to have the accurate percentage of smoking population who die per year. Because of the non-linear nature of responses, this analysis took the log of response answers for inclusion in the multivariate models. The risk perception question included in the NSDUH survey is described in Appendix 5B and from a methodological standpoint in section 4.2.3.3. of Chapter 4.

For summary and comparison purposes, Table 8 shows which control variables have been elected to be used in this study's modeling for each dataset.

Table 8. Comparing available control variables for all datasets

Variable Type	**Canadian Youth Smoking Survey**	**US National Survey on Drug Use and Health**
	Socio-demographics	
Gender	Gender	Gender
Age	Grade	Age
Ethnicity	None*	White Black Native American/AK Native Native HI/Pac Islands Asian More than one race Hispanic
Geographical	Province	None
Size of place where live	None	If MSA is over 1 million If MSA is under 1 million Do not live in MSA
	Economics independence from parents	
Disposable income	Weekly allowance	If receive income from a job
	Socio-economics	
Family income	None	Family income in bands
School type	None	Public Private Charter Home
	Household characteristics	
Parenting arrangement	Living with both parents One parent and partner One parent alone Shared custody	Living with both parents

* Survey asks respondents if they are an 'Aboriginal person, that is a North American Indian, Metis or Inuit (Eskimo)?' but this data is not released to the public

Discussions of the survey questions used to create control and explanatory variables can be found in Appendix 5A for the YSS and Appendix 5B for the NSDUH.

Sample characteristics for the Canadian YSS are found in Appendix 5C while sample characteristics for the US NSDUH are found in Appendix 5D.

5.2.2. Empirical specification

This analysis views the initial decision to smoke as the result of a confluence of factors. As the survey data used here to test adolescents' behaviors and risk perceptions regarding smoking is cross-sectional, the model takes a one dimensional nature depicting one episode of smoking as a decision based on utilities attached to alternate decisions. This model follows that of Liu and Hsieh (1995), Lundborg and Lindgren (2004) and Viscusi (1990), where individuals attach perceived probabilities of the benefits and costs attached to the smoking decision. However, the model has been extended to include contextual effects (provincial characteristics) where possible and information sources about smoking risks.

The empirical model is based on the simple premise that if we if we assume individuals to be maximizing their own utility then they will start smoking only if the utility they expect to gain from smoking (including the possibility that one might die from it) outweighs the expected utility of not smoking. The model also make the assumption that individuals aim to maximize their own utility but may derive their own utility for this decision based upon the decisions of others much in the way described by Manski (2000). The technical details of the smoking decision model this chapter adopts can be found in Appendix 5E.

The empirical structure of this chapter relies heavily on the Bayesian decision-making model to explain how individual decision-makers employ new information to fill gaps in current understanding to update utilities constructed in the past. Section 2.3.1 in Chapter 2 goes through the empirical construction of the Bayesian risk perception model used throughout this thesis.

The smoking model is made up of a series of vectors (β_n) to express all of the different determinants influencing whether an individual has tried smoking or not.

$$S_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu \qquad (5.1)$$

Where X_n represents a vector of all variables associated with each type of potential determinant of smoking for each respondent. $n=1$ represents socio-demographic and socio-economic variables (gender, grade, disposable income, household structure), $n=2$ represents the influence of others/society (parental smoking peer smoking), $n=3$ represents the influence of public health-related information sources (school education programs, health warnings on cigarette packages), $n=4$ represents the aggregate group perception of those around individuals (provincial characteristics) and $n=5$ risk perceptions where individuals will smoke if the expected utility at time=1 is positive (see Appendix 5E). μ is a random error term. The dependent variable used (smoked a whole cigarette) is binary in composition, therefore this model is estimated using a probit model, where no endogeneity is present.

This smoking model is based on the conceptual framework emerging from Chapter 2. The influences of others' behaviors such as parents and peers, society's behaviors and public health-related information sources captured in this model support the Bayesian learning model's depiction of the role of information sources updating an individual's current stock of information. This model does, however, pose a crucial methodological issue stemming from the relationship between smoking and risk perceptions about smoking as this model depicts risk perceptions as also potentially contributing to the Bayesian learning model.

5.2.3. Endogeneity between behavior and risk perceptions

Examining risk perceptions and smoking behaviors presents a significant endogeneity problem. Endogeneity can be either the result of two-way causality or some third unobservable influence impacting the determinative power of an independent variable. Risk perceptions could be a function of experience with smoking, a determinant in smoking behaviors, as hypothesized here or both relationships could simultaneously occur. This would be the causality type of endogeneity. Alternatively, if risk perceptions are influenced by another omitted factor such as taking drugs that also influence the dependent variable through the endogenous independent variable, then there is a problem of unobservable variables.

In order to test for endogenous risk perception variables in equation (1), I specify an OLS model for the quantitative risk perceptions variable (continuous) and a probit model for the qualitative risk perceptions variable (binary) to identify instrumental variables that determine risk perceptions but not smoking behaviors. This model is depicted below in equation (5.2).

$$RISK_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_n X_n .... + \mu \quad (5.2)$$

This model includes all the various vectors that serve as determinants of risk perceptions about smoking (X_n), provides the coefficients (α_n) associated with these vectors of variables and includes a random error term (μ). I included the residual for this OLS regression in my main model predicting smoking behaviors and found that in the case of the quantitative measure of risk perceptions, the residual significantly predicting smoking

behaviors, suggesting that the quantitative measure of risk perceptions is endogenous. This same test of the significance of the residuals from a probit model estimating the qualitative measures of risk perceptions did not find endogeneity in any of the qualitative measures of risk perceptions.

For the YSS, in the case of the quantitative measure of risk perceptions, the residual significantly predicted smoking behaviors, suggesting that the quantitative measure of risk perceptions is endogenous. This same test of the significance of the residuals from a probit model estimating the qualitative measures of risk perceptions did not find endogeneity in any of the qualitative measures of risk perceptions.

For the NSDUH, there appears to be an endogenous relationship between smoking behavior and risk perceptions as the residual from a model predicting risk perceptions was significant in the main model with smoking behavior as the dependent variable.

In order to correct for this endogeneity of the risk perceptions variable I simultaneously estimate the original model (smoking behavior) and a risk perceptions equation. These simultaneous equations represent an attempt to find instruments that predict risk perceptions but not smoking behavior. This analysis uses a two-stage probit model where the response variable for tried smoking is binary and the endogenous variable is continuous (Keshk 2003).

All X_n variables are considered exogenous while q_{1i} represents the endogenous risk perceptions variable. Instruments had to be correlated with risk perceptions variables but

uncorrelated with the error term of the primary model (smoking behavior). As a preliminary tool, correlation analysis helped to elect potential instrumental variables. Analysis also looked at the existing literature to see what previous work in the area had used as instruments, which is discussed below. Instruments were deemed appropriate if they predicted risk perceptions but not smoking behavior. Finally, Hausman tests determined whether the estimates offered by the new model including instrumental variables differed enough from the original OLS estimates to render the OLS estimates inconsistent. We also used Wald tests and J-Hansen statistics to test goodness of fit for the elected instruments.

Previous literature did not offer strong guidance about good instruments because of problems with weak instruments (Lundborg and Lindgren, 2004) or not being able to find suitable instruments within the available dataset (Lundborg and Andersson 2007) except where Viscusi et al. (2000) used whether individuals thought that smoking led to diabetes (risk beliefs) as a single instrument. Therefore, I tested a large array of possible instruments for each dataset. Finding variables that predict risk perceptions but not behavior proved difficult as intuitively, if the hypothesis is that risk perceptions influence behavior then variables that influence risk perceptions might also impact behaviors. For the YSS, I tested variables about respondents' after-school activities, TV watching, reading, perception of weight, social setting, beliefs and opinions about smoking and why others start smoking and experience with alcohol and drugs. For the NSDUH, I tested variables including experience with alcohol and drugs, medical treatment for substance abuse and mental health characteristics. Attitudes towards risks were hypothesized as potential predictors of risk perceptions but not smoking. Questions from the YSS and NSDUH allowed for testing this hypothesis.

In the case of YSS, two suitable instrument were available to correct for the endogeneity of the quantitative measure of risk perceptions. The first, whether respondents play sports or do physical activities without a coach or an instructor (e.g. biking, skateboarding, etc.) denotes a sense of independence and aptitude for risk among respondents. The second depicts respondents' risk beliefs about smoking as in Viscusi et al. (2000) by asking if respondents think that 'smokers can quit anytime they want.' This question corresponds more with how risky respondents perceive addiction to be and thus drives smoking risk perceptions and not whether someone has smoked. This could mean that individuals at the age this study covers do not think about addiction and quitting at the time of initiation and it only comes into the decision through the risk perceptions variable.

For the NSDUH, two instruments used predict risk perceptions but not smoking behavior, suggesting that they would function adequately as instruments. The two instruments used are responses to questions about the risks respondents attach to 'using LSD once or twice a week' and 'using cocaine once a month' with potential responses to both of 'no risk,' 'slight risk,' 'moderate risk,' 'great risk,' 'don't know,' 'refused' and 'no answer.' LSD and cocaine are both drugs which receive significant media attention but to which adolescents are likely to have limited access partly due to cost constraints. Therefore, answers to the questions used here as instruments would not be likely to be based upon previous experience as could be the case with the same question for a drug like marijuana that is more readily available to adolescents. As these questions capture risk perceptions and not experience with these drugs, it make sense that they predict perceptions about the risks of smoking. These questions capture respondents' appetites for risks with regards to

drug behaviors and not whether they have partaken in these drugs and therefore have a predictive relationship with adolescents' perceptions of smoking risks.

5.3. Results for Canadian YSS data

5.3.1. Descriptive findings for Canadian YSS

A descriptive look at the data shows that 24 percent of respondents have tried smoking and 13 percent have smoked a whole cigarette. Table 9 shows the distribution of quantitative specifications of mortality risks resulting from cigarette smoking. The table includes calculations for the full sample and each subcategory of two expressions of smoking behavior (tried smoking/never tried smoking and smoked a whole cigarette/never smoked a whole cigarette). The shaded row denotes the actual true level of mortality per year associated with smoking in Canada. Those individuals who answered the risk perceptions correctly were categorized as estimating perceptions correctly. Those who estimated fewer than the actual number of people who die from smoking per year in Canada were classified as underestimating the risks of smoking. Similarly, those who estimated more than the actual number of people who die from smoking per year in Canada were classified as overestimating the risks of smoking. Those who would be deemed as underestimating risk perceptions would be considered to have low risk perceptions while those overestimating would be considered to have high risk perceptions.

Table 9. Canadian YSS - Distribution of mortality risk perceptions associated with smoking (quantitative measure of risk)

Distribution of mortality risk perception	Response of how many die in Canada per year from smoking	Full sample	Tried smoking	Never tried smoking	Smoked whole cigarette	Never smoked whole cigarette
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Underestimate	1,000, 5,000, 15,000 or 25,000	45.6%	42.2%	46.7%	40.9%	46.3%
Correct estimate	45,000	14.6%	16.1%	14.1%	16.8%	14.2%
Overestimate	75,000, 100,000 or over 100,000	39.8%	41.7%	39.2%	42.4%	39.4%
Sample size		18,515	4,359	14,156	2,398	16,117

Note: Question is 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes? Potential responses are those listed in column (2) above. (1) calculated by response from (2) divided by the number of smokers in Canada, 7 million (Statistics Canada 2006).

By examining column (3) of Table 9, we see that 46 percent of respondents underestimated the mortality risks of smoking while 15 percent correctly estimated risks and 40 percent overestimated the risk. Therefore, a sizable portion of respondents underestimated the mortality associated with smoking. Those who have tried smoking are evenly split along underestimation and overestimation of mortality risks. However, for those who have never tried smoking, 47 percent underestimate risk perceptions while 39 percent overestimate; therefore more people who have tried smoking are likely to overestimate the risks than those who have not.

Except for one notable difference, the same pattern holds largely true for whether respondents have smoked a whole cigarette. The only difference between the 'tried smoking' variable and 'smoked whole cigarette' variable is that those individuals who have smoked a whole cigarette are slightly more likely to overestimate the risks of smoking rather than underestimate. For those who have never tried smoking or never smoked a whole cigarette, the responses are almost identical.

Table 10 displays the distribution of responses to a qualitative measure of risk expressed as deaths related to smoking versus various other causes of avoidable mortality. The 'correct' response to each question is 'agree.' Those responding 'disagree and 'don't know' were classified together to denote incorrect risk perceptions. Respondents electing not to give an answer have been excluded from this table. These risk questions do not allow for classification of risk perceptions as high versus low. Risk perceptions about smoking can only be classified as either high or low relative to what risk smoking is being compared to *OR* either correct or incorrect based upon whether the respondent answered the relative risk question correctly. When the terms overestimating or underestimating are used, they are used with reference to whether smoking is overestimated or underestimated relative to the risk with which it is being compared.

Table 10. Canadian YSS - Distribution of relative risk perceptions associated with smoking (qualitative measures of risk)

Relative risk perception	*Full sample*	*Tried smoking*	*Never tried smoking*	*Smoked whole cigarette*	*Never smoked whole cigarette*	*Sample size*
Alcohol						
Agree	59.1%	59.0%	59.1%	58.1%	59.2%	18,692
Disagree/DK	40.9%	41.0%	40.9%	41.9%	40.8%	
Illegal drugs						
Agree	40.4%	46.0%	38.7%	47.7%	39.3%	18,677
Disagree/DK	59.6%	54.0%	61.3%	52.3%	60.6%	
Car accidents						
Agree	47.7%	48.5%	47.4%	49.4%	47.4%	18,616
Disagree/DK	52.3%	51.5%	52.6%	50.6%	52.6%	
AIDS						
Agree	38.8%	43.8%	37.3%	44.1%	38.1%	18,616
Disagree/DK	61.2%	56.2%	62.7%	55.9%	61.9%	
Suicides						
Agree	52.8%	55.7%	51.9%	44.5%	47.6%	18,609
Disagree/DK	47.2%	44.3%	48.1%	55.5%	52.4%	
Murders						
Agree	44.2%	46.9%	43.4%	48.0%	43.7%	18,664
Disagree/DK	55.8%	53.1%	56.6%	52.0%	56.3%	

Note: Question is 'Cigarette smoking causes more deaths each year than....alcohol, illegal drugs, car accidents, AIDS, suicides, murders'

Over half of respondents were incorrect about the death risk related to smoking in relation to AIDS (61.2%), illegal drugs (59.6%), murders (55.8%) and more weakly, car accidents (52.3%). The majority of respondents were correct about the risks of smoking versus alcohol (59.1%) and suicides (52.8%). These findings remain directionally constant regardless of smoking behavior (trying versus smoking a whole cigarette). Respondents overestimating the death risks of illegal drugs, AIDS and murders relative to smoking is curious because these causes of death are ones about which respondents of the age group would be personally less familiar than alcohol and car accidents but get information about from the media. Therefore, a stigma is attached to these causes of deaths because of media coverage, whereas alcohol use is more common place and suicides are less talked about it. It is important to note that age effects can capture differences in the extent of information in hand of individuals (Viscusi 1991).

Whether a respondent has tried smoking or not does not appear to make much difference in how they view the mortality risks related to smoking versus alcohol and car accidents. On the other hand, respondents who had tried smoking were more likely (46.0%) than those who had never tried (38.7%) to think that smoking is more risky that illegal drugs. The same is true for the question about the relative risks of AIDS versus smoking, suicides versus smoking and murders versus smoking such that when someone had tried smoking, they more likely than those who had not tried smoking to perceive smoking as more risky than the other behavior. The same findings were largely true for all qualitative measures of risk when examining how smoking a whole cigarette made a difference in risk perception responses.

5.3.2. Multivariate analysis with Canadian YSS

Analysis of the YSS considers two separate kinds of models for each risk perceptions elicitation methodology. For all findings variance inflation factors (VIF) were always below 10 suggesting no evidence of multicollinearity in the models presented. The results for the quantitative risk perception measure appear in Tables 11 and 12. Table 11 displays a simple model only including control variables both in a non-instrumented form (column (1)) and then instrumented to correct for endogeneity found in the quantitative risk variable as discussed above (column (2)).

Table 11. Canadian YSS - Determinants of whether survey respondents have smoked a whole cigarette (includes quantitative measure of risk perceptions)

	(1) Simple model		(2) Simple model (I.V.)	
	Coef.	z	Coef.	z
Risk perceptions				
Log (quantitative risk perceptions)*	-3.9E-03	-0.40	-0.57 [a]	-2.83
Socio-demographics				
Gender	-0.04	-1.65	0.06	1.31
Grade 5	-1.42 [a]	-24.43	-1.70 [a]	-14.58
Grade 6	-1.13 [a]	-24.93	-1.28 [a]	-17.39
Grade 7	-0.67 [a]	-18.30	-0.75 [a]	-15.44
Grade 8	-0.28 [a]	-8.60	-0.31 [a]	-8.00
Quebec	0.58 [a]	18.63	0.53 [a]	13.86
Economic independence from parents				
Weekly allowance	0.28 [a]	10.61	0.35 [a]	9.20
Household characteristics				
Lives one parent and partner	0.51 [a]	12.74	0.57 [a]	11.31
Lives one parent	0.46 [a]	12.82	0.51 [a]	11.79
Lives shared custody	0.44 [a]	6.41	0.48 [a]	6.19
Wald χ^2 / LR χ^2	1841.65		2321.21	
Pseudo R^2	0.164		0.164	
Log pseudolikelihood / Log likelihood	-5969.6		-5912.7	
Number of observations	18,515		18,345	

Notes: All models include robust standard errors
(*) Instrumented using questions about whether respondents 'played sports or done physical activities without a coach or an instructor (e.g. biking, skateboarding, etc.)' at least once a week and if 'smokers can quit anytime they want.'
[a] Significant at 1%

As expected, risk perceptions play a significantly determinative role in whether respondents have smoked a whole cigarette once the risk perceptions variable is instrumented (**RQ1**).

The more risky a respondent perceived smoking to be, the less likely he/she was to have smoked a whole cigarette.

The other explanatory variables also offered interesting findings. Gender was insignificant in both models showing no determinative power related to smoking. Age and receiving a weekly allowance were both positively related to smoking behavior. The negative sign on each of the grade variables denotes that individuals in those grades are less likely to smoke than those who are older (in grade 9). Respondents being residents of Quebec versus any other province in Canada also exerted a positive effect on smoking. Living arrangement also proved important in predicting smoking behavior. Living in a household without one's two parents was found to be a positive determinant of respondents having smoked a whole cigarette.

To test **RQ3** (if adding other known determinants of smoking alters the significance of risk perceptions), Table 12 expands this simple model to include parents' and friends' smoking behaviors.[13]

[13] Results for control variables were consistent across the models displayed in Table 11 and for brevity purposes are not displayed.

Table 12. Canadian YSS - Determinants of whether survey respondents have smoked a whole cigarette (includes quantitative measure of risk perceptions) – expanded models

	(1) Expanded model including parents' smoking behaviors and interaction terms		(2) Expanded model including parents' smoking behaviors and interaction terms (I.V.)		(3) Expanded model including friends' smoking behaviors		(4) Expanded model including friends' smoking behaviors (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Risk perceptions								
Log (quantitative risk perceptions)*	-0.01	-1.39	-0.46 [b]	-2.31	-0.01	-0.53	-0.23	-1.19
Socio-demographics								
	Included		Included		Included		Included	
Economic independence from parents								
	Included		Included		Included		Included	
Household characteristics								
	Included		Included		Included		Included	
Societal influences								
Only father smokes	0.19 [a]	4.67	0.24 [a]	5.05	0.17 [a]	3.74	0.20 [a]	3.93
Father smokes DK	0.01	0.04	-0.03	-0.12	-0.26	-0.98	-0.24	-0.98
Only mother smokes	0.26 [a]	5.50	0.32 [a]	5.67	0.28 [a]	5.36	0.31 [a]	5.32
Mother smokes DK	0.21	1.00	0.34	1.53	0.21	0.72	0.29	1.15
Both parents smoke	0.24 [a]	5.19	0.29 [a]	5.44	0.25 [a]	4.62	0.27 [a]	4.84
Number of people who smoke in home	0.25 [a]	18.24	0.25 [a]	17.21	0.15 [a]	9.55	0.16 [a]	9.36
Percent of friends that smoke	-	-	-	-	1.99 [a]	36.21	1.96 [a]	34.37
Interaction terms								
Weekly allowance and father smokes DK	0.56 [b]	2.16	0.65 [b]	2.35	0.76 [b]	2.29	0.78 [b]	2.44
Weekly allowance * Mother smokes DK	-0.24	-0.72	-0.50	-1.46	-0.79	-1.82	-0.96	-2.25
Wald χ^2 / LR χ^2	2355.10		3134.97		3000.90		4338.66	
Pseudo R^2	0.222		0.222		0.338		0.338	
Log pseudolikelihood / Log likelihood	-5534.0		-5498.7		-4272.9		-4252.2	
Number of observations	18,461		18,335		16,353		16,255	

Notes: All models include robust standard errors
(*) Instrumented using questions about whether respondents 'played sports or done physical activities without a coach or an instructor (e.g. biking, skateboarding, etc.)' at least once a week and if 'smokers can quit anytime they want.'
[a] Significant at 1% [b] Significant at 5%

Just as in the non-instrumented simple model in Table 11, the expanded models treating risk perceptions as exogenous showed no significant determinant power of risk perceptions. When treated as endogenous, the significance of the risk perceptions variable remains consistent upon the inclusion of parents' smoking behavior as shown in column (2) but

when a variable expressing the percentage of the respondent's friends who smoke was included, risk perceptions lost its significance as shown in column (4) (**RQ3**). Including the variable expressing the percentage of friends who smoke substantially altered the goodness of fit of the smoking behavior model. The Pseudo R^2 climbed to 34% from 22% with the addition of this single variable. This finding suggests that the risk perceptions variable was picking up many of the aspects captured by the peer effects variable but once the peer effects was included, these elements were picked up by this new variable.

Fathers' smoking, while mothers do not and mothers' smoking, while fathers do not meant that respondents were more likely to have smoked a whole cigarette than those whose parents did not smoke. This finding also held true when testing whether both parents smoking versus neither parent smoking had a significant effect.

I tested a number of interactive effects between various explanatory variables. Only the ones of significance were included in the model presented here.[14] An interaction term expressing whether respondents had a weekly allowance and whether they knew if their father smoked proved a significant predictor of adolescents smoking a whole cigarette. This same interaction term including the mother rather than the father was not as consistently significant. An adolescent not knowing whether their father smokes or not could serve as a proxy for how much he sees his father. Whether or not a child knows if his mother smokes does not interact with weekly allowance to predict smoking behaviors. These results suggest that the importance of a weekly allowance on smoking behavior

[14] I examined the importance of weekly allowance and household structure (two parents, single parents, etc.) and found that variations in household structure do not interact with receiving disposable income to significantly determine adolescents' smoking habits. Looking at the interaction between parental smoking habits and whether respondents receive a weekly allowance, the importance of receiving disposable income did not vary across parental smoking behaviors.

could depend upon how often fathers interact with their children. However, mothers probably see their children more often than fathers, therefore, whether they know if their mother smokes or not is not as important because there are many other types of mother-child interactions.

Appendix 5F displays results of a model using whether respondents had smoked 100 cigarettes as the dependent variable. Again, when treated as exogenous, risk perceptions do not predict smoking behaviors. However, unlike in Table 12, once this risk perceptions variable is treated as endogenous, risk perceptions appear to have a significant and negative relationship with smoking behavior even when peer behaviors are included (**RQ3**). This finding suggests that when smoking behavior is captured using a measure that more precisely describes the extent of smoking behavior, risk perceptions provide an even better predictor of behavior.

In order to test **RQ2** about the whether the methods for measuring risk perceptions in the YSS are actually depicting the same respondent characteristics, I run the same expanded model from column (1) (including parental smoking behaviors and interaction terms) in Table 12 for each of the specific qualitative risk perception questions (alcohol, illegal drugs, etc.). Results appear in Table 13 below. Findings with regards to the control variables and explanatory variables were the same as those from previous models expressing risk perceptions in a quantitative form in Table 12. The expanded version of these models with results for all control and explanatory variables can be found in Appendix 5G.

Table 13. Canadian YSS - Determinants of whether survey respondents have smoked a whole cigarette (includes qualitative measures of risk perceptions)

	(1) Expanded model including parents' smoking behaviors and interaction terms		(2) Expanded model including parents' smoking behaviors and interaction terms		(3) Expanded model including parents' smoking behaviors and interaction terms		(4) Expanded model including parents' smoking behaviors and interaction terms		(5) Expanded model including parents' smoking behaviors and interaction terms		(6) Expanded model including parents' smoking behaviors and interaction terms	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Risk perceptions												
Risk smoking....relative to alcohol	-0.08 [a]	-2.96	-	-	-	-	-	-	-	-	-	-
...relative to illegal drugs	-	-	0.03	1.00								
...relative to car accidents	-	-	-	-	1.1E-03	0.04	-	-	-	-	-	-
...relative to AIDS	-	-	-	-	-	-	0.04	1.44	-	-	-	-
...relative to suicides	-	-	-	-	-	-	-	-	-0.04	-1.52	-	-
...relative to murders	-	-									-0.02	-0.70
Socio-demographics												
	Included		Included		Included		Included		Included		Included	
Economic independence from parents												
	Included		Included		Included		Included		Included		Included	
Household characteristics												
	Included		Included		Included		Included		Included		Included	
Societal influences												

	Included	Included	Included	Included	Included	Included
			Interaction terms			
	Included	Included	Included	Included	Included	Included
Wald χ^2	2384.65	2374.22	2365.41	2368.69	2373.11	2377.17
Pseudo R^2	0.22	0.221	0.221	0.222	0.222	0.221
Log pseudolikelihood	-5591.3	-5593.3	-5582.6	-5575.6	-5575.2	-5590.0
Number of observations	18,637	18,622	18,561	18,561	18,554	18,609

Notes: All models include robust standard errors
[a] Significant at 1% [b] Significant at 5%

Results from models including qualitative measures of risk perceptions portray risk perceptions as playing a relatively smaller role in smoking behavior except in the case of comparing the risks of smoking to alcohol (**RQ1** and **RQ2**). Those respondents who agreed that smoking caused more deaths than alcohol were less likely to have smoked a whole cigarette. Otherwise, risk perceptions were insignificant in determining smoking status when smoking risks were assessed against illegal drugs, AIDS, car accidents, suicides and murders.

Table 14 shows how the marginal effects of risk perceptions as measured using both the quantitative and qualitative methods (**RQ2**) changes with differing incarnations of the main smoking behavior model where various explanatory variables are included or excluded. The table shows five models that allow us to test all three research questions. The first is a simple one to test **RQ1**. The second includes parents smoking behaviors and interaction terms. The third adds whether respondents have been taught in school about the health problems related to smoking. The fourth includes a variable expressing whether respondents have seen health warnings on cigarette packages and the fifth model includes friends' smoking behaviors. The models are cumulative in their addition of variables such that the model in column (5) adds peer effects but also includes all the variables of the previous model in column (4) (to test **RQ3**).

Table 14. Canadian YSS - Marginal probability effects of varying measures of risk perceptions (Effect of explanatory variables on the change in probability whether a respondent has smoked a whole cigarette or not)

	(1) Simple model		(2) Expanded model including parents' smoking behaviors and interaction terms		(3) Expanded model including if taught in school about health problems due to smoking		(4) Expanded model including if seen health warning messages on cigarette packages		(5) Expanded model including friends' smoking behaviors	
Quantitative Risk Measure	Coef.	z	Coef.	z	Coef.	z	Coef.	Z	Coef.	z
Risk perception										
Log (quantitative risk perceptions)*	-0.09 [a]	-2.83	-0.06 [b]	-2.31	-0.06 [b]	-2.21	-0.07 [b]	-2.31	-0.03	-1.28
Qualitative Risk Measures	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Risk perception										
Risk smoking relative to alcohol	-0.01 [b]	-2.35	-0.01 [a]	-2.93	-0.01 [a]	-3.05	-0.01 [a]	-3.41	-0.01 [a]	-2.71
Risk smoking relative to illegal drugs	0.01	1.34	3.9E-03	1.00	3.3E-03	0.85	2.1E-03	0.54	7.9E-04	0.20
Risk smoking relative to car accidents	2.7E-03	0.64	1.6E-04	0.04	2.1E-05	0.01	-1.3E-03	-0.34	-0.01	0.03
Risk smoking relative to AIDS	4.8E-03	1.13	0.01	1.43	0.01	1.29	3.4E-03	0.89	2.1E-03	0.53
Risk smoking relative to suicides	-0.01 [b]	-2.04	-0.01	-1.52	-0.01	-1.54	-0.01 [b]	-1.99	-0.01	-1.43
Risk smoking relative to murders	-1.2E-03	-0.28	-2.7E-03	-0.70	-2.9E-03	-0.76	-4.5E-03	-1.18	-3.5E-03	-0.89

Notes: All models include robust standard errors

Each model includes the explanatory variables of the one in the prior column plus the new variables added. For example, column (3) demonstrates results for a model with all the specifications of the model in column (2) plus the variable 'not seen health warnings on cigarette packages.'

(*) Instrumented using questions about whether respondents 'played sports or done physical activities without a coach or an instructor (e.g. biking, skateboarding, etc.)' at least once a week and if 'smokers can quit anytime they want.'

[a] Significant at 1% [b] Significant at 5%

Similarly to the model results in Table 11-13, the quantitative measure of risk perceptions and the qualitative measures of risk comparing smoking to alcohol have significant determinative power in relation to whether respondents have smoked a whole cigarette (**RQ1** and **RQ2**). In some models, the qualitative measure of risk comparing smoking to suicides also becomes significant. For these three variables, higher risk perceptions of smoking relative to suicides result in respondents being less likely to have smoked a whole cigarette (**RQ1**). For all measures of risk except the qualitative measure including alcohol, once friends' smoking behaviors are included, the risk perceptions variable loses significance (**RQ3**). In contrast, the qualitative measures of risk actually become more significant, the more explanatory variables are included in the model. This could be related to the fact that these questions are picking up respondents' opinions about information other than just smoking risks as they also elicit opinions about other mortality risks in relation to smoking (**RQ2**).

5.4. Results for US NSDUH data

5.4.1. Descriptive findings for US NSDUH

Of the 12 to 17 year old respondents included in the NSDUH, 30 percent have smoked a cigarette while 8 percent have smoked at least 100 cigarettes in their lifetime. Table 15 shows the distribution of responses to a risk perception question (the effects of smoking one or more packs of cigarettes per day for a member of the general population) depending upon smoking experience. This table includes calculations for the full sample as well as each subcategory of two expressions of smoking behavior (smoked a cigarette/never smoked a cigarette and smoked at least 100 cigarettes in lifetime/never smoked 100 cigarettes in lifetime). There is not a 'correct' answer to this risk perception question as it entirely depends on the respondent's normative judgment regarding what constitutes

varying levels of risk. Therefore, findings here tell us about how individuals with different smoking behaviors might perceive the same action in divergent manners. Those attaching great risks to smoking would be classified as having the highest risk perceptions about smoking while those attaching no risk, the lowest.

Table 15. US NSDUH - Distribution of risk perceptions associated with smoking

Distribution of risk perceptions	Full sample	Smoked a cigarette	Never smoked a cigarette	Smoked 100 cigarettes in life	Never smoked 100 cigarettes in life
(1)	(2)	(3)	(4)	(5)	(6)
No risk	1.7%	**2.2%**	1.6%	**3.9%**	1.6%
Slight risk	5.1%	**7.1%**	4.3%	**11.3%**	4.6%
Moderate risk	25.4%	**29.9%**	23.5%	**35.1%**	24.6%
Great risk	67.7%	60.9%	**70.7%**	49.7%	**69.3%**
Sample size	18,135	5,492	12,643	1,411 *	16,698*

Note: Question is 'How much do people risk harming themselves physically and in other ways when they smoke one or more packs of cigarettes per day?' Potential responses are those listed in column (1) above as well as 'don't know, 'refused,' and 'no answer.' Treatment of these three types of responses is discussed in the methods section.
*Total is 18,109 respondents because of 25 respondents answering 'don't know' and 1 refusing to respond to the question 'Have you smoked at least 100 cigarettes in your entire life?'

This preliminary descriptive analysis suggests that those individuals who have smoked a cigarette or smoked at least 100 cigarettes are more likely to view the risks of smoking at least one cigarette pack a day as 'moderate,' 'slight' or non-existent than their counterparts who have engaged smoking of either level of depth. Similarly, those who have never engaged in either level of smoking behavior are more likely to perceive smoking at least one or more packs as day as a 'great risk' than those who do smoke. These results highlight a potential relationship between smoking behavior and risk perceptions that deserves further empirical investigation.

5.4.2. Multivariate analysis with US NSDUH

Analysis of the NSDUH uses either a probit model because the dependent variable is binary or a two-stage CDSIMEQ model for simultaneous equations where endogeneity is present.

This model allows for correction of endogeneity found in the tests outlined earlier. For all findings, VIF were always below 10 suggesting no multicollinearity between the variables included in each model. Table 16 includes results from a simple non-instrumented model and the same simple model instrumented.

Table 16. US NSDUH - Determinants of whether survey respondents have smoked a cigarette

	(1) Simple model		(2) Simple model (I.V.)	
	Coef.	z	Coef.	z
	Risk perceptions			
Risk perceptions*	-0.17 [a]	-10.45	-0.1 [b]	-2.54
	Socio-demographics			
Gender	-0.21 [a]	-9.46	-0.20 [a]	-8.87
Age	0.26 [a]	34.68	0.26 [a]	33.82
Black Afr-Amer	-0.29 [a]	-7.51	-0.29 [a]	-7.92
Native American/AK Native	0.38 [a]	4.51	0.38 [a]	4.63
Native HI/Pac Islands	0.24	1.19	0.24	1.36
Asian	-0.45 [a]	-5.70	-0.45 [a]	-5.68
More than one race	0.08	1.40	0.08	1.36
Hispanic	-0.03	-0.83	-0.03	-0.82
MSE under 1 million	0.14 [a]	5.34	0.14 [a]	5.35
Not in MSA	0.16 [a]	5.40	0.16 [a]	5.48
	Socio-economics			
Receive income from job	0.10 [a]	3.65	0.10 [a]	3.58
Family income	-0.05 [a]	-7.59	-0.05 [a]	-7.83
Private school	-0.18 [a]	-4.07	-0.18 [a]	-4.01
Home school	-0.03	-0.37	-0.03	-0.37
	Household characteristics			
Two parent household	-0.18 [a]	-6.69	-0.18 [a]	-6.79
	Attitudes and beliefs			
Seldom like dangerous things	0.28 [a]	7.86	0.28 [a]	7.83
Sometimes like dangerous things	0.55 [a]	14.23	0.55 [a]	14.33
Always like dangerous things	0.72 [a]	12.71	0.71 [a]	12.70
Seldom test self with risks	0.15 [a]	4.30	0.15 [a]	4.25
Sometimes test self with risks	0.28 [a]	7.18	0.28 [a]	7.23
Always test self with risks	0.49 [a]	8.11	0.49 [a]	8.20
Never wear seatbelt in front car	0.65 [a]	10.71	0.66 [a]	10.87
Seldom wear seatbelt in front car	0.51 [a]	12.67	0.52 [a]	12.79
Sometimes wear seatbelt in front car	0.34 [a]	12.47	0.34 [a]	12.49
Religion influences decisions	-0.19 [a]	-8.31	-0.20 [a]	-8.38
Wald χ^2 / LR χ^2	3704.10		4550.48	
Pseudo R^2	0.209		0.205	
Log pseudolikelihood / Log likelihood	-8795.9		-8846.07	
Number of observations	18,135		18,135	

Notes: Non-instrumented model in columns (1) includes robust standard errors.
Instrumented model in columns (2) includes uncorrected standard errors.

(*) Instrumented using questions about the risks respondents attach to 'using LSD once or twice a week' and the risk of 'using cocaine once a month' with responses of 'No risk,' 'Slight risk,' 'Moderate risk,' 'Great risk,' 'Don't know,' 'Refused,' and 'No answer.'
[a] Significant at 1% [b] Significant at 5%

As predicted, risk perceptions play a significantly determinant role in whether respondents have smoked a cigarette (**RQ1**). These results show a negative relationship between risk perceptions and smoking behavior as the more risky a respondent believes smoking to be, the less likely he/she is to have smoked a cigarette. This is the case in both the non-instrumented and instrumented models.

Male respondents were less likely to have smoked a cigarette while age showed a positive relationship with likelihood of smoking a cigarette. With regards to ethnicity, some ethnic backgrounds proved important predictors of smoking while others did not. African-Americans and Asians were less likely to have smoked a cigarette than white respondents. Conversely, Native Americans were more likely to have smoked a cigarette than white respondents. Individuals from rural setting or cities less than 1 million were more likely to have smoked than respondents from cities of over 1 million.

Family socio-economics appear to have a significantly determinative influence on smoking behavior. Those adolescents who receive income from a job are more like likely to have smoked. The finding also suggests that those who experience the independence gained from earning their own money also may denote independence when it comes to making decisions about smoking. On the other hand, family income is negatively related to smoking behavior as adolescents from wealthier families appear less likely to have smoked a cigarette. In the same way, findings reflect a negative relationship between attending a private school versus a public school and smoking a cigarette. Home schooling, which here

is a proxy for how close respondents are with their parents does not prove a significant predictor of smoking behavior relative to attending public school.

Household structure does appear to have an influence on adolescent smoking behavior. Those adolescents who live in a home with both their mother and father are less likely to have smoked a cigarette than those who live with either one of their parents or neither.

Respondents' appetite for risk and the importance of religious beliefs in influencing decisions had the expected relationship with smoking. Adolescents with a greater propensity to like doing dangerous things or testing themselves be taking risks were more likely to have smoked. Additionally, those individuals who always, sometimes or seldom wear a seatbelt when riding in the front of a car were less likely to have smoked a cigarette than those who never wear a seatbelt. Those whose religion influences their decisions in general are less likely to have smoked a cigarette as well. All of these findings highlight the role of attitudes and beliefs in determining uptake of risky behaviors. However, even with these attitudes and beliefs included as variables, risk perceptions with regards to smoking still remains a significant determinant of smoking behavior in the instrumented and non-instrumented models.

Table 17 shows that risk perceptions continue to remain a consistently significant predictor of smoking behavior across all columns even when other variables that have been demonstrated in the literature to play an important role in determining adolescent smoking behavior are included in the model (**RQ3**).

Table 17. US NSDUH - Determinants of whether survey respondents have smoked a cigarette

	(1) Expanded model including parents' talking about dangers of smoking		(2) Expanded model including parents' talking about dangers of smoking (I.V.)		(3) Expanded model including classmates' smoking behaviors		(4) Expanded model including classmates' smoking behaviors (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
			Risk perceptions					
Risk perceptions*	-0.17[a]	-10.36	-0.11[b]	-2.46	-0.17[a]	-10.07	-0.15[a]	-3.32
			Socio-demographics					
	Included		Included		Included		Included	
			Economic independence from parents					
	Included		Included		Included		Included	
			Socio-economics					
	Included		Included		Included		Included	
			Household characteristics					
	Included		Included		Included		Included	
			Attitudes and beliefs					
	Included		Included		Included		Included	
			Societal influences					
Parents talked dangers NO	0.04	1.78	0.04	1.90	0.03	1.44	0.03	1.47
Parents talked dangers DK	-0.35[b]	-2.20	-0.34	-1.94	-0.33[b]	-2.12	-0.33	-1.81
Few stdnts smoke	-	-	-	-	0.47[a]	9.29	0.47[a]	9.32
Most stdnts smoke	-	-	-	-	1.00[a]	18.70	1.00[a]	18.73
All stdnts smoke	-	-	-	-	1.05[a]	9.27	1.04[a]	8.79
Stdnts smoke DK	-	-	-	-	0.44[a]	4.58	0.45[a]	4.39
Wald χ^2 / LR χ^2	3722.27		4561.26		4006.53		5204.74	
Pseudo R^2	0.210		0.205		0.238		0.234	
Log pseudolikelihood / Log likelihood	-8791.3		-8840.7		-8475.1		-8518.9	
Number of observations	18,135		18,135		18,135		18,135	

Notes: Non-instrumented model in column (1) and (3) include robust standard errors.
Instrumented models in columns (2) and (4) include uncorrected standard errors.
(*) Instrumented using questions about the risks respondents attach to 'using LSD once or twice a week' and the risk of 'using cocaine once a month' with responses of 'No risk,' 'Slight risk,' 'Moderate risk,' 'Great risk,' 'Don't know,' 'Refused,' and 'No answer.'
[a] Significant at 1% [b] Significant at 5%

This table shows results for a model including parents' interactions with their children about the dangers of smoking thereby capturing the role of parents as an information source for their children. Parents not talking to their children about the dangers of smoking had a positive relationship with respondents having smoked a cigarette relative to those

respondents whose parents had not had that discussion. However, when variables regarding classmates' smoking behaviors are included in the model then the parents variables become insignificant. The impact of peers is significantly positive, however, as those respondents who reported that few, most or all students in their class smoke were more likely to have smoked a cigarette than those who reported that no classmates smoke. Because this dataset does not include information on parental smoking behavior, the variables reflecting parents' and peers' influences on behavior are not comparable. However, what can be said is that in the presence of both potential influences on smoking behavior, risk perceptions remain a significant predictor of smoking behavior.

Appendix 5H displays the results of identical models to those in Tables 16 and 17 but using the dependent variable of whether respondents have smoked 100 cigarettes instead of whether respondents had smoked a whole cigarette. This dependent variable provides a richer understanding of the extent of respondents' smoking behaviors. Results using this dependent variable establish the same relationship between risk perceptions and smoking behavior as those found when running a simple and an expanded model including parents and classmates variable treating the risk variable as exogenous and endogenous (**RQ1** and **RQ3**). Using another way of expressing respondents' smoking behaviors gives further credence to findings from Tables 16 and 17 of a negative relationship between smoking and risk perceptions.

While the use of cigarettes among adolescent population receives significant attention in the academic and wider media setting, the increasing smoking prevalence rates among female adolescents has been highlighted as particularly alarming. In order to investigate the gender dimensions of smoking determinants, the same model (both non-instrumented

and instrumented) was run with only a male and female population sub-samples. The results appear in Appendix 5I.

Risk perceptions remain a consistent predictor of smoking behavior regardless of gender except in the instrumented model where perceptions do not predict smoking behavior for females. This result could be reflecting some instability in preferences for females or the fact that other factors play more important roles for females at this age.

5.5. Discussion

Results will be discussed in light of the three research questions posed. Additional discussion of the chapter's findings with regards to the determinants of smoking such as gender, age, ethnicity, household structure and urban/rural setting can be founding Appendix 5J.

5.5.1. RQ1 - Determinative power of risk perceptions

Findings indicate that when risk perceptions were found to play a significant role in adolescent smoking behavior it was a negative one such that individuals with higher risk perceptions regarding smoking were less likely to have smoked.. The single quantitative measure of risk used in the YSS negatively and significantly determined smoking behaviors in the presence of many explanatory and control variables except when peer effects were added. The qualitative measure of risk from the YSS did not predict smoking behaviors except when smoking risks were compared to alcohol risks, in which case smoking risks were negatively related to smoking behavior. Five of the six qualitative measures of risk perceptions having no significantly determinative role in predicting risk perceptions appears to be more a function of the risk perception question asked than the actual level of

risk respondents attach to smoking. This methodological point will be discussed in more detail in the next section.

The qualitative measure of risk perceptions from the NSDUH also displayed a negative and significant relationship with likelihood of smoking in all models except when only female respondents were included in an instrumented regression.

Descriptive level findings about the relationship between quantitatively-measured risk perceptions and smoking experience point to a greater amount of underestimation of risk among individuals with no smoking experience. Therefore, individuals appear to be learning by personal experience about smoking risks thus supporting the Bayesian concept of individuals using information at their disposal to update prior knowledge. As there is a substantial portion of the survey population underestimating and correctly estimating the mortality risk related to smoking, it can be assumed that individuals were not subject to a focusing illusion where when individuals are asked about the impact of a single item on their well-being, they tend to overestimate or exaggerate the importance of that one factor (Kahneman et al. 2006).

5.5.2. RQ2 - Risk perception elicitation methods

Although measuring risk perceptions qualitatively and quantitatively both denote a role for risk perceptions in adolescent smoking behavior, their expression of influence differs. In terms of the methodological question posed as how to best capture adolescents' risk perceptions about smoking, the use of multiple measures of risk perceptions (quantitative, qualitative (relative risk and Likert scale)) has offered guidance as to which method provides the most consistent results.

The quantitative measure of risk having a significant effect on smoking behavior is consistent with previous findings in connection with adolescent (Lundborg 2007; Lundborg and Lindgren 2004) and adult populations (Viscusi 1990; Costa-Font and Rovira 2005; Liu and Hsieh 1995). The question used in this survey asks about fatality rate, not risk of having a certain condition such as lung cancer (Viscusi 1991), which provides a greater idea of whether respondents' understand the risks of smoking in totality beyond one possible negative consequence.

The determinative power of the quantitative risk measure stands despite possible complications in question phrasing by assuming respondents know how many people smoke in Canada. A way to get around this issue of assuming that respondents know how many people smoke in Canada or the size of the Canadian population would have been to give them a number for either piece of information. For example, Lichtenstein et al. (1978) gave subjects the number of deaths per year from one cause of death to provide an order-of-magnitude in reference to the other causes of death asked about as they found that individuals do not necessarily have a good idea about how many people live or die in a country in an average year. However, given that these respondents are in school and students learn this kind of geographical information in school at that age, I could expect that these respondents will have less of a problem with that concept than the general population. Just as giving respondents multiple choice answers introduces an anchoring bias so does introducing a figure to the equation. The lack of an anchor avoided any form of anchoring bias around a provided figure (Fischhoff et al. 2000). None of these solutions, however, alleviate the issues individuals have when faced with number-based questions that

are inherent in any quantitative means of eliciting risk perceptions (Grimes and Snively 1999; Woloshin et al. 1999).

Results of the two qualitative measures of risk (YSS and NSDUH) highlight the characteristics of an effective qualitative risk perceptions elicitation method. Crucial to the problems associate with the YSS qualitative method are question phrasing and introduction of reference points to each question, which manifested themselves not only in an insignificant relationship between risk and smoking but also overwhelmingly inaccurate survey responses. In the case of the YSS, of the six quantitative risk perceptions questions asked, in not one of the questions did over 60 percent of respondents get the question correct. For four out of six questions, less than half of respondents got the question correct. The qualitative risk measures always forced respondents to compare smoking risks with other risks about which they may or may not be informed therefore the 'information gap' could fall either on the smoking risk side or on the risk being compared to smoking. Jamieson and Romer (2001)'s survey of 14-22 year olds also found consistent inaccuracy of relative risk perceptions when looking at risks of smoking versus alcohol and marijuana.

Findings regarding the qualitative risk measure from the YSS highlight that perhaps where risk perceptions are accurate, they are more likely to alter chances of smoking. The only qualitative measures of risk that proved significant in determining smoking behavior were risk measures comparing smoking deaths to deaths from alcohol and only in some models, suicides. This appears to be the case because individuals have more knowledge about the relative risk of alcohol and suicides versus smoking. These two causes of deaths are the only qualitative risk questions where over half of respondents were correct in agreeing that smoking causes more deaths per year than the other cause of preventable mortality named.

Question phrasing could have played a role in this elicitation method failing to consistently predict smoking. The question is phrased in very broad terms referring to the *general population*'s risk of death therefore this result could also represent optimism bias. An individual views a risky scenario with optimism bias if he thinks that a risk applies more to others than him. Research findings can be riddled with optimism bias when risk perception questions ask about smokers in general and not about respondents as smokers themselves (Slovic 2001). Therefore, these individuals who have tried smoking might view smoking as riskier than illegal drugs and/or AIDS for others but may view themselves as not at risk for the negative effects of either.

Individuals have a tendency to underestimate the risks of smoking when it is compared to other risks (Borland 1997; Eiser et al. 1979). Previous evidence points towards the general public's lack of understanding how the risks of smoking compare to other risks. When the American Cancer Society (1993) asked respondents how the risk of dying from smoking compared to the risk of dying from five of the risks used in this study as comparators (drugs, AIDS, alcohol, murders and car accidents), only 21% thought smoking was the greatest killer of these risks.

Adolescents could fail to be myopic when examining survey questions such that respondents actually use the risk compared to smoking as a reference point and focus on this topic rather than assess the risks of smoking themselves. The significant body of literature on the use of reference points (Kahneman 1992; Kahneman and Tversky 1979) to frame the perception of an event applies here. As the qualitative risk measures used in this study compare smoking to a variety of other preventable causes of mortality such as AIDS

and suicide, individuals could be responding to these questions more based upon how they perceive the risk attached to the event being compared to smoking rather than the relative risk of the two causes of mortality. As each of the six questions were asked at the same time in the survey, respondents could be focusing much more on the risk compared to smoking since it is the only part of the question altered. For each respondent, this reference point differs based upon experience with and feelings about that risk being compared to smoking. Unlike other risks, smoking risks have been extensively communicated and individuals might be more likely to have some probability measure in mind than when thinking about the risk being compared to smoking.

The other qualitative measure of risk used in this analysis, the Likert response question found in the NSDUH, consistently exhibited determinative power with regards to adolescent smoking behavior even when including other variables representing other established potential determinants of smoking behavior such as peer smoking. The qualitative measure of risk used in the NSDUH asked respondents only about the risks they perceive from smoking and does not require respondents to express risk perceptions as a comparative concept. This result demonstrates how a qualitative measure of risk can be more effective in consistently capturing a relationship between behavior and perceptions. This measure of risk certainly has its downsides in that the answer each respondent gives depends upon his own conception of what constitutes a 'slight' 'moderate' or 'great risk.' The models used in this analysis attempt to mitigate the bias resulting from this question design by including variables expressing respondents' risk appetites for other topics thus offering a richer picture of each respondent's vision of the spectrum of risk.

Aside from their predictive power in assessing likelihood of smoking, examining results from tests for an endogenous relationship between smoking and risk perceptions reveals additional evidence about which risk perception elicitation method capture perceptions most accurately. The quantitative measure of risk from the YSS and the qualitative measure from the NSDUH were found to be endogenously related to respondent smoking behavior. On the other hand, the qualitative measures of risk from the YSS were not endogenously related to the dependent variable. Because the qualitative measures of risks asked respondents to compare the risk of smoking to other risks such as alcohol, AIDS and suicides, these variables could be expressing more than simply respondent perceptions of smoking risks and instead be more influenced by the risk compared to smoking rather than smoking risks themselves. The fact that the quantitative measure from the YSS and the qualitative measure from the NSDUH proved to have the expected endogenous relationship with smoking behavior suggests that these measures of risk captured risk perceptions and not a combination of other respondent characteristics.

Employing both quantitative and qualitative measures of risk can provide a fuller picture of risk perceptions as responses may depend on respondent characteristics such as education or social class (Gaba and Viscusi 1998). After examining the findings for each risk measure, there appears to be value in using multiple methods for eliciting risk perceptions. However, the design of each should be robust enough that they can be compared more directly. For example, with the YSS, the qualitative measure of risks is laden with methodological downsides because of the use of reference points and the potential for optimism bias because of question phrasing; therefore findings are not really comparable between risk measures. On the other hand, a qualitative measure like that in the NSDUH

and a quantitative one like in the YSS asked of the same respondent population would offer a more accurate comparison of risk perception elicitation method.

5.5.2. RQ3 - Social and environmental influences on smoking behavior

With regards to environmental effects and social interactions, results support the hypothesis that adolescents acquire information in the Bayesian framework of relying on information sources to update previous experience and knowledge. These information sources include parents' behavioral examples, peer effects, household environment and more generally, the environment where respondents live including cultural characteristics. Of key importance to this analysis is not simply the direction of influence these social and environmental factors have on behavior but if they diminish the significance of risk perceptions playing a role in predicting behavior. This section focuses on how adding these additional determinants of smoking may have influenced the significance of risk perceptions in predicting behavior. A discussion of these variables as determinants of smoking behavior can be found in Appendix 5J. A summary table of results regarding explanatory and control variables can be found below in Table 18.

Table 18. Determinants of smoking behavior – summary table of control and explanatory variables

	Canada – YSS	US - NSDUH
	Smoking behavior	*Smoking behavior*
	Socio-demographics	
Gender (male =1)	None	Negative
Age	Positive	Positive
Quebec (relative to other provinces)	Positive	-
Black Afr-Amer	-	Negative
Native American/AK Native	-	Positive
Native HI/Pac Islands	-	None
Asian	-	Negative
More than one race	-	None
Hispanic	-	None
MSE under 1 million	Positive	-
Not in MSA	Positive	-
	Economic independence from parents	
Weekly allowance	Positive	-
Receive income from job	-	Positive
	Socio-economics	
Family income	-	Negative
Private school	-	Negative
Home school	-	None
	Household characteristics	
Two parent household	Negative	Negative
	Attitudes and beliefs	
Risk tolerant	-	Positive
Religion influences decisions	-	Negative
	Societal influences	
Only father smokes	Positive	-
Only mother smokes	Positive	-
Both parents smoke	Positive	-
Number of people who smoke in home	Positive	-
Parents talked dangers NO	-	Positive only for females
All students smoke		Positive
Percent of friends that smoke	Positive	-

Here, the addition of societal and environmental influences highlights the robustness of findings regarding the importance of risk perceptions in predicting smoking behavior. In models from both surveys, adding a variable expressing parental influence did not diminish the significance of risk perceptions' predictive power. Measures of parental influence on smoking differed between the two surveys therefore direct comparison is difficult. The YSS had information reported by the respondent about whether their parent smoked. The

NSDUH captured parents' involvement in smoking in a very different way by eliciting whether parents solicit themselves as information sources about smoking risks.

Friends' smoking but not parental smoking diminished the importance of risk perceptions in determining adolescent smoking behavior in the case of the YSS except when risk was measured qualitatively as 'risk smoking relative to alcohol.' For the NSDUH, classmates' smoking was positively related to smoking likelihood but risk perceptions remained significant even up on inclusion of this variable.

The fact that the quantitative measure of risk perceptions used in the YSS loses significance when peer smoking is included in the model suggests that risk and friends' smoking are picking up many of the same characteristics present in the smoking decision. Parental smoking behaviors do not diminish the significance of risk perceptions considerably but adding them into the model does reduce the coefficient on the quantitative measure of risk. These findings highlight the importance of social and environmental effects on adolescent smoking behavior and support the Bayesian model where individuals use the information gained from experience around them to develop their own perception of risk.

These results are interesting because in the case of the YSS, they imply a relationship between how friends' smoking and risk perceptions impact smoking behavior. Risk perceptions pick up some of the same determinative factors as friends' smoking behaviors. This result also supports the hypothesis that adolescents' interactions with others guide utility assessment in conditions of uncertainty such as the risks of smoking. This finding may not hold true for the NSDUH because the peers variable here captures the behavior of individuals who are not necessarily the respondents'' friends but simply classmates. When

given a better idea of the peer social circle the respondent surrounds himself with, as is the case with the YSS, peer effects do diminish the importance of risk perceptions. The influence of peers on adolescents' risk perceptions about smoking will be analyzed in full in Chapter 7.

5.5.3. Treatment of risk aversion

An important variable that was omitted from the YSS models were measures of risk aversion. These variables were omitted because questions about how respondents act in risky situations other than smoking were not included in the data set. Because of the omission of risk aversion measures about respondents, the risk perceptions variable regarding smoking could be picking up some of the influence respondents' general perceptions of risks and risk attitudes have on smoking. Results from the NSDUH demonstrate that even where the models include information about respondents' attitudes and beliefs about risks having nothing to do with smoking (dangerous things, propensity to test oneself with risks and wearing a seat belt in the front of the care), risk perceptions about smoking hold as significant influences on smoking behavior.

Given previous findings in the literature, this result was expected where general risk aversion impacts smoking behavior but risk perceptions regarding smoking still remain significant when including these variables (Lundborg and Andersen 2008). Studies looking at smoking risk perceptions and behaviors include general respondent risk beliefs and attitudes in models predicting smoking behavior when these data are available (Liu and Hsieh 1995; Lundborg and Andersen 2008; Lundborg and Lindgren 2004; Viscusi et al. 2000), otherwise, like in the case of the YSS, the risk perceptions variable regarding smoking suffers from picking up variance that probably could be attributed to general risk

perceptions about non-smoking related topics (Costa-Font and Rovira 2005). The literature does not, usually include risk aversion measures in the models predicting risk perceptions about smoking (Costa-Font and Rovira 2005; Viscusi and Hakes 2008) except if they are specific beliefs related to smoking risks (Liu and Hsieh 1995), therefore, this thesis took this same stance and included beliefs specifically about smoking in models predicting risk perceptions but not information on general risk aversion. These were available in the case of the YSS but not the NSDUH and are included in models displayed in Chapters 6-8.

5.6. Conclusion

This analysis has empirically assessed the importance of risk perceptions in determining adolescent smoking behavior and determined the extent to which employing different methods of measuring adolescents' risk perceptions would play a role in the determinative power of risk in adolescents' smoking behavior. It also tests how including social and environment effects on smoking may influence the determinative power of risk perceptions.

Findings indicate that risk perceptions do play a significant role in adolescent smoking behavior with risk perceptions negatively related to smoking behavior when measured using an elicitation mode that is not fraught with methodological difficulties. Going forward, this chapter demonstrates that differing measures of risk perceptions are useful but design of questions sets out how universally informative a measure can be. Qualitative measures that focus solely on smoking rather than distracting findings with other risks appear to improve the explanatory power of these kinds of risk perception measurement methods. Findings add to the literature highlighting the importance of risk perceptions in determining adolescents' smoking behavior. They also offer the first study using two methods of measuring risk perceptions and comparing results. This chapter also tests the

robustness of results regarding the role of risk perceptions by adding key explanatory variables such as parental and peer smoking to the models.

This chapter sets out the role of risk perceptions in the behavioral choice of smoking. Given their power in predicting behavior, of crucial importance remains an understanding of the determinants of adolescents' risk perceptions and which information sources prove most influential in altering the extent to which perceptions mirror reality. The next three empirical chapters look at three categories of information sources' influences on risk perceptions: their agents (parents, doctors and dentists), their peers and public health efforts. I start with their agents.

Chapter 6. The influence of adolescents' agents (parents, doctors and dentists) on adolescents' perceptions about smoking risks

This examination of the determinants of risk perceptions focuses on identifying information channels that influence an individual's risk perceptions and quantifying their effects on modifying perceptions. This chapter is the first of three chapters to answer the second research question posed in Chapter 1:

(2) Which sources of information do adolescents rely on to inform their perceptions of risks?

6.1. Introduction and research questions

This study takes a broad definition of the term 'information sources' to capture the role of parents and medical professionals by not only examining the direct transfer of risk information from these figures to adolescents, but also their roles as influencers and role models within society through their behavior.

Disentangling the influence of parents and doctors requires attention to the potential specific effect each can exert. As discussed in the conceptual framework emerging from Chapter 2, doctors and dentists are assumed to have a principal-agent relationship with adolescents because of the information asymmetry existing between adolescents and medical professionals regarding smoking experience and smoking risk information. However, the extent of this relationship somewhat depends on their close spatial proximity. Work from the spatial proximity realm would suggest that those individuals with a physically closer relationship to adolescents would have a more influential agency relationship. Clearly, adolescents see their parents more often than they do doctors and

dentists and have a biological connection to their parents so the nature of this relationship is very different. Additionally, children, especially adolescents are loathe to listen to their parents telling them 'not to do' any given behavior. Parents can, however, demonstrate their disapproval through setting rules about not smoking in the house and thus indirectly inform their children of disapproval.

On the other hand, adolescents are less likely to be aware of their doctor or dentist's smoking habits but are more likely to be given information about smoking risks from these individuals in the clinical setting. Therefore the role of medical professionals will be very different than that of parents. Doctors and dentists, unlike parents might be envisaged as agents offering technical information or non-biased information based purely on objective information.

The literature suggests that parents, doctors and dentists can play integral roles in the likelihood of an adolescent partaking in a risky behavior; however limited work sheds light on these individuals' roles in impacting adolescents' risk perceptions. Therefore, a key question remains as to how the variety of distinct agent roles will affect the capacity to alter principals' perceptions. Findings will determine which agents are more likely to convey relevant information aiding adolescents' constructing of risks perceptions. In particular, the research questions aimed to answer in this study are as follows:

Parents

RQ1. Do *parents' smoking behaviors* have any determinative influence on their children's risk perceptions regarding smoking? (parents as *indirect* providers of information about smoking risks)

RQ2. Do *parental attitudes about smoking* based upon household smoking habits or *perceptions of parents feelings about their child's smoking* impact adolescents' risk perceptions about smoking? (parents as *indirect* providers of information about smoking risks)

RQ3. Does *parents' discussing tobacco risk* with their children have a determinative influence on their children's' perceptions of smoking risk? (parents as agents for their children)

Medical professionals (doctors and dentists)

RQ4. Do conversations with a *doctor/ dentist* about individual smoking behaviors impact adolescents' risk perceptions? (medical professionals as *indirect* providers of information about smoking risks)

RQ5. Does a *doctor/ dentist* providing information about the risks of smoking play a determinative role in adolescents' risks perceptions? (medical professionals as *direct* providers of information about smoking risks and agents for adolescent patients)

6.2. Data and Methods

6.2.1. Data sources

The Canadian YSS can provide answers to **RQ1** and **2** and **RQ4** and **5**. The U.S. NSDUH offers data that can be used for **RQ2** and **RQ3**. As both datasets do not offer identical questions about parental smoking behaviors and interactions with their children, direct comparison between countries will not be possible but some comparison of findings will be

informative in either supporting findings or offering differing opinions for a variety of context specific or methodological reasons.

The YSS includes information about parents' smoking behaviors as reported by their children. Although a parents' questionnaire was given to respondents' parents as part of the survey, response rate was low and data is not available for analysis.[15] This survey has data on parents' behaviors, household smoking habits and doctors' and dentists' interactions with their patients about smoking habits and risks.

The following table lists those questions from the YSS which pertain to the research questions posed above.

[15] Based upon e-mail from Bernie Edwards of Statistics Canada on 4 July 2005

Table 19. Survey questions of interest from the YSS

Topic	*Question*	*Responses*
	Parents	
Parental smoking behaviors as perceived by their adolescent child*	Does your father/*mother* smoke?' If you don't live with your father/*mother*, but if most of the time you live with someone who is like a father/*mother* to you, please answer about this person	Yes No don't know I don't live with a father/*mother* or anyone who is like a father/*mother*
Adolescent's perception of how their parents feel about their smoking	How does your father/*mother* feel about your smoking? If you don't live with your father/*mother*, but if most of the time you live with someone who is like a father/*mother* to you, please answer about this person	I don't smoke He/*She* approves He/*She* doesn't care He/*She* doesn't like it He/*She* doesn't know that I smoke I don't live with a father/*mother* or anyone who is like a father/*mother*
Household rules and behaviors regarding smoking.	Excluding yourself, how many people smoke INSIDE your home everyday or almost everyday? Do not count those who usually smoke outside	Write in a number
	Do <u>you</u> ever smoke INSIDE your home?	I don't smoke Yes No
Topic	*Question*	*Responses*
	Medical professionals	
Interactions with doctors	Has a doctor ever asked you whether you smoke cigarettes or use smokeless tobacco?'	Yes No
	Has a doctor ever talked to you about what smoking or using smokeless tobacco does to your health?	Yes No
Interactions with dentists	Has a dentist ever asked you whether you smoke cigarettes or use smokeless tobacco?	Yes No
	Has a dentist ever talked to you about what smoking or using smokeless tobacco does to your health?	Yes No

* Respondents were questioned about fathers and mothers individually so there were actually four questions about parents' behavior in total

Behavioral example serves as the most direct means of influence parents can have by offering children indirect experience with smoking.[16] For the purposes of this analysis, these questions were used to create three variables expressing parental smoking habits – only father smokes, only mother smokes and both parents smoke. Separate and joint parental smoking variables were used because of evidence in the literature that this distinction can alter results (Tyas and Pederson 1998). The second and third types of questions concerning the role of parents both relate to the environment in which adolescents receive new information. Parents creating an environment where smoking is permitted sends messages about what behaviors are acceptable.

The NSDUH has data on adolescents' perceptions of their parents' approval or disapproval of their smoking (indirect influence) and whether parents have talked about the dangers of smoking to their child (direct influence). It includes no data about doctors and dentists being involved in the adolescent respondents' lives in any capacity.

The following table lists those questions from the NSDUH which aid in investigating the research questions posed above.

[16] Questions about parents' past smoking behaviors asked of those respondents who stated that their parents did not smoke at the time of the survey proved not to have a role in determining risk perceptions suggesting that only revealed behaviors matter for influencing risk perceptions. Therefore, only parents' current behaviors are used as determinants of risk perceptions in all models.

Table 20. Survey questions of interest from the NSDUH

Topic	*Question*	*Responses*
	Parents	
Adolescent's perception of how their parents would feel about their smoking	How do you think your parents would feel about you smoking one or more packs of cigarettes per day?	Neither approve nor disapprove Somewhat disapprove Strongly disapprove Don't know Refuse No answer
Parents as direct source of information about smoking risks	During the past 12 months, have you talked with at least one of your parents about the dangers of tobacco, alcohol, or drug use? By parents, we mean either your biological parents adoptive parents, stepparents, or adult guardians – whether or not they live with you	Yes No Don't know Refuse No answer.

The first question looks at some of the same issues as would come across in the second question listed in the Table 19 from the YSS. The second question looks at the parent's role as a direct source of information about the risks of smoking, much as the Canadian YSS asks respondents about a doctor's or dentist's role.

A set of questions from the NSDUH asking respondents about the relationship they have with their parents also sheds light onto how likely it would be that respondents even consider what their parents say about the dangers of tobacco use as valid or important. These questions include topics such as if parents check if respondents do their homework, help with their homework, let respondents know if they have done a good job at something, told them they are proud of something they have done and argued or had a fight with at least one parent.

Sample characteristics for the Canadian YSS are found in Appendix 6A while sample characteristics for the US NSDUH are found in Appendix 6B.

6.2.2. Empirical specification

This chapter finds its grounding in the Bayesian learning framework where an individual's risk perceptions result from the influence of a variety of information sources but the importance of these sources depends on the weight attached to the information they supply. Behavioral decisions remain a construct of utility-based decision-making as depicted in Chapter 5. Based on results from Chapter 5 demonstrating a significant relationship between risk perceptions and behaviors, this analysis can assume that part of this utility equation is risk perceptions.

Individuals in this young population sample gain indirect experience and information to formulate risk perceptions because of their own limited direct experience. The question remains though of which of these exogenous individual agents matter most for risk belief development. The model presented here requires the ability to express with relativity, the value of information coming from various agents thus allowing an understanding of how spatial proximity and the extent of agency relationships matter in risk perception development. An individual's risk perceptions are, however, determined by many other factors than the three categories of agents specifically investigated in this empirical analysis therefore the model appears as follows:

$$R_i = \beta_1 X + \beta_2 A_i + \beta_3 P + \beta_4 D + \beta_5 N + \beta_6 H + \varepsilon \qquad (6.1)$$

where R_i expresses an individual's perceptions of risk, X is a vector of personal and household characteristics such as gender, grade and availability of disposable income, A_i is the individual's smoking behavior, P is a vector representing parental influence including individual parents' smoking behaviors, both parents' smoking behaviors and household smoking habits, D is a vector of the various capacities in which a doctor can act as an

information source about smoking risks, N is a vector of the various capacities in which a dentist can act as an information source about smoking risks, H represents household structure characteristics and ε is the random set of factors across all individuals that independently impact risk perceptions.

As in Lundborg (2007), there is some debate onto whether smoking status should be an explanatory variable. From a Bayesian learning model perspective (Viscusi 1991) it is not clear how one's own experience in adolescence affects risk perceptions. However, if smokers change their perceptions depending on their behavior, so that individuals deliberately misperceive the risks of smoking to continue smoking, then this variable should remain. Based on the conceptual framework set out in this thesis at the end of Chapter 2, this analysis assumes that the Bayesian model includes one's own behavioral experience as another potential piece of information to which one may attach some level of credibility. Therefore, it should be included in the model as an explanatory variable and controlled for as being endogenously related to risk perceptions if necessary.

6.2.3. Methodological issues

Two major methodological issues have to be addressed in order to make sure that the statistical representation of the above described model is of best fit. The first of these is testing for potential endogeneity between the dependent variable (R_i) and an individual's smoking behaviors (A_i). Appendix 6C describes the process used to test for endogeneity and the election of valid instruments. To summarize, those instruments found suitable to correct for endogeneity in the smoking behavior variable in relation to risk perceptions are listed in the table below.

Table 21. Instruments used

	Dependent variable
	*Risk perceptions**
Canadian YSS	(1) Take part in clubs or groups such as scouts, community or church groups at least weekly (2) Read for fun at least monthly
US NSDUH	(1) Received treatment from *a pediatrician or family doctor* about emotional or behavioral problems not caused by alcohol or drugs (2) Have been home-schooled in the past 12 months (3) Received treatment from *mental health center* about emotional or behavioral problems not caused by alcohol or drugs

*Predict smoking behavior but not risk perceptions

These instruments were deemed valid based not only upon the empirical tests laid out in Appendix 6C but also because they intuitively make sense. The instruments used for the YSS survey models are both substitute activities for smoking. Brown et al. (2006) also found community social capital as expressed by being involved in community organizations such as scouts or sports clubs to be significantly related to smoking behavior. Responses to these questions would not capture respondents' attitudes towards risks because they focus on how adolescents spend their time on activities that do not involve risk.

The NSDUH instruments can be categorized in two camps. One has to do with treatment not related to alcohol, tobacco or drug use and thus predicts smoking behavior but does not capture risk perceptions about smoking and the other has to do with likelihood of an adolescent's exposure to smoking through their peer group. Further logic behind these instrument choices can be found in 6C.

The second important methodological issue is including a variable for sample selection correction in order to account for 'not stated' responses to the 'risk' question (R_i). The sample selection correction included in models corrects for any biases introduced by

dropping the respondents providing no answer.[17] This sample selection variable ($\hat{\lambda}$) was never significant for any regression meaning that dropping the 'not stated' respondents does not significantly alter results.

To perform the above described analysis using the Canadian YSS, the dependent variable in all regressions is a measure of risk perceptions based on the following question asking respondents to select from eight choices, 'the closest to the number of Canadians that die each year as a result of smoking cigarettes'[18] The correct answer is 45,000. Respondents could also respond not state an answer ('not stated'). These respondents were excluded from the analysis and treated for using a sample selection correction as described above. This question requires a significant knowledge component in order to answer it appropriately. The methodological difficulties encountered when eliciting risk perceptions with such a question are discussed in Chapters 4 and 5.

Multivariate analyses contain explanatory variables such as respondent smoking status and attitudes and beliefs about smoking and control variables such as gender, grade, whether the respondent lives in Quebec and income (receipt of weekly allowance). The extended versions of the model also include friends' smoking statuses and interaction terms between control variables and information sources. Separate models are run using different

[17] For the Canadian YSS, 503 (2.6%) of 19,018 respondents did not answer the risk question so dropping these individuals does not significantly alter sample size.
For the US NSDUH, 142 (0.8%) of 18,294 respondents, answered 'don't know,' 14 (0.1%) 'refused' and 3 (0.02%) 'no answer.' Again, dropping these individuals and correcting for them using a sample selection variable as described above does not significantly decrease sample size.
[18] Chapters 4 and 5 denote this question the 'quantitative measure of risk.' Although there are relative measures of risk also included in the YSS, results from Chapter 5 demonstrate their inconsistency in reflecting a relationship between perceptions and behaviors potentially because of their use of reference points in question phrasing. The quantitative measure of risk held a consistent relationship with smoking behaviors therefore this study will employ that measure of risk perceptions for the Canadian YSS going forward.

questions to express doctor or dentist roles in risk perception beliefs because of potential for multicollinearity between responses.

Performing this analysis with the US NSDUH data requires an ordered logit estimation technique because the dependent variable is a qualitative measure of risk asking respondents to indicate whether they think 'smoking 1 or more packs of cigarettes per day' poses 'no risk,' 'slight risk,' 'moderate risk' or 'great risk.'[19] The ordered nature of responses form a Likert scale in which case the ordered probit model offers the best fit. Respondents could also answer 'don't know', 'refused' and 'no answer.'

Multivariate analysis includes socio-demographic, socio-economic variables and household characteristics as control variables. These are gender, age, ethnicity, urban/rural, whether respondent has an income-earning job, family income, whether both parents live in respondents' household and how many individuals less than 18 years live in the respondent's household. The inclusion of all of these controls aims to associate any element of the process of determining risk perceptions that comes from the experience of being in any of these categories (ex. being a female, being an African-American, etc) to these control variables. This allows for a more precise understanding of the determinative roles of the explanatory variables involving parents' roles as information sources about risk perceptions. Models also include a set of variables depicting the nature of the relationship respondents have with their parents. These variables include if parents seldom or never make their child do chores, limit the amount of time they watch television, limit the amount of time they are out on a school night, check if homework do, help with homework, tell

[19] Chapters 4 and 5 undertake more discussion about this measure of risk perceptions from a methodological standpoint.

them they are proud of things they have done, tell them they have done a good job or if the respondent has argued with his parent over ten times in the past year. The extended version of the model also includes variables capturing peers' smoking behaviors to test if including the role of peers as information sources diminishes the significance of parents.

6.3. Results for Canadian YSS data

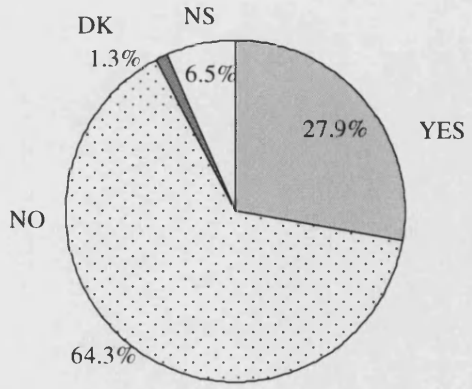
6.3.1. Descriptive findings for Canadian YSS

6.3.1.1. Parents' behaviors and attitudes about smoking

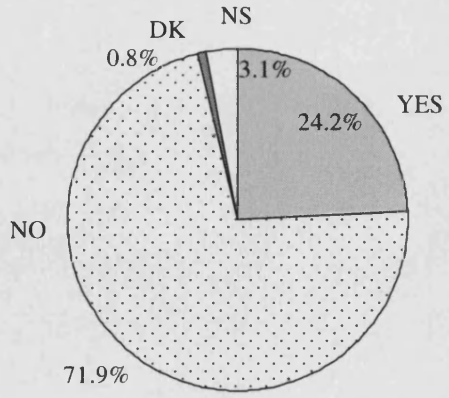
An initial simplistic look at the YSS data provides some ideas about what empirical relationships will be made evident through regression techniques. Figure 9 below shows that it is more likely for fathers to smoke than mothers but respondents are more certain of their mother's smoking behavior than their father's.

Figure 9. Canadian YSS - Father's and mother's current smoking behaviors as reported by their children

Does your father smoke?
If you don't live with your father, but most of the time you live with someone who like a father to you, please answer about this person.
100% = 19,018 respondents



Does your mother smoke?
If you don't live with your mother, but most of the time you live with someone who like a mother to you, please answer about this person.
100% = 19,018 respondents

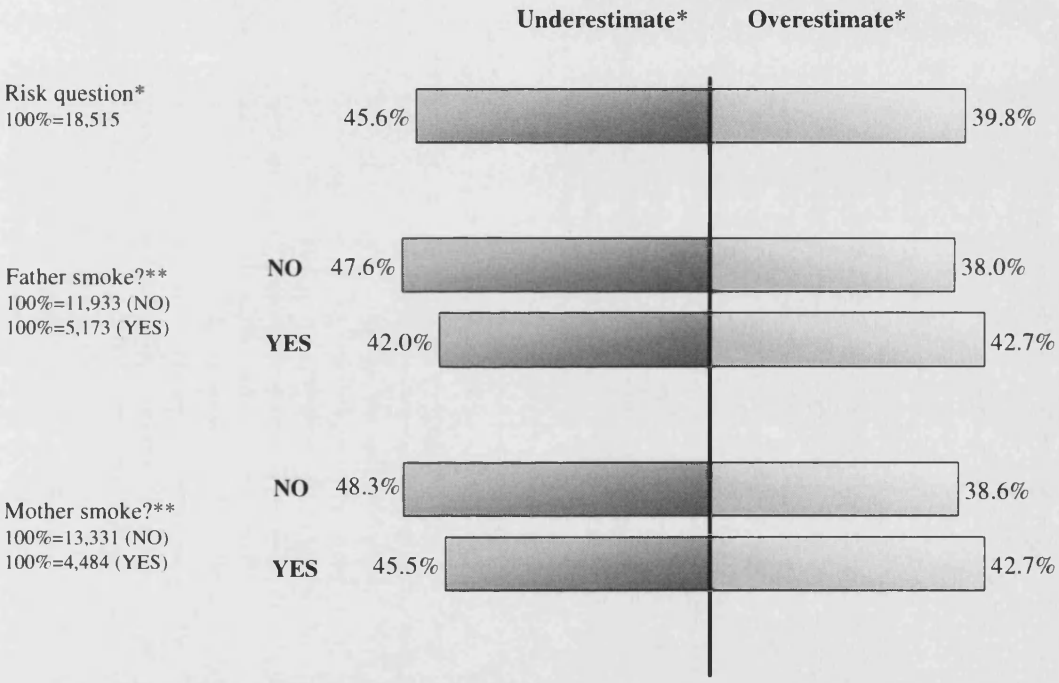


Note: Exact wording of responses is as follows - Yes, No, I don't know, I don't live with a father or anyone like a father (not stated)

Further analysis shows that 13.5% of respondents' have two parents or parental figures that smoke.

Figure 10 shows that both in the case of fathers and mothers, adolescents are more likely to underestimate the risks of smoking mortality when their parents do not smoke (**RQ1**). The converse is true as well, where those whose parents smoke are more likely to overestimate the total population's risks from smoking than those whose parents do not.

Figure 10. Canadian YSS - Risk perceptions about smoking and parental smoking behaviors



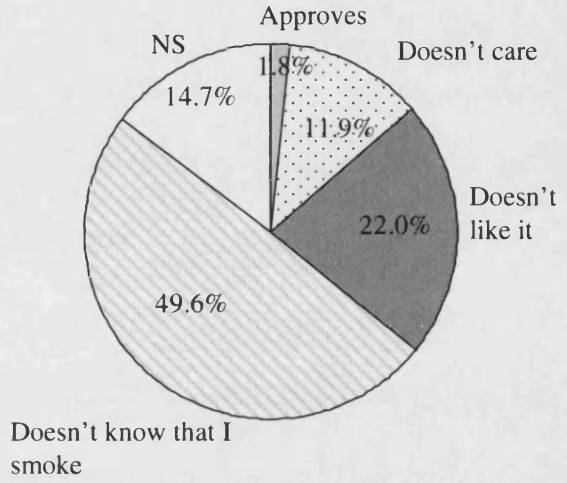
* Risk question is 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

** All figures are of subset who answered risk question

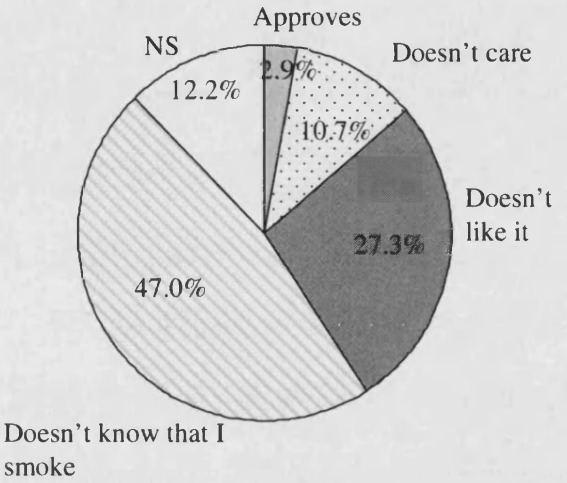
Some differences in adolescents' perceptions of their father's and mother's approval or disapproval of their smoking emerge. Figure 11 displays how respondents are more likely to think that their mother disapproves of their smoking than their father. Additionally, fathers are more likely than mothers to be perceived as not knowing and not caring about their child's smoking.

Figure 11. Canadian YSS - Adolescent smokers' perceptions of parental approval or disapproval about their smoking habits

How does your father feel about your smoking? 100% = 1,244 respondents



How does your mother feel about your smoking? 100% = 1,312 respondents



* NS stands for 'I don't live with a father/*mother* or anyone who is like a father/*mother*'

6.3.1.2. Household behaviors and attitudes about smoking

Of all survey respondents, 31% live in a home where someone smokes inside every day or almost every day. Figure 12 shows the distribution of responses according to number of people smoking inside the home. Similarly to the result found with parental smoking behaviors, a larger percentage of those who underestimate the mortality risks of smoking live in a home where no one smokes inside than those who have correct or overestimated risks (**RQ2**).

Figure 12. Canadian YSS - Number of people that smoke inside the home

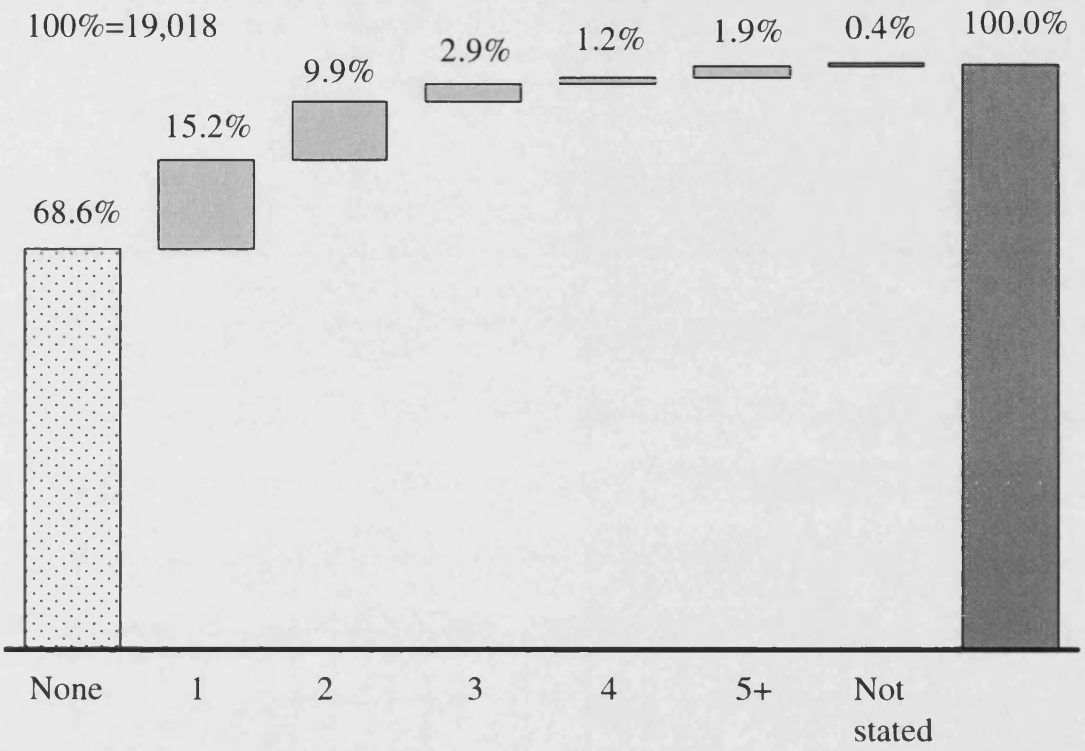


Table 22 displays how many people smoke in a respondent's home given the respondent falling into two categories of risk perceptions (underestimate and correct or overestimate).

Table 22. Canadian YSS - Risk perception responses separated by how many people smoke inside adolescent's home

Number of people who smoke inside home	Underestimate	Correct or Overestimate
0	71.4% (6,028)	66.5% (6,696)
1	14.6% (1,235)	15.5% (1,565)
2	8.8% (746)	10.8% (1,089)
3	2.2% (188)	3.5% (352)
4	1.1% (95)	1.3% (126)
5 or more	1.6% (131)	2.1% (210)
NS	0.3% (25)	0.3% (29)
Total	100% (8,448)	100% (10,067)

Number in parentheses indicates the number of respondents
All questions have 18,515 respondents
Note: Exact wording of questions is as follows – 'Excluding yourself, how many people smoke INSIDE your home every day or almost every day? Do not count those who usually smoke outside. Respondents then write in a number.
Risk question is 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

The group that has correct or overestimated risk perceptions has a larger percentage of respondents with one or more people smoking in the home than the respondents underestimating risks.

A little less than half of respondents (43%) who smoke do so inside their homes. Similarly to the data in the previous table, a higher percentage of individuals with correct or overestimated risk perceptions have had experience with smoking in the home than those underestimating risks (**RQ2**).

Table 23. Canadian YSS - Risk perception responses separated by whether smoke inside their home

Do you smoke INSIDE your home?	Underestimate	Correct or Overestimate
No	54.0% (292)	48.9% (366)
Yes	39.9% (216)	44.3% (331)
NS	6.1% (33)	6.8% (58)
Total	100% (541)	100% (748)

Number in parentheses indicates the number of respondents
Note: Risk question is 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

6.3.1.3. Doctors' and dentists' interactions with adolescents about smoking

Two questions about the interactions respondents have had with medical professionals regarding smoking are relevant to answering **RQ 4-5**. Responses to both questions are depicted below in Table 24.

Table 24. Canadian YSS - Doctors' and dentists' interactions with respondents regarding smoking and using smokeless tobacco

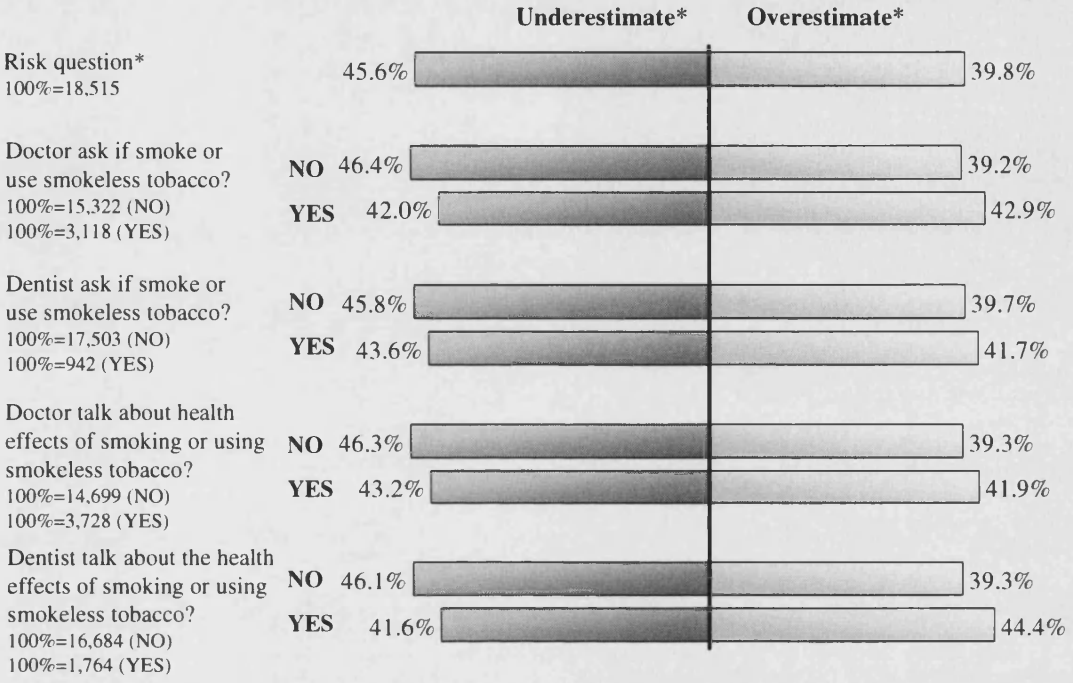
	No	*Yes*	Not Stated
Doctor			
Doctor asked if smoke	81.9% (15,578)	16.7% (3,173)	1.4% (267)
Doctor talked health effects	78.6% (14,947)	19.9% (3,789)	1.5% (282)
Dentist			
Dentist asked if smoke	93.5% (17,786)	5.1% (962)	1.4% (270)
Dentist talked health effects	89.2% (16,958)	9.4% (1,790)	1.4% (270)

Number in parentheses indicates the number of respondents
All questions have 19,018 respondents
Note: Exact wording of questions is as follows – 'Has a doctor/*dentist* ever asked you whether you smoke cigarettes or use smokeless tobacco?' (Yes, No, Not Stated) and 'Has a doctor/*dentist* ever talked to you about what smoking or using smokeless tobacco does to your health?' (Yes, No, Not Stated)

Only 16.7% of respondents had been asked by a doctor about whether they smoked or used smokeless tobacco while only slightly more, 19.9% had been talked to about the health effects of tobacco use. Dentists were even less likely to have discussed these topics with their patients than doctors. 5.1% of students had been asked by a dentist whether or not they smoke while 9.4% had been talked to about the health effects of tobacco use by a dentist. It was more likely for both doctors and dentists to have discussed the health effects related to tobacco use than actually ask their patients about their tobacco-related behaviors.

When examining how patients who did have interactions with a medical professional about tobacco use faired in their assessment of tobacco risks versus those who did not, findings in Figure 13 highlight a link between risk assessment and contacts with a doctor or dentist related to tobacco use.

Figure 13. Canadian YSS - Risk perceptions about smoking and interactions with medical professionals about tobacco use



* Risk question is 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

Respondents who had been asked by a doctor if they smoked or used smokeless tobacco were more likely to overestimate than underestimate mortality related to smoking (**RQ4**). Respondents that were not asked by either a doctor or a dentist about tobacco use habits were more likely to underestimate the risks of smoking than the total respondent population. Dentists asking respondents about their tobacco use appears to make only a minor difference with regards to patients' risk perceptions with respondents almost equally distributed among over- and underestimation of risk perceptions. More patients with whom doctors and dentists did not discuss the health effects of tobacco use underestimated rather than overestimated the mortality risks of smoking (**RQ5**).

6.3.2. Multivariate analysis with Canadian YSS

Separate sets of models were run to depict the influence two different types of interactions healthcare professionals have with respondents, (1) asking respondents if they smoke or use smokeless tobacco (Table 25) and (2) talking to respondents about the health effects of smoking or using smokeless tobacco (Table 26). I also run two versions of each of these two models, varying the number of information sources included, (1) only medical professionals and (2) parents' and household smoking behaviors. For each of these models a separate regression is run treating smoking behavior as exogenous and then endogenous. For all findings variance inflation factors (VIF) were always below 10 for each variable suggesting no evidence of multicollinearity in the models presented.

Findings about respondents' own smoking habits in their home and parental approval of respondents' smoking were inconclusive potentially due to small sample size. These questions were only asked of those respondents who smoke. Results from regressions examining these explanatory variables and related discussions are available in Appendices 6D and 6E

Table 25 presents the results of two regressions that all include variables expressing whether the respondent's doctor or dentist have asked them if they smoke or use smokeless tobacco. The results in columns (3) and (4) add parental and household smoking behaviors thus allowing a comparison of how all of these three information sources impact adolescent risk perceptions. Columns (1) and (3) treat smoking behavior as exogenous and (2) and (4) as endogenous thus using instruments.

Table 25. Canadian YSS - Determinants of risk perceptions about smoking-related mortality with variable about whether health professional (doctor, dentist) asked respondent if they smoked or used smokeless tobacco, parents smoking behaviors

	(1) Simple model with doctors and dentists		(2) Simple model with doctors and dentists (I.V.)		(3) Expanded model with parents and household		(4) Expanded model with parents and household (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior								
Smoked whole cigarette*	-0.02	-0.68	-0.05	-0.21	-0.06	-1.94	-0.22	-0.77
Socio-demographics								
Gender	0.19[a]	9.02	0.18[a]	8.76	0.18[a]	9.02	0.18[a]	8.65
Grade 5	-0.41[a]	-11.45	-0.42[a]	-6.60	-0.42[a]	-11.74	-0.46[a]	-6.27
Grade 6	-0.21[a]	-6.54	-0.22[a]	-3.87	-0.22[a]	-6.83	-0.26[a]	-3.91
Grade 7	-0.10[a]	-3.35	-0.11[b]	-2.43	-0.11[a]	-3.56	-0.14[a]	-2.64
Grade 8	-0.05	-1.68	-0.05	-1.59	-0.05	-1.87	-0.07	-1.90
Quebec	-0.08[a]	-2.93	-0.08	-1.91	-0.08[a]	-3.07	-0.07	-1.55
Economic independence from parents								
Weekly allowance	0.11[a]	4.99	0.11[a]	4.40	0.10[a]	4.66	0.10[a]	4.36
Information sources – medical professionals								
Doctor asked if smoke yes	0.08[a]	2.97	0.09[a]	2.72	0.08[a]	2.73	0.09[a]	2.70
Dentist asked if smoke yes	-0.03	-0.52	-0.03	-0.44	-0.04	-0.82	-0.03	-0.52
Attitudes and beliefs about smoking								
Possible to become addicted	0.05	1.34	0.05	1.36	0.05	1.35	0.06	1.48
Can quit when want	-0.13[a]	-5.47	-0.13[a]	-5.49	-0.13[a]	-5.46	-0.13[a]	-5.42
Smoke can cause nonsmokers harm	0.30[a]	8.27	0.32[a]	8.57	0.30[a]	8.30	0.32[a]	8.57
Information sources – parents and household								
Only father smokes	-	-	-	-	0.08[a]	2.60	0.08[a]	2.57
Father smokes DK	-	-	-	-	0.18	1.74	0.19	1.85
Only mother smokes	-	-	-	-	0.12[a]	3.16	0.12[a]	3.12
Mother smokes DK	-	-	-	-	0.04	0.28	0.06	0.44
Both parents smoke	-	-	-	-	0.07	1.83	0.07	1.82
Number of people who smoke in home	-	-	-	-	0.03[b]	2.32	0.04	1.82
F-stat	37.20 (0.000)		37.38 (0.000)		28.35 (0.000)		28.27 (0.000)	
R^2	0.033		0.033		0.035		0.034	
Hansen j statistic	-		0.667 (0.414)		-		1.234 (0.267)	
Number of observations	18,297		18,119		18,287		18,109	

Notes: All models include robust standard errors

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly' when the column heading includes (I.V.)

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

For all models, doctors' asking respondents if they smoke or use smokeless tobacco proved to have a significant and positive relationship with smoking risk perceptions relative to

doctors not asking respondents about their tobacco use (**RQ4**). Therefore, mediating agents appear to have an influence on individuals' risks perceptions through raising awareness of the objective health effects of smoking. Dentists asking respondents the same question did not prove significant in altering risk perceptions at all.

Father's smoking and mother's smoking as well as both parents smoking have positive and significant relationships with risk perceptions in all models (**RQ1**). The number of people smoking in the respondent's home also has a positive and significant relationship with risk perceptions (**RQ2**). This finding captures not only the impact of parents' behaviors but also siblings and perhaps other family members living in the home.

Table 26 displays the results of two regressions that include variables expressing whether respondents have had a doctor or dentist communicate the health effects of smoking or using smokeless tobacco to them. Columns (3) and (4) include parents and household smoking behaviors. In this model, both doctors and dentists' roles as direct providers of information appear important in determining adolescents' risk perceptions (**RQ5**). The results presented here focus on the key explanatory variables. The full results are available in Appendix 6F.

These models highlight that doctors' talking to respondents about the health effects of smoking or using smokeless tobacco has a significant and positive relationship with smoking risk perceptions relative to doctors not talking to respondents about these issues. In all models, doctors and dentists have a positive determinative power in altering respondents' risk perceptions. Parents' smoking and household smoking maintain a

significant and positive impact on adolescents' risk perceptions across all permutations (**RQ1-2**).

Table 26. Canadian YSS - Determinants of risk perceptions about smoking-related mortality with variable about whether health professional (doctor, dentist) had talked to respondent about the health effects of smoking or using smokeless tobacco

	(1) Simple model with doctors and dentists		(2) Simple model with doctors and dentists (I.V.)		(3) Expanded model with parents and household		(4) Expanded model with parents and household (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior								
Smoked whole cigarette*	-0.02	-0.68	-0.01	-0.06	-0.06	-1.94	-0.18	-0.62
Socio-demographics								
	Included		Included		Included		Included	
Economic independence from parents								
	Included		Included		Included		Included	
Information sources – medical professionals								
Doctor talked health effects yes	0.06 [b]	2.18	0.06	1.96	0.06	1.98	0.06	1.94
Dentist talked health effects yes	0.10 [a]	2.67	0.10 [b]	2.59	0.09 [b]	2.47	0.09 [b]	2.39
Attitudes and beliefs about smoking								
	Included		Included		Included		Included	
Information sources – parents and household								
Only father smokes	-	-	-	-	0.08 [a]	2.60	0.08 [b]	2.56
Father smokes DK	-	-	-	-	0.17	1.72	0.19	1.82
Only mother smokes	-	-	-	-	0.12 [a]	3.20	0.12 [a]	3.12
Mother smokes DK	-	-	-	-	0.04	0.32	0.06	0.47
Both parents smoke			-	-	0.07	1.83	0.07	1.80
Number of people who smoke in home	-	-	-	-	0.03 [b]	2.16	0.04	1.59
F-stat	37.67 (0.000)		37.71 (0.000)		28.61 (0.000)		28.45 (0.000)	
R^2	0.033		0.034		0.035		0.035	
Hansen j statistic	-		0.669 (0.413)		-		1.217 (0.270)	
Number of observations	18,297		18,119		18,287		18,109	

Notes: All models include robust standard errors
(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly' when the column heading includes (I.V.)
[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-values

For models in presented in Tables 25 and 26, relationships between control and explanatory variables are the same. Respondents' smoking behaviors never proved significant in any of these models. Therefore, the directionality of influence goes from risk perceptions affecting behaviors and not past behavioral experience influencing risk perceptions. Male

respondents were more likely to have higher risk perceptions about smoking than females while age was found to be positively related to perceptions of risk. Being a resident of Quebec did not prove to play a significantly determinative role in adolescents' risk perceptions about smoking once the model included instruments. Weekly allowance also demonstrated a positive and significant relationship with risk perceptions.

Attitudes and beliefs about the risks of smoking also were significant determinants of risk perceptions. For all models, respondents thinking that smokers can quit whenever they want had a significant and downward impact on risk perceptions while if they thought that smoke can cause nonsmokers harm, they were more likely to have higher risk perceptions. However, adolescents' thinking it was possible to become addicted to tobacco had no significant determinative impact on risk perceptions.

To further the understanding of the extent to which the role of medical professionals and parents as information sources varies with respondent characteristics; Table 27 includes those interaction terms that proved significant predictors of risk perceptions. Gender, age and receiving a weekly allowance were all separately tested for interactions with medical professionals' communications with respondents, parental behaviors and household smoking behaviors. Age did not prove significant when interacting with any of these information sources. Columns (1), (2) and (3) include variables for medical professionals asking about smoking behaviors. Each model includes more explanatory variables with (2) adding household structure and (3) adding peers' smoking behaviors. Columns (4), (5) and (6) include variables for medical professionals talking about health effects of smoking.

Table 27. Canadian YSS - Determinants of risk perceptions including interaction terms

	(1) Expanded model including doctors and dentists asking about smoking and *parental and household smoking behaviors* (I.V.)		(2) Expanded model including doctors and dentists asking about smoking and *household structure* (I.V.)		(3) Expanded model including doctors and dentists asking about smoking and *peers' smoking behaviors* (I.V.)		(4) Expanded model including doctors and dentists talking about health effects of smoking and *parental and household smoking behaviors* (I.V.)		(5) Expanded model including doctors and dentists talking about health effects of smoking and *household structure* (I.V.)		(6) Expanded model including doctors and dentists talking about health effects of smoking and *peers' smoking behaviors* (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior												
Smoked whole cigarette*	-0.22	-0.76	-0.25	-0.83	-0.79	-1.42	-0.17	-0.61	-0.20	-0.69	-0.73	-1.32
Socio-demographics												
	Included		Included		Included		Included		Included		Included	
Economic independence from parents												
	Included		Included		Included		Included		Included		Included	
Household structure characteristics												
Lives one parent and partner	-	-	0.10[b]	2.33	0.10[b]	2.25	-	-	0.09[b]	2.25	0.10[b]	2.20
Lives one parent	-	-	0.06	1.68	0.09[b]	2.19	-	-	0.06	1.65	0.09[b]	2.17
Lives shared custody	-	-	0.06	0.89	0.08	1.22	-	-	0.06	0.91	0.09	1.25
Information sources – medical professionals												
Doctor asked if smoke yes	0.14[a]	3.25	0.14[a]	3.24	0.12	2.62	-	-	-	-	-	-
Dentist asked if smoke yes	-0.03	-0.50	-0.03	-0.47	-0.02	-0.35	-	-	-	-	-	-
Doctor talked health effects yes	-	-	-	-	-	-	0.06	1.92	0.06	1.92	0.06	1.78
Dentist talked health effects yes	-	-	-	-	-	-	0.19[a]	3.54	0.19[a]	3.55	0.14[b]	2.31
Interaction terms with information sources –medical professionals												
Weekly allowance * Doctor *asked* if	-0.10	-1.80	-0.10	-1.81	-0.06	-1.06	-	-	-	-	-	-

smoke yes												
Weekly allowance * Dentist *talked health effects* yes	-	-	-	-	-	-	-0.19 [a]	-2.74	-0.19 [a]	-2.74	-0.16 [b]	-2.03
Attitudes and beliefs about smoking												
	Included		Included		Included		Included		Included		Included	
Information sources – parents and household												
Only father smokes	0.08 [b]	2.54	0.08 [b]	2.42	0.09 [a]	2.76	0.08 [b]	2.52	0.08 [b]	2.40	0.09 [a]	2.76
Only mother smokes	0.12 [a]	3.09	0.11 [a]	2.91	0.11 [a]	2.61	0.12 [a]	3.10	0.11 [a]	2.92	0.11 [a]	2.61
Both parents smoke	0.07	1.84	0.06	1.59	0.06	1.53	0.07	1.82	0.06	1.58	0.06	1.53
Number of people who smoke in home	0.04	1.81	0.04	1.77	0.07 [a]	2.96	0.04	1.59	0.03	1.54	0.06 [a]	2.81
Interaction terms with information sources - parents												
Gender * Father smokes DK	0.41 [b]	2.01	0.41 [b]	2.03	0.30	1.32	0.41 [b]	2.00	0.41 [b]	2.02	0.29	1.31
Gender * Mother smokes DK	-0.41	-1.61	-0.41	-1.62	-0.27	-0.98	-0.41	-1.63	-0.42	-1.64	-0.26	-0.98
Weekly allowance * Mother smokes DK	-0.47	-1.76	-0.47	-1.74	-0.79 [a]	-2.65	-0.47	-1.77	-0.47	-1.76	-0.78 [a]	-2.65
Information sources - friends												
Percent of friends that smoke	-	-	-	-	0.36	1.12	-	-	-	-	0.33	1.02
F-stat	24.37 (0.000)		21.29 (0.000)		18.79(0.000)		24.79 (0.000)		21.66 (0.000)		19.00 (0.000)	
R^2	0.035		0.035		0.015		0.036		0.036		0.019	
Hansen j statistic	1.222 (0.269)		1.417 (0.234)		1.177 (0.278)		1.258 (0.262)		1.455 (0.228)		1.256 (0.262)	
Number of observations	18,109		18,109		16,066		18,109		18,109		16,066	

Notes: All models include robust standard errors

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.'

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

The roles of doctors, dentists and parents remain the same as in the models above with all parties exerting significant determinative power on adolescents' risk perceptions (**RQ1** and **2, RQ4** and **5**). Therefore, even when peers' smoking behaviors are included in the model (expressed by percentage of a respondents' friends that smoke), these individuals' actions remain significant and are actually significant at the 95 or 99% level whereas peer smoking is significant at 90% or 95%.[20] Other control and explanatory variables also remain the same except smoking behavior becoming significant in those regressions including peers' smoking behaviors.

Household structure also demonstrated predictive power but as expected does not alter the impact of various information sources on risk perceptions and actually gains significance when peers' smoking behavior is added to the model. This means that with the addition of the peers' smoking variable, the role of household smoking becomes more defined as peers' smoking picks up some of the variance attributed to household smoking. Results show that those individuals who live in homes with one parent and his/her partner or one parent have higher risk perception regarding smoking than those who live with both parents.

Interaction terms provide greater insight into which groups medical professionals and parents most impact. If individuals receive a weekly allowance and their doctor asked them about their smoking habits or dentist talked about the health effects of smoking, then these individuals appear to have lower risk perceptions than those not receiving an allowance or interacting with a doctor or dentist (**RQ4**). Therefore, receiving a weekly allowance may negate the impact of a medical professionals' ability to convey the risks of smoking.

[20] Further analysis of the impact of peers on adolescents' risk perceptions is the subject of Chapter 7.

Another interaction term proving significant is that if an adolescent receives a weekly allowance and does not know if his mother smokes then risk perceptions are more likely to be low (**RQ1**). This finding suggest that lack of parental involvement in their child's life as proxied by respondents receiving an allowance to purchase items for themselves has an impact on perceptions of risk as these respondents are lacking parental influence to act as information sources about smoking risks.

6.4. Results for US NSDUH data

6.4.1. Descriptive findings for US NSDUH

Examining the distribution of respondent's responses regarding their parents' smoking among answers to the question about smoking risks highlights some potential connections between parents' and adolescents' risk perceptions about smoking. Table 28 displays the answers to a question about how adolescents think that their parents would feel about them smoking one or more packs of cigarettes per day. These answers are distributed across responses to the question of how much risk adolescents believe that smoking at least one pack of cigarettes per day poses.

Table 28. US NSDUH - How respondents think their parents would feel about them smoking one or more packs of cigarettes per day distributed among respondent risk perceptions

Risk of smoking	Neither approve nor disapprove	Somewhat disapprove	Strongly disapprove	*Don't Know*	*Refused*	*No answer*
No risk	**8.2% (67)**	2.9% (25)	1.3% (206)	**7.7% (14)**	9.1% (4)	0.0% (0)
Slight risk	14.3% (117)	9.6% (83)	4.4% (708)	**8.8% (16)**	15.9% (7)	0.0% (0)
Moderate risk	27.6% (226)	37.8% (327)	24.6% (3,992)	30.4% (55)	27.3% (12)	0.0% (0)
Great risk	50.0% (410)	49.7% (429)	**69.8% (11,317)**	53.0% (96)	47.7% (21)	100.0% (3)
Total	100.0% (820)	100.0% (864)	100.0% (16,223)	100.0% (181)	100.0% (44)	100.0% (3)

Numbers in parenthesis indicates the number of respondents
Note: Exact wording of question is as follows – 'How do you think your parents would feel about you smoking one or more packs of cigarettes per day?' Potential responses are 'Neither approve nor disapprove,' 'Somewhat disapprove,' 'Strongly disapprove,' Don't know,' 'Refuse,' 'No answer.'

This table shows that those adolescents who think that their parents would neither approve nor disapprove and those who don't know what their parents think about them potentially smoking are more likely to associate smoking with no risk than their peers whose parents have conveyed a message of disapproving of this behavior. Likewise, adolescents who think that their parents would strongly disapprove of their smoking are more likely to perceive smoking as being of great risk. Therefore we see some relationship at the descriptive level between parental disapproval of smoking behavior and their child's risk perceptions (**RQ2**).

Contributing further evidence that parents matter in the way adolescents perceive the risks of smoking, Table 29 distributes responses with regards to adolescents' experiences with the parents talking to them about the danger of tobacco, alcohol or drug use among risk perception responses.

Table 29. US NSDUH - Experience talking with parents about dangers of tobacco, alcohol or drug use distributed among respondent risk perceptions

Risk of smoking	Yes	No	*Don't Know*	*Refused*	*No answer*
No risk	1.5% (163)	**2.1% (146)**	2.9% (3)	11.8% (4)	0.0% (0)
Slight risk	4.3% (471)	**6.4% (453)**	3.8% (4)	8.8% (3)	0.0% (0)
Moderate risk	24.6% (2,687)	26.7% (1,889)	25.7% (27)	26.5% (9)	0.0% (0)
Great risk	**69.6% (7,603)**	64.8% (4,581)	**67.6% (71)**	52.9% (18)	100.0% (3)
Total	100.0% (10,924)	100.0% (7,069)	100.0% (105)	100.0% (34)	100.0% (3)

Numbers in parenthesis indicates the number of respondents
Note: Exact wording of question is as follows – 'During the past 12 months, have you talked with at least one of your parents about the dangers of tobacco, alcohol, or drug use? By parents, we mean either your biological parents adoptive parents, stepparents, or adult guardians – whether or not they live with you.' Potential responses are 'Yes,' 'No,' Don't know,' 'Refuse,' 'No answer.'

These results suggest that if parents have spoken to their adolescent children about the risks of tobacco, alcohol or drug use, then these adolescents are more likely to perceive smoking risks as great than the children of those parents who have not had a discussion about the topic (**RQ3**). The differences in percentages are noticeable but not dramatic therefore multivariate regression may be able to reveal more about that relationship.

6.4.2. Multivariate analysis with US NSDUH

The models using the US NSDUH data to test the role of parents as information sources are either ordered logit when treating smoking as exogenous or instrumented OLS regressions when using instruments. For all findings variance inflation factors (VIF) were always below 10 for each covariate suggesting no evidence of multicollinearity in the models presented.

Table 30 shows results of four models where risk perceptions as a four response Likert scale serves as the dependent variable and a variety of control and explanatory variables are assessed for their determinative power with regards to risk perceptions. Two measures of parents' roles as information sources are included in all regressions. The first being whether a respondent's parent has talked to the respondent about the dangers of smoking

and the second being how the respondent thinks their parent feels about them smoking. Model in columns (3) and (4) include variables expressing the nature of respondents' relationship with their parents such as whether they make the respondent do chores around the hose, limit the amount of TV he/she watches, limit the amount of time the respondent stays out on school nights, checks if homework is done, helps with homework, tells the respondent they are proud of them, never tells them they did a good job and how many times the respondent has argued with their parent. The model in column (4) includes peers' smoking behaviors in order to test the strength of the role of parents as information sources.

Table 30. US NSDUH - Determinants of risk perceptions about smoking-related physical harm including variables expressing parents' roles as information sources about smoking risks

	(1) Simple model with parents variables		(2) Simple model with parents variables (I.V.)		(3) Expanded model with parental relationship variables (I.V.)		(4) Expanded model with peers' smoking behaviors (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior								
Smoked a cigarette*	-0.41 [a]	-10.73	-0.17	-0.99	-0.19	-0.90	-0.20	-0.84
Socio-demographics								
Gender	-0.44 [a]	-13.71	-0.13 [a]	-12.52	-0.13 [a]	-12.93	-0.13 [a]	-11.67
Age	0.07 [a]	6.07	0.03	1.87	0.03	1.83	0.03 [b]	2.29
Black Afr-Amer	0.09	1.58	-0.01	-0.29	0.00	0.15	0.00	0.13
Native American/AK Native	0.06	0.40	-0.02	-0.37	0.00	-0.05	0.00	-0.02
Native HI/Pac Islands	-0.08	-0.24	-0.03	-0.27	-0.02	-0.15	-0.01	-0.14
Asian	0.06	0.54	-0.02	-0.39	-0.01	-0.27	-0.01	-0.33
More than one race	0.10	1.20	0.04	1.55	0.04	1.66	0.04	1.70
Hispanic	-0.05	-0.97	-0.03	-1.74	-0.02	-0.96	-0.02	-1.00
MSA under 1 million	-0.03	-0.89	-0.01	-0.54	-0.01	-0.54	-0.01	-0.49
Not in MSA	-0.07	-1.68	-0.01	-0.62	-0.01	-0.43	-0.01	-0.38
Economic independence from parents								
Receive income from job	0.07	1.61	0.02	1.41	0.02	1.40	0.02	1.35
Socio-economics								
Family income	0.04 [a]	3.96	0.02 [a]	4.27	0.01 [a]	3.22	0.01 [a]	3.35
Household characteristics								
Two parent household	0.07	1.68	0.02	1.26	0.02	1.26	0.02	1.21
Number of under 18s in HH	-0.04 [b]	-2.01	-0.02 [b]	-2.53	-0.02 [b]	-2.49	-0.02 [b]	-2.50
Information sources – parents								
Parents talked dangers NO	-0.17 [a]	-5.09	-0.05 [a]	-4.27	-0.04 [a]	-3.52	-0.04 [b]	-3.53
Feel parents somewhat disapprove of smoking	0.16	1.58	0.14 [a]	3.04	0.14 [a]	2.92	0.14 [a]	2.95
Feel parents strongly disapprove of smoking	0.88 [a]	10.54	0.37 [a]	7.24	0.35 [a]	6.16	0.34 [a]	5.92
Information sources – relationship with parents								
Seldom or never make do chores in house	-	-	-	-	0.00	0.05	0.00	0.06
Seldom or never limit amount of TV	-	-	-	-	0.00	-0.10	0.00	-0.09
Seldom or never limit time out on school night	-	-	-	-	-0.03 [b]	-2.20	-0.03 [b]	-2.20

Seldom or never check if homework done	-	-	-	-	0.00	0.34	0.00	0.34
Seldom or never help with homework	-	-	-	-	-0.01	-0.37	-0.01	-0.34
Seldom or never tell proud of things done	-	-	-	-	-0.02	-0.81	-0.02	-0.74
Seldom or never tell done good job	-	-	-	-	-0.02	-1.17	-0.02	-1.18
Argued with parent 10+ times in past year	-	-	-	-	0.02	0.89	0.02	0.97
Information sources – peers								
Few stdnts smoke	-	-	-	-	-	-	-0.01	-0.22
Most stdnts smoke	-	-	-	-	-	-	0.00	-0.05
All stdnts smoke	-	-	-	-	-	-	-0.03	-0.31
Stdnts smoke DK	-	-	-	-	-	-	0.05	1.21
F-stat	-		27.8 (0.000)		17.67 (0.000)		15.42 (0.000)	
Pseudo/Centered R^2	0.026		0.051		0.054		0.054	
Wald χ^2	737.79		-		-		-	
Hansen j statistic	-		2.142 (0.343)		2.312 (0.315)		2.254 (0.324)	
Number of observations	18,135		17,983		17,983		17,983	

Notes: All models include robust standard errors.
(*) Instrumented using questions asking respondents about during the past 12 months, 'did you receive treatment or counseling from a pediatrician or other family doctor for emotional or behavioral problems not caused by alcohol or drugs,' 'did you receive treatment or counseling at a mental health clinic or center because you had problems with your behavior or emotions not caused by alcohol' and 'have you been home-schooled at any time during the past 12 months?' when the column heading includes (I.V.)
[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-values

Displaying the non-instrumented simple and expanded models treating smoking behavior as exogenous highlights the impact of instrumenting the smoking behavior variable as it becomes insignificant upon instrumentation. The coefficients on the ordered logit model in column (1) are not directly interpretable meaning that no comparison between the impact of each explanatory variable can be made. The coefficients on the instrumented models in columns (2-4) are all interpretable in a relative sense. However, the significance and directionality of the coefficients are interpretable for all models. This suggests that initiating smoking behavior does not have a determinative influence on risk perceptions.

As this is only longitudinal data, this finding could change once alterations in risk perceptions with behavioral changes could be examined.

With regards to the role of parents as information sources, these findings highlight the importance not only of parents actually providing information about the dangers of smoking but also perceptions of parent approval or disapproval regarding smoking (**RQ2**). Whether respondents' parents talked to respondents about the dangers of smoking was positively and significantly related to risk perceptions while respondents feeling that their parents somewhat or strongly disapprove of them smoking also had a positive and significant relationship with risk perceptions. This finding remains true even when further information about respondents' relationships with their parents is revealed.

Variables expressing the kind of relationships respondents have with their parents suggest that the nature of interactions respondents have with their parents appear not to have a significant impact on their perceptions of risk (**RQ3**). Only parents seldom or never limiting the respondent's time out on a school night appeared significantly related to risk perceptions. Those respondents whose parents do not limit their time out on school night are more likely to have lower perceptions about the risks of smoking than those whose parents limit the time they are out. This finding could be reflecting less about the respondent's relationship with his parents and more about what happens when respondents stay out late at night, namely the development of their perceptions about smoking risks.

When variables capturing peer smoking are included, the role of parents both as information sources about the dangers of smoking and respondents' perceptions of parental disapproval of smoking remain significant (**RQ2** and **RQ3**). However, the peer smoking

variables do not emerge as significant therefore this expression of peer influence does not demonstrate a role in adolescent risk perception development.[21]

As for control variables, gender and age were the only significant socio-demographic variables with males being less likely to attach high risks to smoking than females and age being positively related to risk perceptions. Ethnicity and being from an urban or rural area as denoted by MSA (Metropolitan Statistical Area)[22] status do not prove significant predictors of risk perceptions in any of the models.

Respondents having an income earning job demonstrated no significant relationship with risk perceptions but family income appears to have a positive and significant relationship. Both parents living in the same household had no significant impact on risk perceptions but respondents coming from households with a higher numbers of siblings (or others under 18 years) were more likely to have lower risk perceptions about smoking.

Models to test the veracity of these findings through a series of empirical robustness checks support the findings from above. These checks involved changing the form of the dependent variable in multiple ways as well as running predicted values of the smoking behavior variable. Results and an explanation of the empirical checks can be found in Appendix 6G. The fact that all of these permutations of the original model presented in Appendix 6G support the finding that smoking behavior has no determinative influence on risk perceptions highlights the robustness of this finding. Similarly, the significance of how

[21] Chapter 7 will further investigate the role of peer effects in the development of risk perceptions.
[22] A MSA must have one urbanized area of more than 50,000 inhabitants (U.S. Census 2005).

respondents perceive that their parents feel about smoking remains the same across all models thus supporting the robustness of this finding as well (**RQ2**).

6.5. Discussion

Findings indicate that parents, doctors and dentists all can play crucial roles in determining adolescents' perceptions of smoking risks. This section will discuss results categorized by each of the research questions posed.

6.5.1. RQ1 - RQ3 - Parents as an information source about smoking risks

Parents' influence on adolescents' risk perceptions about smoking was found to occur when using multiple measures of influence across two data sets. This study takes a broad definition of the term' information source' by assuming that individuals can act as information sources not only by directly offering information to a recipient about smoking risks but also through the example of their own smoking behavior and attitudes regarding smoking and being around smokers. Both in the narrow sense of 'information sources' and in the more broad definition, parents appear to have a role. In the YSS, parental smoking and house rules about smoking and therefore parental attitude about smoking in the house were found to be significantly related with risk perceptions. Similarly, for the NSDUH, parents talking to respondents about the dangers of smoking and respondents feeling that their parents' disapprove of smoking (perception of parental attitude) were found to be significant determinants of risks associated with smoking.

Findings from the YSS suggest that adolescents learn about smoking risks from their parents' behaviors and more generally the household their parents create as an example (**RQ1** and **RQ2**). However, directionally, findings appear surprising at first glance. Either a respondent's mother OR father smoking translates into adolescents being more likely to

have higher risk perceptions about smoking. Therefore, being around smoking and seeing parents smoke appears to be giving respondents more experience with smoking and thus raising their perceptions of risks attached (**RQ1**). The significant role of household smoking behaviors is not unexpected given that the household constitutes the greatest sources of secondhand smoke exposure for adolescents (Department of Health and Human Services, 2006). These findings provide further evidence of potential intergenerational transmission of risk attitudes from parents to their children (Dohnmen et al., 2005; Dohmen et al., 2008). Results also support the previous work of Halpern-Felsher and Rubinstein (2005) finding that when adolescents were asked about the risks of secondhand smoke from parents, the workplace and friends, parental secondhand smoke had the highest risk perceptions attached to it relative to the other sources. In the risk literature in general, however, the more individuals have experience with a risk, the more likely they are to hold lower risk perceptions about it. This has been found in the case of technical experts on nuclear energy versus the general population (Fischhoff et al. 1978).

Living with a smoker or smokers could be so obviously risky to respondents that they attach levels of risk to smoking higher than the true risk. However, if someone lives with a smoker, the mortality risk for smoking is higher for them so they may not actually be overestimating risks. Even though the risk perceptions question asks about mortality risks for the entire population of Canada, respondents could still be answering as they view their own personal risk. Those with no smokers in their home have a lower risk than the rest of the population of contracting a smoking-related illness so this result may demonstrate how people process changes in risk with different environments and how even though the question is about the general population's risk, respondents still focus on their own personal risk.

Smelling and breathing smoke, experiencing any ill health-effects themselves or seeing their parents ill as a result of smoking-related conditions could all contribute to parental smoking being positively related to respondent risk perceptions. Individuals who experience health-related risks due to smoking are more likely to quit as health events are the most salient form of information an individual can receive about health risks (Carbone et al., 2005; Coleman et al., 2003; Khwaja et al., 2006; Sloan et al., 2003; Smith et al., 2001). This study is limited by lack of data on parent and familial health events related to smoking and therefore could not test for their impact. Although simply having a parent who smokes is not as severe as a personal health shock, perhaps simply experiencing smoking does not result in positive expectations about the behavior. As parents appear to be acting as information sources about smoking risks to adolescents through their behavioral example this result indicates that as adolescents become more aware of the acute side effects and environmental effects of smoking, the more likely they are to think of it as risky. This finding highlights a gap in adolescents' understanding of risk perceptions as they turn to their parents' non-utility maximizing behavior to acquire information pointing to the importance of more fruitful means of achieving the same increase in risk perceptions.

An interaction term used in the YSS models between respondents' gender and not knowing if their father or mother smokes proved a significant predictor of risk perceptions. If respondents are male and they don't know if their father smokes, then they are more likely to have higher risk perceptions regarding smoking. However, if respondents are female and they don't know if their mother smokes then this plays an insignificant role in determining risk perceptions. This result demonstrates the importance of gender-specific parental relations for boys in making decisions about smoking risks. Girls make decisions about

smoking risks relying on other sources, which will be discussed at length in the next chapter on peer effects.

Parental attitude about smoking in the home also appears to impact adolescents' risk perceptions in the same positive direction (**RQ2**). The more people smoke in a respondent's home, the higher risk perceptions are likely to be. Again, greater experience with the environmental effects of smoking (i.e. what it is like to live with a smoker) appears to give respondents more knowledge about the risks of smoking.

The NSDUH data allows a direct examination of the place of parents as information disseminators about smoking risks (**RQ3**). This study does not support findings of Lundborg (2007) suggesting that direct information from parents about smoking risks has an insignificant influence on adolescent risk perceptions. Instead, parents talking about the dangers of smoking demonstrated a positive and significant effect on adolescent risk perceptions. Once again, where individuals appear to acquire more information about smoking, they perceive risks to be higher. These results support the hypothesis that adolescents do in fact appear to rely on their parents as agents to aid in their risk perception development process since parents have more experience on the subject and are given a place of authority as parental figures.

An additional measure of parents' roles in risk perceptions used in the NSDUH captures how respondents' perceptions of their parents' attitudes about smoking impact their own risk perceptions (**RQ2**). Results suggest that where respondents think that their parents disapprove of smoking, they are more likely to have higher risk perceptions. Therefore, respondents appear to acknowledge and adopt their parent's utility setting with regards to

smoking risks. This also further supports an argument suggesting that parents act as agents for their adolescent offspring making decisions about perceptions of smoking risks.

This was not the case with the YSS as parents' views about smoking did not demonstrate a significant effect on adolescents' risk perceptions but as explained in Appendix 6E, the small sample size of less than 1200 respondents and this question only being asked of respondents who smoke makes these results in comparable to those of the NSDUH as they examine different population (smokers versus all respondents).

However, overall, it can be said that findings from the YSS and NSDUH reveal respondents using their parents as sources of information (and perhaps agents) to develop their perceptions of risk. In one instance, it is by watching their behavior (YSS) and in another it is by knowing their attitudes (NSDUH). Therefore, in both cases adolescents use their parents' as agents of information. Especially in the case of the YSS where respondents are under the age of 16, respondents may not have many peers who actually smoke, therefore parents may be the only source of experience they have in knowing someone who smokes.

Including information about the nature of respondents' relationships with their parents in models using the NSDUH data such as if they help respondents with their homework or make them do chores at home did not prove significant predictors of risk perceptions except the variable capturing if parents limit the time respondents went out on school nights. The general lack of significance attached to the nature of parental relationships and more importantly the fact that the significance on the parents as information sources variables did not change, suggests that parents' roles remain consistent regardless of the relationship they have with their children. In other words, when these new variables are added to give a

better picture of respondents' parental relationships, they do not pick up any of the same characteristics of what determines respondents' risk perceptions about smoking as the variables testing parents' roles as information sources. This finding speaks to the robustness and universality of the importance of parents in the risk perception development process regardless of the nature of relationship they have with their children.

The finding that those respondents whose parents seldom or never limit their time out on a school night are more likely to have lower risk perceptions is probably picking up the fact that when respondents' stay out late on a school night they would be with their peers. They may be gaining experience, directly or indirectly about smoking through being with peers. Therefore, like in the case of being around parents who smoke in the YSS models, if respondents spend time out late with their friends gaining experience with smoking, they are more likely to have higher risk perceptions.

6.5.2. RQ4 - RQ5 - Doctors and dentists as information sources about smoking risks

Only the YSS asks respondents about the conversations they have had with these medical professionals about their smoking behaviors (acting as an indirect source of information about risks) (**RQ4**) or the role doctors and dentists have played in their understanding of smoking dangers (acting as a direct source of information about risks) (**RQ5**). Findings point to the crucial role medical professionals can have in determining adolescents' risk perceptions and support the hypothesis that these figures act as agents for adolescents' decision-making about risks.

Doctors asking respondents about their smoking behavior was associated with higher risk perceptions. For dentists, this variable was insignificant (**RQ4**). One explanation for this

finding is that because an individual's dental care coverage may vary greatly, then the role the dentist plays in a respondent's life in terms of how often they see the dentist and for how long may cause significant variation in the credibility adolescents place on this individual. In general, however, findings about both medical professionals pointed to an underutilization of these resources as information for respondents about risk perceptions regarding smoking simply because only 16.7% of respondents were asked about smoking while only 5.1% of dentists asked this question.

Medical professionals acting as direct sources of information about smoking risks by talking about the health effects of smoking proved consistently significant for doctors and dentists with respondents being more likely to have higher risk perceptions about smoking if they had these conversations with a doctor or dentist (**RQ5**). For doctors, however, this variable is only significant at the 10% level whereas for dentists it is at the 1% or 5% level in all models. Again, findings at the descriptive level point to underutilization of doctors and dentists as an information source with less than a quarter of doctors and ten percent of dentists talking about the health effects of smoking with their patients. This supports previous research pointing to the lack of preventive actions performed by doctors (Klein 1995; Thorndike et al. 1999; Vokes et al. 2006) and dentists (Dolan et al. 1997).

Both of these sets of findings support previous working suggesting that adolescents are open to receiving information from their doctors about health behaviors (Klein 1995) and support the concept of adolescents using medical professionals as agents to reduce the informational asymmetry faced by adolescents versus medical professionals. Previous work on how adults' risk perceptions have changed as a result of physician interventions reached the same findings as this study (Klein 1995). This study supports two studies

examining how doctors play a role in altering adults' risk perceptions about smoking which found that those patients who receive some kind of smoking-related physician intervention are be more likely to have higher risk perceptions (Bock et al. 2000; Bock et al. 2001). Lundborg (2007) looked at the impacts of many information sources on adolescents' risk perceptions but did not include medical professionals in his model.

This is the only study analyzing the impact of dentists on adolescents' risk perceptions about smoking. These mixed results about dentists' abilities to aid in adolescents' development of risk perceptions would be expected because of previous research showing that dentists may (Hovell et al. 1996)) or may not (Kentala et al. 1999) have an impact on adolescents' smoking behavior. Importantly, in this case, however, is the variable particularly capturing dentists' offering information to adolescents about smoking dangers always being significant thereby pointing to potential for dentists to influence their adolescent patients.

Findings from interaction terms about the relationship between respondents receiving a weekly allowance and whether doctors and dentists act as information sources present a statement about how independence matters. Let us assume that those respondents who receive a weekly allowance are more independent from their parents than those who do not because presumably they use this allowance to support their lifestyle. When respondents receive a weekly allowance they were found to no longer alter their risk perceptions in a positive direction upon information from medical professionals. Instead, they actually perceived risks as lower if they received a weekly allowance and the medical professional offered them information about smoking or asked them about their smoking habits. This finding highlights a relationship between respondents feeling independent to make their

own decisions economically and listening to others. Therefore, where individuals feel more individually empowered on the economic end, then they are less likely to care what the doctor or dentists discusses with them regarding smoking or smoking risks.

6.5.3. Other explanatory variables

A summary table of results regarding explanatory and control variables appears below in Table 31. This table as well as a discussion about these findings can be found in Appendix 6H.

Table 31. Summary table of directions of control and explanatory variables

	Canada – YSS	**US - NSDUH**
	Risk perceptions	*Risk perceptions*
	Smoking behavior	
Smoked whole cigarette/a cigarette	None	None
	Socio-demographics	
Gender (male =1)	Positive	Negative
Age	Positive	Positive
Quebec (relative to other provinces)	Negative	-
Black Afr-Amer	-	None
Native American/AK Native	-	None
Native HI/Pac Islands	-	None
Asian	-	None
More than one race	-	None
Hispanic	-	None
MSE under 1 million	None	-
Not in MSA	None	-
	Economic independence from parents	
Weekly allowance	Positive	-
Receive income from job	-	None
	Socio-economics	
Family income	-	Positive
	Attitudes and beliefs about smoking	
Possible to become addicted	None	-
Can quit when want	Negative	-
Smoke can cause nonsmokers harm	Positive	-
	Household characteristics	
Two parent household	Negative	None
Number of under 18s in household	-	Negative

Note: Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'none.'
'-' means that this variable is not included in the dataset

Note: Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'none.'
'-' means that this variable is not included in the dataset

Of particular note are findings about attitudes and beliefs related to smoking having a significant impact on risk perceptions. This result offers support for the conceptual framework presented in Chapter 2 that posited beliefs as having influence over risk perceptions.

A key finding of note is that in analysis using the YSS data and the NSDUH data, smoking behavior was not a significant predictor of risk perceptions. For the NSDUH, instruments were needed in order for smoking behavior to be insignificant but with the use of valid instruments, all models, including those used for robustness checks pointed towards an insignificant relationship between whether or not someone had smoked a cigarette and their risk perceptions.

This finding is especially important when looked at in conjunction with findings from Chapter 5 where risk perceptions are found to significantly predict smoking behavior. Therefore, this study establishes the directionality of influence between perceptions and behavior. This finding is in disagreement with some previous research on adult populations where behavior was found to be positively and significantly related (Antoñanzas et al. 2000) and negatively and significantly related (Costa-Font and Rovira 2005; Liu and Hsieh 1995; Viscusi 1992*b*) with risk perceptions. However, in some cases these findings are reported without controlling for potential endogeneity in the smoking status variable (Antoñanzas et al. 2000). On the other hand, these results support Lundborg's (2007) work with an adolescent survey population finding smoking behavior to be an insignificant

predictor of risk perceptions once smoking is treated as endogenous. In this study, the fact that two datasets using different measures of risk and very similar measures of smoking behavior both met the same conclusion strengthens the robustness of this result.

6.6. Conclusion

This analysis has empirically investigated the role of parents, doctors and dentists as information sources for adolescents when developing their risk perceptions about smoking. It tests the role of these adult figures acting as agents with more information than the adolescents they come in contact with either as their children or patients.

Although the two datasets used employ different ways to measure the influence of parents, both datasets have demonstrated the significant role of parents not only as direct information sources about smoking risks but also more indirectly by the smoking rules they set at home and the perceptions their children have about their approval of smoking behaviors. The role of doctors and dentists could only be tested using one dataset but the direct and indirect dissemination of information by medical professionals about smoking risks were found to be predictors of risk perceptions. Doctors asking about respondents' smoking behavior and doctors and dentist providing direct information about the health effects related to smoking all appear significant predictors of adolescents' risk perceptions pointing to their importance as a policy tool for mitigating the chances of adolescents having inaccurate perceptions of smoking risks.

This chapter, in conjunction with findings from Chapter 5 also points to the directionally of influence between smoking and risk perceptions with risk perceptions appearing to determine behavior and behavior not appearing to determine risk perceptions. This further

strengthens the importance of understanding the development of adolescents' risk perceptions in order to ensure that the smoking decision is replete with conceptions of risk as close to reality as possible.

Findings from this chapter support a key underlying assumption of this thesis that because of adolescents' limited personal experience with smoking at the ages tested in this study, this population relies on exogenous information source to develop perceptions of risks. While the roles of adult figures individually known to respondents appears universally important for predicting adolescents' risk perceptions, the understanding of additional exogenous information sources more environmental and societal in nature remains.

Chapter 7. The influence of peers on adolescents' perceptions about smoking risks

Further developing on the second research question from Chapter 1, this chapter extends the analysis presented in Chapter 6 to examine the impact of peers as information sources for adolescents developing risk perceptions about smoking.

(2) Which sources of information do adolescents rely on to inform their perceptions of risks?

Smokers exert a dangerous, negative externality on non-smokers not only directly by causing them potential harm from second hand smoke but also indirectly by influencing their perceptions about smoking. However, very limited empirical evidence has been devoted to examine these effects. Investigation of peer effects will focus around the central question of whether adolescents' risk perceptions appear to be induced by the societal approach to risks found in each individual's environment both at the micro (friends) and macro (society) levels.

7.1. Introduction and research questions

Preliminary findings in Chapter 5 and 6 where peer effects variables have been used as controls suggest friends' smoking behaviors play an important role in the development of adolescents' risk perceptions. However, further examination of the importance of adolescents' friends in their risk beliefs remains. Similar to work on the roles of medical professionals and parents as determinants of risk perceptions in Chapter 6, this chapter is guided by the Bayesian learning model's depiction of risk perceptions being determined by the influence of information sources to which individuals attach various weights. Additionally, the principal-agent relationship also becomes important when looking at peer

effects, just as in Chapter 6 with parents and medical professionals. Where principal-agent relationships are weak, especially in the case of parents, peers could be filling this void of a figure that an adolescent assumes to be informed.

Prior studies on the issue of risk formation have examined the influence of factors such as age and gender on the learning process (ex. Liu and Hsieh 1995; Lundborg and Lindgren 2004; Viscusi 1991) but, to date, only a few have dealt with various information sources, such as peer effects. Previous studies have explored the influence of peer effects on smoking (Lundborg 2006) and recently one paper has addressed the question of peer effects influencing adolescents' stock of information about smoking risks (Lundborg 2007).

Most studies on this topic examine individual-level variation though it is increasingly more apparent that individuals' behavior change depending on the setting due to differences in environmental effects and contextual characteristics (Ajzen and Fishbein 1980). Situations where context matters for behavioral decisions include dieting and eating as well as smoking. The aim then lies in determining what drives some adolescents to perceive the risks of smoking as low and smoke while others perceive risks as high and abstain from smoking.

This societal approach to examine smoking risk measures societal influence using micro-level factors such as close friends' smoking habits and macro-level measures such as provincial smoking prevalence. Similar to previous work that looks at peer effects and risky behaviors (Glaeser et al. 2002*b*; Cutler and Glaeser 2007), this analysis uses a social multiplier to predict risk perceptions by examining individual level versus aggregated data. In the case of smoking, the influence of context and social norms followed by community

enforcement and reinforcement of these norms appears to induce health effects by increasing the speed of information diffusion so that individuals are more likely to adhere to healthier social norms (Brown et al. 2006). I am unaware of any previous study testing for the presence of a social multiplier with risk perceptions as the dependent variable. The existence of any social multiplier becomes particularly important when thinking about the policy conclusions from this work as the policy impact on peers' behaviors would then be amplified through peers' effects to the extent specified by the social multiplier.

Examining the role of friends presents multiple empirical issues including that if the hypothesis is correct that adolescent friend groups influence each other's risk perceptions through their behaviors then the relationship between an individual's risk perceptions and the behaviors of his friends would be endogenous. Chapter 3 discusses Manski's paradigms for classifying social interactions as being subject to endogenous, contextual and correlated effects (1993). This analysis takes an approach incorporating Manksi's depiction of peer effects as well as Glaeser et al.'s (2002*b*) work on the existence of a social multiplier, which is also discussed in Chapter 3.

Based on this literature looking at adolescents' friends and individual decision-making and results from Chapters 5 and 6, peer effects ought to also exert substantial influence on adolescents' risk perceptions. The research questions examined are the following:

RQ1. Does *friends' smoking behavior/being involved with friends that smoke* impact adolescents' risk perceptions about smoking?

RQ2. Do *overall societal level smoking habits* have any determinative power in adolescents' risk beliefs?

RQ3. Do *perceptions about what their friends think* about smoking translate into how adolescents themselves perceive risks for the general population?

RQ4. Does *a social multiplier effect*, as developed by Glaeser and Scheinkman (2000), exist for adolescent risk perceptions about smoking?

7.2. Data and methods used

7.2.1. Data sources

The Canadian YSS can provide answers for **RQ1, RQ2** and **RQ4** and the US NSDUH **RQ1** and **RQ3**. Although both datasets answer **RQ1**, as exact question phrasing is different between surveys, only general comparisons between results will be possible. Peer groups are defined as friends in the YSS and classmates in the respondents' grade in the NSDUH. Because of available province identifiers in the YSS data, this work can also examine the impact of macro-level peer effects through including a variable expressing provincial level smoking behavior.

Two questions from the YSS provide insight into how friends could play a role in adolescents' perceptions of smoking risks. The survey includes a question asking 'how many close friends do you have (that is, very good friends)' after which respondents fill in a number or '00' if no friends. A question follows to find out about friends' smoking habits. 'How many of your close friends smoke?' The response mode for this question is the same as for the previous. 'Number of close friends that smoke' was used in other

studies such as Leatherdale et al. (2006) and Leatherdale and Manske (2005) to express peer smoking.

Another measure of peer smoking 'percent friends smoke' was created by dividing the number of close friends that respondents claim smoke by the number of friends respondents claim to have. This measure expresses smoking prevalence among a respondent's friend group and has been used in previous literature (Norton et al. 1998; Gaviria and Raphael 2001; Powell et al. 2005), however not necessarily as reported by the respondents themselves. For example, Gaviria and Raphael (2001) had data about which school each respondent was in and then calculated the percent of students in a respondent's school who smoke based upon survey responses from each respondent individually about their smoking status. The analysis that follows runs separate models to test how the two different measures of smoking among a respondent's friends (number of close friends that smoke and percent of close friends that smoke) might offer divergent findings regarding their determinative role in risk perception formation.

The NSDUH has numerous questions of interest to examine the role of peers and friends. Two questions address the indirect experience factors about which this study is interested. The first asks 'Do you have any friends who do not smoke cigarettes? and the second 'How many students in your grade at school would you say smoke cigarettes?' There is a distinction here between friends and peers providing an idea of any decision-making on the part of respondents to elect friends that are different in habits to their peer group. However, the first question is only asked of those respondents who had smoked in the past thirty days causing the sample size to be small. Therefore, this analysis used only the second question about classmates' smoking.

Another question of interest focuses on respondents' perceptions of what their friends think about smoking by asking 'how do you think your close friends would feel about you smoking one or more packs of cigarettes a day?' with responses of 'neither approve nor disapprove,' somewhat disapprove,' and 'strongly disapprove.' This offers insight into how much adolescents care about what their friends think.[23]

The dependent variable, risk perceptions, appears in the same format as in Chapter 5 with the YSS asking respondents to choose one of eight responses (plus don't know) closest to the number of Canadians that die each year as a result of smoking cigarettes'[24] and the NSDUH asking respondents about the risks people take of harming themselves as a result of smoking one or more packs of cigarettes per day with responses on a Likert scale.

Sample characteristics from the YSS can be found in Appendix 7A while those for the NSDUH appear in Appendix 7B.

7.2.2. Empirical specification

Because the decision-makers in this research context are adolescents between the ages of 10 and 17 years old, personal experience with smoking varies greatly for each individual. This analysis is motivated by the hypothesis that, this population sample, especially the

[23] The US NSDUH includes more questions about the impact of peers on adolescent smoking such as whether respondents choose not to be around friends who don't smoke and if one of a respondent's best friends offered him a cigarette, would he smoke it but again these questions were only asked of those who smoke on a regular basis so the sample size is small and they were not used in this analysis.

[24] Chapter 5 denotes this the 'quantitative measure of risk.' Although there are relative measures of risk also included in the YSS, results from Chapter 5 demonstrate their inconsistency in reflecting a relationship between perceptions and behaviors because of their use of reference points in question phrasing. The quantitative measure of risk held a consistent relationship with smoking behaviors therefore this study will employ that measure of risk perceptions. Further discussions of the mechanics of this measure of risk are found in Chapters 4 and 5.

younger respondents, will have little direct experience with smoking and thus will be more likely to rely on the indirect example of others to attach utility to the smoking decision. This follows along with Manski's preference interactions, where individuals set preferences, or in this case risk perceptions, depending on the choices of others (1993). Therefore, one's utility is not solely dependent upon personal consumption but also that of others. In other words, an individual's utility is based upon the average of his 'group's utility with reference to any given consumption choice (Bowles 2000). This 'group' could be as narrow as a household or as wide as an ethnic group. In this research, the 'group' is one's self-perceived friend group.

Capturing the impact of peers on adolescents' behavioral decisions largely builds upon Glaeser et al.'s (2002*b*) framework for the social multiplier model. Glaeser et al.'s model demonstrates how an individual's actions may depend upon the average actions of an aggregated group. This representation of decision-making depicts an expanded view of standard neoclassical theory stating that individuals only care about their own consumption and utility. Evidence of social interactions supports the idea that utilities attached to decisions are more of a fluid interaction between members of a social setting where utility assessments become common within groups. Therefore, although starting with the premise of an individual's maximization of his own utility, external information sources aid in setting utility maximization goals.

Instead of examining an individual's actions this analysis looks at how an individual's risk perceptions depend on group actions. The model for the relationship between individual and aggregate actions appears as follows:

$$R_i = \vartheta_i + \frac{\gamma}{\mathrm{N}-1} \sum_{j \in G(i), j \neq 1} \overline{A}_j \quad (7.1)$$

Source: Modified from Glaeser et al. (2002*b*)

Equation (7.1) depicts how an individual (*i*)'s risk perceptions (R_i) are influenced by the average actions of a group ($\overline{A}_j$) (i.e. whether they smoke or not). ϑ_i reflects the exogenous factors apart from those related to peer effects that could increase the likelihood of smoking or perceptions of risk, γ is the social interaction parameter quantifying the role of social influences on individual behavior and G(i) reflects the size of the group in which *i* is a member.

Due to constraints present when using secondary data sources, individual respondents could not be grouped with their friend groups or even their school or class in school. In other words, there was no way of knowing which respondents are friends with each other. Therefore, the smallest group possible with the Canadian YSS is created by dividing each of the 10 provinces by the five grades represented thus forming 50 possible groups in which a respondent has membership. It is also possible to examine a variable capturing smoking prevalence levels in individual provinces to investigate how general societal smoking habits impact adolescents' individual decision-making about smoking risks. Social multiplier analysis using the NSDUH is not possible because the data cannot be broken down into groups even by region or state let alone any more finite division based upon friend groups.

An individual's risk perceptions are, however, determined by many other factors than peer group behavior. Therefore, the model used to test the determinants of an individual's risk perceptions includes these other factors:

$$R_i = \beta_1 X + \beta_2 P + \beta_4 A_i + \beta_4 A_j + \varepsilon \quad (7.2)$$

Where R_i expresses an individual (i)'s perceptions of risk, X is a vector of personal and household characteristics such as gender, grade, ethnicity, availability of disposable income, family income and household structure of respondent i, P captures provincial characteristics where i resides, A_i is the individual's smoking behavior, A_j is the friend's smoking behaviors and ε is the random set of factors across all individuals that independently impact risk perceptions.

For the case of the Canadian YSS, A_j is expressed either as the number of friends respondents have who smoke or a percentage of the respondent's friends who smoke (for **RQ1**). In some models using the YSS, P is nine dummy variables for province of residence capturing all characteristics of each province. In others, P is a single variable that varies by the percentage of current smokers in each province according to the Canadian Tobacco Use Monitoring Survey (2005). In this way provincial characteristics are captured either using the nine provincial dummy variables or using the percentage of smoking in each province variable to capture provincial smoking characteristics more specifically (for **RQ2**).

In the case of the US NSDUH, A_j is captured using responses to two questions. First, how many students in the respondent's grade smoke (for **RQ1**) and second, how a respondent

feels that friends would feel about the respondent smoking one or more packs of cigarettes per day (for **RQ3**). The NSDUH does include variables to capture characteristics of respondents' geographical locale or any other information to approximate P and control for contextual effects.

7.2.3. Methodological issues when looking at peer effects

There are multiple empirical issues involved with estimating equation (2): endogeneity/simultaneity problems, isolating peer effects as being behavioral and not contextually related and 'the reflection problem'.

First, an individual's smoking behavior (A_i) and the smoking behavior of his friend group (A_j) present a simultaneity problem since both could impact an individual's perceptions of risk but an individual's perception of risk also has determinative influence on his smoking behavior (see Chapter 5) as well as that of his peer's through his own behavioral influence. Peer and individual behavior are therefore endogenously related to the dependent variable and peer behavior and individual behavior are likely to be endogenously related to each other.

Other studies facing the same issue of bi-directionality between group and individual effect (Case and Katz 1991; Gaviria and Raphael 2001; Lundborg 2006) used average background characteristics for classmates such as proportion of classmates living in a single-parent household or the proportion of classmates whose parents were born outside of the country surveyed. The Canadian YSS does not have class-level data limiting the ability to find instruments to correct for this specific endogeneity problem. The lowest unit of

measurement possible in this study is grade level in each province (50 groups). This still leaves groups of between 192 and 680 individuals and therefore two large for using instruments based on their average background characteristics. At the grade level by province, contextual effects would still exhibit significant heterogeneity. All variables that could capture contextual effects are included in every model within the analysis but this cannot adequately remove the bi-directionality issue.

Because instrumentation of individual smoking behavior is possible with the datasets available, this study elects to use instruments to correct for endogeneity present in the individual's smoking behavior variable (A_i). In both the YSS and NSDUH models, the same instruments were used in this chapter as in Chapter 6. Appendix 6C provides detailed information about the testing process for endogeneity, each of the instruments used and tests for their robustness.

A second major empirical issue faced when estimating equation (3) is the presence of factors other than peer effects being attributed to peer effects. For example, the percentage of an individual's friends that smoke may be the result of their cultural background and its views on tobacco use. We also have trouble distinguishing whether this cultural group lives in the same neighborhoods as a result of their behavioral choices or if their behavioral choices have resulted from neighborhood location (Nakajima 2007). By including variables for province and grade, the models using the Canadian YSS data attempt to control for contextual effects and pick up the endogenous relationship between peer groups and individuals risk perceptions. Control variables for province, grade and household structure capture characteristics common to friend groups and individuals in the sample that

could be mistaken for peer effects but in fact are a function of these socio-demographic traits. These are the most specific neighborhood characteristics provided in the Canadian YSS survey.

For the US data, the use of age, ethnicity, income, urban/rural and household structure variables attempt to control for contextual effects and thus remove any false association with peer effects. As mentioned before, particular regional or state identification for each respondent is not available thus limiting the ability to control for contextual effects in models using the NSDUH data.

Third and related to the second problem is the issues arising from introducing context as an explanatory variable. This 'reflection problem' occurs when aggregate behavior determines and is determined by individual behavior. In the presence of this reflection problem, Manski (1993, 2000) distinguishes between correlated effects (unobserved similar characteristics), contextual effects (common presence of an exogenous characteristic) and endogenous effects (behavior of an individual is affected by others' behavior). One method of measuring social interaction effects is using a lagged group effect but this requires panel data therefore we elect to use the alternative method of using other indicators of central tendency such as the median to depict societal characteristics (Manski, 2000).

Additionally, because respondents could elect to not answer any of the risk perceptions questions (dependent variables) and thus have their answer recorded as 'not stated' or 'don't know,' empirical analysis includes a sample selection correction to adjust for any

biases introduce by dropping the respondents providing no answer.[25] This sample selection variable ($\hat{\lambda}$) was never significant for any regression meaning that dropping the 'not stated' respondents does not significantly alter results.

To perform the above described analysis with the YSS, OLS regression techniques with instrumental variables are used because the dependent variable is continuous. This type of model employs the IVREG command in STATA. When the smoking variable is treated as exogenous, an OLS regression model is employed.

In order to test for a social multiplier effect, this study aggregates the data at the province and grade level to form 50 observations (10 provinces and 5 grades). This allowed a comparison between individual-level regressions and models run at the aggregate level.

Using the NSDUH data requires an ordered logit model, when cigarette smoking is treated as an exogenous dependent variable. When treating smoking behavior as endogenous, an ordered logit model that allows for instrumentation would have been ideal but because of the lack of such a program in STATA, this analysis uses the IVREG command in STATA for these models. Because of the ordinal nature of responses to the risk perceptions question, this type of model provided an adequate solution. Results were then checked for robustness using multiple methods including expressing the risk perceptions variable as continuous and running an IVREG regression, expressing the risk perceptions variable as a binary response (great or moderate risk=1 and no or slight risk=0) and running an IVPROBIT model and running a predicted value for the smoking behavior variable.

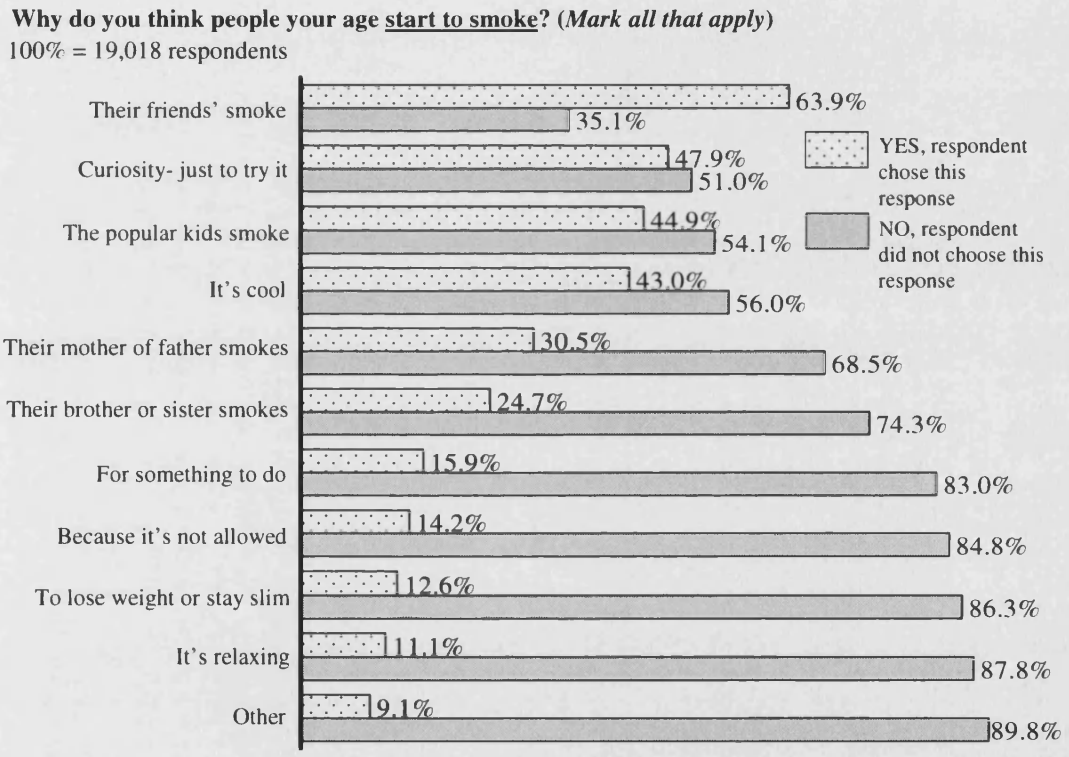
[25] 503 (2.6%) of 19,018 respondents did not answer this question so dropping these individuals does not significantly alter sample size.

7.3. Results for Canadian YSS data

7.3.1. Descriptive findings for Canadian YSS

An examination of the Canadian YSS at a descriptive level establishes the role of peers in risk perceptions development. Figure 14 shows that adolescents are more likely to state that their' friends' smoking leads adolescents to start smoking than any other given reason including parents or siblings.

Figure 14. Canadian YSS - Friends' smoking leads all other potential responses for reasons adolescents claim other adolescents start smoking



Note: 1.07% of respondents did not answer this question and were recorded as 'not stated'

Additionally, the impression that popular kids smoke is the third most often cited reason. These answers demonstrate adolescents' awareness of the influence they exert on each other's decision-making.

Table 32 displays the level of social involvement respondents have as expressed by the number of close friends they claim to have and then how many of these close friends that smoke. In terms of friends that smoke, the majority of respondents (69.2%) have no close friends that smoke.

Table 32. Canadian YSS - A small minority of respondents have no friends and the majority of respondents have no friends that smoke

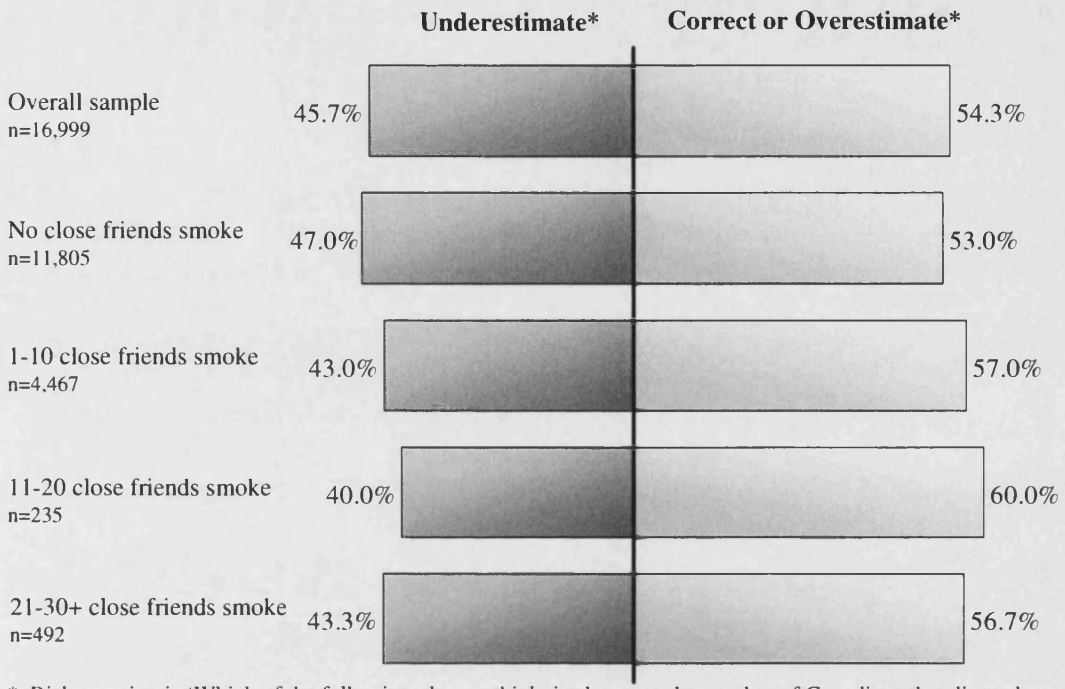
Number	Have close friends	Have close friends that smoke
0	8.3% (1,569)	69.2% (12,069)
1-10	69.1% (13,134)	26.3% (4,586)
11-20	14.9% (2,828)	1.4% (239)
21-30+	5.4% (1,028)	0.7% (118)
NS	2.4% (459)	2.7% (473)
Total	100% (19,018)	100% (17,449)*

Number in parentheses indicates the number of respondents
* Question only asked of those who claimed to have friends or answered 'not stated' in previous question

The overwhelming majority of respondents appear to have close friends and thus experience the social interactions associated with friendships. As adolescents' friend groups and number of friends could vary within short time spans, this cross-sectional data does not permit an understanding of how changes in social involvement or number of close friends that smoke alters over time. However, this snapshot of respondent experience shows that the sample appears socially included and almost 70% have no close friends that smoke.

Examining how friends' smoking statuses might impact risk perceptions appears below in Figure 15. These data show that individuals with experience being around friends that smoke are more likely to have correct or overestimated perceptions of mortality risks related to smoking than those with no close friends that smoke (47% underestimate risks versus 40-43% of others) (**RQ1**).

Figure 15. Canadian YSS - Friends' smoking behaviors and risk perceptions



* Risk question is 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

These descriptive statistics give some clues as to what the relationship between friends and risk perceptions might look like but further analysis remains necessary to understand the role of peer effects.

7.3.2. Multivariate analysis with Canadian YSS

In order to achieve satisfyingly robust results, multivariate analysis includes multiple permutations of each model predicting risk perceptions. Separate models were run for each method of measuring peer effects (number of friends that smoke and percent of friends that smoke) and for different ways of capturing the contextual effects of provincial residence (province of residence and smoking prevalence in province of residence). For all findings presented, variance inflation factors (VIF) were always below 10 suggesting no evidence of multicollinearity.

Table 33 displays the results of six regressions employing dummy variables to represent province of residence thus capturing unique provincial characteristics ranging from lifestyle aspects to cultural environment. All models also express peer behaviors as the number of the respondent's friends that smoke. Columns (3) and (4) include variables denoting the informational influence of doctors, dentists and parents to test the robustness of findings include the roles of other information sources tested in Chapter 6, Columns (5) and (6) separate the sample into two sub-populations based upon school grade. Columns (2) and (4) also treat the smoking behavior variable as endogenous while the remaining columns treat the variable as exogenous.

Table 33. Canadian YSS - Determinants of risk perceptions about smoking-related mortality including peer effects expressed as number of friends who smoke and individual province variables

	(1) Simple model with number of friends that smoke		(2) Simple model with number of friends that smoke (I.V.)		(3) Expanded model including *doctors and dentists asking about smoking parents' smoking behavior*		(4) Expanded model including *doctors and dentists asking about smoking parents' smoking behavior* (I.V.)		(5) Expanded model with only *respondents in grade 7 and below*		(6) Expanded model with only *respondents in grade 8 and above*	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior												
Smoked whole cigarette*	-0.03	-0.78	-0.38	-1.08	-0.06	-1.82	-0.65	-1.58	2.5E-03	0.0E+00	-0.82[b]	-2.02
Controls - socio-demographics and economic independence from parents												
Gender, grade, province, weekly allowance	Included		Included		Included		Included		Included		Included	
Household structure characteristics												
Living arrangement – both parents, one parent, etc.	Included		Included		Included		Included		Included		Included	
Attitudes and beliefs about smoking												
Addiction, quitting, smoke causing harm	Included		Included		Included		Included		Included		Included	
Information sources – medical professionals												
Doctor asked if smoke yes	-	-	-	-	0.07[b]	2.36	0.09[a]	2.75	0.13[b]	2.62	0.08	1.83
Dentist asked if smoke yes	-	-	-	-	-0.05	-1.00	-0.02	-0.36	-0.15	-1.68	0.08	1.03
Information sources – parents and household												
Only father smokes	-	-	-	-	0.10[a]	2.95	0.10[a]	2.93	0.10[b]	2.27	0.10[b]	2.00
Only mother smokes	-	-	-	-	0.10[a]	2.43	0.11[a]	2.61	0.11	1.93	0.12[b]	2.00

Both parents smoke	-	-	-	-	0.06	1.43	0.06	1.54	0.07	1.31	0.06	0.91
Number of people who smoke in home	-	-	-	-	0.04 [a]	2.96	0.07 [a]	2.95	0.05	1.51	0.07 [b]	2.20
Information sources – friends												
Number of close friends smoke	0.01	1.52	0.02	1.44	0.00	0.92	0.02	1.65	0.01	0.19	0.03 [b]	2.00
F-stat	23.99 (0.000)		23.97 (0.000)		18.35 (0.000)		18.08 (0.000)		9.83 (0.000)		7.57 (0.000)	
R^2	0.037		0.031		0.040		0.025		0.036		-	
Sargan			1.218 (0.270)				1.856 (0.173)		1.54 (0.215)		0.21 (0.646)	
Number of observations	16,437		16,289		16,435		16,287		9,121		7,166	

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

Results from both of these tables demonstrate that both number of close friends that smoke and percent of close friends that smoke do not appear to have a significantly positive effect on adolescents' perceptions of smoking risks unless the model is run for an older subset of the respondent population (**RQ1**). In Table 33, column (6), where the peer smoking variable is significant, other sources of information about smoking risks are included in the model but the result remains significant at the 5% level. Therefore, as respondents get older and are more likely to have experienced smoking among their peers, then peer smoking starts to impact risk perceptions.

A separate set of models was run to include the same variations in model compositions but instead of expressing the influence of peers as the number of close friends that smoke, it uses the measure of percentage of close friends that smoke. This second variable denoting peer effects provides a view on friend group composition in terms of smoking behaviors. Results are available in Appendix 7C. The non-significance of 'percent close friend that smoke' in any model points to the actual number of close friends that smoking mattering more than friend group composition.

In order to further investigate the relationship between peer effects and smoking risk perceptions a further set of models in Table 34 includes a variable expressing provincial smoking prevalence. All models treat the smoking variable as endogenous. The first three columns express the role of friends as information sources using the variable 'number of close friends that smoke' while the last three models use 'percent close friends that smoke.' Columns (3) and (6) correct for slight multicollinearity present in the models found in columns (1)-(2) and (4)-(5) by removing any expression of either province identifier or provincial smoking prevalence.

Table 34. Canadian YSS - Determinants of risk perceptions about smoking-related mortality including peer effects and provincial smoking variation

	(1) Simple model with number of friends that smoke (I.V.)		(2) Expanded model including *doctors and dentists asking about smoking parents' smoking behavior* (I.V.)		(3) Expanded model correcting for multicollinearity**		(4) Simple model with percent of friends that smoke (I.V.)		(5) Expanded model including *doctors and dentists asking about smoking parents' smoking behavior* (I.V.)		(6) Expanded model correcting for multicollinearity**	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior												
Smoked whole cigarette*	-0.45	-1.41	-0.74[b]	-1.98	-0.77[b]	-2.10	-0.58	-1.32	-0.92	-1.84	-0.95	-1.92
Controls - socio-demographics and economic independence from parents												
Gender, grade, weekly allowance	Included		Included		Included		Included		Included		Included	
Household structure characteristics												
Living arrangement – both parents, one parent, etc.	Included		Included		Included		Included		Included		Included	
Attitudes and beliefs about smoking												
Addiction, quitting, smoke causing harm	Included		Included		Included		Included		Included		Included	
Information sources – medical professionals												
Doctor, dentist asked if smoke	Included		Included		Included		Included		Included		Included	
Information sources – parents and household												
Father, mother, household smoking behaviors	Included		Included		Included		Included		Included		Included	
Information sources – friends												
Number of close friends smoke	0.02	1.72	0.02[b]	1.97	0.02[b]	2.03	-	-	-	-	-	-
Percent close friends smoke	-	-	-	-	-	-	0.35	1.21	0.45	1.50	0.45	1.53
Information sources - population level smoking behavior												

Provincial smoking prevalence	-1.03 [b]	-2.07	-1.06 [b]	-2.17	-	-	-1.02 [b]	-2.05	-1.06 [b]	-2.14	-	-
F-stat	32.17 (0.000)		21.23 (0.000)		21.45 (0.000)		31.92 (0.000)		21.13 (0.000)		21.37 (0.000)	
R^2	0.026		0.017		0.015		0.021		0.006		0.003	
Sargan	1.348 (0.246)		1.632 (0.202)		1.497 (0.221)		1.304 (0.253)		1.491 (0.222)		1.354 (0.245)	
Number of observations	16,289		16,287		16,287		16,068		16,066		16,066	

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.

(**) Correcting for multicollinearity involved removing any variables expressing provincial characteristics therefore no province dummies or provincial smoking prevalence variable

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

Results suggest that where there are a higher percentage of smokers in society, adolescents are likely to have a lower perception of smoking risks (**RQ2**). Therefore, both at the micro-level (friend group) and macro-level (province), smoking behaviors influence adolescents' perceptions of risks but in different directions (**RQ1** and **RQ2**).

When an alternative variable, provincial smoking prevalence, was used to control for differences in smoking behaviors across provinces rather than simply using province dummies as in Tables 33, it appears to have captured specific macro-level societal factors influencing adolescents' smoking behaviors. The provincial smoking prevalence variable in the models of Table 34 would capture the province's smoking habits and no other cultural or societal elements that make Canadian provinces unique as provincial dummies do. These results tell us something very specific about the role of society in altering risk perceptions about smoking. While the micro-level friend group does not appear to be largely significant in determinant adolescents' risk perceptions, the behaviors of society are (**RQ1** and **RQ2**). Directionally, this finding is interesting in that the higher a province's smoking prevalence, the lower a respondent's risk perceptions are likely to be.

Results from this model differ from those in Tables 33 with regards to the level of significance attached to the friends smoking variables. When there is no variable controlling for provincial smoking variation, the number of close friends that smoke becomes significant. This reveals a relationship between peer smoking, provincial smoking and risk perceptions. When both peer effects and provincial effects are in the model, peers are not a determinant of risk perceptions but with no variable capturing provincial effects, peer effects are important. Therefore, the importance of peer effects becomes subsumed in the provincial variables (**RQ1** and **RQ2**).

The following models shown in Table 35 remove the lack of clarity around the relationship between respondent smoking and that of his peers and his society. Below are the results of models run for two population sub-samples each based on smoking behavior (*have not* smoked a whole cigarette and *have* smoked a whole cigarette) using the number of close friends that smoke to represent peer effects and the two different expressions for societal effects (provincial dummies from Table 33 and provincial smoking prevalence from Table 34). Identical models using percent close friends smoke to represent peer effects can be found in Appendix 7D.

Table 35. Canadian YSS - Determinants of risk perceptions about smoking-related mortality with population sub-samples according to smoking behavior and using number of close friends that smoke to represent peer effects

	(1) Expanded model with *province dummies* and sub-sample who *have not* smoked a whole cigarette		(2) Expanded model with *province dummies* and sub-sample who *have* smoked a whole cigarette		(3) Expanded model with *provincial smoking prevalence* and sub-sample who *have not* smoked a whole cigarette		(4) Expanded model with *provincial smoking prevalence* and sub-sample who *have* smoked a whole cigarette	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Controls – socio-demographics and economic independence from parents								
Gender, grade, *province*, weekly allowance	Included		Included		-		-	
Gender, grade, weekly allowance	-		-		Included		Included	
Household structure characteristics								
Living arrangement – both parents, one parent, etc.	Included		Included		Included		Included	
Attitudes and beliefs about smoking								
Addiction, quitting, smoke causing harm	Included		Included		Included		Included	
Information sources – medical professionals								
Doctor, dentist asked if smoke	Included		Included		Included		Included	
Information sources – parents and household								
Father, mother, household smoking behaviors	Included		Included		Included		Included	
Information sources – friends								
Number of close friends smoke	2.5E-03	0.48	4.3E-03	0.78	2.0E-03	0.38	4.8E-03	0.86
Information sources - population level smoking behavior								
Provincial smoking prevalence	-	-	-	-	-1.44 [a]	-3.47	-2.33	-1.85
F-stat	16.80 (0.000)		3.40 (0.000)		20.21 (0.000)		3.62 (0.000)	
R^2	0.041		0.043		0.038		0.036	
Number of observations	14,217		2,218		14,217		2,218	

[a] Significant at 1%

Numbers in parentheses are p-values

Further investigation of the significance of peer effects shows that when respondents are cut into sub-samples based upon their smoking behavior, the number of close friends that smoke remains an insignificant determinant of risk perceptions (**RQ1**). However, provincial smoking prevalence has a negative and significant relationship with risk perceptions of individuals who have not smoked a whole cigarette at the 1% level and at the 10% level of those who have smoked a whole cigarette (**RQ2**). This finding further supports the earlier finding about the decisive role of society's behaviors rather than peer group behaviors on an adolescent's risk beliefs.

In order to investigate the presence of any social multiplier (Glaeser et al. 2002*b*) effect, Table 36 shows the results of models aggregating the data to the province and grade levels. As the YSS was collected in all ten Canadian provinces and among students in five grades, the aggregated models have sample sizes of 50 observations. At the individual level, in columns (1) and (3), the number of close friends that respondents have who smoke and the percentage of a respondents' friends who smoke have no significant relationship with respondents' risk perceptions about smoking mortality. However, upon aggregating to the province and grade levels in columns (2) and (4), the number of friends who smoke becomes negatively and significantly related to risk perceptions (column (2)) while there is no evidence of such a social multiplier effect in the case of the percent of friends that smoke (column (4)) (**RQ4**).

Table 36. Canadian YSS - Determinants of risk perceptions about smoking-related mortality collapsed into groups by grade and province

	(1) Simple model with number of friends that smoke (I.V.)		(2) Collapsed model with number of friends that smoke (I.V.)		(3) Simple model with percent of friends that smoke (I.V.)		(4) Collapsed simple model with percent of friends that smoke (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior								
Smoked whole cigarette*	-0.59	-1.63	0.05	0.06	-0.75	-1.52	4.36	0.79
Socio-demographics								
Gender	0.17 [a]	7.85	0.50	0.57	0.17 [a]	7.92	0.20	0.15
Grade 5	-0.61 [a]	-8.07	-	-	-0.61 [a]	-7.99	-	-
Grade 6	-0.38 [a]	-5.34			-0.38 [a]	-5.39		
Grade 7	-0.23 [a]	-4.03			-0.24 [a]	-4.05		
Grade 8	-0.10 [a]	-2.66			-0.11 [a]	-2.72		
Province New Foundland and Labrador	-0.17 [a]	-3.10	-	-	-0.17 [a]	-3.05	-	-
Province Prince Edward Island	-0.12 [b]	-2.26	-	-	-0.13 [b]	-2.32	-	-
Province Nova Scotia	-0.04	-0.91	-	-	-0.04	-0.81	-	-
Province New Brunswick	-0.15 [a]	-3.05	-	-	-0.15 [a]	-3.09	-	-
Province Quebec	-0.14 [b]	-2.24	-	-	-0.14 [b]	-2.17	-	-
Province Ontario	-0.18 [a]	-4.33	-	-	-0.18 [a]	-4.22	-	-
Province Manitoba	-0.28 [a]	-5.66	-	-	-0.28 [a]	-5.65	-	-
Province Saskatchewan	-0.06	-1.28	-	-	-0.07	-1.38	-	-
Province Alberta	-0.10 [b]	-2.13	-	-	-0.10 [b]	-2.03	-	-
Economic independence from parents								
Weekly allowance	0.12 [a]	4.78	1.34 [a]	2.74	0.12 [a]	4.74	1.56 [a]	3.01
Household structure characteristics								
Lives one parent and partner	0.15 [a]	3.05	1.14	0.77	0.14 [a]	2.92	0.13	0.07
Lives one parent	0.11 [a]	2.59	2.06	1.56	0.11 [a]	2.60	2.17	1.63
Lives shared custody	0.10	1.52	3.17	1.59	0.11	1.64	3.91	1.39
Information sources – friends								
Number of close friends smoke	0.02	1.80	-0.05 [b]	-2.48	-	-	-	-
Percent close friends smoke	-	-	-	-	0.44	1.40	-6.88	-0.97
F-stat	21.47 (0.000)		6.47 (0.000)		21.11 (0.000)		5.290 (0.000)	
Sargan	0.956 (0.328)		0.001 (0.977)		0.855 (0.355)		-	

Number of observations	16,430	50	16,204	50

(*) For columns (1)-(3), instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.'
For column (4), instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly.
[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-values

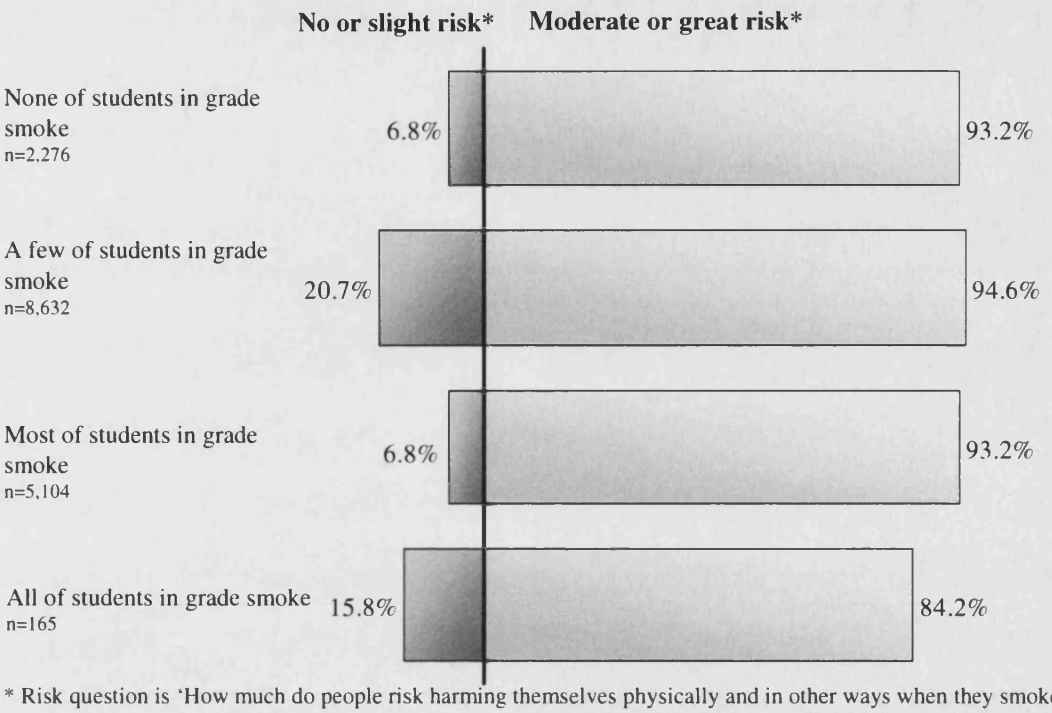
Surprisingly, however, although the peer effects variable, *number of close friends smoke*, has a greater coefficient in the aggregated regression suggesting a social multiplier effect, the variable changes sign such that the more close friends one has that smokes, the lower risk perceptions are likely to be. This change of sign could reflect the existence of an aggregation reversal (Glaeser and Sacerdote 2007). Therefore, peer effects might have two distinct effects, a direct effect on smoking and an indirect effect on people's beliefs. This finding implies that adolescents have a smaller influence over each other as individuals than the wider society of adolescents in which each of them live adding robustness to the results found in earlier models where any provincial smoking prevalence is a consistent determinant of risk perceptions while individual peers' behaviors are not (**RQ1** and **RQ2**).

7.4. Results for US NSDUH data

7.4.1. Descriptive findings for US NSDUH

Descriptive findings point to an influential role for peers in individual adolescents' assessments of smoking related health risks. Figure 16 demonstrates a potential association between the proportion of classmates that adolescents perceive to smoke and adolescents' risk perceptions about smoking, however the results are unclear.

Figure 16. US NDSUH - Students in grade's smoking behaviors and risk perceptions



* Risk question is 'How much do people risk harming themselves physically and in other ways when they smoke one or more packs of cigarettes per day?' Potential responses are 'No risk,' 'Slight risk,' 'Moderate risk,' 'Great risk.'

Exact question about peer smoking is 'How many of the students in your grade at school would you say smoke cigarettes?' 'None of them,' 'A few of them,' 'Most of them,' 'All of them,' 'Don't Know,' 'Refused,' 'Blank (No answer),' 'Legitimate skip.'

A higher percentage of respondents who state that a few or all of the students in their grade smoke have a higher likelihood of attaching no or slight risk to smoking than those who say that none or most of their fellow students smoke (**RQ1**). This pattern of response gives an unclear picture of the relationship between classmates' smoking behaviors and adolescents' risk perceptions and hints at a non-linear relationship between these variables. Panel data would be helpful here to test the hypothesis of whether risk perceptions change as the number of classmates smoking increases with respondent age. In this analysis, such a hypothesis can only be examined through the 'age' variable in the multivariate analysis that follows since presumably, as respondents get older, more of their classmates will smoke.

Identical to the question examined in Chapter 6 with regards to respondents' perceptions

about how their parents would feel about them smoking, I analyze the same question for respondents' perceptions about what their friends would feel about their smoking. Table 37 presents results of this question distributed based upon responses to the question about smoking risk perceptions.

Table 37. US NDSUH - Perceptions about how friends would feel about respondent smoking one or more packs a cigarette per day

Response	*No or slight risk*	*Moderate or great risk*
Neither approve nor disapprove	29.0% (362)	13.6% (2,301)
Somewhat disapprove	21.3% (266)	18.8% (3,172)
Strongly disapprove	47.2% (588)	66.5% (11,237)
Don't know	1.7% (21)	0.9% (151)
Refused to answer	0.8% (10)	0.1% (24)
No answer	0.0% (0)	0.0% (3)
Total	100% (1,247)	100% (16,888)

Number in parentheses indicates the number of respondents
Exact question about perceived friend approval is 'How do you think your close friends would feel about you smoking one or more packs of cigarettes a day?' Potential responses are 'Neither approve nor disapprove,' 'Somewhat disapprove,' 'Strongly disapprove,' 'Don't know,' 'Refused,' and 'Blank (No answer).'

These figures suggest that perceptions of what their friends think about smoking may matter in adolescents' thoughts about smoking risks. Those who attach no or slight risks to smoking are more likely to perceive their friends as neither approving nor disapproving of them smoking than those who attach moderate or great risk (**RQ3**). Therefore, in cases where adolescents come across as complacent about their friends' smoking then those friends tend to be more likely to attach no or slight risks to smoking. Although minimal differences in percentages exist across the risk perception distribution, these results suggest a potential relationship deserving more complex analysis to test the veracity of this finding.

7.4.2. Multivariate analysis with US NSDUH

The multivariate analysis performed on the US NSDUH data involves several versions of each model in order to test the strength of findings. Tests for multicollinearity found VIF factors below 10 for all models thus pointing to no evidence of multicollinearity.

Table 38 displays results of the most simple model testing the role of peers as determinants of risk perceptions under the assumption that 'smoked a cigarette' is exogenous and then endogenous. The last two columns extend this model by including two different ways parents could play a role in adolescents' determination of risk perceptions. There are also two versions of this model changing the assumption that 'smoked a cigarette' is exogenous and then endogenous. The coefficients on the ordered logit model in column (1) are not directly interpretable while the significance and directionality do have meaning. The instrumented models do have coefficients that can be interpreted one against the other to see which explanatory variables impact risk perceptions most.

Table 38. US NSDUH - Determinants of risk perceptions about smoking-related harm including peer effects

	(1) Simple model with peers variables		(2) Simple model with peers variables (I.V.)		(3) Extended model including parents variables		(4) Extended model including parents variables (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior								
Smoked a cigarette*	-0.34 [a]	-8.82	-0.11	-0.48	-0.29 [a]	-7.29	-0.04	-0.19
Socio-demographics								
Gender	-0.39 [a]	-11.88	-0.11 [a]	-10.61	-0.40 [a]	-11.88	-0.11 [a]	-10.57
Age	0.08 [a]	6.32	0.02	1.71	0.08 [a]	7.02	0.02	1.81
Black Afr-Amer	0.13 [b]	2.33	0.01	0.40	0.12 [b]	2.19	0.02	0.53
Native American/AK Native	0.11	0.80	0.00	-0.04	0.13	0.95	0.00	-0.06
Native HI/Pac Islands	-0.10	-0.32	-0.04	-0.41	-0.08	-0.24	-0.04	-0.34
Asian	0.03	0.27	-0.02	-0.43	0.04	0.40	-0.01	-0.16
More than one race	0.11	1.34	0.04	1.80	0.11	1.35	0.04	1.70
Hispanic	0.00	0.10	-0.01	-0.41	-0.02	-0.42	-0.01	-0.89
MSA under 1 million	-0.03	-0.84	-0.01	-0.58	-0.03	-0.87	-0.01	-0.74
Not in MSA	-0.07	-1.54	-0.01	-0.67	-0.07	-1.57	-0.01	-0.75
Socio-economics								
Receive income from job	0.06	1.49	0.02	1.03	0.06	1.51	0.01	0.90
Family income	0.04 [a]	4.34	0.02 [a]	4.65	0.03 [a]	3.09	0.01 [a]	3.85
Household characteristics								
Two parent household	0.08 [b]	2.12	0.03	1.60	0.07	1.69	0.02	1.49
Number of under 18s in HH	-0.05 [b]	-2.49	-0.02 [a]	-2.93	-0.05 [b]	-2.22	-0.02 [b]	-2.53
Information sources – peers								
Few stdnts smoke	-0.03	-0.48	0.01	0.60	-0.06	-1.04	0.00	-0.12
Most stdnts smoke	-0.02	-0.35	0.02	0.31	-0.04	-0.64	0.00	-0.06
All stdnts smoke	-0.06	-0.28	-0.03	-0.38	-0.01	-0.05	-0.03	-0.39
Stdnts smoke DK	0.12	0.93	0.05	1.43	0.10	0.81	0.04	1.10
Feel friends somewhat disapprove of smoking	0.20 [a]	3.88	0.10 [a]	2.91	0.09	1.73	0.06	1.91
Feel friends strongly disapprove of smoking	0.74 [a]	15.26	0.25 [a]	3.89	0.59 [a]	11.80	0.20 [a]	3.47
Information sources – parents								
Parents talked dangers NO	-	-	-	-	-0.13 [a]	-3.98	-0.04 [a]	-3.69
Feel parents somewhat disapprove of smoking	-	-	-	-	0.11	1.03	0.10 [b]	2.00
Feel parents strongly disapprove of smoking	-	-	-	-	0.67 [a]	7.87	0.30 [a]	7.06
F-stat	-		29.19 (0.000)		-		26.97 (0.000)	
Pseudo/Centered R^2	0.029		0.052		0.034		0.065	

Wald χ^2	834.47	-	966.22	-
Hansen j statistic	-	2.752 (0.253)	-	2.107 (0.349)
Number of observations	18,135	17,983	18,135	17,983

Notes: All models include robust standard errors
(*) Instrumented using questions asking respondents about during the past 12 months, 'did you receive treatment or counseling from a pediatrician or other family doctor for emotional or behavioral problems not caused by alcohol or drugs,' 'did you receive treatment or counseling at a mental health clinic or center because you had problems with your behavior or emotions not caused by alcohol' and 'have you been home-schooled at any time during the past 12 months?' when the column heading includes (I.V.)
[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-values

Across all models, the role of peer effects appears mixed. Classmates' smoking behaviors appear insignificant predictors of adolescents' perceptions of risks (**RQ1**), however, perceptions of what respondents' peers might think about their smoking came out as a significant determinant of risk perceptions (**RQ3**). A respondent feeling that his friends disapprove of smoking has a significant and positive relationship with risk perceptions. This finding is the case across all models in this table demonstrating that respondents care what their peers think. The coefficients on the variable expressing respondents perceiving their friends as strongly disapproving of smoking are very high at 25% and 20% (in the instrumented models). This is the highest coefficient in the column (2) model and the second highest in the column (4) model apart from perceptions of what parents think about smoking.

When parents' roles as information sources are added to the model in the third and fourth columns, the significance and signs on the peers' variables are maintained from the previous models. Therefore, parents and peers have specific and differing roles in influencing adolescents' risk perceptions captured in each of these variables. Therefore, perceptions of both what peers and parents think about smoking are key factors in predicting adolescents' risk perceptions (**RQ3**).

A display and discussion of results regarding the other explanatory and control variables in these models is available in Appendix 7E because they are the same as those found in Chapter 6.

Further analysis of the extended model containing variables expressing parents' roles as information sources as well as that of peers demonstrates how findings remain largely consistent when running identical models for differing age groups and male and females alone. The non-instrumented model in columns (1-3) and (5) are from ordered logit models, therefore, the significance and directionality of the coefficients are meaningful but the value itself is not directly interpretable. The coefficients on the instrumented models in columns (4) and (6) are directly interpretable because these are instrumented OLS regressions. Table 39 displays the results of this analysis.

Table 39. US NSDUH - Determinants of risk perceptions about smoking-related mortality by age and gender

	(1) Extended model including parents variables with respondents *ages 12-14 years*		(2) Extended model including parents variables with respondents *ages 15-17 years*		(3) Extended model including parents variables with only *males*		(4) Extended model including parents variables with only *males* (I.V.)		(5) Extended model including parents variables with only *females*		(6) Extended model including parents variables with only *females* (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior												
Smoked a cigarette*	-0.33 [a]	-5.19	-0.25 [a]	-4.95	-0.27 [a]	-5.10	0.61	1.02	-0.32 [a]	-5.35	-0.42	-1.80
Socio-demographics												
Gender, Age, Ethnicity, Urban/Rural	Included		Included		Included		Included		Included		Included	
Socio-economics												
Employment, Family income	Included		Included		Included		Included		Included		Included	
Household characteristics												
Two parents, Number of under 18s in household	Included		Included		Included		Included		Included		Included	
Information sources – peers												
Few stdnts smoke	-0.07	-1.12	0.09	0.69	-0.05	-0.71	-0.05	-0.96	-0.03	-0.36	0.03	1.07
Most stdnts smoke	-0.01	-0.08	0.08	0.62	-0.05	-0.58	-0.16	-1.11	-0.02	-0.22	0.09	1.47
All stdnts smoke	-0.48	-1.30	0.30	1.15	-0.14	-0.49	-0.24	-1.30	0.21	0.74	0.11	1.15
Stdnts smoke DK	0.22	1.48	-0.08	-0.35	0.11	0.75	0.03	0.53	0.08	0.37	0.03	0.53
Feel friends somewhat disapprove of smoking	0.07	0.78	0.11	1.60	0.07	0.97	0.13	1.75	0.12	1.42	0.03	0.72
Feel friends strongly disapprove of smoking	0.52 [a]	6.27	0.64 [a]	10.03	0.57 [a]	8.65	0.35 [a]	2.60	0.61	7.92	0.10	1.58
Information sources – parents												
Parents talked	-0.15 [a]	-3.14	-0.11 [b]	-2.43	-0.14 [a]	-3.16	-0.04 [a]	-2.76	-0.12 [b]	-2.33	-0.02	-1.55

dangers NO												
Feel parents somewhat disapprove of smoking	-0.13	-0.64	0.22	1.81	0.03	0.24	-0.03	-0.26	0.17	1.09	0.17[a]	2.71
Feel parents strongly disapprove of smoking	0.43[a]	2.76	0.83[a]	8.05	0.81[a]	6.88	0.42[a]	6.06	0.50[a]	3.99	0.18[a]	3.10
F-stat	-		-		-		12.83 (0.000)		-		9.79 (0.000)	
Pseudo/Centered R^2	0.028		0.046		0.032		-0.090		0.029		0.006	
Wald χ^2	401.41		627.29		486.27		-		364.84		-	
Hansen j statistic	-		-		-		1.842 (0.398)		-		0.461 (0.794)	
Number of observations	9,074		9,061		9,245		9,161		8,890		8,822	

Notes: All models include robust standard errors

(*) Instrumented using questions asking respondents about during the past 12 months, 'did you receive treatment or counseling from a pediatrician or other family doctor for emotional or behavioral problems not caused by alcohol or drugs,' 'did you receive treatment or counseling at a mental health clinic or center because you had problems with your behavior or emotions not caused by alcohol' and 'have you been home-schooled at any time during the past 12 months?' when the column heading includes (I.V.)

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

The first two columns treat the smoking behavior variable as exogenous. No difference appears in the roles of peers as information sources for the younger sub-sample aged 12-14 years and the older group aged 15-17 years. Classmates' smoking proved an insignificant predictor of risk perceptions for both age groups while perceptions of what their friends think about them smoking remain significant for each age group (**RQ1**).

When splitting the sample by gender, some evidence of unstable preferences emerges when looking at the sign of the smoking behavior variable across all four models where the variable is treated as exogenous and then endogenous. When smoking is treated as exogenous, it is negatively and significantly related to risk perceptions for both male and female respondents. For males, the significance of smoking diminishes as the variable is treated as endogenous. However, females appear to acquire information about the risks of smoking through their own behavior. This relationship is only significant at the 10% level. Smoking being significant for females and not males points to males perhaps being more affected by other risk perception determinants.

With regards to the role of peers as an information source, the role of classmates' smoking does not differ between genders with classmates' smoking being an insignificant predictor of risk perceptions across all models (**RQ1**). Even though findings are not significant for each gender separately, the direction of coefficients suggest an interesting difference in the way peer smoking influences male and female adolescents' risk perceptions. If all students in a male respondent's class smoke then he is more likely to perceive smoking risks as lower than a male respondent who has no classmates that smoke. Conversely, this same variable with females has a positive relationship such that a female with classmates who smoke is less likely to perceive the risks of smoking as lower than a female respondent who

has no classmates that smoke. Therefore, male adolescents look at their peers' smoking as risk diminishing whereas females see it as risk augmenting (**RQ1**).

However, this bi-directionality of influence for the peer effects variables changes when examining perceptions of peer approval of smoking. Perceptions of what their friends would think about their smoking remain significant for males but not females (**RQ3**). If a respondent perceives that his friends strongly disapprove of smoking then he is more likely to perceive the risks of smoking as higher than a male respondent who perceives his friends to neither approve nor disapprove of smoking. This same variable for females is insignificant suggesting that females are not a concerned about their friends' thoughts about smoking.

Results about the difference in the determinative power of parents as information sources across genders also points to difference among the sexes in who they rely on in developing risk perceptions. For males, parents' talking about the dangers of smoking is a positive and significant predictor of risk perceptions but for females it is directionally opposite to the finding for males and not as significant. However, for both males and females, perceptions of strong parental disapproval of smoking are positively and significantly related to risk perceptions. Therefore, perceptions of parental approval appear to matter to both male and female adolescents but males are more likely to attach credibility to information from parents about smoking dangers than females.

In order to test the veracity of these models, analysis included a series of empirical robustness checks. These involved changing the form of the dependent variable in multiple ways as well as running predicted values of the smoking behavior variable. Results and an

explanation of the empirical checks can be found in Appendix 7F. The fact that all of these permutations of the original models presented in Table 38 support previous findings about the role of peers as determinants of risk perceptions points to the robustness of previously presented findings.

7.5. Discussion

This chapter has addressed the issue of peer effects and societal characteristics influencing risk perception formation. This topic has been addressed by examining the effect of peers and society as expressed in multiple different ways indirect experience with smoking by being around peers and classmates who smoke (YSS and NSDUH), perceptions of peers' opinions about smoking (NSUDH) and smoking prevalence in society (YSS). These issues have been analyzed at the individual and aggregate levels for the YSS data set through tests for a social multiplier effect. This discussion will be focused around results for each the roles of micro-level peer effects (**RQ1** and **RQ3**), macro-level societal effects (**RQ2**) and evidence of a social multiplier effect (**RQ4**).

7.5.1. RQ1 and RQ3- Micro-level peer effects

To generalize between both datasets, results indicate that micro-level peer effects, meaning friends' or classmates' smoking exert no significant or a weakly significant upward influence on risk perceptions (**RQ1**). More specifically, findings using data from the YSS point towards a weakly significant (predominantly 10% significance level or less) relationship between peer smoking as expressed through the two different variables used to denote peer effects, number of close friends that smoke and the percent of friends that smoke. Peer smoking behavior was found to be only a weak predictor of adolescent risk perceptions except in two cases using YSS data; respondents above grade 8 and when macro-effects were controlled for by including provincial level smoking prevalence. In

these cases, peer smoking was positively related to smoking. When controlling for parents' smoking behavior and doctors and dentists asking respondents about their smoking habits, the number of close friends that smoke was close to 10% significant and directionally positive. When using percent of friends who smoke as a measure of peer effects, an expression of friend group composition, peer effects was also directionally positive but only significant for the older sub-sample (grade 8 or more) (**RQ1**).

Coefficients varied greatly, however, with friend group smoking composition appearing to matter more than absolute number of friends that smoke. In other words, when using the variable denoting the proportion of an adolescent's friends smoked, peer effects on risk perceptions appear greater than when including the variable expressing the number of friends who smoke (**RQ1**). However, without significance, these coefficients cannot be deemed entirely meaningful.

In the case of the NSDUH, peers' smoking appears to be an insignificant predictor of risk perceptions but perceptions of friends' approval about smoking does have a significant relationship with risk perceptions such that those who feel that their friends strongly disapprove of smoking are more likely to have higher risk perceptions (**RQ1** and **RQ3**). According to the Bayesian model of weighting information sources and updating one's prior stock of information based upon the credibility attached to information sources, this finding could be taken to say that adolescents may not deem their own peers' knowledgeable enough about smoking to shape their risk perceptions. Chapter 6 demonstrated the influence adult figures such as doctors, dentists and parents have on adolescents' risk perceptions. Therefore, respondents could simply not deem the behavioral example of their peers as a credible information source. Perceptions of friends'

approval or disapproval regarding smoking does matter in predicting an adolescent's risk perceptions because this variable captures more about societal acceptance than simply just smoking behavior (**RQ3**). Peers can be deemed knowledgeable about approving or disapproving of a behavior whether or not this approval or disapproval is based on facts. On the other hand, direct behavioral example does not have imbedded in it the social effects of peers' opinions about behavior.

Even though peer smoking is never significant in any of the NSDUH models, coefficient direction does differ between respondent gender such that male respondents are more likely to have lower risk perceptions if all of their friends smoke whereas females are more likely to have higher risk perceptions if all of their friends smoke (**RQ1**). Some gender differences also emerge with perceptions of friend approval. Just as in the complete sample, males were more likely to have higher risk perceptions if they felt that their friends strongly disapproved of smoking (**RQ3**). This result was not significant at the 10% level for females.

Given that the populations examined in this analysis are young, perhaps with age individuals demonstrate greater peer effects as the peer group expands and people have learned more about what society believes (Sloan et al. 2003). Results from both datasets would support this assertion. This finding falls in line with the Bayesian framework's depiction of information sources being used only when deemed credible. Respondents in this sample refrain from relying on their peers for information about smoking risks until a sufficient number of peers have started smoking at older age. Peers' behaviors then become credible sources of information because the behavior is no longer as anomalous.

When data were separated into older and younger sub-samples, for the older groups (grades 8-9 for YSS and 15 to 17 years for the NSDUH), peers' behaviors exhibited a positive and in some cases significant relationship with risk perceptions while in the case of the YSS, the peer effects for the younger group were an insignificant predictor of risk perceptions. The peer effects variable for the younger sub-sample from the NSDUH actually demonstrated a negative relationship with risk perceptions such that if all students in a respondent's grade smoked, then the respondent was less likely to have high risk perceptions about smoking.

In this analysis, the peer group is defined as the respondent's friend group in the case of the YSS survey and the respondent's grade in school in the NSDUH survey. Models using the YSS data employed an index of group behavior as the percentage of the respondent's peers who smoke as in Norton et al. (1998), Gaviria and Raphael (2001) and Powell et al. (2005). Norton et al. (2003) have questioned the consistency of measures of peer smoking based upon respondents' perceptions of their peers' smoking. This study, like many on peer effects regarding risky behaviors relies on respondents having realistic perceptions of smoking prevalence among their friends. Reid et al. (2007) have demonstrated adolescents' propensity to overestimate peer smoking prevalence and crucially that grade, gender, close friends' smoking, seeing smoking at school, family member smoking, smoking in the home and own smoking status have significant relationships with adolescents overestimating how much their friends smoke. Those individuals who overestimate their peer's smoking status are more likely to be and become smokers themselves. Another option is to capture peer influence through the smoking status of a randomly selected respondent friend (Maxwell, 2002). Without information about which respondents are friends with each other, this kind of measure was not possible. Therefore, part of the issue here is how good a measure

variables used to express peer smoking prevalence are at capturing 'true' peers' smoking behaviors.

In comparing the findings from the Canadian and US datasets, the peer effects variables were more often significant with the US data (**RQ1**). The Canadian data also used the sub-group 'friends' as the peer group rather than 'students in grade at school.' The greater level of granularity regarding the smoking habits of those who respondents elect to spend time with emerged as a more significant predictor of risk. On the other hand, respondents did not choose the students in their class therefore the measure for peer effects in the NSDUH might not fully be capturing this elective element of peer group composition. Instead, it captures the characteristics of the school the respondent attends, which he/she has little say over since parents and/or public authorities would make that decision. Peer group smoking prevalence and an individual's smoking behavior is likely to be a recursive relationship where individuals practicing the same behavior are more likely to be friends and thus promote each others' risky behaviors (de Vries et al., 2006; Ennett et al., 1994; Maxwell, 2002). Therefore, a measure of peers that does not capture any element of choice in peers by demarcating them as 'friends' as with the NSDUH may not be adequately capturing this effect of adolescents choosing friends with like behaviors and in turn perceptions of risk. This finding supports the assertion that effectively demonstrating the characteristics of friend groups rather than non-respondent-selected classmate groups matters.

The ability to examine these results against the existing literature faces constraints given that, to my knowledge, no other studies have been published that test the determinative influence of peer smoking on adolescents' risk perceptions. Lundborg's (2007) analysis took a stricter view on the role of peers as information sources by testing whether a variety

of information sources directly offering adolescents information on smoking risks proved significant predictors of adolescents' risk perceptions. He examined the respondent searching for information himself and receiving it from each of the following - a teacher, other adult at school, parents, siblings, friends, other adults, media and other sources. Only information found by the respondent himself and that given by a teacher or other adult at school significantly predicted risk. Therefore, even though this study's definition of friends as information sources is much broader than that used in Lundborg (2007), the NSDUH model and some YSS findings support Lundborg's finding of an insignificant role of peers as information sources in adolescents' risk perception about smoking.

However, these results would put into question Lundborg's (2007) decision to use peer effects (fraction of classmates that smoke) as an instrument when correcting for endogeneity in the risk perceptions variable with smoking as the dependent variable in his model. While classmates' and friends' smoking may not consistently predict perceptions of risks across the models presented here, it does in the instrumented models using YSS data. The presence of a predictive relationship between peers' smoking and adolescents' risk perceptions demonstrated would call for a re-think of Lundborg's (2007) instrument choice, especially given findings of strong peer effects in predicting risk perceptions in the social multiplier analysis discussed below.

7.5.2. RQ2 - Macro-level societal effects

Macro-level societal effects were only able to be tested using the YSS data because the NSDUH did not include any information about respondent state or even region of residence. The provincial smoking prevalence variable does tell us something interesting about how society's attitudes and behaviors regarding smoking impact adolescent beliefs

about smoking risks. However, this same positive relationship between experiencing someone smoking and risk perceptions does not hold true for seeing society in general smoke (found in Chapter 6 with parents and in this chapter to a lesser extent with peers). When the provincial smoking prevalence is included in any model, the higher the smoking prevalence in the province, the more likely a respondent is to have lower risk perceptions (**RQ2**). A possible explanation for this negative relationship between provincial smoking prevalence and risk perceptions could be that while individuals feel some close connection with their friends and family members, they do not have this connection with the public. Therefore, if they experience a family member or friend smoking, they think about the risks to that person but for society in general, smoking is more of a cultural, social activity and does not have the same kind of intimacy of risks attached to it.

Similarly to findings regarding parental and household smoking habits, if being around friends who smoke has any influence on risk perceptions, this influence appears to be positive (**RQ1**). This could be because adolescents who actually see someone partaking in one of these behaviors in their immediate environment can see the risks attached to the behavior. They may even experience the health effects related to smoking through a parent being ill as health events are the most salient form of information an individual can receive about health risks (Sloan et al. 2003).

Of methodological difficulty in examining the impact of macro-groups is the unequal impact of macro-groups' behavior on each individual in the group's composition (Weinberg 2007). In other words, the characteristics of a group, in this case, the province, have a non-linear effect on the characteristics of each individual in the group since adolescents who have a tendency to smoke are more likely to interact with others who

smoke than those who do not have a tendency to smoke. This analysis takes the average behavior of the macro-group, in this case the province and assumes that all individuals in the group interact with each other the same amount. Clearly, this constitutes a gross assumption given that characteristics such as respondent ethnicity and religion would create clusters within this macro-group among which individuals holding the same characteristics would be more likely to associate. Such sub-group information was not included in this dataset. This study does not control for this non-linear effect but includes a variable for how many friends who smoke when including the macro-group characteristic variable (provincial smoking prevalence) under the assumption that some sub-group smoking characteristics would be captured through this variable.

With particular reference to those models using the YSS data, because of the young age of many respondents and therefore the lack of exposure to smoking themselves or to peers that smoke, this study could be underestimating the importance of peer influence. This hypothesis garners support from findings regarding provincial smoking prevalence where adolescents appear to rely more on cultural smoking habits than those of their immediate peer group. This changes, however, as respondents get older and begin to also rely on their peer group. Therefore, the influence of one's environment, both on the micro (friends) and macro (province) level matters but perhaps more or less at different points in one's life.

7.5.3. RQ4 - Social multiplier and aggregation reversals

The YSS data also permitted an investigation of any social multiplier effect occurring between peer smoking and risk perceptions. The results emerging from this analysis reveal evidence not only of a social multiplier effect but also an aggregation reversal (**RQ4**). Upon collapsing the data into smaller groups based on province and grade, the number of

close friends that smokes not only becomes significant at the 5% level from the 10% level but the sign changes from positive to negative. The same sign change occurs with the percent of close friends that smoke variable but results are not significant for either model. This sign change from the individual to aggregate level supports the existence of aggregation reversals as investigated by Glaeser and Sacerdote (2007).

Evidence points to an adolescent's risk perceptions regarding smoking being influenced by peer effects through a social multiplier effect (**RQ4**). The existence of a social multiplier can be demonstrated by the increase in coefficient from data at the individual level to a model expressing aggregate level data (Becker and Murphy, 2000). In this case, the social multiplier in the aggregate model is 0.5 (in absolute value terms) whereas the social multiplier in the individual level model is 0.2. Therefore, any change in peer smoking behavior would impact both an individual person's risk perceptions and those of the entire group by social influence. The social multiplier highlights the effects being ignored when simply looking at individual level data as such an analysis underestimates an independent variable's impact on the outcome variable (Glaeser et al. 2002).

This result is presented with a caveat as unobservable elements determining adolescent risk perceptions could be leading to an overstatement of the true estimate of the social multiplier. The value of this multiplier is lower than those found in studies about college dorm drinking behavior (Glaeser et al. 2002) in which this figure lies in the range of 1.4 to 2.2 depending on aggregation level from floor to dormitory levels respectively and crime (Levitt 1999) with figures between 1.7 and 8.2 again depending on aggregation level from country level to national level respectively. Therefore, aggregation level is crucial.

Another explanation for this difference in social multiplier figure may lie in non-random sorting of unobservable effects, which are more likely to be high at the aggregate level.

Glaeser and Sacerdote's (2007) present a helpful framework under which to interpret these results displaying an aggregation reversal. Aggregation reversals are said to happen when an independent variable (in this case, friends' smoking) affects a dependent variable (risk perceptions about smoking) directly and indirectly by being correlated with beliefs. Assuming that beliefs are learned socially then data aggregation augments any link between the friends' smoking and beliefs. As the size of the social multiplier increases or the behavior of individuals in the immediate surrounds of the respondent impact the respondent in an even greater fashion then aggregation reversals become more likely to occur (Glaeser and Sacerdote 2007). For this reason, we see peer effects changing from being positively and almost significant at the 10% level when examined at the individual level to negatively and significantly related to risk perceptions at the aggregate level.

This dataset does not allow us to examine the beliefs behind respondents' aggregation reversal because of lack of information on those beliefs which may stand behind this aggregation reversal. Beliefs that could interact with friends' smoking to predict an aggregation reversal might be respondents' religious beliefs or general risk appetite. Political views would also be interesting to test among such as young population. Respondents are years away from voting and unlikely to be engaged in thinking about elections themselves leaving political views to be entirely socially and environmentally formed.

7.5.4. Methodological considerations

This study was constrained by the available data from both the YSS and the NSDUH surveys. Clearly, the analysis of the YSS data was much more extensive because of the ability to break down respondents into macro-groups. Data on relocation of individuals across groups would have been advantageous to test the power of group composition and determine the extent to which gender impacts how individuals function within social settings (Angrist and Lang 2004; Kling et al. 2005).

The young age of the Canadian YSS sample population (10-15 years) means that many of the respondents would have never smoked before or been exposed to individuals who do smoke. Therefore, findings could be underestimating peer effects. For this reason, analysis includes a breakdown of the sample by age. Findings point to peer effects having less determinative influence on the younger sub-sample's risk perceptions. On the other hand, the NSDUH data had an older respondent population (12-17 years) and peer smoking was universally not a significant predictor of risk perceptions. As discussed earlier, this result could be more related to the question asking about classmates rather than friends as opposed to having anything to do with respondent age. However, perceptions of friends' disapproval of smoking did have a significant relationship with risk perceptions across all age groups. This result could be teasing out the difference between peers influencing each other through behavioral example and seeming approval or disapproval. In a setting where youths have not started to smoke yet or are just starting, perceptions of peer approval appear more likely to determine risk perceptions than actual peer behavior.

Without panel data, this analysis was unable to address endogeneity existent in expressing peer smoking behaviors as controlled for by Clark and Lohéac (2007). By using instruments to control for endogeneity between respondent smoking status and risk perceptions, we cannot instrument peer smoking and individual risk perceptions as well. With panel data, a lagged variable could have been used to avoid this endogeneity problem. Panel data would have also allowed for an examination of how the importance of peer effects changes over time for the same individuals.

7.6. Conclusion

This analysis has empirically assessed the role of peers' smoking behaviors and perceptions of peers' approval or disapproval of smoking on adolescents' perceptions of smoking risks (micro-level effects). Data from the YSS was also employed to test for the importance of provincial smoking behaviors (macro-level effects) on adolescents' risk perceptions and the presence of a social multiplier effect and aggregation reversals.

Together with findings from Chapter 6, this chapter presents a richer depiction of the role individuals and societies have in shaping adolescents' risk perceptions. To present, this research has developed an understanding of the determinative influences of doctors, dentists, parents, peers and the larger society on adolescents' perceptions of smoking risks. In order to examine how similar empirical and theoretical frameworks hold up when examining policy initiatives, let us now turn our analysis to the roles of tobacco warning labels and school education programs in determining adolescents' risk perceptions.

Chapter 8. The influence of public health initiatives – tobacco package warning messages and school-based education programs- on adolescents' perceptions about smoking risks

As in Chapters 6 and 7, this chapter also focuses on the second of the two main questions posed in this thesis.

(2) Which sources of information do adolescents rely on to inform their perceptions of risks?

As part of examining the risk information learning process undergone by adolescents, the place of exogenous information sources should be investigated in order to have a richer understanding of adolescents' information uptake. In the case of risk information about smoking, significant policies have been set out from a public health perspective to inform potential and current smokers about smoking risks and ultimately lead to reduced smoking prevalence.

This chapter assesses the impact significant public health efforts have had on adolescents' risk perceptions. Two of these policies are the use of warning messages on cigarette and tobacco packs and public health education programs in schools. Clearly, the second is specifically aimed at adolescents while the first reaches the entire population. However, this work solely assesses how these policies impact adolescents.

8.1. Introduction and Research Questions

A chief aim of public health policies lies in promoting knowledge and awareness of the health consequences of smoking to correct the market failure of smoking. Therefore, this chapter examines how existing knowledge about the health hazards of smoking

disseminated through warning labels and school-based education determines risk perceptions. These two particular public health policies were chosen because of the availability of data to examine both and the way that adolescents are often particularly targeted using each of these policies.

This study also elects to include knowledge as an explanatory variable in a model with risk perceptions as the dependent variable to look at the relationship between knowledge and risk perceptions thus separating out the 'knowledge effect.'

Tobacco package warning messages

RQ1. Does frequency of looking at warning messages impact how much they matter in predicting risk perceptions? Or does remembering message contents matter more?

RQ2. Do adolescents have to believe the contents of health warnings in order for them to have any determinative influence on their perceptions of risk?

School-based public health information dissemination

RQ3. Does being taught in school about the health risks of smoking impact adolescents' risk perceptions?

RQ4. Do school rules about smoking have a role in students' risk perceptions about smoking?

8.2. Data and Methods

8.2.1. Data sources

Of the two datasets utilized in this thesis, only the YSS offers the appropriate data to answer these research questions. The NSDUH has questions about whether respondents received information about the dangers of alcohol and drugs in school but tobacco use or smoking were not included in these questions. There are also no questions about health warning messages.

Table 40 lists those questions that provide helpful information to investigate the research questions stated above. The questions about warning labels were asked only of those individuals who had seen health warnings or offered no response to the question seeing health warnings. Therefore, sample size for this analysis is cut from over 18,000 to over 14,000. Having multiple questions about health warning messages allows analysis to highlight the crucial difference between seeing health warning messages and actually internalizing and accepting their contents as true.

Table 40. Survey questions of interest from the YSS

Topic	*Question*	*Responses*
	Information sources – health warning messages	
Frequency look at warning messages (**RQ1**)	About how often do you find yourself looking at these health warning messages	never less than once a week about once a week once every 2 or 3 days about once a day a few times a day more than a few times a day not stated*
Remembering message contents (**RQ1**)	In your own words, write or describe the ones (warning messages) you remember.	Count of how many correct messages each respondent wrote down ranging from 0 to 8
Believe the contents of messages (**RQ2**)	Do you believe the health warnings that you see on cigarette packages?'	Yes No I don't know I have not seen them
	Information sources – school setting	
Environmental effect of school rules (**RQ4**)	In your school, what are the rules about smoking?	I don't think there are any rules On school property smoking is allowed only in some areas Smoking is not allowed anywhere on school property I don't know No answer
	Information sources – school public health efforts	
Experience with school-based public health activities (**RQ3**)	Have you ever been taught in school about health problems due to smoking?	Yes No I don't know

* This study created a binary variable to express whether a respondent never looks at warning labels or does so anywhere from less than once a week to more than a few times a day.

The question about school rules regarding smoking, speak to the same kind of environmental effect as household smoking characteristics discussed in Chapter 6 (**RQ4**). Although this question has little to do with the success of school-based public health efforts in altering risk perceptions, it does offer an understanding of how the school environment can influence risk perceptions.

Sample characteristics for the Canadian YSS are found in Appendix 8A.

8.1.2. Empirical specification

This analysis starts with the assumption that individuals modify their expected utility gained from smoking and thus their risk perceptions about the dangers attached to smoking based upon the receipt of information. A discussion of this utility model where individuals are expected to maximize their utility based their assumptions about the utilities attached to smoking and not smoking can be found in Appendix 2A. The extent to which any of this newly received information alters risk perceptions depends upon the credibility attached to the source of information n a Bayesian updating process as depicted in Chapter 2 and modeled in the previous empirical chapters.

In this chapter, the source of information to be examined for its credibility in the eyes of adolescents is public health policy regarding health warning messages and school-based tobacco education. The model to best examine the impact of public health efforts from tobacco warning labels and school programs incorporates these influences while also controlling for other factors such as knowledge and beliefs, since public health efforts often trigger changes in these components of risk perception formulation. The model appear as follows

$$R_i = \beta_1 A + \beta_2 W + \beta_3 S + \beta_4 K + \beta_5 X + \varepsilon \quad (8.1)$$

where R_i expresses an individual's perceptions of risk, A_i is the individual's smoking behavior, W is a vector representing experience with and beliefs about health warnings, S is a vector representing how the school acts as an information source through school rules and school-based education programs, K represents the knowledge respondents have about the health problems associated with smoking, X is a vector of respondent characteristics including gender, grade, availability of disposable income and respondent attitudes and

beliefs about smoking and ε is the random set of factors across all individuals that independently impact risk perceptions.

As in Chapters 6 and 7, potential endogeneity between the dependent variable (R_i) and an individual's smoking behaviors (A_i) poses a major methodological issue that has to be addressed in order to make sure that the statistical representation of the above described model is of best fit. The relationship between smoking and risk perceptions could be recursive in nature or instead both variables could be influenced by a common exogenous third variable. The same tests used in Chapter 6 and 7 were employed to check for endogeneity and find appropriate instruments. These tests and the logic behind choosing these instruments are discussed at length in Appendix 6C. Both instruments reflect the ways adolescents spend their time -'take part in clubs or groups such as Guides or Scouts, 4-H club, community, church or other religious groups' at least weekly and 'read for fun' at least monthly. Importantly, these instruments do not reflect respondents' attitudes towards risks or smoking thus providing adequate instruments to predict smoking behavior and not smoking risk perceptions.

All models in this chapter are run treating the smoking behavior variable as endogenous given the results from previous chapters highlighting how the treatment of the smoking variable as exogenous does not significantly alter findings. Additionally, when the models were run treating smoking behavior as exogenous, results were rife with multicollinearity, which disappeared with instrumentation. All models are also two –stage ordinary least squares regressions (IVREG command in STATA) since a two-stage ordered logit model allowing for instrumentation is not currently available in STATA.

Three variables capture the effects of cigarette package health warnings on risk perceptions: the number of valid health warnings respondents can remember, if respondents ever look at health warnings and if respondents believe in the health warnings they have seen. The variable expressing respondent knowledge about smoking risks could also be indirectly expressing the impact of warning messages. This variable expresses how many smoking-related health problems the respondent can identify.

Three dummy variables express the role of the school setting as an information source with whether respondents can smoke in some areas of their school, if smoking is not allowed and if respondents do not know school smoking rules. One dummy variable tests the significance of school public health efforts by capturing whether respondents have been taught in school about health problems related to smoking.

Other explanatory variables include controls for gender, grade, receipt of a weekly allowance, provincial variation and beliefs about smoking such as if it causes nonsmokers harm and if smokers can quit when they want. These variables capture contextual effects that could inaccurately overestimate the explanatory power of other variables in the model.

8.2. Results

8.2.1. Descriptive findings

A preliminary analysis of survey findings at the descriptive level establishes the high level of notice adolescents give to health warnings and also the commonality of schools conveying the health risks of smoking. Table 41 demonstrates that when respondents

expressed that they have seen health warning on tobacco packages and then were asked to recall warning content, their responses appear related to age and risk beliefs.

Table 41. Canadian YSS - Means of the number of valid health warnings respondents can recall by risk perception and age

	Underestimate Risks		*Correct Risk Perception*		*Overestimate Risks*		Total	
Grade	*N*	*Mean*	*N*	*Mean*	*N*	*Mean*	*N*	*Mean*
Grades 5-6	2,458	1.32	608	1.54	1,946	1.43	5,012	1.39
		(1.15)		(1.32)		(1.24)		(1.21)
Grades 7-9	3,913	1.63	1,549	1.86	3,972	1.78	9,434	1.73
		(1.29)		(1.42)		(1.40)		(1.36)
Total	6,371	1.51	2,157	1.77	5,918	1.66	14,446	1.61
		(1.24)		(1.40)		(1.36)		(1.32)

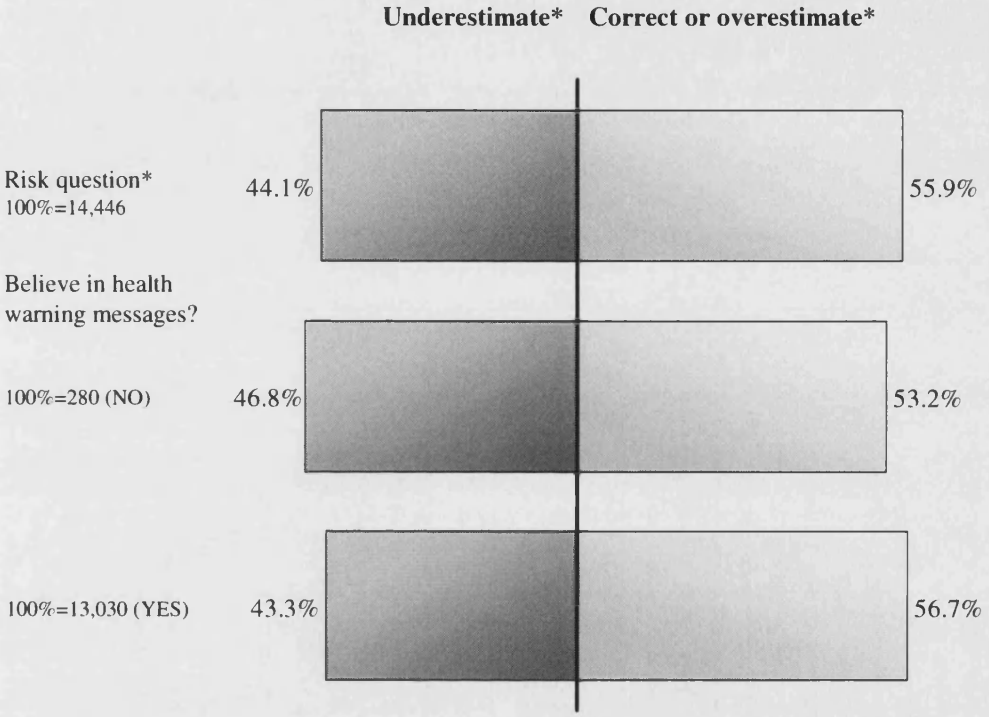
Notes: N = number of observations
Numbers in parentheses are standard deviations
Question asked 'In your own words, write or describe [health warning messages on cigarette packages] you remember?' Answers then classified from 0 to 8 based on how many messages respondent writes down. Respondents classified into risk categories based on response to 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

The average number of health warnings recalled by individuals who had correctly estimated or overestimated the mortality risks of smoking was higher than for individuals who underestimated smoking risks (**RQ1**). This finding remains consistent for the entire sample and when broken down into two smaller sub-samples by age group. Older respondents also appear to be able to remember more health warnings than younger respondents. This result is not surprising given that they are more likely to have had more experience with cigarette packages because of their age. There may also be cognitive development explanations for this finding as well.

Of this survey's respondents, 90.3% believe the health warnings they see on cigarette packages while only 1.9% do not. Of these respondents with different beliefs about the veracity of health warnings, disparity among risk perceptions exists. Figure 17 demonstrates that a larger percentage of those who do not believe health warning messages

underestimate the mortality risks of smoking than of those who do believe health warning messages.

Figure 17. Canadian YSS - Perceptions of risks according to whether believe health warning messages or not



* Risk question is 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

Survey results also suggest that a school teaching their students about the health problems related to smoking has some impact on how they perceive smoking risks. Table 42 shows how as risk perceptions increase, the likelihood of a respondent having been taught in school about health problems related to smoking also goes up.

Table 42. Canadian YSS - Means of whether respondent has been taught in school about the health problems related to smoking by age and risk perceptions

	Underestimate Risks		*Correct Risk Perception*		*Overestimate Risks*		Total	
Grade	*N*	*Mean*	*N*	*Mean*	*N*	*Mean*	*N*	*Mean*
Grades 5-6	3,588	0.68	831	0.74	2,580	0.72	6,999	0.70
		(0.47)		(0.44)		(0.45)		(0.46)
Grades 7-9	4,860	0.81	1,864	0.83	4,792	0.84	11,516	0.83
		(0.39)		(0.38)		(0.37)		(0.38)
Total	8,448	0.76	2,695	0.80	7,372	0.80	18,515	0.78
		(0.43)		(0.40)		(0.40)		(0.41)

Notes: N = number of observations
Numbers in parentheses are standard deviations
Question asked 'Have you ever been taught in school about health problems due to smoking?'
Risk perception is value chosen in response to 'Which of the following, do you think, is closest to the number of Canadians that die each year as a result of smoking cigarettes?' Potential responses are 1,000, 5,000, 15,000, 25,000 (all underestimates), 45,000 (correct estimate), 75,000, 100,000 and over 100,000 (all overestimates).

Additionally, older students are more likely to have been taught in school about the health problems related to smoking and have higher risk perceptions about the mortality risks attached to smoking.

8.2.2. Multivariate analysis

Regression analysis uses multiple models to demonstrate the robustness of results. For all models, each variable had a variance inflation factor (VIF) below 10 suggesting no presence of multicollinearity. Where the VIF of an individual variable was above 10, this control or explanatory variable was removed from the analysis. Not surprisingly, for example, multicollinearity was found to be present in one of the belief variables, 'possible to become addicted to smoking' when the variable expressing whether respondents 'believe in the content of health warnings' also appeared in a model. In this case, 'possible to become addicted to smoking' was removed from the model. Other situations where multicollinearity has been an issue are noted in the results tables.

Table 43 displays three models starting with a model simply including those explanatory variables expressing the impact of health warning messages but leaving out the influence of school influence. The second column displays a model including all explanatory variables aiming to capture school influence but leaves out health warning message. The final column includes all explanatory variables for both health warnings and school influence. All control variables are included in each model but results are not displayed because they have been discussed and shown in Chapters 6 and 7, which run similar models and reach the same findings for these control variables. However, the model in column (3) does exclude the 'believe health warnings YES' variable and one measure of attitudes and beliefs about smoking, 'possible to become addicted' because of strong presence of multicollinearity (VIF over 10 for both variables). This evidence of multicollinearity would have been expected as belief in the veracity of warning labels would logically be correlated with individuals' beliefs about smoking.

Table 43. Canadian YSS - Determinative power of health warnings on tobacco packages and school environment on risk perceptions

	(1) Includes health warnings (I.V.)		(2) Includes all school influence (I.V.)		(3) Includes health warnings and school influence** (I.V.)	
	Coef.	z	Coef.	z	Coef.	z
Smoking behavior						
Smoked whole cigarette*	Yes		Yes		Yes	
Controls - socio-demographics and economic independence from parents						
Gender, grade, province, weekly allowance	Yes		Yes		Yes	
Attitudes and beliefs about smoking						
Possible addiction, can quit when want, can cause nonsmokers harm	Yes		Yes		Yes, except possible addiction, see (**) note	
Knowledge about smoking risks						
Number of smoking-related health problems identify	0.04 [a]	4.36	0.07 [a]	7.93	0.04 [a]	3.86
Information sources – health warning messages						
Number of valid health warnings remember	0.05 [a]	5.96	-	-	0.06 [a]	6.21
Ever look at health warnings YES	0.01	0.37	-	-	0.01	0.19
Believe health warnings YES	0.35 [a]	2.97	-	-	-	-
Information sources – school setting						
Can smoke in some areas of school	-	-	-0.08	-1.51	-0.11	-1.79
No smoking allowed at school	-	-	-0.02	-0.43	-0.04	-0.65
Don't know school smoking rules	-	-	-0.06	-1.03	-0.13 [b]	-2.00
Information sources – school public health efforts						
Taught in school about health problems related to smoking	-	-	0.09 [b]	2.38	0.05	1.17
F-stat	31.05 (0.000)		34.92 (0.000)		24.23 (0.000)	
R^2	0.031		0.037		0.035	
Hansen j statistic	0.921 (0337)		0.640 (0.424)		0.914 (0.339)	
Number of observations	14,302		18,119		14,175	

Notes: All models include robust standard errors

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.'

(**) 'Believe health warnings YES' as well as associated dummy variables and 'Possible to become addicted' had to be removed from the regression in column (3) because of strong multicollinearity

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

Findings regarding health warnings suggest that both remembering the contents of health warning message and believing in the truthfulness of their contents matter more in determining risk perceptions than simply looking at health warnings (**RQ1** and **RQ2**). Therefore, if a respondent states that he/she believes what health warning messages say then he/she is more likely to have higher perceptions of risk. The coefficient on this relationship is especially high at 35% suggesting that belief is an especially important information source (column (1)) (**RQ2**). Remembering the contents of warnings also proved important for determining risk perceptions as the more health warnings respondents could list, the higher their risk perceptions about smoking were likely to be (**RQ1**). Simply looking at health warnings does not appear to have a significantly determinative role (**RQ1**).

A relationship also appears between knowledge and health warning messages as when health warning messages are excluded from the model in column (2), the effects of knowledge is greater than when warning messages are included in the model. Therefore, explanatory variables capturing the impact of warning messages pick up some of the same respondent characteristics as knowledge about smoking risks.

The importance of the school as both a disseminator of risk information and for setting a tone for behavioral risk through smoking rules is not as enduringly clear. In both models including variables to express respondents' understanding of school smoking rules, if respondents thought that students could smoke in some areas of school then they were more likely to have lower perceptions of smoking risks than if respondents' schools had no rules about smoking (**RQ4**). However, this result was only significant at the 10% level in the last model (column (3)). This finding could depict students thinking that if smoking is

permissible on campus then the behavior must not be that bad. However, banning smoking from school appears to have no significant influence on risk perceptions. This means that 'realized' behavior appears to have more of an impact on students' perceptions of risks than the lack of any behavior. Another finding with regards to school rules about smoking was that if respondents did not know their school's smoking rules then they were more likely to have lower perceptions of risk. Therefore, lack of demonstrable rule-setting at the school level led respondents to be more likely to feel less concern about smoking risks.

Results regarding the importance of being taught in school about health problems related to smoking appear mixed. When the model includes only school-related variables as explanatory variables (column (2)), schools teaching respondents about health problems related to smoking had a positive and significant relationship with risk perceptions but when the model expands to include health messages, school teaching loses its significance thus suggesting that health warning messages pick up unexplained heterogeneity that school teaching had been capturing (**RQ3**). This suggests that other variables such as health warning messages and perhaps additional ones not included in this regression such as parental smoking habits or peer effects (*see* Table 45)) have a greater influence than school teaching (**RQ3**). Because of the ambiguity in this question with regards to the context in which respondents had been taught in school about smoking-related health problems, this finding does not mean that specific public health programs or individual teachers speaking to their students about smoking risks do not aid in altering risk perceptions. However, the finding does put into question the school's role as a place to learn about the health problems related to smoking.

Because of findings at the descriptive level suggesting some differences in answers depending on age group, Table 44 shows the same regression as in column (3) of Table 43 run for two separate age samples: grades 5 and 6 (ages 10-12 years) and grades 7-9 (ages 12-15 years).

Table 44. Canadian YSS - Difference in determinative power of health warnings on tobacco packages and school environment on risk perceptions depending upon age

	(1) Grades 5 and 6 (I.V.)		(2) Grades 7, 8 and 9 (I.V.)	
	Coef.	z	Coef.	z
Smoking behavior				
Log (quantitative risk perceptions)*	Yes		Yes	
Controls - socio-demographics and economic independence from parents				
Gender, grade, province, weekly allowance	Yes		Yes	
Attitudes and beliefs about smoking				
Can quit when want **	Yes		Yes	
Knowledge about smoking risks				
Number of smoking-related health problems identify	0.07 [a]	3.64	0.04 [a]	3.62
Information sources – health warning messages				
Number of valid health warnings remember	0.08 [a]	4.00	0.06 [a]	5.48
Ever look at health warnings YES	0.03	0.46	0.00	0.15
Information sources – school setting				
Can smoke in some areas of school	-0.04	-0.31	-0.02	-0.31
No smoking allowed at school	-0.08	-0.92	-0.01	-0.19
Don't know school smoking rules	-0.12	-1.24	-0.16	-1.74
Information sources – school public health efforts				
Taught in school about health problems related to smoking	0.13	1.82	0.05	1.06
F-stat	18.18 (0.000)		15.29 (0.000)	
R^2	0.018		0.023	
Hansen j statistic	0.209 (0.648)		0.379 (0.538)	
Number of observations	4,901		9,323	

Notes: All models include robust standard errors
(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.'
(**) 'Possible to become addicted' and 'smoke can cause nonsmokers harm' had to be removed from these models because of strong multicollinearity
[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-value

The directionality and significance remains the same for all variables except two when comparing either model to the total sample or when comparing the two samples against

each other. For younger respondents, not knowing about school smoking rules had no significant effect on risk perceptions. On the other hand, for younger respondents, being taught in school about health problems related to smoking demonstrated a positive and weakly significant relationship with risk perceptions whereas this variable was not significant for older respondents. The coefficient for this variable is also very high at 0.13. These differences in findings for the two age groups suggest that perhaps as individuals get older and start to question the veracity of information they receive from their school, they are less likely to use this information to update their risk perceptions. Alternatively, as respondents get older, they would attach more credibility to alternative sources of information such as peers' behaviors as demonstrated in Chapter 7.

In order to further investigate the robustness of these relationships, the following table demonstrates the veracity of previous findings in Tables 43 and 44 about the determinative power of warning messages and the school setting by including other information sources explored in previous chapters (Chapter 6 and 7). Table 45 displays the results of model including variables for household structure, parental smoking habits, household smoking characteristics, medical professionals' interactions with adolescents regarding smoking and peers' smoking behaviors as well as provincial level smoking prevalence. Also included are separate regressions run for males (column (2)) and females (column (3)) to highlight gender-specific effects. The final column, column (4) includes the provincial smoking prevalence variable, which cannot be included in earlier regressions that control for province because of multicollinearity considerations.

Table 45. Canadian YSS - Testing the robustness of findings with interaction terms and additional determinants of risk perceptions

	(1) Expanded model (I.V.)		(2) Expanded model with *only males* (I.V.)		(3) Expanded model with *only females* (I.V.)		(4) Expanded model including provincial smoking (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior								
Smoked whole cigarette*	-0.37	-0.86	0.39	0.65	-2.09	-2.09	-0.50	-1.24
Controls - socio-demographics and economic independence from parents								
Gender, grade, province, weekly allowance	Yes		Yes		Yes		Yes	
Attitudes and beliefs about smoking								
Can quit when want, can cause nonsmokers harm	Yes		Yes		Yes		Yes	
Knowledge about smoking risks								
Number of smoking-related health problems identify	0.04 [a]	3.63	0.05 [a]	3.18	0.03	1.85	0.03 [a]	3.34
Information sources – health warning messages								
Number of valid health warnings remember	0.05 [a]	5.63	0.06 [a]	4.05	0.04 [a]	3.14	0.05 [a]	5.64
Ever look at health warnings YES	-0.01	-0.40	0.02	0.51	-0.01	-0.17	-0.01	-0.26
Information sources – school setting								
Can smoke in some areas of school	-0.11	-1.79	-0.21 [b]	-2.44	-0.04	-0.37	-0.11	-1.77
No smoking allowed at school	-0.06	-1.05	-0.14	-1.83	-0.01	-0.08	-0.06	-1.01
Don't know school smoking rules	-0.16 [b]	-2.38	-0.19 [b]	-2.10	-0.15	-1.36	-0.16 [b]	-2.36
Information sources – school public health efforts								
Taught in school about health problems related to smoking	0.04	0.95	0.06	0.91	0.00	0.04	-0.11	-1.77
Information sources – medical professionals								
Doctor asked if smoke yes	0.10 [a]	2.82	0.13 [a]	2.75	0.13 [b]	2.24	0.10 [a]	2.89
Dentist asked if smoke yes	-0.03	-0.55	-0.18	-1.92	0.10	1.13	-0.03	-0.42
Information sources – parents and household								
Only father smokes	0.06	1.61	0.08	1.58	0.04	0.72	0.06	1.59
Only mother smokes	0.10 [b]	2.31	0.15 [a]	2.63	0.07	1.10	0.10 [b]	2.34

Both parents smoke	0.06	1.35	0.10	1.62	0.03	0.44	0.06	1.38
Number of people who smoke in home	0.04	1.80	0.00	-0.09	0.10[a]	2.81	0.05[b]	2.18
Household structure characteristics								
Lives one parent and partner	0.11[b]	2.32	0.08	1.20	0.15[b]	2.24	0.11[b]	2.42
Lives one parent	0.06	1.38	0.04	0.72	0.10	1.58	0.07	1.53
Lives shared custody	0.11	1.62	0.08	0.80	0.19	1.82	0.12	1.68
Information sources – friends								
Number of close friends smoke	0.01	1.04	-0.01	-0.31	0.04	2.03	0.02	1.40
Information sources - population level smoking behavior								
Provincial smoking prevalence	-	-	-	-	-	-	-0.81	-1.64
F-stat	14.09 (0.000)		6.87 (0.000)		6.60 (0.000)		13.89 (0.000)	
R^2	0.034		0.032		0.035		0.029	
Hansen j statistic	1.579 (0.209)		0.005 (0.945)		0.801 (0.371)		2.224 (0.136)	
Number of observations	12,878		6,067		6,811		12,878	

Notes: All models include robust standard errors

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.'

(**) 'Possible to become addicted' had to be removed from these models because of strong multicollinearity

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

These models including additional potential sources of information about smoking risks demonstrate the robustness of findings regarding the importance of health warnings and the school setting in adolescents' development of risk perceptions. Even when household structure characteristics, interactions with medical professionals, parental smoking characteristics, household smoking behaviors and peer effects are included in the models, the determinative power of knowledge about smoking-related health problems, remembering the content of health warning messages and school smoking rules remains the same (**RQ1-4**). In fact, when examining coefficient values, school rules coefficients are one of the greatest contributors to risk perceptions of any information source along side of household structure characteristics, doctors' influence and mother's smoking status. As in prior results, teaching in school about smoking-related health problems remains insignificant (**RQ3**).

Respondent gender appears to relate to substantial heterogeneity in those factors that influence risk perceptions. For males, knowledge about smoking risks is positively related to risk perceptions whereas it is significant only at the 10% level for females. School rules about smoking also proved significant predictors of risk perceptions with respondents who state that individuals can smoke in some areas of school being more likely to have lower perceptions of smoking risks than those respondents who stated that their school has no school rules about smoking. School rules did not prove significant for female respondents (**RQ4**). Having a mother who smoked also proved a positive and significant predictor of males' risk perceptions whereas this variable was insignificant for females. On the other hand, the number of people who smoke in the home was positively and significantly related to risk perceptions for female but insignificant for male respondents. Household characteristics (living in a home with one parent and partner versus two parents) and the

number of close friends that smoke also both exerted positive effects on risk perceptions while appearing to have no effect on the risk perceptions of males. Both sub-samples found school teaching about health problems related to smoking to be an insignificant factor in risk perceptions (**RQ3**) but both groups demonstrate the number of valid health warnings they could remember to have a positive and significant relationship with risk perceptions as does a doctor asking about the respondent's smoking status.

When taking out provincial dummy variables and instead very specifically capturing the smoking prevalence in each province, results highlight the negative relationship between societal smoking and risk perceptions. Although this relationship came out as only 10% significant, the result remains valuable in representing the role of societal behaviors and social norms as an information source.

8.3. Discussion

8.3.1. RQ1 and RQ2 - Warning labels

Findings point to the fact that in order for warning labels to have any determinative power in adolescents' risk perceptions they must remember and believe the veracity of tobacco warning labels' contents rather than simply see the warnings. The positive directionality of variables about health warning messages would be expected according to the Bayesian framework of attaching credibility to an information source. Further support of the assertion that these results follow those of a Bayesian decision model comes in that it is not up to individuals simply remembering the content of messages but more whether they actually believe what the messages say for health warnings to matter in altering risk perceptions. The fact that belief in the veracity of warning messages appears to depend upon age reveals the stage at which adolescents appear to start questioning the credibility of

information presented to them. This result holds important implications for public health policy when thinking about how to aim efforts at specific age groups.

Therefore, these results support previous findings (Hammond et al. 2006; Hammond et al. 2007; Koval et al. 2005), largely examining the impact of graphic health warnings on adult populations for a younger population sub-sample. Findings here also support the less abundant body of research on young adult populations (Koval et al. 2005; O'Hegarty et al. 2006), however, this analysis assesses responses from even younger populations than ages used in this research.[26]

Knowledge about smoking risks, as often disseminated through warning labels emerges as a significant and positive predictor of risk perceptions such that the more smoking-related problems a respondent can identify, then the higher risk perceptions are likely to be. Including smoking risk knowledge as an explanatory variable in these models permits the analysis to control for the knowledge element related to warning labels and pick up variation in responses more clearly due to warning labels and not the respondents' knowledge levels in general. This knowledge variable being significant does, however, allow us to note that knowledge plays a key determinative role in risk perception development of adolescents and that risk perceptions of this age group are not simply driven by the behaviors of others. This finding presents an argument in favor of using rational-based approaches that aim to increase adolescents' stock of information about risks through disseminating smoking risk information. The sources this ought to come from can vary, however and as Lundborg (2007) demonstrates, only a limited number appear effective. Additionally, the relevance of warning labels to adolescents as a population also

[26] Koval et al. (2005) examine responses of 20 to 24 year olds and O'Hegarty et al. (2006) 18 to 24 year olds.

remains an important consideration (Koval et al. 2005) such as using an understanding of why adolescents smoke to determine warning label content (Strahan et al. 2002). However, this analysis' findings suggest that as warning labels exist today, they appear to be garner success as an information source.

These findings point to warnings labels mattering in altering risk perceptions and thus support those of Liu and Hsieh (1995) and Viscusi (1991) in the sense that all of these studies find warning labels to alter risk perceptions. However, both Liu and Hsieh (1995) and Viscusi (1991) use a measure of the impact of warning labels that does not capture as much specific information as those used in this study. Both of these studies examine the effect of warning labels based on the 'number of warning labels seen' whereas this analysis uses the 'number of valid health warnings respondents can remember.' A measure of the influence of warning labels capturing less extensive information was also used in this study, 'respondents ever looked at health warnings' and was not significant. Therefore, this study delineates between simply looking at warning messages, remembering them and believing their content to be true. When all three variables are included, looking at health warnings is the only one not significant. Believing health warnings has the highest value coefficient at 35% and the number of valid health warnings much lower at 5%. Both variables are significant at the 1% level. This result remains significant even when the model is extended to include school setting variables, school public health teaching, parental and household smoking behavior, peer effects, population level smoking behavior and when the data are split based upon age and gender.

Lundborg and Lindgren (2004) suggest that warnings and anti-smoking campaigns may influence younger individuals to a greater extent than older individuals because of their

experience in always being under a stricter regulatory setting than adults. Although findings do elucidate the differences in determinants of risk perceptions with regards to respondents' ages, the difference in regulatory environment from someone in grade five and grade nine would not be radically different enough to denote any changes in the significance of health warnings as a determinant of risk perceptions. All of these individuals have grown up with graphic warning labels on cigarette labels from a young age as Canada has had such warnings since 1990. In the case of this dataset, difference in age has more to do with the changes in the influence of exogenous sources as adolescents grow up.

8.3.2. RQ3 and RQ4 - School public health programs and rules about smoking

The importance of school smoking rules and school teaching about health problems related to smoking is not so clear. In most models, a respondent being taught in school about health problems related to smoking was not a significant predictor of an adolescent's risk perceptions (**RQ3**). However, when the population sample is divided based upon age, being taught in school about the dangers of smoking demonstrated a positive and significant relationship with risk perceptions for younger respondents (grades 5 and 6) (**RQ3**). Given the lack of detail around the context in which schools taught respondents about smoking-related health problems, this finding prohibits specific policy recommendations but suggests that if this genre of public health policy is to be effective, efforts should be well focused and targeted as current actions do not appear helpful in universally altering risk perceptions.

Lundborg (2007) found that teachers positively and significantly alter adolescents' perceptions of risks while other adults at school negatively and significantly impact risk

perceptions. Because the YSS provides no information about who administers teaching about the health problems related to smoking in the school setting for each respondent, this result cannot neither support nor refute Lundborg's findings.

School rules about smoking being allowed on campus, in some areas or not being allowed at all appear to be a largely insignificant or weakly significant predictor of adolescent risk perceptions except when respondents state that they do not know their school's smoking rules (**RQ4**). A respondent not knowing his school's smoking rule emerged as a negative and significant predictor of risk perceptions. Additionally, if a respondent's school allows students to smoke in some areas of school versus smoking being allowed in general then he/she is more likely to have lower perceptions about smoking risks. Findings regarding school rules regarding smoking remained consistent even when adding other information sources. When either smoking allowed at schools only in some areas or students are not aware of school smoking rules, risk perceptions are more likely to be lower. Findings about the importance of school rules in determining risk perceptions point to the importance of creating an environment where rules about smoking are known in order for school rules to have an impact on risk beliefs (**RQ4**). Overall, these results about the school as a place to gain information about smoking risks point to environmental example mattering more than classroom-based factual discussions about health problems related to smoking in impacting adolescents' risk perceptions. This salience of environmental factors was also found to be the case in Chapter 7 with provincial smoking behaviors.

8.3.3. Extended models including all explanatory variables

The results already discussed remain consistent when adding other explanatory variables focused on in Chapters 6 and 7. However, it is important to discuss the results of these

models because they allow us to understand which information sources and factors matter most in influencing adolescents' risk perceptions. Results from previous chapters hold up such that the role of doctors asking respondents if they smoke, parental smoking habits, household smoking habits and living in a home without both parents have significant determinative relationships with risk perceptions. Respondent smoking behavior also remains insignificant.

When separate models were run for population sub-samples according to gender, it appears that males' risk perceptions are more subject to influence from school smoking rules than those of females (**RQ4**). In the same way, knowledge about smoking risks in the form of the number of smoking-related health problems respondents can identify is positively and significantly related to risk perceptions for males but not females. This finding falls largely in line with that of Lundborg and Andersson's (2007) finding that males rather than females are more likely to use information about smoking risks from various information sources (although Lundborg and Andersson define 'information source' more narrowly as directly disseminating risk information) to develop their perceptions of smoking risks.

Females rely on other information sources and factors to formulate and update their risk perceptions. Findings from these models suggest that females rely on their own smoking status, the number of people who smoke in the home, household structure (as in Lundborg and Andersson (2007)) and the number of close friends that smoke more than males. These variables were all insignificant for males. However, in addition to relying more on knowledge and school rules about smoking, parental smoking status also matters more for males than female respondents.

When provincial smoking was included in the model, this variable was also significant and demonstrates a negative relationship. The signs and determinative power of other explanatory variables also remained the same as in the model using provincial dummies instead of this more precise measure of smoking prevalence.

8.4. Conclusion

This chapter has highlighted the success of Canada's health warnings program in its ability to convey information adolescents deem credible, remember and then use to alter their perceptions of the risks about smoking. Results point to the importance of adolescents doing more than simply seeing health warning messages but processing the information they contain and using it to update their current stock of knowledge. Not quite as universally successful appear school-related public health efforts. Respondents knowing what school rules about smoking are also seem to exert a significant impact on risk perceptions.

These findings point to adolescents certainly being at a stage where they question the credibility of information given to them and the sources of information themselves based on their differentiation of credulity attached to different information sources.

The extension of models to include all explanatory variables used in previous chapters supports the robustness of the empirical analysis of this thesis. Findings delineate those information sources adolescents' deem credible in formulating their risk perceptions. These include health warning messages, doctors, parents, the household, peers and society (as measured by the province). The importance of these findings lies in something greater than simply their empirical robustness but more generally in what they mean for adolescent

smoking prevention policy. With an improved understanding of which individuals play key influence on how adolescents develop their risk attitudes, these findings can be exploited to focus policy more effectively.

The next chapter discusses this thesis' empirical findings in light of their policy implications as well as methodological and theoretical significance. It also points to where future research could further fill out the gaps left by the limitations of this analysis.

Chapter 9. Discussion and conclusion

At the heart of this thesis lies the basic question as to how to influence the likelihood that individuals deliberately undertake activities which bring disutility to themselves and possibly others. Research starts from the premise that perceptions of risks related to a behavior matter in determining the likelihood that an individual undertakes a risky activity. Analysis then proceeds to investigate how perceptions of risks related to risky activities may be altered by various information sources.

Findings can be categorized as theoretical, methodological and policy-focused in nature. This chapter will take each of these types of findings in turn. First, I will examine results from a theoretical perspective assessing how the key theories and frameworks as laid out in the conceptual framework developed in Chapter 2 held up under empirical scrutiny.

Second, the methodological-related findings of this thesis will be discussed. This research has answered multiple outstanding questions not only within the literature on smoking and risk perceptions but also in the larger setting of risk perceptions research as discussed in Chapter 3, regarding risk perceptions elicitation methodology and confronting issues with endogeneity between behaviors and risk perceptions.

Third, results will be set within the policy atmosphere found in Canada and the US to understand the implications these findings have for further policy recommendations about the way adolescents can be helped in understanding and processing information about smoking risks.

Prior to discussing the theoretical methodological and policy-based findings of this research, I will discuss findings regarding this thesis' two key questions: (1) whether altering risk perceptions will make a difference in the likelihood of individuals consciously undertaking an activity reducing their stock of health capital and then, (2) what information sources may influence individuals' risk perceptions.

9.1. General findings for this thesis' two key questions

This thesis has used data from two surveys of adolescents in Canada and the US to demonstrate the link between risk perceptions and behavioral choices within a context where the decision-maker has limited personal experience as stated in Chapter 1.

① Do perceptions of risk inform adolescents' decisions to smoke? (Chapter 5)

Across both datasets used in this thesis, the higher adolescents' risk perceptions were found to be, the more likely individuals were to have never engaged in smoking behavior. This relationship was found to be significant in the presence of many other explanatory variables and controls deemed throughout the literature as well-known predictors of adolescent smoking behaviors such as parental smoking habits, household smoking habits, age, gender and income. Smoking behaviors were never found to be significant predictors of risk perceptions across both datasets once models controlled for an endogenous relationship between risk perceptions and behaviors. This result lends credibility to the hypothesis posed at the start of this thesis that adolescents rely more on exogenous sources of information about smoking risks than personal experiences to form their perceptions of smoking risks.

The finding that risk perceptions about smoking-related mortality predict adolescent smoking allows one to confront previous questions posed in the literature about adolescents negating the time dimensions of smoking-related utility when making behavioral decisions. The risks of smoking seeming so far in the future and adolescents miscalculating the future utility consequences of today's behavior constitutes an often cited reason why youths may smoke even though they know the risks of smoking (O'Donoghue and Rabin 2000). Mortality is the last possible negative consequence of smoking thus pointing to timing of risks not being such a key driver behind adolescent smoking (Lundborg 2007). Similarly, adolescents do not appear to be denying the risks associated with smoking. These results point to adolescents thinking about the future when making smoking decisions thus demonstrating less time discounting than expected.

Empirical results also provide an answer to the second overarching question asked in Chapter 1.

(2) Which sources of information do adolescents rely on to inform their perceptions of risks? (Chapters 6-8)

This population sample's age prevented them from relying on personal experience with smoking to formulate risk perceptions allowing this research to focus on the valued role of exogenous information to fill this gap. Adolescents were found to rely on exogenous sources of information rather than any limited personal experience they may have in order to develop their perceptions of risk. These sources of information proved both direct and indirect in nature with direct dissemination about dangers associated with a risky behavior proving as instrumental in predicting risk perceptions as indirect information about risks

through behavioral example. Medical professionals, parents, peers, society, warning labels and knowledge of school rules (but not school rules themselves) were found to predict adolescents' risk perceptions. This work provides the empirical basis for public health policy proposals. Successful interventions can then be employed to achieve public policy aims of reducing preventable exposures to health risks such as smoking.

I will now discuss this thesis' findings in detail in light of their theoretical, methodological and policy-related implications.

9.2. What this thesis' results say about theory

This research assumes that individuals have expectations about how they wish to maximize their utility. In the case of adolescents, fitting in with peers, not getting into trouble (or perhaps getting into trouble), doing well in school (or not caring about school) and playing sports would be many of the constraints around which adolescents would try to reach some sort of self-prescribed optimal level of achievement. Of course, this kind of process is not one in which adolescents cognitively engage but instead subconsciously underlies their day to day decision-making. However, the decisions adolescents make do not always result in utility maximization. An example of this would be an adolescent beginning to smoke. As smoking dangers have been well publicized, it cannot be said that adolescents lack information about smoking but because of uncertainty they might not know how those dangers and risks apply to them. Behavioral outcomes would then not necessarily appear rational within a utility maximizing framework.

Therefore, expectations about what will happen if one smokes are not necessarily rational because of uncertain pay-offs. In order to correct for this uncertainty, this thesis proposes

that individuals update whatever is their current stock of information ('prior') with inputs from a variety of sources according the Bayesian learning framework discussed in Chapter 2. Characteristics such as age, ethnicity, socio-economic status and gender all vary the ways in which each individual updates his stock of information.

From a theoretical perspective, this thesis aims to alter this inherently individualistic Bayesian model to include environmental and social effects as well as test for the presence of affect heuristics, principal-agency relationships and the importance of spatial proximity in adolescents' decision-making about the risks of smoking. The following bullet points summarize how empirical findings from this thesis speak to this underlying theoretical framework and how each of these findings points to one or more research questions posed in the empirical chapters. Subsequently, I discuss what this thesis says about each aspect of the conceptual framework posed at the conclusion of Chapter 2: the Bayesian learning model, affect heuristics, principal-agency relationships and spatial proximity

Key theoretical findings

Bayesian learning framework

- Offers support for more broadly defining 'information' to include personal experience and learning from the experience of others (*Chapter 6* – **RQ1** and **RQ2**, **RQ3** and **RQ4**, *Chapter 7* – **RQ1-RQ3**, *Chapter 8* – **RQ4**)
- Extends the Bayesian learning framework to include social interactions and the importance of environmental factors (*Chapter 5* – **RQ3**, *Chapter 6* – **RQ2**, *Chapter 7* – **RQ1-RQ4**, *Chapter 8* – **RQ4**))

Cognitive biases (affect heuristics)

- Finds support for adolescents not solely using rational cognitive processes but employing affect heuristics when making decisions about risk assessment (*Chapter 5* – **RQ2**)

Principal-agent relationships

- Provides evidence of principal-agency relationships between medical professionals and adolescents where adolescents rely on medical professionals for direct information about risks (*Chapter 6* – **RQ4-RQ5**)
- Supports the hypothesis that adolescents rely on their parents as in a principal agent relationship to define their own understanding of risks (*Chapter 6* – **RQ1-RQ3**)

Spatial proximity

- Points to the role spatial proximity plays in the credibility adolescents attach to the importance of behavioral examples and opinions regarding smoking as potential sources of information (*Chapter 6* – **RQ1-RQ2**, *Chapter 7* – **RQ1-RQ4**)

9.2.1. Implications for Bayesian learning model

At its most basic level, the Bayesian learning model is one where evidence and observations allow individuals to update their 'prior' understanding of the probability that a hypothesis is true. This model focuses on the individual as the sole actor when updating one's decision-making. It does not explicitly incorporate the continuous effect of influences from one's environment or peers. This thesis assumes that because adolescents have had limited personal experience with smoking, they will rely on indirect experience (examples of others smoking) and information (discussions about risks of smoking) provided by others to develop perceptions of risk. This hypothesis was proven correct by evidence that parents, medical professionals (Chapter 6), peers, society (Chapter 7),

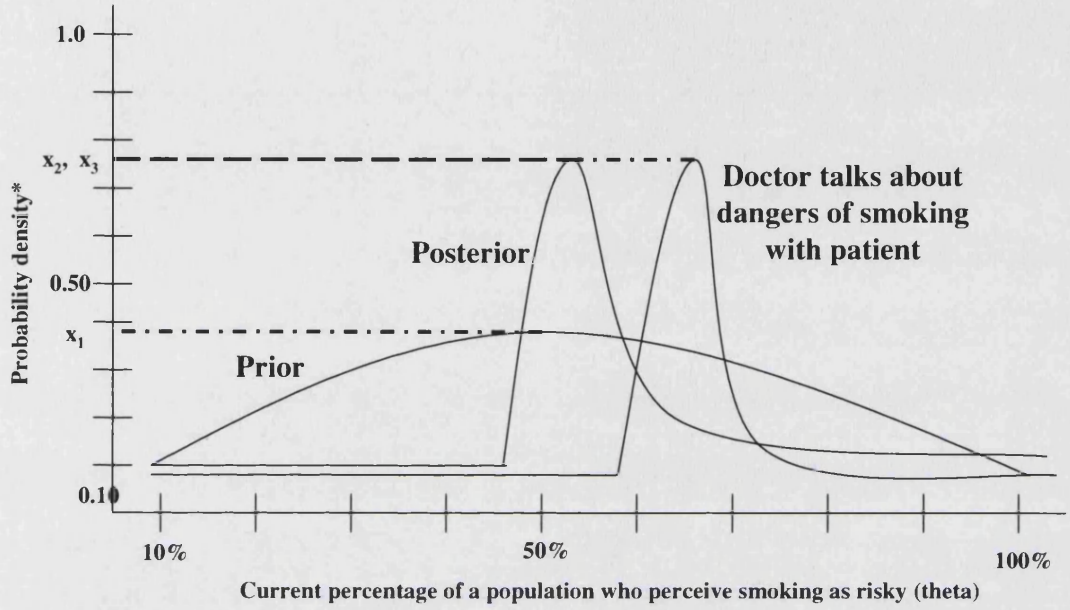
warning labels and school smoking rules (Chapter 8) can contribute to adolescents' risk perceptions alongside of evidence that smoking does not predict risk perceptions (Chapters 6-8). Respondent characteristics such as gender and age mitigated the extent to which each of these factors matter as evidenced by their significance in predicting risk perceptions.

Of crucial importance in this thesis' examination of the Bayesian framework's role in risk perceptions comes in providing evidence that respondents learn as a result of new information rather than simply that a correlation exists, for example, between parental smoking and their child's risk perceptions (Viscusi 1985). Because the individuals analyzed in this work are seventeen years of age and younger, the information they receive about smoking risks both directly in the form of information about smoking dangers and indirectly by learning from others' behaviors would all be newly acquired information. The ability to test changes in risk perceptions over time as a result of changes in stocks of information was limited by the cross-sectional nature of both datasets used in this thesis.

The same analysis could have been performed on adults but instead was performed on adolescents. The decision to focus on adolescents was driven by two factors. First, limited work has looked at how adolescents' perceptions of risks influence their smoking behavior. Second, looking at only adolescents allows analysis to focus on the influence of exogenous information sources where policy can have an impact most clearly. Examining an adolescent population means that the sample have limited personal experience with smoking and therefore rely on looking at the behavior of others and content gained from other information sources such as anti-smoking campaigns. These individuals' views would also be captured at the very commencement of their learning process about smoking risks. Therefore, in this case, the 'prior' would be filled with a large degree of uncertainty.

Figure 18 depicts what an adolescent's movement towards more certainty about the risks of smoking would look like according to results found here and the Bayesian model.

Figure 18. Posterior information dominates prior in the case of adolescents' risk perceptions about smoking



*The probability that theta is equal to x_n

This figure depicts a situation demonstrated in the empirical analysis of this thesis where a respondent's views on the risks of smoking are likely to be moved in a positive direction with more certainty about risks once a doctor speaks to the adolescent about smoking dangers. The x-axis of this figure measures the accuracy of an individual's perceptions of smoking risks while the y-axis measures the probability density or likelihood that the value of the x-axis is actually equal to the mean. The variance in an adolescent's views falls from the level present in the prior to a narrower curve in the posterior position. This demonstrates an increased level of certainty about risks. Therefore, the new data dominates the prior because of so much uncertainty before. This same example would hold true for any of the information sources investigated in this thesis that were found to predict risk perceptions. The only differences would be the curve moving towards the left or right

along the x-axis depending on if an information sources has a positive or negative relationship with risk perceptions.

Viscusi applies the Bayesian framework to risk perceptions development (1989) and particularly to perceptions about smoking (1991) in stating that individuals acquire information through their prior set of beliefs, direct and indirect individual experience and exogenous or public information to which the individual is exposed (Liu and Hsieh 1995). As hypothesized by Viscusi (1991), this thesis found younger respondents to be more likely to rely on school programs to teach them about smoking risks than older respondents (*Chapter 8* – **RQ3**). With a difference in respondent age of only about five to six years at the most, this finding points to how quickly the value of each influence can change once indirect experience (more peer smoking) starts to take a larger role. Therefore, the Bayesian concept of credibility attached to sources is a dynamic one for adolescents.

Previous work on risk perceptions and smoking behaviors has discussed what the Bayesian decision-making model says about the relationship between age and risk perceptions (Liu and Hsieh 1995; Lundborg and Lindgren 2004; Lundborg 2007; Viscusi 1990, 1991).[27] This thesis found a positive relationship between respondent age and risk perceptions, which is the opposite to that found in the studies cited above where younger age groups were found to perceive risks as higher than older ones. Viscusi (1991) attributes his finding to the youngest sub-sample of his population group being subject to a stricter regulatory environment with stronger warning labels and other policies measures in place than the older sub-samples. This explanation functions well in this instance because the population

[27] Other work on age as a determinant of perceptions of risks about smoking has found a less defined relationship between risk perceptions and age (Antoñanzas et al. 2000; Costa-Font and Rovira 2005).

surveyed includes adults. Lundborg and Lindgren (2004) also use this explanation for the same finding when their population sample only includes individuals between the ages of 12 and 18 years.

This thesis would agree that younger individuals are subject to a stricter regulatory environment, however, at a certain point in time all adolescent respondents would have grown up under strict regulations. Due to the fact that both surveys used in this analysis would be asking questions of individuals who had grown up in a tight regulatory setting, perhaps this difference in age finding is more due to the fact that as individuals get older, they understand the risks of behavior more as a function of acquiring more information and for this reason, age and risk display a positive relationship.

This example of how respondents' sources of information change with age captures the dynamic characteristics of the Bayesian model where credibility and availability of information may differ with age. In general, the Bayesian construct found support throughout this thesis' findings where in a setting with uncertainty and incomplete information, adolescents use many sources to update their risk perceptions to the extent deemed appropriate based upon the credibility attached to each information source (Chapters 6-8). The extent to which each information source tested was deemed credible by the survey population will be discussed below in section 9.4.

9.2.2. Implications for risk assessment with intuitive feelings (cognitive biases or affect heuristics)

The literature on decision-making finds evidence of inconsistency across decision-making contexts, ignoring of information based upon desired outcomes and in general, allowing

affect or feelings to drive a rational decision-making process even in the presence of an objective understanding of risks and consequences. Risky contexts constitute situations where feelings tend to play a relatively large role (Finucane et al. 2000), especially because of variations in the volume and understanding of available information (Slovic et al. 2004).

Results from this thesis tend to support the assertion that decision-making with regards to risky contexts tends to be influenced by affect heuristics. This conclusion comes from methodological findings on how to measure risk perceptions (*Chapter 5* – **RQ2**). Analysis of the YSS, which had two types of risk perceptions questions (quantitative and qualitative) demonstrated that measuring risk perceptions using a means which includes reference points and comparison between risks does not offer a consistent understanding of respondent risk perceptions. Theoretically, if one measure of risk perceptions about smoking proves a significant predictor of smoking behavior then other measures would also be significant. In this case, only one of the qualitative measures of risk perceptions (risk smoking relative to alcohol) proved a significant predictor of risk perceptions across all tested models while a second qualitative measure (risk smoking relative to suicides) appeared as more weakly significant across some models. The remaining four measures were all insignificant predictors of behavior. Therefore, when smoking is compared to other risks (against which smoking is always more risky in comparison), responses are not only different at a descriptive level but their ability to predict smoking behavior is not uniform.

In this setting, respondents may have focused more on the risk being compared to smoking rather than assessing the risks in comparisons together thus providing inconsistent results. Therefore, risk perceptions were found to have an inconsistent role in behavioral change,

which supports previous findings of systematic limits in individual's abilities to process information in contexts of risk and especially in cases with reference points (Kahneman and Tversky 1979). This result stemming from the use of qualitative risk measures does not suggest qualitative elicitation techniques to be universally flawed as evidence from the US NSDUH models point to alternatively phrased qualitative risk measures predicting smoking behavior.

9.2.3. Implications for the principal-agent theory

While adolescents clearly have the capacity to act on their own accord with regards to the decision of whether to smoke or not, a variant of the principal-agent relationship can be seen in empirical findings. This analysis calls it a variant on principal-agency theory because the interests of parents/medical professionals as agents may not be entirely different from those of adolescents as principals. Therefore, the way this thesis looks at principal-agent theory focuses more on how adolescents rely on their parents and medical professionals as agents to amend the information asymmetry existing between adolescents and parents as well as medical professionals about smoking risks.

Limited previous work has examined the potential for a principal-agent relationship within families (Munro 1999). While parental smoking was shown to have a positive and significant relationship both on the likelihood of adolescents' smoking as well as their risk perceptions in findings from the YSS data, a particular question from the NSDUH gives greater insight into the potential for a principal-agent relationship between parents and their adolescent children. Respondents' perceptions about whether their parents approve or disapprove of smoking were found to be the greatest predictor of respondent risk perceptions using the NSDUH data. They had higher coefficients in predicting

adolescents' smoking risk perceptions than parental smoking status. While parents talking to their children about smoking risks matters, perceptions of parental disapproval mattered most even when controlling for the nature of the relationship between the respondent and parent (i.e., whether parents check homework, tell them they have done a good job). This finding speaks to how much it appears that adolescents rely on their parents' opinions to develop their own risk perceptions thus pointing to a role for parents as agents helping their children as principals when the principal is less informed than themselves (*Chapter 6* – **RQ1-RQ3**).

The principal-agent relationship also appears to apply with the medical profession acting as agents for their patients by patients deeming their information about the dangers of smoking credible. Results from empirical models using the YSS data demonstrate the significant role of both doctors and dentists in shaping adolescent risk perceptions by talking with their patients about the health effects of smoking (*Chapter 6* – **RQ4-RQ5**).

9.2.4. Implications for spatial proximity theory

Findings from this thesis point to the importance of spatial proximity in influencing the credibility attached to various information sources. In general, smoking behaviors of adolescents' household members appear to strongly influence both adolescents' likelihood of smoking and their risk perceptions about smoking. More striking is the finding that when parents are separated out as two distinct variables, mother's smoking versus father's smoking, while both are significant in all models, mother's smoking has a higher coefficient meaning that it predicts more of adolescents' smoking behaviors and risk perceptions than father's smoking. Since adolescents are likely to spend more time with their mothers than their fathers, this finding gives even more credence to the importance of

spatial proximity as increased interpersonal exchange appears to translate into more of an influence (*Chapter 6* – **RQ1**).

The same could be said for results regarding peers' smoking. An adolescent's peers' smoking habits were demonstrated to have a significant relationship with an adolescent's likelihood of smoking (*Chapter 5* – **RQ3**). The coefficient value in these regressions for peer effects was higher than any other variables again pointing to the importance of relationship proximity given all the time adolescents spend in school and outside of school with their peers.

The story appears slightly different in the case of models where risk perceptions constitute the dependent variable. While peers play a role in the development of risk perceptions, coefficient values are not greater than those found attached to variables capturing parental impact on respondents' perceptions of risks (*Chapter 7* – **RQ1**). Therefore, results suggest that spatial proximity can play a role in predicting a risky behavior but the evidence is more mixed when looking at results for risk perceptions.

Examining these findings highlights an area requiring future research with data allowing for a greater depth of analysis around closeness of relationships. Results here suggest that when developing perceptions of risks, respondents tend to rely more on figures to whom they attach credibility or even fear, in the case of doctors and dentists than those individuals that they spend more time around such as a their father (*Chapter 6*).

9.3. What this thesis says about methods for examining these issues

From a data and methods perspective, this thesis has made three key contributions. This section will also address two specific methodological differences that separate this work from anything previously performed on smoking and risk perceptions from a methods perspective. These points relate both to how this work can be differentiated against other previous research in the area of risk perceptions and smoking and with what the results shown here mean for the methodological points raised in Chapter 4.

First, the YSS dataset allowed for identical analysis to be run using two different measures of risk perceptions (quantitative and qualitative) (*Chapter 5* – **RQ2**). Placing the role of risk perceptions and behavioral economics more generally into the public health arena requires a clear view on how best to measure risk about health-related consequences. Both quantitative and qualitative risk perception elicitation methodologies are subject to a bevy of criticisms (Fischhoff et al. 1993) stemming from the cognitive biases individuals employ in settings of incomplete information or uncertainty (Tversky and Kahneman 1974). These two measures of risk were only used in the analysis found in Chapter 5 examining the determinants of smoking behavior because of the lack of reliability of the qualitative risk measure owing to its comparative format inviting biases into question responses. To the best of my knowledge, no previous research on risk perceptions about smoking from a behavioral economics perspective has used two measures of risk perceptions from the same dataset. The ability to perform this analysis adds to previous research on risk perception methodology by truly being able to directly compare methodologies against each other.

To assess smoking risks, at the least, individuals require adequate information about the negative side effects of smoking, the likelihood of their occurrence, those factors which may augment or diminish the likelihood of adverse outcomes and the ability to avoid harm once starting smoking (Weinstein 1999). Evidence from this thesis suggests that adolescents' expressions of their assessment of risk depend upon the elicitation methodology used. In this study, when the risk of smoking was compared to that of other avoidable deaths (car accidents, AIDS, alcohol, murders, suicides, illegal drugs), risk perceptions did not appear accurate because of their lack of consistency across responses, however, when assessing smoking risks alone, over half of respondents from both surveys were likely to overestimate or have correct estimates of smoking-related mortality risks or attach 'great risk' to smoking. Therefore, this research does not find wide scale underestimation of smoking risks but points to clear room for improvement in the aim of all adolescents having accurate risk perceptions (*Chapter 5* – **RQ1**).

Second, this work focuses on predictors of risk perceptions to include direct and indirect sources of information. Lundborg (2007) examined the determinative power of direct information about smoking risks and dangers as disseminated by the respondent seeking after information himself or from a teacher, other adult at school, parents, siblings, friends, other adults, media sources (TV, magazines or radio) and a final category of 'other sources.' This study takes a broader view of the definition of information sources in adolescents' development of risk perceptions. This wider definition proved to be correct as indirect sources of information such as parental smoking behaviors, household structure, perceptions of parental approval about smoking, peers' smoking behaviors, perceptions of friends' approval about smoking and societal smoking behaviors were shown to predict perceptions of risk (Chapters 6-8). This study is the first in the research area to take this

broader definition of information and demonstrate that information can be disseminated both directly through facts and increased knowledge of risks (*Chapter 6* – **RQ3**, **RQ5**, *Chapter* 8 – **RQ1**, **RQ3**) and indirectly through behavioral example (*Chapter 6* – **RQ1**, *Chapter 7* – **RQ1**, **RQ2**, **RQ4**, *Chapter 8* – **RQ4**) and feelings of approval (*Chapter 6* – **RQ2**, *Chapter 7* – **RQ**3).

Third, this work has taken previous empirical strategies in risk perceptions research a step forward. Explaining the potentially recursive relationship between behaviors and perceptions of risks holds particular importance in risk research. Previous work in the field of risk perceptions and smoking has recognized the often endogenous relationship between smoking and risk perceptions (Antoñanzas et al. 2000; Liu and Hsieh 1995; Lundborg and Lindgren 2004; Lundborg 2007; Viscusi 1990; Viscusi 1991). However, only Lundborg and Lindgren (2004) and Lundborg (2007) examine an adolescent population. Neither of these studies presented a simultaneous equations model with an instrument or instruments adequately correcting for endogeneity present in the risk perceptions variable when predicting smoking behavior. This study was able to find two suitable instruments for use with each dataset thus offering two sets of models controlling for this endogenous relationship using an adolescent population. Therefore, this analysis advanced the previous literature in the area by having the available survey data that provided suitable instruments. These instruments were chosen because they met the empirical tests described in Chapters 5-8 and made intuitive sense. The use of instruments used throughout this thesis represents a step forward in this research area, which comes as a result of using large and extensive surveys to analyze issues that have been looked at using more focused surveys. The surveys used here tested a range of questions within the area of youth tobacco and in the case of the NSDUH many other issues such drug, health care and mental care use.

Through this use of instrumentation to correct for endogeneity this thesis was able to provide evidence of risk perceptions predicting smoking behavior (*Chapter 4* – **RQ1**) but personal experience with smoking not predicting risk perceptions (*Chapter 6-8*) thus offering more support for the assumption that adolescents rely on exogenous sources of information to develop their perceptions of risk about smoking.

Other points to mention regarding what this thesis adds from a methods perspective have to do with the characteristics of the sample population used and the use of two datasets to examine the same research questions.

First, the population analyzed was 10 to 15 years old for the YSS dataset and 12 to 17 years for the NSDUH dataset. These are the youngest sample examined on topics about risk perceptions.[28] The young respondent age proves particularly important when trying to gauge an understanding of what information sources individuals use when in a setting of uncertainty and incompletely formed preferences. In adolescence, utility setting and risk perceptions are not as stable as in adulthood because the information acquisition phase is still ongoing. As smoking behaviors enduring into adulthood often commence in adolescence, understanding what that process looks like even earlier on allows for the ability to have influence at this crucial stage. Even an examination of the role of risk perceptions in predicting smoking behaviors benefits from having a young population sample. By testing whether the inclusion of other predictors of smoking behaviors impacts

[28] The other two studies on risk perceptions and smoking have a sample age of 12 to 18 years (Lundborg and Lindgren 2004) and 15 to 18 years (Lundborg 2007).

the significance of risk perceptions in predicting smoking conveys the robustness of findings about the importance of risk perceptions.

Second, this study takes two datasets and poses the same research questions to be tested on each. Except for the work presented in Chapter 8 on public health and the section in Chapter 6 on medical professionals, all other analysis was performed using two datasets. Asking the same research questions of two datasets using different methodologies for measuring risk perceptions and sometimes dissimilar means to capture the influence of various information sources allowed for confirmation of findings. Often in risk literature, questions about the robustness of findings stem from issues with risk perception elicitation methodology. However, in this case, while risk perception methodology has been extensively discussed, findings regarding various explanatory variables have been tested in two policy and risk elicitation environments. The four country International Tobacco Control project survey would also allow for direct cross-country comparison (Hammond et al. 2006; Siahpush et al. 2006) analyzing topics such as the determinants of smoking and smoking knowledge. However, it does not narrowly focus on risk perception determinants and methodologies surrounding their elicitation. Without a directly comparable cross-country dataset, the approach this thesis took of examining the same research questions across two datasets using similar adolescent populations permitted a first look at how risk perceptions research could benefit from cross-country comparative work in order to make policy recommendations.

9.4. What this thesis' results say about public health policy

Public health policy acts to influence all conduits through which adolescents garner information to develop and adapt risk perceptions. Therefore, results of this thesis should

be reviewed in light of a basic understanding of the tobacco policy setting found in both Canada and the United States. A review of the current tobacco policy environment in Canada and the United States can be found in Appendices 3A and 3B, respectively.

This section will discuss what empirical findings say about each country's overall policy focus, the place of the household in tobacco control, medical professionals and peers in tobacco policy, implementation of warning labels and use of school smoking rules and health education programs. From a policy perspective, the key findings of this research are outlined in the bullet points below. When possible, these findings were tested across both datasets.

Key policy-related findings

- Risk perceptions predict smoking but smoking does not predict risk perception – this could be because experience effects are not as strong during adolescence as individuals do no internalize risks for themselves (cognitive dissonance) (*Chapter 5* – **RQ1**, *Chapter 6-8*)
- Parents' smoking habits have a positive impact on risk perceptions (*Chapter 6* – **RQ1**)
- Medical professionals play a determinative role in adolescents' risk perceptions (*Chapter 6* – **RQ4-RQ5**)
- Environment (cultural norms as manifested through smoking prevalence) matters more for influencing risk perceptions than micro-level friend groups' behaviors (*Chapter 7* – **RQ1- RQ2**)

- Perceptions of what respondents think their friends think about smoking are more important than the actual smoking behavior of friends in determining adolescents' risk perceptions (*Chapter 7* – **RQ1, RQ3**)
- Similarly, perceptions of what respondents think parents would think about smoking matter more than direct information from parents about the dangers of smoking (*Chapter 6* – **RQ2-RQ3**)
- On the public health front, warning labels appear to have a great capacity to alter risk perceptions when they are highly visible such as including graphics and colors (*Chapter 8* – **RQ1-RQ2**)
- School-based teaching did not seem to have any significant level of success in impacting adolescents' risk perceptions (*Chapter 8* – **RQ3**)

9.4.1 Policy approaches in Canada and the US

While the analysis performed in this thesis does not speak to testing the overall policy environment in each country, it is important to note a clear fundamental difference in the policy process between each country and what this may mean for the success of youth tobacco policy. Canada focuses much more on national-level youth prevention and cessation programs while the US employs little of its national-level infrastructure to disseminate public health programs and instead the national-level acts more as a reviewer of state policy progress. States come up with tobacco control programs. The CDC may review progress on a given initiative such as preventing youth smoking initiation and then other states may adapt their current programs based on findings. Therefore, it is very much an iterative process between the state/local and national levels in the US whereas Canada has national policies and then the provinces and territories may have their own specific policies in addition. The only case where the US has national level policies is with the

federal age limit for purchasing cigarettes and the four warnings appearing on tobacco packages.

For example, Canada has a plethora of national level television and print ad campaigns regarding the dangers of tobacco use whereas the US had only had one national level campaign. Canadian territories and provinces have a clear role in legislating individual laws such as smoking bans but tobacco control policy is not only set out but also administered more closely from the national level. The local level functions more to enhance national campaigns.

In the US, national goals act as guidance for state and local-level action. Very limited action in terms of enacting legislation comes from the national level in the US.[29] The more fragmented US system has wider disparities in smoking rates across the states than Canada sees across the provinces.[30] Wide heterogeneity in population characteristics such as socio-economic status and cultural backgrounds across the US states plays a crucial role in these great differences in smoking rates. Leaving tobacco policy development and implementation to the states and leaving policy review and guideline setting at the national level is very much a characteristic of the US policy model partly due to the need to develop specific approaches for each state's often unique population. However, the lack of consistency in US tobacco control policies may in some cases be detrimental when attempting to push forward a united message about the dangers and risks of smoking. The

[29] See case example of legislation around internet-based cigarette sales below in Appendix 3B

[30] Canada sees a range of 5% on each side of the national average smoking rate of 19% for each province (CTUMS 2006) whereas US state smoking rates range from 10.5% to 27.6% for adults with a national rate of 20.9% and 7.3% to 36.4% for youths with a national rate at 21.7% (CDC 2006*b*)

success of the 'truth' campaign in educating youths about the risks of smoking only strengthens this point.

To generalize, both countries acknowledge the importance of influencing adolescents both in the prevention and cessation processes. However, Canada demonstrates a commitment to strong warning labels and developing less harmful cigarettes while at the same time operating the usual bevy of tobacco control policies including school-based education programs, cessation programs, access initiatives, taxation and focusing on the reducing environmental smoking. The US utilizes the same policy tools with the variant that warning labels are not as stressed as in Canada.

Let us now focus our efforts on the particular aspects of tobacco policy in Canada and the US to which the findings of this thesis can comment more pointedly starting with the role of the household.

9.4.2. Focus on the household in tobacco control

This thesis points to parents and the household having key roles both in the likelihood of adolescents smoking cigarettes and underestimating smoking risks. Table 46 summarizes findings regarding the household's role in predicting smoking behavior and risk perceptions as captured by a variety of variables depending on the survey.

Table 46. Summary of findings regarding parents and the household

	Smoked a whole cigarette	**Ever smoked a cigarette**	**Number of Canadians per year that will die from smoking**	**Risk harming selves from smoking one or more packs a day**
	Smoking behavior		*Risk perceptions*	
	Canada	US	Canada	US
		Socio-economics		
Family income	-	Negative	-*	Positive

Household characteristics				
Lives with both parents	Negative	Negative	Negative	Positive
Information sources – parents and household				
Parents smoke	Positive	-	Positive	-
Number of people who smoke in home	Positive	-	Positive	
Parents talked about dangers of smoking	-	Negative	-	Positive
Feel parents disapprove of smoking	-	-	-	Positive

Note: This table summarizes results from Chapter 5 and 6. Only those relationships with significance of 10% or greater are reported here as being positive or negative.
'-' means that this variable is not included in the dataset
* Respondent receiving a weekly allowance was found to be positively and significantly related to risk perceptions. The likelihood of a respondent receiving a weekly allowance would increase as family socioeconomic status rises.

This table highlights the key role parents have not only in adolescents' likelihood of smoking but also perceptions of risk about smoking. This is not surprising given that the household constitutes the greatest sources of secondhand smoke exposure for adolescents (Department of Health and Human Services 2006). The extent to which tobacco policy acknowledges and does something about the importance of parents and the household as it influences both behavior and risk perceptions does not vary much between Canada and the US. Because the household lies in the private domain, the role of governments and public health authorities as legislators and policy implementers focuses more on the realm of acting as sources of information promoting smoke-free homes and parents not smoking in general. Aims to decrease parental smoking rates are connected with overall adult cessation programs.

Both countries point to reducing environmental smoke as part of their nationally set tobacco policy goals. The term 'environmental smoke' includes not only the workplace and public places but also the home. The strategy around reducing smoking prevalence in the household relies mainly on distributing facts about the dangers of smoking in the home

such as how much it increases the likelihood that a child will smoke, the health implications of children breathing secondhand smoke and the difficulty of quitting in a household without smoking rules. For more information on environmental smoking strategies in Canada and the US see Appendix 9A.

Often the dissemination of information about secondhand smoke risks gets wrapped up in efforts to pass smoking bans and therefore may be lost in some individuals' minds as to also being applicable in the home. The evidence from this thesis suggests that parents have a significant opportunity to disseminate information directly to their children about smoking risks and also have their behavior likely to be mirrored by their children (*Chapter 6* – **RQ1-RQ3**). At present, plenty of information is available on websites but would not reach as many viewers, especially those reluctant to confront such issues. Targeted public advertisements would bring the salience of this key piece of tobacco policy to the forefront. While much has been achieved through the increasing speed with which territories and states are passing smoking bans in workplaces and public places, the importance of the household in this equation should not be lost and deserves specific attention.

9.4.3. Medical professionals playing a part in tobacco control

Findings from this thesis point to the value doctors and dentists offer in playing a role in tobacco prevention and cessation through their influence on both adolescents' likelihood of smoking a cigarette and risk perceptions. Table 47 summarizes results regarding doctors and dentists asking respondents if they smoke and talking to them about the health effects of smoking.

Table 47. Summary of findings regarding doctors and dentists

	Smoked a whole cigarette	Number of Canadians per year that will die from smoking
	Smoking behavior	*Risk perceptions*
	Canada	Canada
Information sources – medical professionals		
Doctor asks if smoke	Positive	Positive
Doctor talks about the health effects of smoking	Positive	None
Dentist asks if smokes	None	Positive
Dentist talks about the health effects of smoking	None	Positive

Note: This table summarizes results from Chapter 5 and 6. Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'None.'

Sargent and DiFranza (2003) depict the role of physicians as being a voice of influence in their local area to support tobacco control initiatives such as access rules and smoking bans. They also highlight a lack of clinical evidence in support of doctors offering health promotion counseling of children and adolescent patients. Instead, they suggest that materials should be given along with limited advice that would stimulate a conversation between the parent and child about smoking. Evidence from this thesis would offer a different conclusion when thinking about the role of the medical professional in influencing adolescent smoking (*Chapter 6* – **RQ4-RQ5**).

Both Canada and the US acknowledge the important place of health care professionals in preventing smoking among youth and aiding in cessation efforts. Often tobacco policy points to the role of medical doctors specifically but does not focus on dentists. However, evidence here suggests that dentists also have a clear role in influencing adolescents' perceptions of smoking risks.

In some cases there is an issue of insurance reimbursement when doctors or dentists offer cessation advice to a patient without an apparent sign of the health effects of smoking.

Smoking cessation efforts are by nature preventative and thus would not fill well into the insurance symptom-attached reimbursement model. Some individual insurance companies in the US have taken the initiative to offer more liberal payment criteria for physicians offering cessation advice to patients because of its proven effectiveness (Manley 2001). Financial incentives encouraging doctors and dentists to speak about tobacco use with patients, especially adolescents before they display side effects from smoking appears a crucial piece of encouraging medical professionals to be involved in tobacco control efforts bringing a clinical perspective.

With appropriate financial mechanisms in place, perhaps then the low current rates of physician and dentist involvement in tobacco control will change. Both Canada and the US have national guidelines as to how doctors should speak to patients about smoking habits. Evidence from US studies reveals that doctors miss opportunities to speak to adolescents about smoking risks (Gill et al. 2004). This thesis' descriptive level findings about how often doctors talk to respondents about the health effects of smoking also point to the under use of this resource with 17% of respondents having been asked by a doctor if they smoked and 20% being spoken to about the health effects of smoking by a doctor. Figures were even lower for dentists doing the same at 5% and 9.4%, respectively (*Chapter 6*).

Therefore, despite explicit acknowledgement of the role of doctors and dentists in tobacco control policy in both countries, evidence of these professionals exploiting their position of credibility in adolescents' lives appears scant. The medical communities are all in support of the professions playing a role in tobacco control with the Canadian Medical Association, Canadian Dental Association, American Medical Association and American Dental Association all issuing statements in favor of overall tobacco control efforts and their

members being involved in prevention and cessation (American Dental Association 2007; American Medical Association 2007; Canadian Council for Tobacco Control 2007).

The capability of medical professionals appears sorely underused in both Canada and the US. Evidence of varying levels of efforts being made by medical professionals to discuss smoking with patients coupled with their position to influence adolescents' behaviors and perceptions of risks represents a missed-out policy opportunity. With appropriate financial incentives in place such as clear reimbursement guidelines, a conversation about smoking could become a requisite part of an adolescent patient's annual check-up with both medical professionals. The medical professional could then utilize his position of credibility among adolescents and effect tobacco control beyond helping design policy as part of boards at the more senior levels. Crystallizing the importance of medical professionals in national policy guidelines through specific initiatives aimed at improving the volume of interactions medical professionals have with adolescents about smoking would encourage medical professionals to take advantage of the significant credibility given to them by adolescent patients as disseminators of smoking risk information.

9.4.4. Policies counteracting peer effects

The influence of peers on adolescents' likelihoods of smoking has been well established in the literature (Chaloupka and Warner 2000; Nakajima 2007; Piko et al. 2005) with a much more limited understanding on how they can effect risk perceptions. Table 48 summarizes this thesis' findings with regards to how peers and society in general impact adolescents' likelihoods of smoking and risk perceptions about smoking.

Table 48. Summary of findings regarding peers and social setting

	Smoked a whole cigarette	Ever smoked a cigarette	Number of Canadians per year that will die from smoking	Risk harming selves from smoking one or more packs a day
	Smoking behavior		*Risk perceptions*	
	Canada	US	Canada	US
Information sources - peers				
Number close friends smoke	Positive	-	Positive Negative*	-
Percent close friends smoke	Positive	-	None	-
All students smoke	-	Positive	-	None
Friends disapprove of smoking	-	None	-	Positive
Information sources - population level smoking behavior				
Provincial smoking prevalence	Positive	-	Negative	-

Note: This table summarizes results from Chapter 5 and 7. Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'none.'
'-' means that this variable is not included in the dataset
* Negative in social multiplier collapsed model only (Chapter 7, Table 36) where peer effects demonstrate aggregation reversals

These results support policy efforts acknowledging and incorporating the way that adolescents develop behaviors and beliefs using each other as information sources (*Chapter 7* – **RQ1-RQ3**). Canada actively integrates the presence of peer effects into its tobacco control efforts. One of the four pillars attached to the prevention aims of the current Federal Tobacco Control Strategy involves using peers to educate each other about the dangers of smoking (Health Canada 2002). For example, Ontario recently extended funding on high school programs to supports student-led activities where 14 to 17 year olds are taught how to increase tobacco use awareness and prevent smoking at the local level (Health Canada 2006). Similarly, Nunavut sent a group of grade 9 to grade 12 students to a one week session on tobacco use and to practice leadership and presentation skills in order to run tobacco reduction projects in their own communities (Health Canada 2006). Findings from this thesis directly support these kinds of interventions as adolescents'

perceptions of what their friends think about smoking dangers was demonstrated to have a positive and significant effect on risk perceptions.[31]

The US concentrates more on access laws and efforts to enforce them as well as taxation to create an environment where it is difficult to obtain tobacco with the thought that fewer adolescents will then smoke instead of focusing on peers learning from each other about the dangers and risks attached to smoking (for more information on findings reflecting on tobacco taxation and disposable income see Appendix 9B). In the US tobacco policy environment, school-based interventions are still marked by a top-down approach with trained teachers or health promotion educators leading the programs. Trained peer educators have been used with success in Canada and would benefit US youth prevention and cessation efforts. For the US in general, a focus on improved dissemination of the risks of smoking through national media strategies (IOM 2007) as well as amending warnings labels to include more information (*see* 9.4.5 below) would offer a multiplicative effect in altering smoking behavior and youth risk perceptions since peer effects are so strong in this setting. Findings regarding the power of peer and social effects in this thesis point to the need to shift public policy in the direction of exploiting the extent to which adolescents attach credibility to their peers' decision-making and opinions about risks. The empirical support here for the existence of a social multiplier effect highlights how policies aimed at youths in particular will have cascading effects because of how peers learn behaviors from each other (*Chapter 7* – **RQ4**). Current US policy leaves gaps in exploiting the nature of peer effects not only in the school education setting but also through mass media campaigns disseminating risk information.

[31] Previous research finding peer influence as influential in starting as in stopping risky behaviors also would support the use of peers in prevention and cessation efforts (Maxwell 2002).

Additionally, efforts to make smoking a socially undesirable activity through actions such as smoking bans would also be supported by findings that provincial level smoking status is negatively related to adolescents' risk perceptions. Therefore, if a province makes smoking unacceptable enough such that individuals smoke less, then adolescents will perceive smoking risks as higher. Smoking bans being enacted across Canada and the US currently address this issue. This thesis highlights another reason why they are an important policy tool beyond simply reducing environmental smoke.

9.4.5. Use and implementation of warning labels

Warnings labels play an integral part in tobacco policy but evidence from previous studies on adolescents have found them to only play an effective role in decreasing the likelihood of adolescents to smoke if messages impact their audience and include specific eye-catching and memorable features such as graphics along with text (Crawford et al. 2002; Koval et al. 2005; O'Hegarty et al. 2006; O'Hegarty et al. 2007). Table 49 summarizes this thesis' findings with regards to how warning labels on cigarette packages can influence the likelihood of adolescents smoking a whole cigarette and their perceptions about the mortality risks of smoking.

Table 49. Summary of findings regarding warning labels

	Smoked a whole cigarette	Number of Canadians per year that will die from smoking
	Smoking behavior	*Risk perceptions*
	Canada	Canada
	Knowledge about smoking risks	
Number of smoking-related health problems identify	Negative	Positive
	Information sources – health warnings messages	
Seen health warnings	Positive	-
Number of valid warnings can remember	None	Positive
Ever look at health warnings	Positive	None
Believe health warnings	Negative	Positive

Note: This table summarizes results from Chapter 5 and 8. Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'none.'
'-' means that this variable was not tested

Comparing policy stances with regards to warning labels in Canada and the US present a stark contrast. While analysis here did not have US data on how warning labels impact adolescent smoking behavior and risk perceptions, conclusions can be drawn based on findings from the Canadian YSS and understanding how warning label policy differs between the two countries.

As discussed above, warning labels in the US are weak compared to those in other countries. When Hammond et al. (2006) compared the impact of warning labels on informing smokers in four countries including Canada and the US[32], 84.3% of Canadians surveyed versus 46.7% of Americans named cigarette packages as sources of information about the dangers of smoking. Canadians also emerged as the group of respondents with the highest level of knowledge about the health effects of smoking. Similarly, after testing for differences in findings based upon changes in UK warning labels, Hammond et al. (2007) found that larger and more extensive warnings were more effective in disseminating

[32] Australia and the UK also included in the study.

information and labels from the US continued to be the least effective of the four countries examined. Plenty of additional evidence comparing graphic warning labels in general versus smaller text ones point to the importance of using large and/or graphic labels to get messages across (Givel 2007; O'Hegarty et al. 2007; Peters et al. 2007).

Canada requires three components on its cigarette packages: (1) graphic health warnings (2) toxic emissions statement – the level of emissions levels of six toxic chemicals in each pack and (3) health information messages – more extensive information messages about the dangers of smoking or tips on quitting, usually printed on the inside of packages. The US requires one of four health warnings to appear on the narrow side of cigarette packages in black and white print. Figure 4 above offers examples of what a cigarette package looks like in each country.

Clearly, a change in policy appears of key importance for US smoking policy aims with regards to reducing youth smoking. This thesis provides ample evidence of the effectiveness of warning labels in altering adolescents' risk perceptions and smoking behaviors in the case of Canada (*Chapter 8* – **RQ1-RQ2**). This study echoes findings of many organizations calling for larger and graphical warnings on US cigarette packages as well as warnings appearing in Spanish. However, it takes findings even further by concluding that warning messages can not only have a role in altering adolescent behavior but also in perceptions of risk and thus contribute in many ways to the likelihood of adolescents smoking.

Even with Canadian warning labels being extensive and constantly rotated to not become stale, results of this work found that 46% of respondents still underestimated the mortality

risks of smoking and responses to questions about the relative risks of smoking against alcohol, illegal drugs, car accidents, AIDS, suicides and murders were also ranging in being incorrect from 41% (thinking alcohol causes more deaths per year than smoking) of respondents to 61% (thinking AIDS causes more deaths per year than smoking) (*Chapter 5*). Therefore, work remains to be done on further educating adolescents about smoking risks. There is also a difference between individuals knowing about risks and seeing them on a warning label and then comprehending what they mean. Warning labels can step in with characteristics such as graphics to aid in efforts to increase knowledge about risks (Mahood 1999). Canada is currently even thinking about only allowing tobacco packages to be printed in black and white, except for the warnings themselves to disassociate advertising with package appearance (Mahood et al. 2006). While this kind of alteration would make warning messages even starker in contrast to the rest of the package, for the US simply having a larger warning on the front side of the package would be an improvement and aid in helping adolescents to develop more accurate perceptions and understandings of smoking risks.

9.4.6. School-related tobacco policy

Although school-based tobacco education programs represent a significant portion of tobacco policy in Canada and the US, their ability to impact behaviors and especially risk perceptions depends greatly on their content, the manner in which they are presented and who presents them. Especially, with regards to altering adolescents' risk perceptions, evidence points to education not making a significant difference (Lundborg and Lindgren 2004). School rules would be expected to function similarly to social setting variables with students being less likely to smoke if they attend school where smoking is not permitted on campus (Leatherdale et al. 2005; Pinilla et al. 2002). Table 50 summarizes how this thesis'

empirical analysis contributes to previous findings on the subject both with reference to smoking behaviors and risk perceptions.

Table 50. Summary of findings regarding school-related tobacco policy

	Smoked a whole cigarette	**Number of Canadians per year that will die from smoking**
	Smoking behavior	*Risk perceptions*
	Canada	Canada
Information sources – school setting		
No smoking allowed school	None	None
Don't know smoking rules	Negative	Weakly negative
Taught in school about health problems related to smoking	Negative	None

Note: This table summarizes results from Chapter 5 and 8. Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'none.'
'-' means that this variable is not included in the dataset

These results point to school rules mattering for respondents' likelihoods of smoking and risk perceptions only when respondents do not know what they are thus highlighting the importance of publicizing rules (*Chapter 8* – **RQ3**). Previous work has found that school smoking rules do not significantly predict youth smoking behavior (Darling et al. 2006; Lovato et al. 2006) and may only do so when strongly enforced (Moore et al. 2001; Wakefield et al. 2000). However, Reitsma and Manske (2004) found that strong enforcement of rules at the secondary school level might actually contribute to individuals being more likely to smoke because of feeling alienated.

Looking at school rules about smoking, they could have no influence because of other factors such as staff and visitors being allowed to smoke on campus. Teachers being allowed to smoke on campus could also thwart any positive outcomes from school smoking policy (Piontek et al. 2007). In the US, about 30 percent of schools allow visitors to smoke while 18 percent allow faculty and staff to smoke (CDC 2006a). Increasing the amount of schools who do not allow staff and visitors to smoke on campus could change this result of

smoking rules not making a difference in adolescent behaviors or risk perceptions. Some provinces in Canada such as Alberta and Quebec have passed specific legislation now allowing smoking on school grounds and for other provinces school fall under workplace bans. However, there are still not universal smoking bans across Canadian schools. Putting in place all-encompassing smoking bans to include not only students but also faculty, staff and visitors may change the results demonstrated here on the effectiveness of school smoking rules in the same way that restaurant bans have successfully altered what appears as the social norm in countries like Ireland and altered smoking rates (Fong et al. 2006).

Results from this thesis also highlight how schools can impact smoking behaviors; however, any ability to alter risk perceptions did not emerge from the data. With regards to findings about the effectiveness of teaching in school about health problems related to smoking, these results could vary based up on province and local level depending on the nature of school tobacco programs. In light of previous evidence about peer effects, presenters of tobacco information in schools could make a major difference in whether school programs can contribute to adolescent risk perceptions. The findings here pointing to risk perceptions not being influenced by school-based information flow need not necessarily imply that respondents attach no credibility to the school setting but instead point to issues with the messenger and/or the means of information distribution. These results point to the value of using what we know about which influences determine adolescents' risk perceptions (peers, medical professionals) and exploiting the ability of these individuals to achieve results. Neither the US nor Canada formally recommends that medical professionals such as doctors make presentations to classrooms about smoking risks. The empirical analysis in this thesis would point to altering school-based education

in such a manner. As discussed before, Canada readily uses peer-led school programs with variations across territories. School education policies organized in concert with parental awareness campaigns and media efforts to increase awareness of smoking dangers would of course constitute a more effective approach than school education in isolation disconnected from wider strategies (Lantz et al. 2000).

9.5. Limitations of this research

The limitations of this research can be classified as being chiefly data-related and methodological in nature. The YSS included further data about access to cigarettes and manufacturer advertising, which are two major policy areas around which this thesis could not make extensive comments because of the lack of particular analysis using these questions. The decision to leave some policy tools out of the analysis was made because of space constraints. Access and advertising questions were specifically chosen to be excluded from this work because they only appeared in the YSS and therefore research questions could not be posed for both datasets. Additionally, because the focus of this thesis was on information acquisition about smoking risks and individuals such as parents, medical professionals and peers and collective sources such as warning labels and school education programs were more directly related to this theme.

The data-related limitations impacting the nature of this work stemmed from not having control over survey question design, which obviously constitutes a chief consequence of using secondary data. Therefore, issues with question wording, mainly of the risk questions limited the study and constrained analysis. Chapter 4 discusses the specific limitations with regards to the different risk methodologies used in this thesis. While this thesis was able to undertake analysis using three methods for measuring risk perceptions about smoking, one

quantitative and two qualitative, the analysis was not able to include a measure of risk often used in the literature and constituting a large portion of debate about risk perception methodology. This question would ask respondents 'among 100 cigarette smokers, how many of them do you think will get lung cancer because they smoke? (Viscusi 1990).[33] This question could also be altered to assess adolescents' understanding of other smoking-related risks such as heart disease or other forms of cancer. This alternative quantitative measure of risk would have allowed for more direct comparison of results between much of the existing literature on this topic.

Not having control over survey questions also means that some research questions could not be tested against both data sets. In this case the NSDUH was more limited in its ability to offer pertinent questions thus only allowing work on the role of medical professionals, warning labels and school-based education programs to be only performed with the YSS data.

An additional characteristic of this study limiting analysis was the use of cross-sectional data. Cross-sectional data was used because of the lack of an available large-scale survey eliciting adolescents' perceptions of smoking risks. Plenty of longitudinal surveys exist regarding adolescent smoking behaviors including respondents' beliefs about smoking but no measures of risk perceptions were available in these surveys. While cross-sectional data looks at a snapshot in time and can allow us to tease out relationships between explanatory variables and dependent variables, time series data would allow for specific examination of how policy change impacts behaviors and risk perceptions. The cross-sectional data also has implications for the extent to which this work can employ the dynamic Bayesian

[33] Also used in Liu and Hsieh (1995), Lundborg and Lindgren (2004) and Viscusi (1991)

decision-making model where individuals' decisions are made based upon an information uptake process. Time series data would have allowed for capturing this process. Using time series data would be especially advantageous in the case of examining adolescents where friend groups and opinions change. Time series data would be more apt in picking up behavioral and attitudinal shifts. To depict some of this dynamic nature of the risk perceptions development process, some empirical chapters have included analysis broken down by age group to see how different information sources matter more or less depending on age.

Longitudinal data capturing perception development would provide a clearer understanding of the status of risk perceptions prior to smoking commencement and how they might change upon partaking in the behavior. Alternatively, longitudinal data could allow for testing of whether smoking actually alters risk perceptions rather than the other way around as a result of a rationalization process or cognitive dissonance. This analysis has attempted to get around this issue by looking at whether smoking predicts risk perceptions and then if risk perception predicts smoking.

9.6. Directions for future research

Despite the extensive nature of findings here with regards to both the determinants of adolescent smoking behavior and risk perceptions, substantial questions remain. The next logical steps for this research would be in two directions. One direction would be to investigate some of the cognitive biases set forward in the behavioral economics literature within the decision-making context of smoking. The other direction would be to take the Bayesian construct and models from this thesis and apply it to either other risky settings

related to health behaviors or include in the same models other policy measures aimed at increasing knowledge about smoking risks. I take each stream of research in turn.

The testing of existing biases and behavioral anomalies against tobacco smoking data would add a significant contribution to the literature. This thesis was only able to mention issues such as the introduction of reference points and potential optimism bias as hypotheses motivating certain findings. An investigation into biases that have so far either only been examined in a cursory manner in the public health realm or been entirely ignored would fill a gap in the existing understanding of risk perceptions' development in health-related settings. The specific biases deserving investigation within the field of smoking and risk perceptions as well as offering wider lessons to be learned across the public health and risk literature appear in Table 51.

Table 51. Cognitive biases to be investigated within the context of smoking

Bias	*DO INDIVIDUALS....*
Optimism bias	...perceive less risk when facing a risk themselves than when thinking about it for others?
Temporal bias	... perceive less risk when the costs of a behavior occur in the distant future rather than in more immediate terms?
Cumulative bias	... perceive individual smoking episodes as less risky than the behavior in its entirety as a habit?
Availability bias	.... overestimate risks about which they have more information versus others where they are less informed?

Only optimism bias has been tested in any depth using smoking data (Arnett 2000; Ayanian and Cleary 1999; Weinstein 1987; Weinstein 1998; Weinstein et al 2005). Cumulative bias has been mentioned in a limited capacity but not investigated fully with a purpose-designed survey for adolescents (Slovic 1998; Slovic 2000*b*; Weinstein et al 2005).

The other stream of research where this work could continue onward is in applying the same ideas across risk-related health behaviors. The same theoretical framework and empirical models used in this study ought to also be employed to examine the relationship between behaviors and risk perceptions in situations such as alcohol use/abuse, drug use, obesity/nutrition and sexual behaviors. Lundborg (2006) has looked at the role of risk perceptions in adolescent alcohol use but a gap in the literature exists in looking at the drivers of risk perceptions regarding alcohol use and other health behaviors. For example, this work on smoking would support the hypothesis that the likelihood of an adolescent having unprotected sexual relations may be related to how that adolescent perceives the risks of acquiring a sexually transmitted disease. Analysis could then take a step back in the decision-making process to determine what factors make a difference in how an individual perceives the risks of unprotected sex. In light of the findings reached in this thesis, friends' sexual behaviors, perceptions of friends and parents' attitudes towards sexual risk-taking as well as the involvement of medical professionals in conversations about sexual behavior could all be potential influences in an individual's stock of information about risks. The models presented here looking at how policy makers and other applicable stakeholders can influence the likelihood of adolescents' taking part in risky behaviors provide a new angle for public health policy to approach current and increasingly pressing health behavioral challenges.

The same models used here could also be employed to test the determinative influence of other tobacco policy tools. In the US, access legislation has been heavily leaned on to produce reductions in prevalence. If we take the view that risk perceptions are important in affecting the likelihood an adolescent will smoke and societal behaviors with regards to smoking appear to influence adolescents' risk perceptions then access policies could

influence risk perceptions by creating an environment where smoking is deemed unacceptable. Therefore, access regulations could work in the same way as perceptions about parents' attitudes about smoking. The influence of smoking bans could be tested in the same way. Tobacco advertising or variables capturing tobacco brand recognition could also be included in the model to test whether they influence adolescents' risk perceptions. Therefore, room exists for expanding this particular smoking model by testing the impacts of different tobacco policies while there is also scope for running the same kind of model using other health behavior topics such as nutrition, substance abuse or sexual behaviors.

On a more micro-level, the topic of aggregation reversals deserves further investigation (Glaeser and Sacerdote 2007). Not only is there only a limited body of research on the topic but the underlying factors to explain why aggregation reversals exist require greater understanding. This study suggests that beliefs such as overall risk appetites, religious beliefs and political views may be interesting to test but the data was not available to do so with the surveys used.

In the more long term view, this area of research would be improved exponentially by having available a longitudinal survey on adolescent risk perceptions and smoking behaviors. Longitudinal data would allow for an understanding of how adolescents' risk perceptions change over time and which factors play the key roles in influencing these changes. Peer effects would be particularly interesting to examine with a panel dataset since friend groups change often throughout adolescence and the characteristics of friends groups might alter an adolescent's perceptions of smoking risks and his likelihood of smoking.

This thesis leaves some work to be done in the particular field of risk perceptions research with regards to smoking. However, more broadly this research points to how an understanding of individuals' formulation of risk perceptions about health behaviors can influence the likelihood that choices will be made with a more robust understanding of the utility attached to alternatives. Enabling individuals to make decisions for themselves in a setting replete with quality information should be the goal of policy. With an understanding of how individuals process new information and from which sources, the likelihood of outcomes can differ and improve.

9.7. Conclusion

This thesis' examination of the determinants of adolescents' smoking behaviors and their risk perceptions about smoking has led to many theory-based, methodological and policy-related conclusions. Given the current state of a stalling in the previously robust picture of decline in adolescent/youth smoking prevalence in both Canada and the US, the issues pointed out here, especially on how we can influence risk perceptions and then alter the likelihood of an adolescent smoking may provide the needed step change in tobacco policy. This research also offers a greater understanding of the uses of Bayesian learning models, principal-agent models and spatial proximity and the implications of affect heuristics in explaining risk taking behavior more generally. While areas of research in this field still remain ripe for examination, this thesis provides a substantial start in taking an extensive look at the relationship between adolescent behaviors and risk perceptions and namely how adolescents utilize various information sources in the decision-making process about risk taking and assessing risk.

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APPENDIX

Appendix 2A. Utility model about risk perceptions of smoking including information uptake

Assume there are two scenarios. x is the stock of health capital one has for both scenarios. In the first, individuals smoke where there is a π probability of a potential quantified loss (L), which is dependent upon whether someone smokes or not. The smoker's utility is then $U_s(x-L)$. In the second scenario, individuals do not smoke ($U(x)$). This leads to the following expected utility function where the first expression captures the loss element from smoking and the second expression the absence of a loss from not smoking –

$$(\pi)U_s(x-L)+(1-\pi)U(x) \qquad (1)$$

π^* is the level of risk perception that leaves individuals indifferent between smoking or not smoking. If $\pi \geq \pi^*$, then individuals would not smoke or vice versa. Therefore, the probability that determines smoking behavior is as follows:

$$\pi^* = \frac{U_s(x)-U(x)}{U(x)-U_s(x-L)} \qquad (2)$$

The numerator depicts the perceived utility or benefit attached to smoking and the denominator the perceived disutility or cost of smoking. Given that in a world of imperfect information π might be based on a variety of information sources including prior individual beliefs, it is worth examining the process of information updating which is assumed to follow a Bayesian model.

According to the Bayesian learning model, individuals will weight different information sources depending on the value of informational content attached to each source. Let us assume that individuals display a baseline belief (ρ_o) updated according to information from private/individual and public/collective sources. We denote η the weight of baseline beliefs and assume that individuals adapt their responses to new information. Thus, the latest information on the true probability of a smoking risk is ρ_1 given a weight of ϑ denoting the credibility attached to that informational content. Therefore, the resulting perception of smoking can be denoted as follows where the first expression is the original, prior set of beliefs updated by the second expression of new information to update beliefs

$$\pi = \frac{\eta\rho_0}{\eta + \vartheta} + \frac{\vartheta\rho_1}{\eta + \vartheta} \qquad (3)$$

Equation (3) can then and be differentiated with respect to ϑ by demonstrating how the perception of risk will change depending on the credibility attached to new information in the following:

$$\frac{\partial\pi}{\partial\vartheta} = \frac{\eta(\rho_1 - \rho_0)}{(\eta + \vartheta)^2} \qquad (4)$$

Therefore, if new information conveys a higher objective level of risk ($\rho_1 > \rho_0$) or the information is deemed to be more credible (ϑ), then risk perceptions will be higher. Following this rationale, one might expand the model by distinguishing between different

information sources in the form of private/individual and public/collective information sources.

Extending the model to differentiate between information takes the latest estimation of the true probability to depend on private/individual informational sources (ρ_{11}) and public/collective information sources (ρ_{12}) including one's own direct experience. As before, the informational content parameter can be expressed as $\vartheta_{11}, \vartheta_{12}$ depending on whether the information source represents a private or a public source of information. Under these assumptions (3) can be re-written as:

$$\pi = \frac{\eta\rho_0}{\eta + \vartheta_{11} + \vartheta_{12}} + \frac{\vartheta_{11}\rho_{11}}{\eta + \vartheta_{11} + \vartheta_{12}} + \frac{\vartheta_{12}\rho_{12}}{\eta + \vartheta_{11} + \vartheta_{12}} \qquad (5)$$

The first expression is the original set of risk perceptions; the second is the new information from private sources and the third is new information from public sources.

Accordingly, the effect of an increase in the privately provided information can be determined as:

$$\frac{\partial\pi}{\partial\vartheta_{11}} = \frac{\eta(\rho_{11} - \rho_0) + \vartheta_{12}(\rho_{11} - \rho_{12})}{(\eta + \vartheta_{11} + \vartheta_{12})^2} \qquad (6)$$

The impact that this information provided by private information sources has on risk perceptions depends on the credibility attached to this information source (ϑ_{11})

The effect of an increase in public information then looks like the following:

$$\frac{\partial \pi}{\partial \vartheta_{12}} = \frac{\eta(\rho_{12} - \rho_0) + \vartheta_{11}(\rho_{12} - \rho_{11})}{(\eta + \vartheta_{11} + \vartheta_{12})^2} \qquad (7)$$

The impact that this information provided by public information sources has on risk perceptions depends on the credibility attached to this information source (ϑ_{12})

If the informational content of private or public information increases, then the individual's risk perception will rise depending on the weight attached to public/collective information with respect to the weight attached to private/individual information in the process of risk perception formation.

The credibility that is attached to private or public information sources can then be parameterized in the regressions appearing in equations 6.1, 7.2 and 8.1 where the coefficient value in front of each information source is the credibility attached to the information sources ($\vartheta_{11}, \vartheta_{12}$) as developed above.

This study defined the risk of smoking either to be in terms of probability of dying from smoking in the case of the Canadian YSS or being physically or otherwise harmed from smoking in the case of the American NSDUH.

This Bayesian decision-making model allows for testing the roles of various information sources in decision-making. It is, however, a model. Therefore, it does not necessarily reflect how decisions are made in reality especially given evidence of the inconsistencies with which individuals make decisions in many contexts as discussed in Chapter 2 such as

prospect theory and cumulative prospect theory. Viscusi (1992a) suggests that such violations of expected utility theory as found in prospect theory do not necessarily reflect a lack of rationality in decision-making but instead what happens when decisions are made without full information. This thesis uses expected utility theory when depicting the Bayesian framework because it provides a systematic basis for predicting behavior because of its strict assumptions (Viscusi 1992a). Savage (1972) also takes a similar position acknowledging how behaviors depart from expected utility theory but not entirely dismissing the theory as it still remains useful as predictive guide. While many of the critiques of expected utility provide valid criticisms in an experimental setting, they do not offer a systematic way to empirically model behavior going forward using large survey data. While expected utility theory does not always accurately reflect the reality of the way individuals make decisions, it still can be used in a predictive manner. When a model is used predicatively, the important point is whether the model offers more predictive power than alternative models (Schoemaker 1982). Therefore, this analysis recognizes and acknowledges the experimental findings regarding the failure of individuals to exhibit utility maximizing behavior. However, the Bayesian framework offers a stylized framework to which large survey data can be applied in order to answer questions about information uptake under conditions of uncertainty.

Appendix 3A. Canadian tobacco policy aimed at adolescents

Healthcare and more specifically public health initiatives such as tobacco policy in Canada constitute a shared responsibility at the federal, provincial and territorial levels. Therefore, while the federal level may have a nationwide tobacco prevalence reduction strategy, it is at the province and territory levels where initiatives such as smoking bans would be put into place.

The plan uses the same four goals set out in the National Strategy from 1999 (prevention, cessation, protection and denormalization (sometimes called harm reduction)) to achieve these tobacco control goals. It also employs mass media and public education campaigns extensively. Table 1 outlines specific actions falling under each of these categories that have been implemented to particularly impact youth smoking levels.

Table 1. Examples of priorities and actions for each FTCS goal

Strategic area	Policy actions and priorities
Prevention	• Enact programs especially designed *to educate youths about dangers of smoking and second-hand smoke* • Use *peers themselves to deliver information about smoking dangers* • Undertake research to set out *best practices for discouraging smoking uptake* with results given to health care professionals, teachers and parents • Use *taxation as a tool to limit smoking prevalence*
Cessation	• Utilize a *systems approach* coordinated at the national level *to encourage cessation* • Improve *public access to information about cessation*
Protection	• Collaborate with NGOs, local and provincial/territorial governments to *reduce smoking in enclosed public spaces* • Health Canada to *assist municipalities* in planning, putting into practice and assessing the results of *non-smoking laws* • National government will *uphold the Tobacco Act** (regulates manufacturing, sales labelling and promotion of tobacco)
Harm reduction	• Examine methods for mandating tobacco manufacturers to *change products to reduce health hazards* • Work in concert with other countries to make sure that changes to tobacco products are aimed at reducing smoking's negative impacts • Ensure that consumers are only given *correct information about smoking risks*

Source: Health Canada (2002)
*Passed in 1997, effective in 2000

Many of these plans focus on curbing youth smoking, especially those falling under the strategic area of prevention. Especially of interest is the second bullet under prevention where the strategy includes enabling peers to teach other about smoking risks. This concept of engaging youths in the information process differs from the traditional top-down approach of a teacher or health educator being tasked with disseminating public health information.

Prior to the FTCS, Canada had a framework for tobacco control through 'A National Strategy To Reduce Tobacco Use in Canada.' In 1999, the National Strategy outlined the importance of collaborative efforts crossing local, provincial/territorial, and national levels as well as the need for research, policy and programs all aimed at the same goal of reducing tobacco use. The National Strategy acknowledges previous policy successes in informing Canadians about smoking's health effects, restricting tobacco advertising, access to minors and restricting where smoking can take place. It also acknowledges the fact that Canadians understand smoking is bad but do not fully comprehend the risks of smoking and secondhand smoke (Health Canada 1999*a*). Table 2 presents the goals of the National Strategy project.

Table 2. Goals of the National Strategy To Reduce Tobacco Use in Canada

1. Prevention – prevent youth tobacco use
2. Cessation – help current smokers quit
3. Protection – protect all Canadians from second-hand smoke
4. Denormalization – educate Canadians so that society's attitudes towards smoking are in alignment with the true nature of smoking risks (addiction, health problems associated)

Source: Health Canada (1999*a*)

Underpinning the National Strategy are years of previous legislation and policy aimed at tobacco control. Table 3 below outlines some of the key legislation covering tobacco control that Canada has implemented since the late 1980s and in the 1990s. It also includes

some initiatives and legislation taking place concurrently with the National Strategy and Federal Tobacco Control Strategy. Those pieces of legislation and policy outlined here were chosen because of their particular pertinence to youths and their relevance for being ongoing when the respondents' surveyed were the target audience. In addition, more sweeping key pieces of legislation and programs that impact all of the population were also included.

Table 3. Selected Canadian tobacco legislation and initiatives (1989-2000)

Name	Year	Type	Focus	Details
Tobacco Products Control Act	1989	Legislation	Advertising Labelling	Prohibites tobacco advertising Regulates product labels In 1995, strict tobacco advertising measures were deemed illegal by the Supreme Court and enforcement of this Act diminished
Tobacco Demand Reduction Strategy (TDRS)	1994	Initiative	Prevalence Secondhand smoke	Helps non-smokers to continue being smoke-free Encourages quitting Protect health and rights of non-smokers Focuses on youth smoking prevention
Tobacco Sales to Young Persons Act	1994	Legislation	Access	Forbids sales of tobacco to those under 18 years Cigarette vending machines can only be in bars and taverns
Tobacco Control Initiative	1996	Initiative	Prevalence Secondhand smoke Public education	Five year program staring in 1997/98 to improve health and quality of Canadians, especially youth Focus on public education about smoking Expanded prevention, protection and cessation goals under TDRS
Tobacco Act	1997* 2000	Legislation	Manufacturing Access Advertising Labelling	Sweeping legislation that sets federal rules on tobacco Requires graphic health warnings, toxic emissions statement and health information messages to appear on all cigarette packages Reduces tobacco sponsorship options Mandates reporting of tobacco sales and product ingredients including toxic elements
Tobacco Act-Access Regulations	1999	Legislation	Access	Repeals the Tobacco Sales to Young Persons Act Mandates that retailers must post a sign saying the tobacco products are only sold to those 18 years or older (or higher if province has different rules) Specifies which forms of identification can be used for proof of age
Tobacco Products Information Regulations	2000	Legislation	Advertising Labelling	Specifies information content on tobacco packages and rules of tobacco display Lays out how toxic emission levels on products should be measured for display

Source: Health Canada website (http://www.hc-sc.gc.ca.com)
* Passed in 1997 but enacted in 2000

Canada continually focuses on core populations identified as especially pertinent for either tailored interventions or population-specific goals such as a drop in prevalence. Youths and adolescents have consistently been one of these groups receiving particular attention because of high adolescent smoking rates and the large jump in prevalence rates between 15-19 year olds and 20-24 year olds. The idea behind much of the current youth tobacco policy in Canada is ensuring that youths understand the risks of smoking before they start, through extensive warning label initiatives and have all the necessary tools at their disposal to quit, through programs such as Quit 4 Life. Quit 4 Life is an online tool designed to equip young smokers with the necessary facts behind why one should quit smoking, offer them support to quit and help them go through a managed quitting program online including features such as tracking progress, e-mail reminders and information on how to deal with the difficulties of quitting such as boredom.

Canada has also extended efforts to get youths involved into tobacco control by including them in how to protect their family from second-hand smoke and getting youths involved in educating each other about smoking risks. The 'Youth Zone' portion of Health Canada's website devoted to tobacco includes tips on how to discuss parents' smoking with one's parents and to act on efforts to keep the home and car smoke-free. While this information is readily available for youths on the internet, the extent to which it is incorporated in other mediums of dissemination such as television and in school-based programs is unclear. The use of 'peer helpers' has been part of the country's youth smoking strategy since prior to

the Tobacco Demand Reduction Strategy (TDRS) (US DHHS 1994). The logic behind incorporating peers in smoking cessation and prevention initiatives lies in the fact that tobacco smoking emerges as being subject to peer effects. Therefore, the initiatives exploit the power of peer effects in impacting adolescents' likelihood of smoking and developing risk perceptions to achieve tobacco control goals (Health Canada 1999*b*). Examples of the use of peers in tobacco control come in the use of high school students to design materials for health education programs for junior high students and the training of peer facilitators to work in cessation programs.

The role of adults in Canada's tobacco control policy is one of being a role model as well as interacting with youths as leaders of sports teams, groups or as teachers in which case they can discuss issues such as tobacco use. Of course, adults also often run tobacco reduction efforts as health educators. Parents in particular have been a point of focus for the TDRS by encouraging to enable increased family communication about smoking and its risks (Health Canada 1999*b*).

Appendix 3B. U.S. tobacco policy aimed at adolescents

As in Canada, US tobacco policy both for adults and children may be set out at the national level but states and municipal areas such as cities have the authority to implement specific legislation such as smoking bans in public places, particular school-based tobacco education programs or taxation levels on cigarettes packs. In this way, the US has a highly fragmented tobacco policy often dictated by the importance of the tobacco industry to a state's economy. Smoking bans have become increasingly popular in the US with twenty-two states, the District of Columbia and Puerto Rico now having put into place a smoking ban in workplaces, bars and restaurants (American Cancer Society 2007). This is a move upward from fifteen states in the year prior. Restrictions on smoking in public areas as well as increased taxes on cigarettes and campaigns against tobacco use have been associated with the fall in smoking prevalence among American high school students from the late 1990s to about 2003 when the most dramatic decline halted (American Cancer Society 2007).[34]

The NTCP funds programs that would achieve these four objectives based largely around specific population-focused interventions such as youth, counter-marketing against the advertising efforts of tobacco manufacturers, program regulation and surveillance and evaluation of the state of smoking. Funding is then given to the states, territories, nationwide organizations and city, county and state level health officials. The CDC recommends how much each state should be spending on tobacco control per capita based upon demographic and tobacco use characteristics of the population. Even though the

[34] Using taxation to curtail youth spending on tobacco assumes that youths are price sensitive. Evidence in the literature is mixed as to whether increasing taxation actually reduces youth expenditure on tobacco with some saying that youths are more price responsive than adults (Chaloupka and Grossman 1996; Lewit et al. 1981) and others disagreeing (Wasserman et al. 1991).

national level provides some funding, about 90 percent of funds used in the US for tobacco control come from excise taxes on tobacco products and tobacco settlement payments (CDC 2007*b*). States then fund local level initiatives. The Institute of Medicine (2007) found that if states fully funded their tobacco control programs, the best case outcome would be a 10% drop in smoking prevalence among the population by 2025. However, for the fiscal year 2007 only Maine, Delaware and Colorado funded their tobacco prevention programs to CDC minimum recommended levels while twenty eight states spent less than half of the CDC recommendation and Michigan, Mississippi, Missouri, New Hampshire and Tennessee spent no significant amount of state funds on tobacco prevention (Tobacco Free Kids 2006).

Given competing funding priorities for each state's budget, part of what the CDC does is to make sure that tobacco control maintains a key priority by offering evidence of how investing in tobacco control programs can make a difference in cigarette sales. For example, a youth-led tobacco campaign that included education, access and environmental initiatives from 1998 to 2002 in Florida reduced smoking among middle school students by 50% and high school students by 35% (Bauer et al. 2000). The CDC also reviews state-specific tobacco control programs to consolidate findings at the national level and offer recommendations.

Youth tobacco prevention efforts in the US focus on coordination across the community and school setting. The four pillars for youth tobacco reform at the community level in the US appear in Table 4.

Table 4. Recommendation from the independent Task Force on Community Preventive Services as presented in *the Guide to Community Preventive Services (Community Guide)*

1. Increase tobacco prices per unit
2. Educate youths about tobacco through mass media campaigns coupled with community interventions
3. Use the community (police, retailers) alongside of more interventions such as stronger retail laws to reduce minors' access to tobacco products
4. Operate school-based interventions as part of the larger media and community effort

Source: CDC (2005*a*)

The use of school-based interventions to discourage tobacco use has been recommended by the Surgeon General to begin in grade 6 (about age 11 or 12) while 37 states require education to commence earlier in elementary school (CDC 2006*a*). As mentioned in the four recommendations from the Guide to Community Preventive Services, school-based polices play a key role in initiatives to combat youth smoking. School-based policies include classroom education as well as school rules about smoking on campus or at school events for both students and staff. At the moment, 70.0% of states do no allow students to smoke on compass in all locations including off-campus at school-sponsored events. However, 95.2% of school districts set that rule and 93.1% of individual schools have that rule (CDC 2006*a*). Therefore, the individual school system more commonly acts as the institution enacting smoking rules in schools and not the state. Smoking rules on campus are more lax for faculty and staff and visitors with 73.4% of schools prohibiting smoking among visitors and 83.2% among faculty and staff. Prohibiting tobacco advertisement at schools and school-sponsored events is also something implemented more at the school level than the state level.

Other pieces of youth tobacco control in the US focus on the role of the parent and household in discouraging smoking. Components of this strategy include highlighting to parents the importance of a smoke-free household, setting expectations about whether

smoking is permissible while children are young, looking out for the signs of smoking from one's children and also limiting the influence of adult media with glamorized views of smoking (American Cancer Society 2007). The US has conferred significant effort into not only aiming to reduce the likelihood of children and adolescents seeing smoking in movies but also films glamorizing the image of smoking in general. From 1988 to 1997, 87 percent of the top 25 box office movies had some scene with tobacco use in it (Dalton et al. 2002). Adolescents seeing smoking in movies has been shown to relate to a higher likelihood of adolescents trying smoking (Sargent et al. 2001; Sargent et al. 2007) and more positive attitudes towards smoking in general (Sargent et al. 2002). There are currently national campaigns such as Smoke Free Movies, aiming to get US studios and the Motion Picture Association of America to commit to limit the amount of smoking shown in movies, especially because of the influence of US films on adolescents internationally.

A major part of tobacco control in the US that differs from many other settings internationally emerges in the use of citizen coalitions to back amendments for changes in smoking laws. For example, Citizens for a Healthier Colorado was formed in order to promote the passage of Amendment 35, which was for a rise in the excise cigarette tax from 20 cent to 84 cents, an increased tax on other tobacco products from 20 to 40% of the manufacturer's list price and that revenues from this tax increase would go towards tobacco use prevention and treatment programs as well as healthcare treatment for low-income Coloradans (CDC 2007*c*). Voters had to pass a ballot initiative and then the constitution of the state had to be changed to incorporate the increase and how the funds would be used. The Citizens for a Healthier Colorado joined forces with non-governmental organizations such as the American Cancer Society and the American Heart Association as well as healthcare providers such as the Children's Hospital, medical professionals and patients to

promote the importance of the initiative to the public using television and radio advertising. The final amendment was passed for a 64 cent per pack increase in taxes and a 40% of the manufacturer's price tax on other tobacco products. Similar situations of multi-stakeholder collaboration have occurred all over the US, namely to pass smoking bans and tax increases.

The success of currently enacted state or more local level policies is often judged in the academic setting but then brought together in a peer-review of findings by the CDC. For example, in 2005, the CDC published the 'Evidence of Effectiveness: A Summary of State Tobacco Control Program Evaluation Literature.' This literature review aligned policy actions with associated changes or in some cases, no changes in smoking prevalence. For example, the IOM (2007) review of programs in California, Massachusetts, Oregon, Washington, Florida and Arizona that aimed at preventing youth access to tobacco, among other objectives such as taxation and cessation found that program intensity had a relationship with the strength of consumption declines and that if youth access restriction require strict retailer compliance to ever be effective (CDC 2005*b*).

The first national level antismoking media campaign ever enacted in the US came in 2000 when the American Legacy Foundation took the example of a campaign in Florida called the 'truth' campaign and sent it nationwide (IOM 2007). 22% of the decline in youth smoking from 2000-02 has been attributed to this national campaign (Farrelly et al. 2005) and drops in youth smoking found in the 2002 National Youth Tobacco Survey since 2000 were also attributed partly to the 'truth' campaign (CDC 2003). In this instance, tobacco control policy follows the more common US policy development process where states often act as experimental grounds for larger nationwide policies.

A current move in US youth tobacco policy is identifying population groups most disproportionately involved in tobacco use and acquiring greater data on their tobacco use to develop new approaches for reducing smoking prevalence among these target groups. Groups often targeted for specialized tailored interventions are Hispanics, Native Americans and rural individuals. Choices about targeting often depend on the state. Youth have been a population-target group for some time.

Use of access policies

Access laws and taxes appear to be the primary policy tools for reducing youth smoking in the US. There are also strong movements to move social norms away from smoking being acceptable to it being socially unacceptable through smoking restrictions. However, access and economic-focused smoking policies do not fundamentally alter adolescents' attitudes and beliefs about the dangers of smoking, which this thesis has demonstrated to be crucial in predicting the likelihood of an adolescent smoking. While retail stores constitute a key source of tobacco for adolescents, especially as adolescents smoke with greater frequency (Jones et al. 2002) , the US hits three hurdles in its efforts to curb tobacco access in this environment. First, states have not been universally committed to enacting and enforcing the federal government's requirement to establish laws preventing tobacco sales to those under eighteen years of age (Sargent and DiFranza 2003). Those states with such laws appear to have mixed results in progress due to differing levels of enforcement (DiFranza et al. 2001).

Second, evidence suggests that youth access programs may not be as helpful in affecting teen smoking prevalence as expected (Craig and Boris 2007; Fichtenberg and Glantz 2002;

Ling et al. 2002). Jones et al. (2002) found that when access rules become stricter, adolescents simply find other means to purchase cigarettes by giving money to others, borrowing cigarettes, using vending machines where possible or even stealing. Therefore, the desire to smoke or the perceived positive social returns from smoking seen by adolescents drive desire to smoke to the point that access considerations become minimal. Policy focus then ought to be aimed more at the social desirability of smoking and tobacco use since this would strike at the root of motivations for wishing to access tobacco products. The uptake in smoking bans in many US states and cities constitutes a policy action that will alter social norms in this way.

Third, consumers in the US can still purchase cigarettes through the mail or internet. To purchase cigarettes online, the purchaser simply ticks a box stating that he/she is eighteen years or over. Ribisi et al. (2003) found that when 4 adolescents attempted to buy cigarettes from 55 internet vendors located in 12 states, minors received cigarettes in 93.6% of attempts using credit cards for payment and 88.9% using money orders and age was never formally verified at any of the deliveries.[35] Loose federal regulation around internet sales including taxation structures have led states to enact their own laws about sales of cigarettes via the Internet such as outlawing internet sales entirely (ex. New York) and others requiring proof of age upon delivery (ex. Texas). The act of internet companies not reporting tobacco sales to the state where delivery takes place is considered a misdemeanor in the US[36] (Jenkins Act (15 U. S. C. 375-378) 2007). The regulatory environment at the federal level around Internet tobacco sales, especially as it concerns ensuring lack of access

[35] This study had adult researchers sitting with the adolescents and helping them while the adolescents made purchases. Jensen et al.'s (2004) study involved no adults in the process at all and found a delivery rate of 76.7% among the 15 and 16 year olds in the study.

[36] Associated misdemeanor class results in fine of no more than $1,000, less than 6 months in jail or both. (Jenkins Act (15 U. S. C. 375-378) 2007).

to individuals under the federal limit of 18 years of age is still evolving. Internet-based tobacco sales poses a striking example of the downside of fragmented tobacco-related legislation as each state weighs its own disincentives and incentives for enacting appropriate measures.

Adolescents' abilities to purchase cigarettes on the Internet not only impact the effectiveness of access policies but also thwart taxation efforts to use the price elasticity of youths to influence youth tobacco expenditure. Jensen et al. (2004) found that the average price of a cigarette carton purchased by an adolescent online was $23 while costing $43 in a California store. This great difference in price is partly due to the fact that excise tax is not added to internet sales.

Appendix 5A. Canadian YSS – Discussion of variables used in empirical analysis

Risk perceptions variables

The YSS employs two measures to assess respondents' risk perceptions. The first, 'the quantitative measure of risk,' comes from a question asking respondents to elect from eight choices, 'the closest to the number of Canadians that die each year as a result of smoking cigarettes.' The correct answer to this question is 45,000 people, which appears as the fifth choice. This question requires respondents to have knowledge about the population of Canada and then some idea of how many smoke, which calls into question how accurate this measure of risk can ever be.

The second measure of risk perceptions comes from a series of six questions asking respondents to agree, disagree or state that they don't know regarding the number of deaths in Canada due to smoking versus various other causes. The questions are phrased as follows: 'Cigarette smoking causes more deaths each year than....alcohol, illegal drugs, car accidents, AIDS, suicides, murders.' This risk perceptions measure takes a relative risk approach. For all causes of death listed in the survey, cigarette smoking causes more deaths and therefore 'agree' is always the correct answer. The inclusion of alcohol or AIDS could be acting as a reference point for respondents thus introducing a systematic cognitive bias of focus on the compared mortality cause rather than smoking.[37] Each of these questions measuring relative risk perceptions was included separately in their own model as the distinct variable measuring risk perception.

[37] A more extensive discussion of both the quantitative and qualitative measure of risk from a methodological standpoint can be found in Chapter 4.

Control and explanatory variables

The survey also includes socio-economic information such as age (expressed through grade level), gender, province of residence, weekly allowance ('disposable income') and household structure. Respondents also state whether their father and mother smoke, how many friends they have and how many friends smoke. To express the importance of the behavior of an adolescent's friend group, the number of friends who smoke was divided by the number of friends respondents claim to have. Other explanatory variables are whether the respondent has been taught in school about health problems due to smoking and if he has seen health warnings that appear on cigarette packages.

Appendix 5B. US NSDUH – Discussion of variables used in empirical analysis

Risk perceptions variables

The NSDUH asked respondents about the risks they perceive from smoking using a qualitative approach. The Likert-scale question is phrased 'How much do people risk harming themselves physically and in other ways when they smoke one or more packs of cigarettes per day?' with potential responses of 'No risk,' 'Slight risk,' 'Moderate risk,' 'Great risk,' 'Don't Know,' 'Refused,' and 'Blank (No answer).' This kind of question creates difficulty because of every individual's unique definition of what constitutes a risk that is 'great,' 'moderate' and so forth.[38]

Control and explanatory variables

This survey also offers demographic and additional respondent and household characteristics to serve as control variables. Those which this study has elected to include are gender, sex, ethnicity, urban/rural, if the respondent earns a personal income, family household income, type of school respondent attends (public, private, charter, home school), whether both the respondent's mother and father live in the respondent's household and how many individuals under age 18 live in the respondent's household. Models also include variables reflecting respondents' attitudes and beliefs in order to pick up respondents' appetite to risk so that the smoking risk perceptions variable is as much about smoking and not the respondents' overall risk appetite as possible. These risk aversion variables capture respondents' like or dislike for doing dangerous things, if they test themselves with risks and how often they wear a seatbelt when riding in a car. The models also include a variable to act as a proxy for the importance of beliefs in respondents' decision-making based on a survey question focusing on how religion influences decisions. This variable also serves to pickup the influence of beliefs and keeps

[38] Chapter 4 includes more information on the methodological difficulties of Likert scale questions.

the smoking risk perception variable from being affected by the role of beliefs about other topics.

There is no data on parental smoking behaviors but to pick up the role of parents as information sources, there is a question about whether the respondent's parents have spoken to him/her about the dangers of tobacco or alcohol use. The role of peer effects will be captured in this analysis by using a question about how many students in the respondent's grade that the respondent claims smoke cigarettes. There are also questions about respondent's awareness of anti-smoking campaigns and information both inside and outside of school. These will be used to test the strength of risk perceptions as a determinant of smoking even when including traditional public health actions.

Appendix 5C. Canadian YSS – Descriptive statistics of the dependent variable and the explanatory variables

Variable	Definition	Mean	Std. dev.
Dependent variable			
Smoked whole cigarette	Smoked a whole cigarette=1	0.129	0.336
Explanatory variables			
	Quantitative risk perceptions question		
Log (quantitative risk perceptions)	Log of choice of pre-set responses to the number of Canadians that die each year due to cigarette smoking divided by the number of smokers in Canada	-5.483	1.406
	Qualitative risk perceptions questions		
Risk smoking relative to alcohol	Agree that cigarette smoking causes more deaths each year than alcohol=1	0.591	0.492
Risk smoking relative to illegal drugs	Agree that cigarette smoking causes more deaths each year than illegal drugs=1	0.404	0.491
Risk smoking relative to car accidents	Agree that cigarette smoking causes more deaths each year than car accidents=1	0.477	0.499
Risk smoking relative to AIDS	Agree that cigarette smoking causes more deaths each year than AIDS=1	0.389	0.487
Risk smoking relative to suicides	Agree that cigarette smoking causes more deaths each year than suicides=1	0.528	0.499
Risk smoking relative to murders	Agree that cigarette smoking causes more deaths each year than murders=1	0.442	0.497
	Socio-demographics		
Gender	Male=1	0.501	0.500
Grade 5	Grade 5=1	0.186	0.389
Grade 6	Grade 6=1	0.195	0.396
Grade 7	Grade 7=1	0.196	0.397
Grade 8	Grade 8=1	0.208	0.406
Grade 9	Grade 9=1	0.215	0.411
Quebec	Individuals who live in Quebec=1	0.170	0.375
	Socio-economics		
Weekly allowance	Receives weekly allowance=1	0.443	0.497
	Household characteristics		
Lives both parents	Lives with both parents=1	0.686	0.464
Lives one parent and partner	Lives with one natural parent and parent's spouse/partner=1	0.094	0.292
Lives one parent	Lives with one parent=1	0.126	0.331
Lives shared custody	Shared/other custody arrangement=1	0.030	0.171
Lives no answer	No response to living situation question=1	0.064	0.245
	Societal influences		
Only father smokes	Father smokes and mother does not=1	0.137	0.344
Father smokes DK	Does not know if father smokes=1	0.013	0.113
Father smokes NS	No response to if father smokes=1	0.064	0.246
Only mother smokes	Mother smokes and father does not=1	0.087	0.282
Mother smokes DK	Mother does not smoke=1	0.008	0.090
Mother smokes NS	No response to if mother smokes=1	0.030	0.171
Both parents smoke	Both parents smoke=1	0.135	0.342
Number of people who smoke in home	Number of people who smoke in the home = 0,1,2,3,4,5 (for 5 or more)	0.580	1.066
Percent friends smoke	Percentage of friends who smoke	0.117	0.240

	Interaction terms		
Interaction weekly allowance and father smokes DK	Interaction term between receives weekly allowance and if does not know if father smokes	0.005	0.068
Interaction weekly allowance and mother smokes DK	Interaction term between receives weekly allowance and if does not know if mother smokes	0.003	0.051
	Information sources – public health		
School ever taught about health problems due to smoking NO	Have never been taught in school about health problems due to smoking=1	0.112	0.316
School ever taught about health problems due to smoking YES	Have ever been taught in school about health problems due to smoking=1	0.775	0.418
School taught about health problems due to smoking DK	Does not know if have ever been taught in school about health problems due to smoking=1	0.102	0.302
School taught about health problems due to smoking NS	No response to if have ever been taught in school about health problems due to smoking=1	0.011	0.106
	Beliefs in health warning messages		
Seen health warnings NO	Not seen the health warnings that appear on cigarette packages=1	0.220	0.414
Seen health warnings YES	Seen the health warnings that appear on cigarette packages=1	0.770	0.421
Seen health warnings NS	No response to if seen the health warnings that appear on cigarette packages=1	0.010	0.100

Appendix 5D. US NSDUH – Descriptive statistics of the dependent variable and the explanatory variables

Variable	Definition	Mean	Std. dev.
Dependent variable			
Smoked a cigarette	Smoked a cigarette=1	0.303	0.459
Explanatory variables			
	Risk perceptions		
Risk perceptions	Risk of smoking 1 or more packs of cigarettes per day=no risk (1), slight risk (2), moderate risk (3), great risk (4)	3.591	0.670
	Socio-demographics		
Gender	Male=1	0.510	0.500
Age	12 years=1, 13 years =2, 14 years =3, 15 years =4, 16 years =5, 17 years =6	3.507	1.685
White	Non-Hispanic White=1	0.641	0.480
Black Afr-Amer	Non-Hispanic Black/African American=1	0.134	0.341
Native American/AK Native	Non-Hispanic Native American/Alaska Native=1	0.016	0.125
Native HI/Pac Islands	Non-Hispanic Native Hawaiian/Pacific Islander=1	0.003	0.055
Asian	Non-Hispanic Asian=1	0.027	0.161
More than one race	Non-Hispanic more than one race=1	0.037	0.188
Hispanic	Hispanic=1	0.143	0.350
MSE over 1 million	Live in MSA (metropolitan statistical area) with fewer than 1 million or more persons=1	0.362	0.480
MSE under 1 million	Live in MSA with fewer than 1 million or more persons=1	0.354	0.478
Not in MSA	Does not live in a MSA=1	0.285	0.451
	Economic independence from parents		
Receive income from job	Receives income from job=1	0.252	0.434
	Socio-economics		
Family income	Total family income=1(less than $10,000), 2($10,000-$19,999), 3($20,000-$29,999), 4($30,000-$39,999), 5($40,000-$49,999), 6($50,000-$74,999), 7($75,000 or more)	4.801	1.970
Public school	Attend public school=1	0.866	0.340
Private school	Attend private school=1	0.075	0.264
Charter school	Attend charter school=1	0.014	0.119
Home school	Attend home school=1	0.018	0.133
DK school type	Don't know school type=1	0.001	0.025
Refused school type	Refuse to answer school type=1	0.001	0.032
Legitimate skip school type	Legitimate skip=1	0.024	0.155
	Household characteristics		
Two parent household	Lives with both parents=1	0.675	0.468
	Attitudes and beliefs		
Never like dangerous things	Never get a real kick out of doing dangerous things=1	0.283	0.451
Seldom like dangerous things	Seldom get a real kick out of doing dangerous things=1	0.297	0.457
Sometimes like dangerous things	Sometimes get a real kick out of doing dangerous things=1	0.331	0.471
Always like dangerous things	Always get a real kick out of doing dangerous things=1	0.080	0.271
DK like dangerous things	DK if get a real kick out of doing dangerous	0.006	0.076

	things=1		
Refused like dangerous things	Refused to answer if get a real kick out of doing dangerous things=1	0.002	0.048
Never test self with risks	Never test self by doing something a little risky=1	0.289	0.453
Seldom test self with risks	Seldom test self by doing something a little risky=1	0.351	0.477
Sometimes test self with risks	Sometimes test self by doing something a little risky=1	0.296	0.456
Always test self with risks	Always test self by doing something a little risky=1	0.061	0.240
DK test self with risks	Don't know if test self by doing something a little risky=1	0.003	0.050
Never wear seatbelt in front car	Never wear a seatbelt when ride in front passenger seat of car=1	0.032	0.177
Seldom wear seatbelt in front car	Seldom wear a seatbelt when ride in front passenger seat of car=1	0.074	0.261
Sometimes wear seatbelt in front car	Sometimes wear a seatbelt when ride in front passenger seat of car=1	0.201	0.401
Always wear seatbelt in front car	Always wear a seatbelt when ride in front passenger seat of car=1	0.692	0.462
DK wear seatbelt in front car	Don't know wear a seatbelt when ride in front passenger seat of car=1	0.000	0.018
Religion influences decisions	Agree or strongly agree that religious beliefs influence decisions=1	0.657	0.475
Religion does not influence decisions	Strongly disagree or disagree that religious beliefs influence decisions=1	0.322	0.467
DK religion influences decisions	Don't know if religious beliefs influence decisions=1	0.015	0.121
Refused religion influences decisions	Refused to answer if religious beliefs influence decisions=1	0.006	0.074
	Societal influences		
Parents talked dangers YES	In the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.602	0.489
Parents talked dangers NO	In the past 12 months, not talked with parents about dangers of tobacco, alcohol or drug use=1	0.390	0.488
Parents talked dangers DK	In the past 12 months, don't know if talked with parents about dangers of tobacco, alcohol or drug use=1	0.006	0.076
Refused parents talked dangers	Refused to answer if in the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.002	0.043
No answer parents talked dangers	No answer regarding f in the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.000	0.013
No stdnts smoke	No students in grade at school smoke cigarettes=1	0.126	0.331
Few stdnts smoke	A few students in grade at school smoke cigarettes=1	0.476	0.499
Most stdnts smoke	Most students in grade at school smoke cigarettes=1	0.281	0.450
All stdnts smoke	All students in grade at school smoke cigarettes=1	0.009	0.095
Stdnts smoke DK	Don't know if students in grade at school smoke cigarettes=1	0.020	0.138
Refused stdnts smoke	Refused if students in grade at school smoke cigarettes=1	0.001	0.036
No answer stdnts smoke	No answer if students in grade at school smoke cigarettes=1	0.005	0.072
Legite skip stdnts smoke	Legitimate skip if students in grade at school smoke cigarettes=1	0.082	0.274

Appendix 5E. Technical specifications of the smoking decision model

The utility attached to smoking is $U(smoke)$ while the utility attached to not smoking is $U(don't\_smoke)$. π represents the probability that someone will die from smoking. The decision to try smoking appears as below:

$$(1-\pi)U(smoke)+\pi U(die\_from\_smoking)>U(don't\_smoke) \qquad (1)$$

The first expression represents the utility gain expected from smoking while the second expression represents the expected utility from dying from smoking. The third expression is the utility expected from not smoking (Viscusi 1992b). Therefore, if the utility attached to smoking (utility attached to smoking plus disutility of dying as a result) is greater than the utility expected from not smoking, then an individual will smoke.

Expression (1) transformed into an equation denoting smoking consumption becomes:

$$[U(smoke)-U(don't\_smoke)]+\pi[U(die\_from\_smoking)-U(smoke)]=S^* \qquad (2)$$

If S^* >0 then individuals deem the utility associated with smoking greater than that with not smoking. We can then predict that an increase in the perceived π (perceived probability that someone will die from smoking) will increase the expected disutility from smoking and alternatively as risk perceptions fall, then likelihood of smoking will fall (Viscusi 1992b).

The decision to try smoking can be influenced by many factors. Therefore, the utilities attached to smoking ($U(smoke)$) and nonsmoking ($U(don't)$) and the perceived probability of dying from smoking (π) have determinants ranging from peer group behavior to personal experience with smoking. These determinants are tested in the parameterization of this model depicted in equation 5.1 in Chapter 5. In that equation S^* is the dependent variable with a variety of explanatory and control variables used to estimate the predictors of smoking.

This smoking decision model is one of expected utility and makes the assumption that individuals operate in a rational way. While the expected utility is limited in explaining the decision to smoke in theoretical terms, if we are to empirically test the decision to smoke, it offers a predictive construct under which to do so. Some of the biases in decision-making also do not have to be associated with irrationality but instead rational means by which individuals circumvent any informational short comings to reach decisions (Viscusi 1992b).

Appendix 5F. Canadian YSS – Determinants of whether survey respondents have smoked 100 cigarettes (includes quantitative measure of risk perceptions)

	(1) Simple model		(2) Simple model (I.V.)		(3) Expanded model including parents' and friends' smoking behaviors		(4) Expanded model including parents' and friends' smoking behaviors (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Risk perceptions								
Log (quantitative risk perceptions)*	-0.01	-0.75	-1.50[a]	-4.31	-2.3E-03	-0.12	-0.96[a]	-2.77
Socio-demographics								
Gender	0.00	-0.07	0.27[a]	3.31	0.04	0.87	0.21[b]	2.52
Grade 5	-1.62[a]	-10.54	-2.37[a]	-10.20	-1.62[a]	-6.38	-2.12[a]	-7.65
Grade 6	-1.24[a]	-14.35	-1.64[a]	-11.80	-1.06[a]	-8.06	-1.34[a]	-8.21
Grade 7	-0.80[a]	-13.41	-0.98[a]	-11.13	-0.75[a]	-9.32	-0.88[a]	-8.74
Grade 8	-0.42[a]	-9.19	-0.52[a]	-7.35	-0.40[a]	-6.77	-0.47[a]	-6.47
Quebec	0.49[a]	10.98	0.37[a]	5.52	0.39[a]	6.90	0.31[a]	4.50
Economic independence from parents								
Weekly allowance	0.35	8.34	0.52[a]	7.83	0.25[a]	4.64	0.34[a]	5.05
Household characteristics								
Lives one parent and partner	0.55[a]	9.84	0.73[a]	8.23	0.23[a]	3.06	0.30[a]	3.48
Lives one parent	0.44[a]	8.35	0.56[a]	7.31	0.12	1.58	0.15	1.84
Lives shared custody	0.48[a]	4.92	0.57[a]	4.20	0.23[b]	2.03	0.27	1.93
Societal influences								
Only father smokes	-	-	-	-	0.10	1.30	0.22[b]	2.26
Father smokes DK	-	-	-	-	0.46	1.84	0.52[b]	2.01
Only mother smokes	-	-	-	-	0.27[a]	3.19	0.39[a]	3.77
Mother smokes DK	-	-	-	-	-0.88	-1.54	-0.79	-1.71
Both parents smoke	-	-	-	-	0.15	1.83	0.25[b]	2.48
Number of people who smoke in home	-	-	-	-	0.20[a]	9.53	0.23[a]	8.39
Percent of friends that smoke	-	-	-	-	2.10[a]	31.04	2.00[a]	21.12
Wald χ^2 / LR χ^2	682.01		1076.97		1418.03		2343.91	
Pseudo R^2	0.184		0.189		0.448		0.449	
Log pseudolikelihood / Log likelihood	-2340.3		-2307.2		-1451.7		-1438.6	
Number of observations	18,515		18,345		16,353		16,255	

Notes: All models include robust standard errors

(*) Instrumented using questions about whether respondents 'played sports or done physical activities without a coach or an instructor (e.g. biking, skateboarding, etc.)' at least once a week and if 'smokers can quit anytime they want.'

[a] Significant at 1% [b] Significant at 5%

Table 5G. Canadian YSS - Determinants of whether survey respondents have smoked a whole cigarette (includes qualitative measures of risk perceptions)

	(1) Expanded model including parents' smoking behaviors and interaction terms		(2) Expanded model including parents' smoking behaviors and interaction terms		(3) Expanded model including parents' smoking behaviors and interaction terms		(4) Expanded model including parents' smoking behaviors and interaction terms		(5) Expanded model including parents' smoking behaviors and interaction terms		(6) Expanded model including parents' smoking behaviors and interaction terms	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Risk perceptions												
Risk smoking....relative to alcohol	-0.08 [a]	-2.96	-	-	-	-	-	-	-	-	-	-
...relative to illegal drugs	-	-	0.03	1.00								
...relative to car accidents	-	-	-	-	1.1E-03	0.04	-	-	-	-	-	-
...relative to AIDS	-	-	-	-	-	-	0.04	1.44	-	-	-	-
...relative to suicides	-	-	-	-	-	-	-	-	-0.04	-1.52	-	-
...relative to murders	-	-									-0.02	-0.70
Socio-demographics												
Gender	-0.04	-1.37	-0.05	-1.70	-0.04	-1.51	-0.05	-1.72	-0.04	-1.34	-0.04	-1.57
Grade 5	-1.54 [a]	-24.86	-1.53 [a]	-24.72	-1.53 [a]	-24.76	-1.52 [a]	-24.59	-1.55 [a]	-24.93	-1.54 [a]	-24.86
Grade 6	-1.21 [a]	-25.31	-1.21 [a]	-25.10	-1.21 [a]	-25.15	-1.21 [a]	-25.05	-1.22 [a]	-25.22	-1.22 [a]	-25.26
Grade 7	-0.73 [a]	-19.38	-0.73 [a]	-19.24	-0.73 [a]	-19.26	-0.73 [a]	-19.23	-0.74 [a]	-19.38	-0.73 [a]	-19.37
Grade 8	-0.32 [a]	-9.47	-0.31 [a]	-9.33	-0.31 [a]	-9.42	-0.31 [a]	-9.27	-0.31 [a]	-9.41	-0.32 [a]	-9.47
Quebec	0.59 [a]	18.29	0.59 [a]	18.34	0.59 [a]	18.22	0.59 [a]	18.41	0.59 [a]	18.20	0.59 [a]	18.22
Economic independence from parents												
Weekly allowance	0.24 [a]	8.71	0.23 [a]	8.47	0.24 [a]	8.54	0.23 [a]	8.46	0.24 [a]	8.58	0.23 [a]	8.46
Household characteristics												
Lives one parent and partner	0.33 [a]	7.65	0.33 [a]	7.63	0.33 [a]	7.62	0.32 [a]	7.54	0.33 [a]	7.59	0.33 [a]	7.68
Lives one parent	0.28 [a]	7.08	0.28 [a]	7.09	0.28 [a]	7.11	0.28 [a]	7.01	0.28 [a]	7.02	0.29 [a]	7.15
Lives shared custody	0.30 [a]	4.14	0.30 [a]	4.14	0.30 [a]	4.17	0.30 [a]	4.14	0.30 [a]	4.11	0.30 [a]	4.14
Societal influences												

Only father smokes	0.19[a]	4.63	0.19[a]	4.49	0.19[a]	4.59	0.19[a]	4.55	0.19[a]	4.53	0.19[a]	4.54
Father smokes DK	0.04	0.23	0.05	0.28	0.05	0.25	0.06	0.30	0.05	0.25	0.05	0.26
Only mother smokes	0.33[a]	5.38	0.26[a]	5.47	0.26[a]	5.47	0.26[a]	5.45	0.25[a]	5.33	0.26[a]	5.46
Mother smokes DK	0.26[a]	5.51	0.17	0.82	0.18	0.88	0.17	0.83	0.16	0.78	0.17	0.80
Both parents smoke	0.16	0.77	0.25[a]	5.39	0.25[a]	5.44	0.25[a]	5.35	0.25[a]	5.39	0.25[a]	5.45
Number of people who smoke in home	0.25[a]	18.31	0.25[a]	18.15	0.24[a]	18.00	0.25[a]	18.21	0.25[a]	18.13	0.25[a]	18.16
Interaction terms												
Weekly allowance and father smokes DK	0.53[b]	2.14	0.52[b]	2.07	0.52[b]	2.10	0.51[a]	2.06	0.53[b]	2.12	0.52[a]	2.10
Weekly allowance * Mother smokes DK	-0.17	-0.52	-0.15	-0.46	-0.16	-0.50	-0.15	-0.46	-0.15	-0.47	-0.15	-0.47
Wald χ^2	2384.65		2374.22		2365.41		2368.69		2373.11		2377.17	
Pseudo R^2	0.22		0.221		0.221		0.222		0.222		0.221	
Log pseudolikelihood	-5591.3		-5593.3		-5582.6		-5575.6		-5575.2		-5590.0	
Number of observations	18,637		18,622		18,561		18,561		18,554		18,609	

Notes: All models include robust standard errors
[a] Significant at 1% [b] Significant at 5%

Appendix 5H. US NSDUH - Determinants of whether survey respondents have smoked 100 cigarettes

	(1) Simple model		(2) Simple model (I.V.)		(3) Expanded model including parents and classmates variables		(4) Expanded model including parents and classmates variables (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Risk perceptions								
Risk perceptions*	-0.29 [a]	-13.09	-0.23 [a]	-3.76	0.29 [a]	-12.72	-0.15 [a]	-3.32
Socio-demographics								
Gender	-0.19 [a]	-5.54	-0.17 [a]	-4.91	-0.10 [a]	-2.76	-0.12 [a]	-5.08
Age	0.32 [a]	24.93	0.31 [a]	23.38	0.28 [a]	20.14	0.21 [a]	25.07
Black Afr-Amer	-0.77 [a]	-10.55	-0.76 [a]	-11.02	-0.80 [a]	-10.81	-0.32 [a]	-8.34
Native American/AK Native	0.10	0.91	0.10	0.91	0.06	0.51	0.36 [a]	4.29
Native HI/Pac Islands	-0.66 [b]	-2.05	-0.59	-1.77	-0.65	-1.89	0.20	1.12
Asian	-0.40 [a]	-3.04	-0.39 [a]	-3.07	-0.35 [b]	-2.51	-0.42 [a]	-5.23
More than one race	-0.04	-0.50	-0.04	-0.47	-0.06	-0.73	0.07	1.27
Hispanic	-0.41 [a]	-6.90	-0.40 [a]	-7.37	-0.41 [a]	-6.85	-0.02	-0.60
MSE under 1 million	0.11 [a]	2.74	0.11 [a]	2.78	0.11 [a]	2.67	0.14 [a]	5.14
Not in MSA	0.13 [a]	3.05	0.14 [a]	3.21	-0.10 [a]	-2.76	0.17 [a]	5.70
Economic independence from parents								
Receive income from job	0.02	0.46	0.01	0.39	0.02	0.58	0.10 [a]	3.77
Socio-economics								
Family income	-0.06 [a]	-5.84	-0.06 [a]	-6.08	-0.05 [a]	-4.99	-0.05 [a]	-6.59
Private school	-0.15 [b]	-2.06	-0.16 [b]	-2.17	-0.05	-0.69	-0.02	-0.41
Home school	0.13	1.13	0.12	1.03	0.24	1.89	0.14	1.55
Household characteristics								
Two parent household	-0.21 [a]	-5.39	-0.21 [a]	-5.48	-0.21 [a]	-5.39	-0.17 [a]	-6.45
Attitudes and beliefs								
Seldom like dangerous things	0.20 [a]	3.27	0.18 [a]	3.01	0.19 [a]	3.11	0.27 [a]	7.39
Sometimes like dangerous things	0.43 [a]	6.59	0.41 [a]	6.41	0.40 [a]	6.14	0.52 [a]	13.33
Always like dangerous things	0.63 [a]	7.51	0.60 [a]	7.28	0.58 [a]	6.84	0.67 [a]	11.83
Seldom test self with risks	-0.03	-0.55	-0.03	-0.51	-0.03	-0.56	0.14 [a]	3.84
Sometimes test self with risks	0.08	1.29	0.09	1.40	0.06	0.96	0.24 [a]	6.20
Always test self with risks	0.23 [b]	2.63	0.24 [a]	2.80	0.19 [b]	2.13	0.42 [a]	6.81
Never wear seatbelt in front car	0.66 [a]	9.00	0.68 [a]	9.63	0.62 [a]	8.29	0.60 [a]	9.64
Sometimes wear seatbelt in front car	0.49 [a]	9.48	0.50 [a]	9.70	0.45 [a]	8.41	0.45 [a]	10.96
Sometimes wear seatbelt in front car	0.27 [a]	6.74	0.27 [a]	6.85	0.24 [a]	5.80	0.29 [a]	10.62
Religion influences decisions	-0.37 [a]	-11.16	-0.37 [a]	-11.02	-0.37 [a]	-10.69	-0.18 [a]	-7.63
Societal influences								
Parents talked dangers NO	-	-	-	-	-0.03	-0.93	0.03	1.47
Parents talked	-	-	-	-	0.20	0.93	-0.33	-1.81

dangers DK								
Few stdnts smoke	-	-	-	-	0.45[a]	3.72	0.47[a]	9.32
Most stdnts smoke	-	-	-	-	0.98[a]	8.07	1.00[a]	18.74
All stdnts smoke	-	-	-	-	1.25[a]	7.63	1.04[a]	8.80
Stdnts smoke DK	-	-	-	-	0.52[a]	2.86	0.45[a]	4.44
Wald χ^2 / LR χ^2	1899.93		2555.68		1941.82		5204.25	
Pseudo R^2	0.274		0.258		0.302		0.234	
Log pseudolikelihood / Log likelihood	-3598.8		-3677.7		-3458.3		-8519.2	
Number of observations	18,109		18,109		18,109		18,135	

Notes: Non-instrumented model in column (1) and (3) include robust standard errors.
Instrumented models in columns (2) and (4) include uncorrected standard errors.
(*) Instrumented using questions about the risks respondents attach to 'using LSD once or twice a week' and the risk of 'using cocaine once a month' with responses of 'No risk,' 'Slight risk,' 'Moderate risk,' 'Great risk,' 'Don't know,' 'Refused,' and 'No answer.'
[a] Significant at 1% [b] Significant at 5%

Appendix 5I. US NSDUH - Determinants of whether survey respondents have smoked a cigarette split by gender

	(1) Expanded model including only males		(2) Expanded model including only females		(3) Expanded model including only males (I.V.)		(4) Expanded model including only females (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Risk perceptions								
Risk perceptions*	-0.17 [a]	-7.78	-0.16 [a]	-6.50	-0.19 [a]	-3.31	-0.10	-1.28
Socio-demographics								
Age	0.21 [a]	18.28	0.21 [a]	17.76	0.21 [a]	18.18	0.21 [a]	17.09
Black Afr-Amer	-0.21 [a]	-3.86	-0.44 [a]	-7.66	-0.21 [a]	-3.91	-0.44 [a]	-8.09
Native American/AK Native	0.46 [a]	4.03	0.20	1.54	0.45 [a]	4.08	0.20	1.58
Native HI/Pac Islands	0.18	0.63	0.27	0.91	0.17	0.67	0.29	1.07
Asian	-0.20	-1.91	-0.67 [a]	-5.37	-0.20	-1.84	-0.67 [a]	-5.48
More than one race	0.12	1.50	0.02	0.29	0.12	1.51	0.02	0.27
Hispanic	0.01	0.13	-0.06	-1.13	0.01	0.11	-0.06	-1.13
MSE under 1 million	0.19 [a]	5.22	0.08 [b]	1.98	0.19 [a]	5.15	0.08	1.98
Not in MSA	0.20 [a]	4.73	0.14 [a]	3.29	0.20 [a]	4.79	0.14 [a]	3.29
Economic independence from parents								
Receive income from job	0.12 [a]	3.18	0.09	2.23	0.12 [a]	3.17	0.09 [b]	2.17
Socio-economics								
Family income	-0.04 [a]	-4.38	-0.05 [a]	-4.74	-0.04 [a]	-4.38	-0.05 [a]	-4.90
Private school	-0.08	-1.35	0.05	0.74	-0.08	-1.29	0.05	0.73
Home school	0.22	1.95	0.02	0.14	0.23	1.93	0.02	0.14
Household characteristics								
Two parent household	-0.11 [a]	-3.06	-0.23 [a]	-5.87	-0.11 [a]	-3.09	-0.23 [a]	-5.94
Attitudes and beliefs								
Seldom like dangerous things	0.25 [a]	4.69	0.30 [a]	5.82	0.24 [a]	4.56	0.29 [a]	5.88
Sometimes like dangerous things	0.42 [a]	7.53	0.63 [a]	11.11	0.42 [a]	7.50	0.62 [a]	11.28
Always like dangerous things	0.63 [a]	8.28	0.74 [a]	8.39	0.63 [a]	8.31	0.73 [a]	8.05
Seldom test self with risks	0.10	1.86	0.16 [a]	3.24	0.09	1.81	0.16 [a]	3.30
Sometimes test self with risks	0.19 [a]	3.45	0.28 [a]	5.01	0.19 [a]	3.44	0.28 [a]	5.07
Always test self with risks	0.34 [a]	4.14	0.55 [a]	5.65	0.33 [a]	4.15	0.55 [a]	5.64
Never wear seatbelt in front car	0.58 [a]	7.44	0.60 [a]	5.90	0.57 [a]	7.24	0.61 [a]	6.15
Sometimes wear seatbelt in front car	0.41 [a]	7.41	0.51 [a]	8.22	0.40 [a]	7.41	0.51 [a]	7.96
Sometimes wear seatbelt in front car	0.30 [a]	7.85	0.28 [a]	6.97	0.29 [a]	7.70	0.28 [a]	7.06
Religion influences decisions	-0.13 [a]	-4.05	-0.23 [a]	-6.67	-0.13 [a]	-3.94	-0.23 [a]	-6.64
Societal influences								
Parents talked dangers NO	-0.01	-0.22	0.07 [b]	2.14	-0.01	-0.28	0.08 [b]	2.26
Parents talked dangers DK	0.01	0.05	-0.81 [a]	-3.05	0.01	0.03	-0.82 [b]	-2.56
Few stdnts smoke	0.46 [a]	7.03	0.50 [a]	6.20	0.47 [a]	7.05	0.50 [a]	6.19

Most stdnts smoke	0.97 [a]	13.64	1.04 [a]	12.60	0.96 [a]	13.66	1.04 [a]	12.63
All stdnts smoke	1.03 [a]	6.63	1.03 [a]	6.11	1.02 [a]	6.25	1.02 [a]	5.82
Stdnts smoke DK	0.41 [a]	3.38	0.50 [a]	3.22	0.42 [a]	3.29	0.51 [a]	3.01
Wald χ^2 / LR χ^2	1972.63		2105.91		2467.92		2827.26	
Pseudo R^2	0.224		0.260		0.220		0.257	
Log pseudolikelihood / Log likelihood /	-4353.2		-4073.9		-4377.9		-4093.5	
Number of observations	9,244		8,888		9,245		8,890	

Notes: Non-instrumented model in column (1) and (2) include robust standard errors.
Instrumented models in columns (3) and (4) include uncorrected standard errors.
Those numbers in bold are those that differ in either significance or level of significance of the variable between males and females
(*) Instrumented using questions about the risks respondents attach to 'using LSD once or twice a week' and the risk of 'using cocaine once a month' with responses of 'No risk,' 'Slight risk,' 'Moderate risk,' 'Great risk,' 'Don't know,' 'Refused,' and 'No answer.'
[a] Significant at 1% [b] Significant at 5%

Appendix 5J. Determinants of smoking – findings regarding control and explanatory variables

	Canada – YSS	US - NSDUH
	Smoking behavior	*Smoking behavior*
	Socio-demographics	
Gender (male =1)	None	Negative
Age	Positive	Positive
Quebec (relative to other provinces)	Positive	-
Black Afr-Amer	-	Negative
Native American/AK Native	-	Positive
Native HI/Pac Islands	-	None
Asian	-	Negative
More than one race	-	None
Hispanic	-	None
MSE under 1 million	Positive	-
Not in MSA	Positive	-
	Economic independence from parents	
Weekly allowance	Positive	-
Receive income from job	-	Positive
	Socio-economics	
Family income	-	Negative
Private school	-	Negative
Home school	-	None
	Household characteristics	
Two parent household	Negative	Negative
	Attitudes and beliefs	
Risk tolerant	-	Positive
Religion influences decisions	-	Negative
	Societal influences	
Only father smokes	Positive	-
Only mother smokes	Positive	-
Both parents smoke	Positive	-
Number of people who smoke in home	Positive	-
Parents talked dangers NO	-	Positive only for females
All students smoke		Positive
Percent of friends that smoke	Positive	-
	Information sources – public health	
School ever taught about health problems due to smoking NO	Positive	-
	Beliefs in health warning messages	
Seen health warnings NO	Negative	-

Note: Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'none.'
'-' means that this variable is not included in the dataset

Gender

Findings regarding gender say something about risk perception measures as well as the relationship between gender and smoking behavior. Gender proved insignificant in all tested models using the YSS data. However, for the NSDUH, females proved more likely

to smoke than males, which is consistent with previous research finding that females are more likely to smoke in adolescence (Lundborg 2007; Lundborg and Lindgren 2004; Lundborg and Andersson 2007). Although the coefficients of the gender variable are not significant in the YSS models, they are directionally consistent with previous findings of females being more likely to smoke. The difference in results between the YSS and NSDUH could be due to the young age of the YSS respondents. The NSDUH includes 12-17 year olds whereas the YSS has 10-15 year olds so the average respondent age is two years higher with the NSDUH. Perhaps by the age of 10 to 15 years, enough of their peers may not have started smoking yet to create the peer effect of coping behavior that is often given as the reason adolescent girls now are more likely to smoke than boys (Snow and Bruce 2003).

Age and economic independence from parents

Across both sets of models using the YSS and NSDUH, age and having economic independence from parents were positively related to respondents having smoked. Results appeared largely as expected in light of previous work in the area. Age has also been found to be positively related to smoking behavior among adolescents in similar studies (Lundborg 2007; Lundborg and Lindgren 2004). Additionally, higher probability of smoking with age is consistent with the idea of age measuring the effect of time preference. However, given that adolescents have limited life experience this argument might not necessarily hold. Findings are consistent with previous work stating that pocket money or allowance is positively related to adolescents' smoking behaviors (Scragg et al. 2002).

Province of residence

An example of contextual and environmental effects comes in the YSS models finding that residency in Quebec is positively related to smoking. This finding highlights a societal/cultural quality in Quebec that differentiates it from the rest of Canada. Given that

risks preferences are likely to be socially formed, our findings suggest that consumption externalities associated with living in a common environment matter. In other words, Manski's contextual effects exert an influence on individuals' behaviors (2000).

Ethnicity

Findings about ethnicity using the NSDUH data point to some ethnic groups playing a determinative role in adolescent smoking while others do not. Being African-American or Asian meant that respondents were less likely to smoke while being Native American had the opposite effect. Being Hispanic, Native Hawaiian or more than one race had no determinative influence on smoking behavior. While some research has found that Hispanic adolescents are more likely to smoke than adolescents from any other ethnic group (Unger et al. 2000), these findings support previous results demonstrating that African-American adolescents are less likely to smoke than those who are White (Griesler et al. 2002), Hispanic and White adolescents are equally likely to smoke (Gritz et al. 1998) and Native Americans having the highest smoking rates of teens in the US (Kegler et al. 2000).

Urban vs. rural setting

Results from the NSDUH models regarding the likelihood of an adolescent smoking if he lives in an urban area versus a rural area support previous research from the USA showing that rural adolescents are more likely to smoke than ones living in an urban environment (Eberhardt et al. 2001; Noland et al. 1990).

Family income

This study's findings using the NSDUH support previous evidence that family income is negatively related to likelihood of adolescent smoking (Lowry et al. 1996; Scarinci et al., 2002; Unger et al. 2007).

Household characteristics

Analysis using both the YSS and NSDUH found that adolescents coming form two parent households were less likely to smoke. Findings about household structure fall in line with the existing literature stating that parental separation increases the likelihood that an adolescent will start smoking (Kirby 2002) and that two parent households have a significantly negative effect on adolescent smoking behavior (Gaviria and Raphael 2001). Separation might lead to parents having less control over their child's behavior because parents could be much busier supporting their home as single parent.

General risk attitudes and beliefs

NSDUH model results regarding how respondents' attitudes about risks and religious beliefs matter in determining smoking behavior are of interest for two reasons. First, their inclusion in the models was aimed at permitting the risk perceptions of smoking variable to pick up as much information about risks respondents attach to smoking rather than general risk attitudes and beliefs. Therefore, the robustness of findings regarding the NSDUH risk perceptions measures are even stronger because of efforts to capture overall respondent risk attitudes. Second, findings about these variables suggest that risk attitudes permeate across risk-taking setting such that risk perceptions regarding smoking impact smoking behavior in the same way as respondents' propensities to like doing dangerous things, testing themselves with risks and wearing a seatbelt. Less risk tolerant respondents were less likely to have to have smoked a cigarette. Religious beliefs also matter as those who state that religion influences their decisions were less likely to have smoked. This finding supports previous evidence that involvement in religion reduces the likelihood of adolescents being involved in risky health behaviors (Goggin et al. 2007; Wills et al. 2003).

Parental smoking

The result from the YSS that father's smoking and mother's smoking have positive impacts on adolescent smoking supports existing research highlighting the importance of parental

smoking habits in influencing children (Bricker et al. 2006; Peterson et al. 2006; Scragg and Laugesen 2007). They also support the concept that adolescents rely on external influences to shape their utility assessment of smoking. Parental smoking variables were tested individually and together. This finding was true for each parent separately, which has not always been the case in studies about adolescent smoking (Tyas and Pederson 1998). Results from this study would support evidence that parents actively and passively transmit risk attitudes and preferences to their children resulting in similar behavior of parents and children (Fernandez and Fogli 2005).

Number of people who smoke in the home

How many people smoke in the respondents' home, like parental smoking, proved a significant predictor of respondent smoking behavior in analysis with the YSS data. This finding provides further evidence of environmental influences on smoking.

Parental involvement in telling respondents about dangers of smoking

The NSDUH measure of parental involvement was never a significant predictor of smoking behavior except when the models were run separately for each gender. In that case, female respondents were more likely to smoke if their parents had not talked to them about the dangers of smoking. This result is not surprising given that adolescents are probably loathe to listen to their parents talk about the dangers of smoking and refuse to have such a conversation. Alternatively, parents of this age group might think respondents are too young to have such a conversation thus being falsely informed at the average age of smoking initiation. Generally, however, male respondents could be relying more on other factors to determine their smoking behavior than the information received from their parents while females deem their parents a more important information source. The role of parents as information sources about smoking risks will be investigated and discussed at length in Chapter 6.

Peer effects

The YSS measured peer effects as the percent of friends who smoke while the NSDUH used a question about how many students in the respondents' grade smoke. Both measures proved positively and significantly related to likelihood of respondent smoking. The importance of friends' smoking on adolescents' smoking has been well established in the literature (Chaloupka and Warner 2000; Gaviria and Raphael 2001; Leatherdale and Manske 2005; Piko et al. 2005; Snow and Bruce 2003). However, when analysis is longitudinal in nature and not cross-sectional as in this study, the influence of peer behaviors appears on par with that of parental behaviors (De Vries et al. 2003). Engels et al. (1997) found the peer influence to be very important in adolescents' smoking behaviors but this impact was much lower when looking at longitudinal data from five years later. Peers and parents were found to be comparably important for adolescents' behaviors later on. Therefore, this study may be overestimating the importance of peer effects because of its cross-sectional design.

Public health efforts

Exogenous effects such as public health programs being taught in school and respondents having seen health warnings on cigarette packages also proved significant but not necessarily in the manner expected for health warnings. This was only able to be testing using the YSS data. Neither caused the risk perceptions variable to lose significance when added to models. Respondents being taught in school about the health effects of smoking meant that respondents were less likely to have smoked. On the other hand, we expected that respondents seeing health warning messages were less likely to have smoked. However, results showed that those students were actually more likely to have smoked a whole cigarette. This finding suggests that perhaps individuals are seeing warnings and

still smoking. Those who don't see the warnings are probably not picking up cigarette packages because they are not smoking.

Appendix 6A. Canadian YSS - Descriptive statistics of the dependent variable and the explanatory variables

Variable	Definition	Mean	Std. dev.
Dependent variable			
Log (quantitative risk perceptions)	Log of choice of pre-set responses to the number of Canadians that die each year due to cigarette smoking divided by the number of smokers in Canada	-5.483	1.406
Explanatory variables			
	Smoking behavior		
Smoked whole cigarette	Smoked a whole cigarette=1	0.129	0.336
	Socio-demographics		
Gender	Male=1	0.501	0.500
Grade 5	Grade 5=1	0.186	0.389
Grade 6	Grade 6=1	0.195	0.396
Grade 7	Grade 7=1	0.196	0.397
Grade 8	Grade 8=1	0.208	0.406
Grade 9	Grade 9=1	0.215	0.411
Quebec	Individuals who live in Quebec=1	0.170	0.375
	Economic independence from parents		
Weekly allowance	Receives weekly allowance=1	0.443	0.497
	Household structure characteristics		
Lives both parents	Lives with both parents=1	0.686	0.464
Lives one parent and partner	Lives with one natural parent and parent's spouse/partner=1	0.094	0.292
Lives one parent	Lives with one parent=1	0.126	0.331
Lives shared custody	Shared/other custody arrangement=1	0.030	0.171
Lives no answer	No response to living situation question=1	0.064	0.245
	Information sources – medical professionals		
Doctor asked if smoke yes	Doctor has asked if smoke or use smokeless tobacco=1	0.167	0.373
Doctor asked if smoke no	Doctor has not asked if smoke or use smokeless tobacco=1	0.820	0.384
Doctor asked if smoke NS	No response to doctor asked if smoke or use smokeless tobacco question=1	0.013	0.113
Dentist asked if smoke yes	Dentist has asked if smoke or use smokeless tobacco=1	0.051	0.219
Dentist asked if smoke no	Dentist has not asked if smoke or use smokeless tobacco=1	0.936	0.244
Dentist asked if smoke NS	No response to dentist asked if smoke or use smokeless tobacco question=1	0.013	0.113
Doctor talked health effects yes	Doctor has talked about the health effects of smoking or using smokeless tobacco=1	0.199	0.400
Doctor talked health effects no	Doctor has not talked about the health effects of smoking or using smokeless tobacco=1	0.787	0.409
Doctor talked health effects NS	No response to doctor talked about the health effects of smoking or using smokeless tobacco question=1	0.014	0.116
Dentist talked health effects yes	Dentist has talked about the health effects of smoking or using smokeless tobacco=1	0.094	0.292
Dentist talked health effects no	Dentist has not talked about the health effects of smoking or using smokeless tobacco=1	0.893	0.309

Dentist talked health effects NS	No response to dentist talked about the health effects of smoking or using smokeless tobacco question=1	0.013	0.113
	Interaction terms with information sources –medical professionals		
Weekly allowance * Doctor *asked* if smoke yes	Interaction term between receives weekly allowance and doctor asked if smoke or use smokeless tobacco	0.096	0.294
Weekly allowance * Dentist *talked health effects* yes	Interaction term between receives weekly allowance and dentist talked about the health effects of smoking or using smokeless tobacco	0.047	0.213
	Attitudes and beliefs about smoking		
Possible to become addicted	Think people can become addicted tobacco=1	0.888	0.315
Can quit when want	Think smokers can quit anytime they want=1	0.284	0.451
Smoke can cause nonsmokers harm	Think tobacco smoke can be harmful to the health of non-smokers=1	0.865	0.342
	Information sources – parents and household		
Only father smokes	Father smokes and mother does not=1	0.137	0.344
Father smokes DK	Does not know if father smokes=1	0.013	0.113
Only mother smokes	Mother smokes and father does not=1	0.087	0.282
Mother smokes DK	Mother does not smoke=1	0.008	0.090
Both parents smoke	Both parents smoke=1	0.135	0.342
Number of people who smoke in home	Number of people who smoke in the home = 0,1,2,3,4,5 (for 5 or more)	0.580	1.066
	Interaction terms with information sources - parents		
Gender * Father smokes DK	Interaction term between gender and if does not know if father smokes	0.007	0.082
Gender * Mother smokes DK	Interaction term between gender and if does not know if mother smokes	0.005	0.071
Weekly allowance * Mother smokes DK	Interaction term between receives weekly allowance and if does not know if mother smokes	0.003	0.051
	Information sources – peers		
Percent friends smoke	Percentage of friends who smoke (0% to 100%)	0.117	0.240

Appendix 6B. US NSDUH – Descriptive statistics of the dependent variable and the explanatory variables

Variable	Definition	Mean	Std. dev.
Dependent variable			
Risk perceptions	Risk of smoking 1 or more packs of cigarettes per day=no risk (1), slight risk (2), moderate risk (3), great risk (4)	3.591	0.670
Explanatory variables			
	Smoking behavior		
Smoked a cigarette	Smoked a cigarette=1	0.303	0.459
	Socio-demographics		
Gender	Male=1	0.510	0.500
Age	12 years=1, 13 years =2, 14 years =3, 15 years =4, 16 years =5, 17 years =6	3.507	1.685
White	Non-Hispanic White=1	0.641	0.480
Black Afr-Amer	Non-Hispanic Black/African American=1	0.134	0.341
Native American/AK Native	Non-Hispanic Native American/Alaska Native=1	0.016	0.125
Native HI/Pac Islands	Non-Hispanic Native Hawaiian/Pacific Islander=1	0.003	0.055
Asian	Non-Hispanic Asian=1	0.027	0.161
More than one race	Non-Hispanic more than one race=1	0.037	0.188
Hispanic	Hispanic=1	0.143	0.350
MSE over 1 million	Live in MSA (metropolitan statistical area) with fewer than 1 million or more persons=1	0.362	0.480
MSE under 1 million	Live in MSA with fewer than 1 million or more persons=1	0.354	0.478
Not in MSA	Does not live in a MSA=1	0.285	0.451
	Economic independence from parents		
Receive income from job	Receives income from job=1	0.252	0.434
	Socio-economics		
Family income	Total family income=1(less than $10,000), 2($10,000-$19,999), 3($20,000-$29,999), 4($30,000-$39,999), 5($40,000-$49,999), 6($50,000-$74,999), 7($75,000 or more)	4.801	1.970
	Household characteristics		
Two parent household	Lives with both parents=1	0.675	0.468
Number of under 18s in HH	Number of kids under age 18 in household=1,2,3,4	2.975	0.790
	Information sources – parents		
Parents talked dangers YES	In the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.602	0.489
Parents talked dangers NO	In the past 12 months, not talked with parents about dangers of tobacco, alcohol or drug use=1	0.390	0.488
Parents talked dangers DK	In the past 12 months, don't know if talked with parents about dangers of tobacco, alcohol or drug use=1	0.006	0.076
Refused parents talked dangers	Refused to answer if in the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.002	0.043
No answer parents talked dangers	No answer regarding if in the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.000	0.013
Feel parents neither approve	Feel parents would neither approve nor	0.045	0.208

nor disapprove of smoking	disapprove of you smoking one pack of cigarettes/day=1		
Feel parents somewhat disapprove of smoking	Feel parents would somewhat disapprove of you smoking one pack of cigarettes/day=1	0.048	0.213
Feel parents strongly disapprove of smoking	Feel parents would strongly disapprove of you smoking one pack of cigarettes/day=1	0.895	0.307
Parents feel about smoking DK	Don't know how parents would feel about you smoking one pack of cigarettes/day=1	0.010	0.099
Refused parents feel about smoking	Refused to answer how parents would feel about you smoking one pack of cigarettes/day=1	0.002	0.049
No answer parents feel about smoking	No answer to how parents would feel about you smoking one pack of cigarettes/day=1	0.000	0.013
	Information sources – relationship with parents		
Otherwise make do chores in house	Parents make youth do chores around the house in the past year - DK, Refused, No answer, Legitimate skip=1	0.003	0.056
Always or sometimes make do chores in house	Parents make youth do chores around the house in the past year – Always or sometimes=1	0.870	0.336
Seldom or never make do chores in house	Parents make youth do chores around the house in the past year – Seldom or never=1	0.127	0.333
Otherwise limit amount of TV	Parents limit the amount of TV in the past year - DK, Refused, No answer, Legitimate skip=1	0.004	0.066
Always or sometimes limit amount of TV	Parents limit the amount of TV in the past year - Always or sometimes=1	0.362	0.481
Seldom or never limit amount of TV	Parents limit the amount of TV in the past year - Seldom or never =1	0.633	0.482
Otherwise limit time out on school night	Parents limit time out on school night in the past year - DK, Refused, No answer, Legitimate skip=1	0.097	0.296
Always or sometimes limit time out on school nights	Parents limit time out on school night in the past year - Always or sometimes=1	0.621	0.485
Seldom or never limit time out on school nights	Parents limit time out on school night in the past year - Seldom or never=1	0.282	0.450
Otherwise check if homework done	Parents check if homework done in the past year - DK, Refused, No answer, Legitimate skip=1	0.090	0.286
Always or sometimes check if homework done	Parents check if homework done in the past year - Always or sometimes=1	0.722	0.448
Seldom or never check if homework done	Parents check if homework done in the past year - Seldom or never=1	0.188	0.391
Otherwise help with homework	Parents help with homework in the past year -DK, Refused, No answer, Legitimate skip	0.091	0.287
Always or sometimes help with homework	Parents help with homework in the past year - Always or sometimes=1	0.735	0.441
Seldom or never help with homework	Parents help with homework in the past year - Seldom or never=1	0.174	0.379
Otherwise tell proud of things done	Parents tell youth proud of something you'd done - DK, Refused, No answer, Legitimate skip	0.003	0.052
Always or sometimes tell proud of things done	Parents tell youth proud of something you'd done - Always or sometimes=1	0.850	0.357
Seldom or never tell proud of things done	Parents tell youth proud of something you'd done - Seldom or never=1	0.148	0.355
Otherwise tell done good job	Parents tell youth had done good job in the past year - DK, Refused, No answer, Legitimate skip	0.003	0.057
Always or sometimes tell done good job	Parents tell youth had done good job in the past year - Always or sometimes=1	0.858	0.349
Seldom or never tell done good job	Parents tell youth had done good job in the past year - Seldom or never=1	0.139	0.346
Otherwise argued with	Argued/had a fight with at least one of your	0.011	0.104

parent in past year	parents in past 12 months - DK, Refused, No answer, Legitimate skip=1		
Argued with parent 9 times or fewer in past year	Argued/had a fight with at least one of your parents in past 12 months – 9 or less times=1	0.746	0.435
Argued with parent 10+ times in past year	Argued/had a fight with at least one of your parents in past 12 months – 10 or more times=1	0.243	0.429
	Information sources – peers		
No stdnts smoke	No students in grade at school smoke cigarettes=1	0.126	0.331
Few stdnts smoke	A few students in grade at school smoke cigarettes=1	0.476	0.499
Most stdnts smoke	Most students in grade at school smoke cigarettes=1	0.281	0.450
All stdnts smoke	All students in grade at school smoke cigarettes=1	0.009	0.095
Stdnts smoke DK	Don't know if students in grade at school smoke cigarettes=1	0.020	0.138
Refused stdnts smoke	Refused if students in grade at school smoke cigarettes=1	0.001	0.036
No answer stdnts smoke	No answer if students in grade at school smoke cigarettes=1	0.005	0.072
Legite skip stdnts smoke	Legitimate skip if students in grade at school smoke cigarettes=1	0.082	0.274

Appendix 6C. Technical specifications of endogeneity tests and instrumentation procedure

Because of the difficulty in separating out the seemingly simultaneously defined process of risk perception development and direct experience with smoking, there is reason to believe that risk and smoking behavior have an endogenous relationship. To check for endogeneity, this analysis uses the conventional test of whether the residuals of a first estimation where smoking behavior (A_i) is the dependent variable are a significant covariate of the main model. The residual significantly predicting risk suggests the presence of an endogenous regressor. Instrumental variables that predict smoking but not risk perceptions correct for this endogeneity problem. Therefore in the two-stage model used, the instruments used were significant in the first regression but would not be significant when risk is the dependent variable. The F-test of the first model in the two-stage regression as well as Hansen J test values were used to assess the validity of chosen instruments. An F-test of the first stage over 10 with a p-value of 0.000 validates the appropriateness of chosen instruments. Similarly, when the p-values for the Sargan statistic become large, then the model rejects the null hypothesis that instruments are correlated with the error terms leading to the conclusion that instruments are well specified.

Endogeneity was found and instruments were used for all models using the Canadian data and the US data. A variety of instruments were tested for predicting smoking behavior but not risk perceptions. For the Canadian YSS, two instruments were used, both which reflect the ways adolescents spend their time thus constituting alternatives to smoking. These two instruments are whether respondents 'take part in clubs or groups such as Guides or Scouts, 4-H club, community, church or other religious groups' at least weekly and 'read for fun' at least monthly. Brown et al. (2006) also found that community social capital as expressed

by being involved in community organizations such as scouts or sports clubs to be significantly related to the number of cigarettes smokers smoke per month. These instruments could be viewed as substitute behaviors for adolescent smoking especially since all of these actions take place outside of class. Responses to these questions would not capture respondents' attitudes towards smoking risks or risks in general because they focus on how adolescents spend their time in activities that do not have any notion of risk attached to them. In other words, if the activities to be possibly substituted for smoking were skydiving or even rollerblading then respondents would be offering some expression about their preferences regarding risk. Since these instruments capture respondents' preferences regarding risk-less activities that offer alternatives to smoking, it makes intuitive sense that responses to these questions predict smoking behavior but not risk.

The instruments found for use with the US NSDUH fall into two categories. One has to do with respondent mental and emotional status as manifested through accessing medical services for emotional or behavioral conditions and the second functions more as a proxy for exposure to smoking as demonstrated from being home schooled. The first two instruments used come from the following questions with reference to the past 12 months,, 'did you receive treatment or counseling from a pediatrician or other family doctor for emotional or behavioral problems that were not caused by alcohol or drugs' and 'did you receive treatment or counseling at a mental health clinic or center because you had problems with your behavior or emotions that were not caused by alcohol or drugs.' Both questions had five responses of 'yes,' 'no,' 'don't know,' 'refused' and 'no answer.' Crucially, both of these questions exclude medical assistance due to alcohol or drug use, which could have caused respondents' perceptions of risks to influence their response. Individuals who answered yes to either of these questions were more likely to have smoked

a cigarette but responses did not have any determinative influence on perceptions of risk. Because these questions do not include elements that would capture respondents' attitudes towards risky situations they proved appropriate instruments for treating smoking behavior as endogenous.

A third instrument used for this dataset was motivated by the hypothesis that if adolescents are home schooled then they are less likely to have been introduced to smoking in their social setting since they do not attend a school with others their age (outside of their own family). Respondents who were home schooled were hypothesized to gain more information from their family members about smoking than their peers and therefore would not have been as exposed to smoking as their peers in school and thus less likely to initiate the behavior. Responses to the question 'have you been home-schooled at any time during the past 12 months' were shown to negatively predict adolescent smoking behavior and have no significant effect on risk perceptions about smoking thus offering a suitable instrument.

Appendix 6D. Canadian YSS - Simple model testing whether adolescents' smoking inside their home impacts risk perceptions

	Simple model	
	Coef.	z
Socio-demographics		
Gender	0.31	3.84
Grade 5	-0.52	-1.74
Grade 6	-0.58	-2.47
Grade 7	-0.21	-1.83
Grade 8	-0.16	-1.68
Quebec	-0.15	-1.73
Economic independence from parents		
Weekly allowance	-0.10	-1.25
Information sources – household setting		
Smoke inside home yes	0.08	0.97
F-stat	3.72 (0.000)	
R^2	0.026	
Number of observations	1,289	

Notes: All models include robust standard errors
[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-values

Models including whether respondents smoke inside the home found these variables to be insignificant (*Chapter 6* - **RQ2**). This could be because it is unclear whether these respondents are actually allowed to smoke in their homes or if they have to smoke secretly if they do. Therefore, these variables are poor proxies for parental approval and parental roles as information sources about smoking risks through the home environment they create.

Appendix 6E. Canadian YSS - Simple model testing whether adolescents' perceptions of how their parents feel about their smoking behavior impacts risk perceptions

	Simple model	
	Coef.	z
Socio-demographics		
Gender	0.34	4.15
Grade 5	-0.54	-1.74
Grade 6	-0.61	-2.44
Grade 7	-0.16	-1.36
Grade 8	-0.12	-1.28
Quebec	-0.15	-1.71
Economic independence from parents		
Weekly allowance	-0.05	-0.57
Information sources – perceptions of parental approval		
Father approves of child smoking	-0.78	-1.72
Father doesn't care if child smokes	0.20	1.26
Father doesn't like child smoking	-0.01	-0.04
Mother approves of child smoking	0.24	1.03
Mother doesn't care if child smokes	-0.03	-0.17
Mother doesn't like child smoking	-0.01	-0.04
F-stat	2.67 (0.000)	
R^2	0.034	
Number of observations	1,198	

Notes: All models include robust standard errors
[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-values

A simple model testing parental approval of child's smoking did not provide definitive results either. These results are not assumed to be conclusive because of the small sample size as these questions were asked of those classified as regular smokers. Characteristics of these respondents as a sub-sample of the entire survey population would presumably differ greatly from those not classified as smoking.

Only father's approval of child smoking was significant at the 10 percent level revealing a negative relationship between risk perceptions and father's approval of smoking. This is directionally consistent with findings from the NSDUH but the remaining expressions of

parental approval emerged as insignificant. Findings could differ between the NSDUH and the YSS for two reasons. First, the YSS asked about perceptions of parental approval for each parent individually whereas the NSDUH elicited a response regarding parents collectively. Whether parental influence is captured jointly or individually for each parent has been shown to make a difference in findings regarding adolescent smoking behaviors and could be doing so here (Tyas and Pederson 1998). Second, this question was only asked of a sub-sample of YSS respondents who were classified as regular smokers based upon smoking behavior questions. In effect, parental approval variables are being tested with different populations in the NSDUH (all respondents) and YSS (regular smokers) models. Not only could the small sample size of fewer than 1,200 observations be an issue in the YSS models but parental approval may also not matter as much once adolescents start to smoke. This result could point to parents' views playing a more definitive role in the decision to smoke rather than once the behavior has commenced.

Appendix 6F Canadian YSS - Determinants of risk perceptions about smoking-related mortality with variable about whether health professional (doctor, dentist) had talked to respondent about the health effects of smoking or using smokeless tobacco

	(1) Simple model with doctors and dentists		(2) Simple model with doctors and dentists (I.V.)		(3) Expanded model with parents and household		(4) Expanded model with parents and household (I.V.)	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior								
Smoked whole cigarette*	-0.02	-0.68	-0.01	-0.06	-0.06	-1.94	-0.18	-0.62
Socio-demographics								
Gender	0.18[a]	8.82	0.18[a]	8.58	0.18[a]	8.82	0.18[a]	8.49
Grade 5	-0.43[a]	-12.07	-0.43[a]	-6.66	-0.44[a]	-12.30	-0.47[a]	-6.28
Grade 6	-0.23[a]	-7.13	-0.23[a]	-3.95	-0.24[a]	-7.36	-0.27[a]	-3.93
Grade 7	-0.11[a]	-3.74	-0.12[b]	-2.49	-0.12[a]	-3.90	-0.14[a]	-2.64
Grade 8	-0.06	-1.96	-0.06	-1.71	-0.06[b]	-2.12	-0.07[b]	-1.98
Quebec	-0.08[a]	-2.83	-0.08	-1.94	-0.08[a]	-2.99	-0.07	-1.59
Economic independence from parents								
Weekly allowance	0.10[a]	4.89	0.10[a]	4.19	0.10[a]	4.56	0.10[a]	4.16
Information sources – medical professionals								
Doctor talked health effects yes	0.06[b]	2.18	0.06	1.96	0.06	1.98	0.06	1.94
Dentist talked health effects yes	0.10[a]	2.67	0.10[b]	2.59	0.09[b]	2.47	0.09[b]	2.39
Attitudes and beliefs about smoking								
Possible to become addicted	0.05	1.30	0.05	1.29	0.05	1.32	0.06	1.41
Can quit when want	-0.13[a]	-5.61	-0.13[a]	-5.63	-0.13[a]	-5.60	-0.13[a]	-5.56
Smoke can cause nonsmokers harm	0.30[a]	8.27	0.32[a]	8.57	0.30[a]	8.29	0.32[a]	8.57
Information sources – parents and household								
Only father smokes	-	-	-	-	0.08[a]	2.60	0.08[b]	2.56
Father smokes DK	-	-	-	-	0.17	1.72	0.19	1.82
Only mother smokes	-	-	-	-	0.12[a]	3.20	0.12[a]	3.12
Mother smokes DK	-	-	-	-	0.04	0.32	0.06	0.47
Both parents smoke			-	-	0.07	1.83	0.07	1.80
Number of people who smoke in home	-	-	-	-	0.03[b]	2.16	0.04	1.59
F-stat	37.67 (0.000)		37.71 (0.000)		28.61 (0.000)		28.45 (0.000)	
R^2	0.033		0.034		0.035		0.035	
Hansen j statistic	-		0.669 (0.413)		-		1.217 (0.270)	
Number of observations	18,297		18,119		18,287		18,109	

Notes: All models include robust standard errors

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly' when the column heading includes (I.V.)

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

Appendix 6G. US NSDUH – Robustness checks on determinants of risk perceptions of smoking-related physical harm including variables capturing parents as information sources about smoking risks

	(1) OLS regression model** (I.V.)		(2) Probit model*** (I.V.)		(3) Predicted 'Smoked a cigarette' in OLS regression** (I.V.)	
	Coef.	z	Coef.	z	Coef.	z
Smoking behavior						
Smoked a cigarette*	-0.05	-0.82	-0.08	-0.12	-0.12	-0.56
Socio-demographics						
Gender, Age, Ethnicity, Urban/Rural	Included		Included		Included	
Economic independence from parents						
Receive income from job	Included		Included		Included	
Socio-economics						
Family income	Included		Included		Included	
Household characteristics						
Two parents, Number of under 18s in household	Included		Included		Included	
Information sources – parents						
Parents talked dangers NO	-0.01 [a]	-3.24	-0.10 [a]	-3.12	-0.01 [b]	-2.14
Feel parents somewhat disapprove of smoking	0.05 [a]	3.36	0.32 [a]	3.01	0.04 [a]	3.46
Feel parents strongly disapprove of smoking	0.10 [a]	6.06	0.70 [a]	5.40	0.10 [a]	5.30
Information sources – relationship with parents						
Parents check homework, limit TV, make do chores, etc.	Included		Included		Included	
F-stat	16.04 (0.000)		-		16.72 (0.000)	
Pseudo/Centered R^2	0.055		-		0.092	
Wald χ^2	-		624.98		-	
Log pseudolikelihood	-		-13625.2		-	
Hansen j statistic	2.646 (0.266)		-		3.127 (0.209)	
Number of observations	17,983		17,983		17,983	

Notes: All models include robust standard errors.

(*) Instrumented using questions asking respondents about during the past 12 months, 'did you receive treatment or counseling from a pediatrician or other family doctor for emotional or behavioral problems not caused by alcohol or drugs,' 'did you receive treatment or counseling at a mental health clinic or center because you had problems with your behavior or emotions not caused by alcohol' and 'have you been home-schooled at any time during the past 12 months?' when the column heading includes (I.V.)

(**)Dependent variable is expressed as a continuous variable by converting Likert scale to values between 0 and 1. Therefore, 'great risk' = 1 and 'no risk' =0 with 'slight risk'=0.5 and 'moderate risk'=0.75. Example calculation for slight risk, slight risk=2 on Likert scale and great risk=4 on Likert scale so value for slight risk is 2/4=0.5.

(***) Dependent variable is expressed as if perceive smoking one pack a day to be a great risk or moderate risk=1 and if perceive risks of smoking one pack a day as no risk or a slight risk then 0.'

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

Column (1) shows results of a regression where a continuous version of the risk perceptions variable is used as the dependent variable. Instruments were used to correct for endogeneity present in the 'smoked a cigarette' variable. Findings here support the results in the previous table suggesting that risk perceptions drive smoking behavior but smoking behavior does not significantly determine risk perceptions. The same findings holds true in the models presented in columns (2) and (3). Column (2) shows results from a model where the dependent variable has been turned into a binary form where the response is '1' if the respondent perceives smoking one pack a day of great or moderate risk and '0' if slight or no risk. Column (3) shows results using the continuous risk perceptions variable from column (1) in an instrumented model with a predicted version of the 'smoked a cigarette' variable.

Appendix 6H. Determinants of risk perceptions – findings regarding control and explanatory variables

Summary table of directions for control and explanatory variables

	Canada – YSS	US - NSDUH
	Risk perceptions	*Risk perceptions*
	Smoking behavior	
Smoked whole cigarette/a cigarette	None	None
	Socio-demographics	
Gender (male =1)	Positive	Negative
Age	Positive	Positive
Quebec (relative to other provinces)	Negative	-
Black Afr-Amer	-	None
Native American/AK Native	-	None
Native HI/Pac Islands	-	None
Asian	-	None
More than one race	-	None
Hispanic	-	None
MSE under 1 million	None	-
Not in MSA	None	-
	Economic independence from parents	
Weekly allowance	Positive	-
Receive income from job	-	None
	Socio-economics	
Family income	-	Positive
	Attitudes and beliefs about smoking	
Possible to become addicted	None	-
Can quit when want	Negative	-
Smoke can cause nonsmokers harm	Positive	-
	Household characteristics	
Two parent household	Negative	None
Number of under 18s in household	-	Negative

Note: Only those relationships with significance of 10% or greater are reported here as being positive or negative. Those of less than 10% significance are denoted by 'none.'
'-' means that this variable is not included in the dataset

Gender

Findings regarding gender from both datasets say something about the surveys used and not simply the impact of gender on smoking behavior. The YSS models demonstrated that males were more likely to have higher risk perceptions while the NSDUH models reached the opposite conclusion. The difference in results between the YSS and NSDUH could be due to the young age of the YSS respondents. In general, women are viewed to be more risk averse than men (Savage 1993; Slovic 1999; Dohmen et al. 2005) especially in health-

related matters (Finucane et al. 2000; Slovic 1987) and smoking (Liu and Hsieh 1995; Lundborg and Andersson 2007; Viscusi 1991) thus supporting the results of the NSDUH models.

The NSDUH includes 12-17 year olds whereas the YSS has 10-15 year olds so the average respondent age is two years higher with the NSDUH. Perhaps at the age of 10 to 15 years, adolescents have not yet started to develop gender-specific perceptions of risk and thus behaviors that reflect these perceptions of risk. Instead the concept of females being more concerned about risky situations could develop over time through adoption of social and environmental norms. Findings from the NSDUH support other studies looking at adolescents' risk perceptions about smoking, which found that females had higher risk perceptions than males looking at a respondent population from 12-18 years (Lundborg and Lindgren 2004) and 15-18 years (Lundborg 2007; Lundborg and Andersson 2007).

Age

Age was found to be significantly and positively related to risk perceptions in models for both surveys. This could be interpreted as saying that as respondents have more direct and indirect experience with smoking as well as receive more information about smoking through a variety of sources simply as a function of getting older, adolescents perceive risks as greater. As the ages of respondents are within a very narrow spectrum, 5 years for both surveys, the fact that this variable is significant denotes the major shift in risk perceptions accompanying age changes in adolescence. This finding highlights how crucial these years are for adolescents amending how they perceive smoking risks. However, it does not support those findings of previous work examining adolescents' risk perceptions about smoking, which found that risk perceptions were higher for younger age groups (Lundborg and Lindgren 2004; Lundborg 2007). Ma et al. (2006) found no association between age or

education level and risk perceptions positing that conveying the risks of smoking to their population sample (Korean adults) may pose more difficulties informing other populations about risks. Therefore, we could say that this analysis points to adolescents holding risk perceptions that can be influenced over time as age proves a significant predictor of risk perceptions.

Province of residence

Being a resident of Quebec was negatively related to risk perceptions, therefore living in an environment with relatively high smoking prevalence in comparison to the rest of Canadian provinces means that respondents are more likely to have lower risk perceptions about smoking. This finding proves interesting given that parents' smoking behavior in a respondent's environment had a positive effect. Therefore, it appears that broader social behaviors have a different impact on adolescents' risk perceptions than the behavior of individuals adolescents personally know. This concept will be further explored in Chapter 6, which covers peer and environmental effects.

Ethnicity and urban vs. rural setting

Neither ethnicity nor whether a respondent lives in an urban or rural setting had a significant determinative impact on risk perceptions.

Economic independence from parents

Results regarding whether adolescents having their own disposable income coming from either a job or a weekly allowance were mixed. For the YSS models, there was a positive and significant relationship between weekly allowance and risk perceptions while the relationship was not significant for the NSDUH models.

Income

The finding with regards to higher family income from the NSDUH models predicting higher risk perceptions could be capturing other characteristics of individuals attached to

financial status such as exposure to more sources of information and being less likely to smoke in general.

Attitudes and beliefs about smoking

Findings from this study about the impact on beliefs on risk perceptions regarding smoking support previous work demonstrating that beliefs about smoking matter in determining perceptions about smoking (Antoñanzas et al. 2000) and more generally, that belief about any topic impacts how individuals perceive the risks associated with that topic (Weinstein 1999).

The fact that the variable capturing whether respondents thought it was 'possible to be addicted' to smoking was not a significant predictor of risk perceptions may be demonstrate that adolescents view dangers of smoking within a short time frame. Previous literature has highlighted adolescents' lack of acknowledgement about the likelihood of becoming addicted to cigarettes (Cohn et al. 1995; Lynch et al. 1994). Adolescents might not even think yet about the addictive aspects of smoking and could be more focused on the immediate dangers potentially faced in the near term.

Household characteristics

Whether a respondent lives in a two–parent household was also not significant for the NSDUH models and negatively related to risk perceptions in the YSS models, which differs from Lundborg's (2007) finding that those adolescents' who live with both parents have higher risk perceptions than those living with one parent. However, the number of individuals under the age of 18 who live in the respondent's house was negatively and significantly related to risk perceptions in the NSDUH models. This finding could be because respondents with more siblings or other individuals under 18 years are more likely to see individuals close to their age smoking than those without many siblings (or

individuals under 18) and therefore attach less risk to smoking by viewing this behavior as acceptable.

Appendix 7A. Canadian YSS - Descriptive statistics of the dependent variable and the explanatory variables

Variable	Definition	Mean*	Std. dev.*
Dependent variable			
Log (quantitative risk perceptions)	Log of choice of pre-set responses to the number of Canadians that die each year due to cigarette smoking divided by the number of smokers in Canada	-5.480	1.396
Explanatory variables			
	Smoking behavior		
Smoked whole cigarette	Smoked a whole cigarette=1	0.135	0.342
	Socio-demographics		
Gender	Male=1	0.493	0.500
Grade 5	Grade 5=1	0.179	0.383
Grade 6	Grade 6=1	0.191	0.393
Grade 7	Grade 7=1	0.198	0.398
Grade 8	Grade 8=1	0.211	0.408
Grade 9	Grade 9=1	0.222	0.415
Province New Foundland and Labrador	Individual lives in New Foundland and Labrador =1	0.085	0.279
Province Prince Edward Island	Individual lives in Prince Edward Island=1	0.057	0.231
Province Nova Scotia	Individual lives in Nova Scotia=1	0.096	0.294
Province New Brunswick	Individual lives in New Brunswick=1	0.086	0.281
Province Quebec	Individual lives in Quebec=1	0.167	0.373
Province Ontario	Individual lives in Ontario=1	0.136	0.343
Province Manitoba	Individual lives in Manitoba=1	0.080	0.271
Province Saskatchewan	Individual lives in Saskatchewan=1	0.091	0.288
Province Alberta	Individual lives in Alberta=1	0.076	0.265
Province British Columbia	Individual lives in British Columbia=1	0.126	0.332
Weekly allowance	Receives weekly allowance=1	0.456	0.498
	Attitudes and beliefs about smoking		
Possible to become addicted	Yes, people can become addicted to tobacco=1	0.899	0.302
Can quit when want	Yes, smokers can quit anytime they want=1	0.280	0.449
Smoke can cause nonsmokers harm	Yes, tobacco smoke can be harmful to the health of non-smokers=1	0.876	0.330
	Household structure characteristics		
Lives both parents	Lives with both parents=1	0.688	0.463
Lives one parent and partner	Lives with one natural parent and parent's spouse/partner=1	0.094	0.292
Lives one parent	Lives with one parent=1	0.124	0.330
Lives shared custody	Shared/other custody arrangement=1	0.031	0.172
Lives no answer	No response to living situation question=1	0.064	0.244
	Information sources – medical professionals		
Doctor asked if smoke yes	Doctor has asked if smoke or use smokeless tobacco=1	0.168	0.374
Doctor asked if smoke no	Doctor has not asked if smoke or use smokeless tobacco=1	0.820	0.384
Doctor asked if smoke NS	No response to doctor asked if smoke or use smokeless tobacco question=1	0.012	0.108
Dentist asked if smoke yes	Dentist has asked if smoke or use smokeless	0.049	0.217

	tobacco=1		
Dentist asked if smoke no	Dentist has not asked if smoke or use smokeless tobacco=1	0.938	0.241
Dentist asked if smoke NS	No response to dentist asked if smoke or use smokeless tobacco question=1	0.012	0.110
	Information sources – parents and household		
Only father smokes	Father smokes and mother does not=1	0.140	0.347
Father smokes DK	Does not know if father smokes=1	0.012	0.109
Only mother smokes	Mother smokes and father does not=1	0.089	0.285
Mother smokes DK	Mother does not smoke=1	0.007	0.084
Both parents smoke	Both parents smoke=1	0.138	0.345
Number of people who smoke in home	Number of people who smoke in the home = 0,1,2,3,4,5 (for 5 or more)	0.591	1.065
	Information sources – peers		
Number of close friends smoke	Number of close friends that smoke=write-in value (0,1,2,...30)	1.158	3.104
Percent friends smoke	Percentage of friends who smoke (0% to 100%)	0.117	0.240
	Information sources – population level smoking behavior		
Provincial smoking prevalence**	Percentage of province population that are currently smokers (0% to 100%)	0.199	0.027

* Values for subset that excludes those individuals who do not provide an answer for 'number of people who smoke in home' and 'number of close friends smoke'

** From Canadian Tobacco Use Monitoring Survey (CTUMS)

Appendix 7B. US NSDUH – Descriptive statistics of the dependent variable and the explanatory variables

Variable	Definition	Mean	Std. dev.
Dependent variable			
Risk perceptions	Risk of smoking 1 or more packs of cigarettes per day=no risk (1), slight risk (2), moderate risk (3), great risk (4)	3.591	0.670
Explanatory variables			
	Smoking behavior		
Smoked a cigarette	Smoked a cigarette=1	0.303	0.459
	Socio-demographics		
Gender	Male=1	0.510	0.500
Age	12 years=1, 13 years =2, 14 years =3, 15 years =4, 16 years =5, 17 years =6	3.507	1.685
White	Non-Hispanic White=1	0.641	0.480
Black Afr-Amer	Non-Hispanic Black/African American=1	0.134	0.341
Native American/AK Native	Non-Hispanic Native American/Alaska Native=1	0.016	0.125
Native HI/Pac Islands	Non-Hispanic Native Hawaiian/Pacific Islander=1	0.003	0.055
Asian	Non-Hispanic Asian=1	0.027	0.161
More than one race	Non-Hispanic more than one race=1	0.037	0.188
Hispanic	Hispanic=1	0.143	0.350
MSE over 1 million	Live in MSA (metropolitan statistical area) with fewer than 1 million or more persons=1	0.362	0.480
MSE under 1 million	Live in MSA with fewer than 1 million or more persons=1	0.354	0.478
Not in MSA	Does not live in a MSA=1	0.285	0.451
	Socio-economics		
Receive income from job	Receives income from job=1	0.252	0.434
Family income	Total family income=1(less than $10,000), 2($10,000-$19,999), 3($20,000-$29,999), 4($30,000-$39,999), 5($40,000-$49,999), 6($50,000-$74,999), 7($75,000 or more)	4.801	1.970
	Household characteristics		
Two parent household	Lives with both parents=1	0.675	0.468
Number of under 18s in HH	Number of kids under age 18 in household=1,2,3,4	2.975	0.790
	Information sources – peers		
No stdnts smoke	No students in grade at school smoke cigarettes=1	0.126	0.331
Few stdnts smoke	A few students in grade at school smoke cigarettes=1	0.476	0.499
Most stdnts smoke	Most students in grade at school smoke cigarettes=1	0.281	0.450
All stdnts smoke	All students in grade at school smoke cigarettes=1	0.009	0.095
Stdnts smoke DK	Don't know if students in grade at school smoke cigarettes=1	0.020	0.138
Refused stdnts smoke	Refused if students in grade at school smoke cigarettes=1	0.001	0.036
No answer stdnts smoke	No answer if students in grade at school smoke cigarettes=1	0.005	0.072
Legite skip stdnts smoke	Legitimate skip if students in grade at school smoke cigarettes=1	0.082	0.274
Feel friends neither approve	Feel friends would neither approve nor disapprove	0.147	0.354

nor disapprove of smoking	of you smoking one or more packs of cigarettes/day=1		
Feel friends somewhat disapprove of smoking	Feel friends would somewhat disapprove of you smoking one or more packs of cigarettes/day=1	0.190	0.392
Feel friends strongly disapprove of smoking	Feel friends would strongly disapprove of you smoking one or more packs of cigarettes/day=1	0.652	0.476
Friends feel about smoking DK	Don't know how friends would feel about you smoking one pack of cigarettes/day=1	0.009	0.097
Refused friends feel about smoking	Refused to answer how friends would feel about you smoking one or more packs of cigarettes/day=1	0.002	0.043
No answer friends feel about smoking	No answer to how friends would feel about you smoking one or more packs of cigarettes/day=1	0.000	0.013
	Information sources – parents		
Parents talked dangers YES	In the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.602	0.489
Parents talked dangers NO	In the past 12 months, not talked with parents about dangers of tobacco, alcohol or drug use=1	0.390	0.488
Parents talked dangers DK	In the past 12 months, don't know if talked with parents about dangers of tobacco, alcohol or drug use=1	0.006	0.076
Refused parents talked dangers	Refused to answer if in the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.002	0.043
No answer parents talked dangers	No answer regarding if in the past 12 months, talked with parents about dangers of tobacco, alcohol or drug use=1	0.000	0.013
Feel parents neither approve nor disapprove of smoking	Feel parents would neither approve nor disapprove of you smoking one pack of cigarettes/day=1	0.045	0.208
Feel parents somewhat disapprove of smoking	Feel parents would somewhat disapprove of you smoking one or more packs of cigarettes/day=1	0.048	0.213
Feel parents strongly disapprove of smoking	Feel parents would strongly disapprove of you smoking one or more packs of cigarettes/day=1	0.895	0.307
Parents feel about smoking DK	Don't know how parents would feel about you smoking one or more packs of cigarettes/day=1	0.010	0.099
Refused parents feel about smoking	Refused to answer how parents would feel about you smoking one or more packs of cigarettes/day=1	0.002	0.049
No answer parents feel about smoking	No answer to how parents would feel about you smoking one or more packs of cigarettes/day=1	0.000	0.013

Appendix 7C. Canadian YSS - Determinants of risk perceptions about smoking-related mortality including peer effects expressed as percentage of friends who smoke and individual province dummies

	(1) Simple model with percent of friends that smoke		(2) Simple model with percent of friends that smoke (I.V.)		(3) Expanded model including *doctors and dentists asking about smoking parents' smoking behavior*		(4) Expanded model including *doctors and dentists asking about smoking parents' smoking behavior* (I.V.)		(5) Expanded model with only *respondents in grade 7 and below*		(6) Expanded model with only *respondents in grade 8 and above*	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Smoking behavior												
Smoked whole cigarette*	-0.01	-0.23	-0.49	-1.01	-0.04	-1.08	-0.82	-1.47	-0.07	-0.05	-1.02	-1.88
Controls - socio-demographics and economic independence from parents												
Gender, grade, province, weekly allowance	Included		Included		Included		Included		Included		Included	
Household structure characteristics												
Living arrangement – both parents, one parent, etc.	Included		Included		Included		Included		Included		Included	
Attitudes and beliefs about smoking												
Addiction, quitting, smoke causing harm	Included		Included		Included		Included		Included		Included	
Information sources – medical professionals												
Doctor asked if smoke yes	-	-	-	-	0.07 [a]	2.29	0.09 [a]	2.65	0.13 [a]	2.56	0.07	1.62
Dentist asked if smoke yes	-	-	-	-	-0.05	-0.96	-0.02	-0.35	-0.14	-1.55	0.07	0.87
Information sources – parents and household												
Only father smokes	-	-	-	-	0.09 [a]	2.80	0.09 [a]	2.75	0.10 [b]	2.13	0.10	1.93
Only mother smokes	-	-	-	-	0.09 [a]	2.37	0.11 [a]	2.59	0.11	1.94	0.13 [b]	2.00
Both parents	-	-	-	-	0.06	1.39	0.06	1.48	0.08	1.49	0.04	0.65

smoke Number of people who smoke in home	-	-	-	-	0.04 [a]	3.30	0.07 [a]	3.13	0.05	1.44	0.08 [b]	2.35
Information sources – friends												
Percent close friends smoke	-0.01	-0.12	0.30	0.97	-0.06	-1.03	0.39	1.21	0.01	0.01	0.54	1.62
F-stat	23.73 (0.000)		23.63 (0.000)		18.23 (0.000)		17.87 (0.000)		9.67 (0.000)		7.43 (0.000)	
R^2	0.037		0.028		0.040		0.015		0.036		-	
Sargan	-		1.228 (0.268)		-		1.794 (0.180)		1.692 (0.193)		0.201 (0.654)	
Number of observations	16,214		16,068		16,212		16,066		8,983		7,083	

(*) Instrumented using questions about whether respondents 'take part in clubs or groups such as Guides or Scouts , 4-H club, community, church or other religious groups,' at least weekly and 'read for fun' at least monthly.

[a] Significant at 1% [b] Significant at 5%

Numbers in parentheses are p-values

Appendix 7D. Canadian YSS - Determinants of risk perceptions about smoking-related mortality with population sub-samples according to smoking behavior using *percent of close friends* that smoke to represent peer effects

	(1) Expanded model with *province dummies* and sub-sample who *have not* smoked a whole cigarette		(2) Expanded model with *province dummies* and sub-sample who *have* smoked a whole cigarette		(3) Expanded model with *provincial smoking prevalence* and sub-sample who *have not* smoked a whole cigarette		(8) Expanded model with *provincial smoking prevalence* and sub-sample who *have* smoked a whole cigarette	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Controls – socio-demographics and economic independence from parents								
Gender, grade, *province*, weekly allowance	Included		Included		-		-	
Gender, grade, weekly allowance	-		-		Included		Included	
Household structure characteristics								
Living arrangement – both parents, one parent, etc.	Included		Included		Included		Included	
Attitudes and beliefs about smoking								
Addiction, quitting, smoke causing harm	Included		Included		Included		Included	
Information sources – medical professionals								
Doctor, dentist asked if smoke	Included		Included		Included		Included	
Information sources – parents and household								
Father, mother, household smoking behaviors	Included		Included		Included		Included	
Information sources – friends								
Percent close friends smoke	-0.08	-1.08	-0.02	-0.20	-0.08	-1.20	-0.02	-0.21
Information sources - population level smoking behavior								
Provincial smoking prevalence	-	-	-	-	-1.44 [a]	-3.44	-2.35	-1.83
F-stat	16.68 (0.000)		4.54 (0.000)		20.22 (0.000)		4.80 (0.000)	
R^2	0.041		0.045		0.039		0.038	
Number of observations	14,029		2,183		14,029		2,183	

[a] Significant at 1%

Numbers in parentheses are p-values

Appendix 7E. US NSDUH – Discussion of results regarding control and explanatory variables in Table 38

As in Chapter 6, the smoking behavior variable expressing whether respondents had smoked a cigarette is significant when expressed as an exogenous variable. When significant, a respondent having smoked a cigarette appears to a have a negative relationship with risk perceptions suggesting that those who smoke perceive the risks of smoking to be lower. However, when instruments are used to correct for this variable being endogenous, smoking a cigarette becomes an insignificant predictor of risk perceptions and changes sign to positive.

Also similar to results presented in Chapter 6, being from a major ethnic group such as being black, Hispanic or Asian relative to being white displayed no significant relationship with risk perceptions in the instrumented models. When the smoking behavior variable is treated as exogenous, only being black was a significant predictor risk perceptions. Being female was positively and significantly related to risk perceptions in all models while age appears positively related to risk perceptions at the 10% level in the instruments models and at the 1% level in the non-instrumented ones. The positive sign on the age variable means that as respondents get older and presumably have been around smoking more, then risk perceptions about smoking get higher. The more individuals under eighteen years (presumably siblings) in a respondent's household, the lower risk perceptions are likely to be.

Parents talking to their children about the dangers associated with smoking again emerged as negatively and significantly related to smoking risk perceptions. As was the case with respondents' perceptions of what their friends think about smoking, respondents'

perceptions of what their parents think about smoking also appear to be significantly and positively related to risk perceptions.

Appendix 7F. US NSDUH – Robustness checks on determinants of risk perceptions of smoking-related physical harm including variables capturing peers as information sources about smoking risks

	(1) OLS regression model** (I.V.)		(2) Probit model*** (I.V.)		(3) Predicted 'Smoked a cigarette' in OLS regression** (I.V.)	
	Coef.	z	Coef.	z	Coef.	z
Smoking behavior						
Smoked a cigarette*	-0.01	-0.16	0.12	0.70	0.01	0.05
Socio-demographics						
Gender, Age, Ethnicity, Urban/Rural	Included		Included		Included	
Economic independence from parents						
Receive income from job	Included		Included		Included	
Socio-economics						
Family income	Included		Included		Included	
Household characteristics						
Two parents, Number of under 18s in household	Included		Included		Included	
Information sources – peers						
Few stdnts smoke	0.00	0.24	0.07	0.91	0.00	0.06
Most stdnts smoke	0.00	0.11	0.01	0.08	0.00	-0.10
All stdnts smoke	-0.01	-0.37	-0.29	-1.35	-0.01	-0.54
Stdnts smoke DK	0.01	1.31	0.16	1.12	0.01	1.33
Feel friends somewhat disapprove of smoking	0.02 [b]	2.01	0.21 [a]	2.65	0.02 [b]	2.17
Feel friends strongly disapprove of smoking	0.05 [a]	3.20	0.42 [a]	2.77	0.06 [a]	3.12
Information sources – parents						
Parents talked dangers NO	-0.01 [a]	-3.35	-0.11 [a]	-3.69	-0.01 [b]	-1.98
Feel parents somewhat disapprove of smoking	0.04 [b]	2.44	0.23	1.89	0.04 [a]	2.78
Feel parents strongly disapprove of smoking	0.09 [a]	6.96	0.57 [a]	7.39	0.09 [a]	6.40
F-stat	24.24 (0.000)		-		24.13 (0.000)	
Pseudo/Centered R^2	0.065		-		0.059	
Wald χ^2	-		714.69 (0.000)		-	
Log pseudolikelihood	-		-13,094.41		-	
Hansen j statistic	2.354 (0.308)		-		2.455 (0.293)	
Number of observations	17,983		17,983		17,983	

Notes: All models include robust standard errors.

(*) Instrumented using questions asking respondents about during the past 12 months, 'did you receive treatment or counseling from a pediatrician or other family doctor for emotional or behavioral problems not caused by alcohol or drugs,' 'did you receive treatment or counseling at a mental health clinic or center because you had problems with your behavior or emotions not caused by alcohol' and 'have you been home-schooled at any time during the past 12 months?' when the column heading includes (I.V.)

(**)Dependent variable is expressed as a continuous variable by converting Likert scale to values between 0 and 1. Therefore, 'great risk' = 1 and 'no risk' =0 with 'slight risk'=0.5 and 'moderate risk'=0.75. Example calculation for slight risk, slight risk=2 on Likert scale and great risk=4 on Likert scale so value for slight risk is 2/4=0.5.

(***) Dependent variable is expressed as if perceive smoking one pack a day to be a great risk or moderate risk=1 and if perceive risks of smoking one pack a day as no risk or a slight risk then 0.'

[a] Significant at 1% [b] Significant at 5%
Numbers in parentheses are p-values

Column (1) shows results of a regression where a continuous version of the risk perceptions variable is used as the dependent variable. Instruments were used to correct for endogeneity present in the 'smoked a cigarette' variable. Findings here support the results in the previous table suggesting that classmates' smoking does not significantly determine respondents' risk perceptions but perceptions of friends' attitudes about smoking does. The same findings holds true in the models presented in columns (2) and (3). Column (2) shows results from a model where the dependent variable has been turned into a binary form where the response is '1' if the respondent perceives smoking one pack a day of great or moderate risk and '0' if slight or no risk. Column (3) shows results using the continuous risk perceptions variable from column (1) in an instrumented model with a predicted version of the 'smoked a cigarette' variable.

Appendix 8A. Canadian YSS - Descriptive statistics of the dependent variable and the explanatory variables

Variable	Definition	Mean	Std. dev.
Dependent variable			
Log (quantitative risk perceptions)	Log of choice of pre-set responses to the number of Canadians that die each year due to cigarette smoking divided by the number of smokers in Canada	-5.483	1.406
Explanatory variables			
	Smoking behavior		
Smoked whole cigarette	Smoked a whole cigarette=1	0.130	0.336
	Socio-demographics		
Gender	Male=1	0.501	0.500
Grade 5	Grade 5=1	0.186	0.389
Grade 6	Grade 6=1	0.195	0.397
Grade 7	Grade 7=1	0.196	0.397
Grade 8	Grade 8=1	0.208	0.406
Grade 9	Grade 9=1	0.214	0.410
Province Quebec	Individual lives in Quebec =1	0.170	0.375
	Economic independence from parents		
Weekly allowance	Receives weekly allowance=1	0.442	0.497
	Attitudes and beliefs about smoking		
Possible to become addicted	Think people can become addicted tobacco=1	0.888	0.315
Can quit when want	Think smokers can quit anytime they want=1	0.284	0.451
Smoke can cause nonsmokers harm	Think tobacco smoke can be harmful to the health of non-smokers=1	0.865	0.342
	Knowledge about smoking risks		
Number of smoking-related health problems identify	Number of health problems people can get if they smoke for many years= write-in (0,1,2…8)	2.405	1.498
	Information sources – health warning messages		
Number of valid health warnings remember	Number of valid health warnings can remember= write-in (0,1,2...8)	1.600	1.320
Ever look at health warnings YES	Looks at health warning messages on cigarette packages at least less than once a week=1	0.700	0.458
Believe health warnings YES	Believes in health warnings that see on cigarette packages=1	0.895	0.307
Believe health warnings NO	Does not believe in health warnings that see on cigarette packages=1	0.019	0.138
Believe health warnings DK	Does not know if believe in health warnings that see on cigarette packages=1	0.053	0.224
Believe health warnings NS	Not response to if believe in health warnings that see on cigarette packages=1	0.033	0.178
	Information sources – school setting		
No school rules about smoking	Does not think school has any rules about smoking=1	0.057	0.232
Can smoke in some areas of school	On school property, smoking is allowed only in some areas=1	0.164	0.371
No smoking allowed at school	Smoking is not allowed anywhere on school property=1	0.620	0.485
Don't know school smoking rules	Does not know what school rules are about smoking=1	0.149	0.356
School smoking rules NS	No answer to what school rules are about smoking=1	0.010	0.101

Information sources – school public health efforts			
Taught in school about health problems related to smoking YES	Taught in school about health problems related to smoking=1	0.774	0.418
Taught in school about health problems related to smoking NO	Not taught in school about health problems related to smoking=1	0.112	0.316
Taught in school about health problems related to smoking DK	Don't know if taught in school about health problems related to smoking=1	0.101	0.302
Taught in school about health problems related to smoking NS	No response to if taught in school about health problems related to smoking=1	0.013	0.111
Information sources – medical professionals			
Doctor asked if smoke yes	Doctor has asked if smoke or use smokeless tobacco=1	0.167	0.373
Doctor asked if smoke no	Doctor has not asked if smoke or use smokeless tobacco=1	0.819	0.385
Doctor asked if smoke NS	No response to doctor asked if smoke or use smokeless tobacco question=1	0.014	0.118
Dentist asked if smoke yes	Dentist has asked if smoke or use smokeless tobacco=1	0.051	0.219
Dentist asked if smoke no	Dentist has not asked if smoke or use smokeless tobacco=1	0.935	0.246
Dentist asked if smoke NS	No response to dentist asked if smoke or use smokeless tobacco question=1	0.014	0.118
Information sources – parents and household			
Only father smokes	Father smokes and mother does not=1	0.137	0.344
Father smokes DK	Does not know if father smokes=1	0.013	0.112
Only mother smokes	Mother smokes and father does not=1	0.087	0.282
Mother smokes DK	Mother does not smoke=1	0.008	0.089
Both parents smoke	Both parents smoke=1	0.135	0.342
Number of people who smoke in home	Number of people who smoke in the home = 0,1,2,3,4,5 (for 5 or more)	0.994	6.458
Household structure characteristics			
Lives both parents	Lives with both parents=1	0.686	0.464
Lives one parent and partner	Lives with one natural parent and parent's spouse/partner=1	0.094	0.292
Lives one parent	Lives with one parent=1	0.126	0.331
Lives shared custody	Shared/other custody arrangement=1	0.030	0.172
Lives no answer	No response to living situation question=1	0.064	0.245
Information sources – peers			
Number of close friends smoke	Number of close friends that smoke=write-in value (0,1,2,...30)	1.158	3.104
Information sources – population level smoking behavior			
Provincial smoking prevalence**	Percentage of province population that are currently smokers (0% to 100%)	0.199	0.027

Appendix 9A. Environmental smoking tobacco policy in Canada and the US

While the goal of reducing environmental smoking is set as a priority at the national or federal level, states and provinces play the greater role in furthering this policy goal because of individual campaigns aimed at wider dissemination about the risks of parental and household smoking. For example, the British Columbia Tobacco Control encourages smoke-free homes to protect infants and children by disseminating more information about secondhand smoke risks (British Columbia Ministry of Health Services 2004). The US does operate a national level initiative to reduce smoking in the home that is a joint activity between the Environmental Protection Agency and the Department of Health and Human Services. 'Care for the Air' is a program for Head-Start families[39] started mainly to reduce asthma rates among children in these households where 20% of Head Start children with asthma are exposed to smoke at home. The program uses videos, information packs and events to inform parents about the dangers with all materials available in English and Spanish (EPA 2007).

In the US, organizations such as 'Smoke Free Homes' (funded partly by the CDC) play crucial roles by bringing together the medical field (especially pediatricians), health promotion workers and public health policy makers to develop best practices in the area. 'Not in Momma's Kitchen' (funded partly by the EPA) is another example of an organization aimed at preventing parents smoking at home specifically focusing on African American households (Not in Momma's Kitchen 2007). Many states have used the specific strengths of these kinds of organizations to run short courses or help design and implement initiatives.

[39] The Head Start program helps economically disadvantaged pre-school aged children get ready for school by improving math and reading skills.

Appendix 9B. Economic factors and risk perceptions

Findings in this thesis suggest that economic factors affect adolescents' smoking behaviors and risk perceptions about smoking. Respondents having a weekly allowance (YSS models) and receiving income from a job (NSDUH models) demonstrated that economic independence from parents has a positive relationship with likelihood of smoking. The NSDUH also had a measure for family income, which emerged as having a negative relationship with smoking not only supporting previous research by reaching the same conclusion (Lowry et al. 1996; Scarinci et al. 2002; Unger et al. 2000) but also establishing a difference in relationship between families versus adolescents having money and likelihood of smoking. Economic independence of adolescents in the form of weekly allowance or income earned from a job have also been shown to have a positive influence on likelihood of smoking in previous literature (Scragg and Laugesen 2007; Soteriades and DiFranza 2003). Both familial economic status and respondents' pointed to a positive relationship between both variables and respondents' perceptions of the risks of smoking. In this setting, income may be a proxy for access to more information about the dangers of smoking. This evidence regarding how parents' socioeconomic status and respondents' economic independence from parents impact smoking behavior and risk perceptions highlight the fact that economic considerations drive adolescents beliefs about smoking and their likelihood of smoking. In this way, not only does taxation policy rightly appear an important focus of policy action in Canada and the US but the US in particular should devote efforts to solving the issues around internet sales of cigarettes by taking action at the national level.