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The Effectiveness of Prices as a Smoking Reduction Mechanism: An Analysis of Adolescent Smoking Behavior

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Mir M Ali

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MIR M ALI

We, the dissertation committee for the above candidate for the

Doctor of Philosophy degree, hereby recommend

acceptance of this dissertation.

Debra S. Dwyer
Dissertation Supervisor
Associate Professor of School of Health, Technology and Management
Adjunct Associate Professor of Economics

John A. Rizzo
Chairman of Defense
Professor of Economics

Mark R. Montgomery
Committee Member
Professor of Economics

Kelly Noonan
Outside Member
Associate Professor of Economics
Rider University

This dissertation is accepted by the Graduate School

Lawrence Martin
Dean of the Graduate School

Abstract of the Dissertation

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Youth smoking is an important public health policy concern. An extensive literature in economics exists that proposes and evaluates policies aimed towards reducing smoking rates. Increasing prices has been widely regarded as the most effective policy to reduce smoking rates among younger populations. However, other disciplines, namely public health and sociology, advocate for different policies to reduce smoking among our youth. The differences in these policy recommendations stem from the different definitions of addiction in the three fields. In this dissertation we incorporate findings from various disciplines that analyze smoking behavior to comprehensively model adolescent smoking. We are primarily concerned with how effective prices are as a tool to reduce adolescent smoking and how that reduction in adolescent smoking translates into a decline in lifetime smoking rates.

Advocating prices and tax as the premier policy tool is largely due to the assumption that, since on average youths exhibit a more elastic demand for cigarettes, prices are an effective tool to reduce take-up. In order for this policy to effectively reduce smoking, and subsequent national health, it must be the case that any other factors that influence propensity to smoke are captured in a reservation price and ultimately willingness to pay. In other words, price continues to have a negative and significant relationship with smoking even after controlling for both peer and family influence and conceptualizing smoking as a stage specific phenomenon. In this paper we seek to empirically test this by analyzing how prices affect smoking at different stages of addiction after controlling for unobserved heterogeneity. It could be that those who are less sensitive to price in the distribution of price elasticities have a greater propensity to become addicted. In addition to several tests aimed at evaluating target efficiency of a price policy, we measure how demand elasticities vary at different stages of addiction.

Moving beyond the conventional definition of smoking to a definition that recognizes the complex nature of addiction by categorizing smoking into various stages of addiction, we learn that prices necessarily are not an efficient instrument to curtain smoking among some subgroups in the population. The effects of prices are not homogeneous among different stages of addiction and the conditional demand elasticities are also not the same across the various stages of addiction. Unobserved heterogeneity is significant and therefore was a problem in previous studies. We account for a significant portion of that unobserved heterogeneity by controlling for peer and family influences with a unique set of valid indicators of each. We not only control for these effects simultaneously but also measure it in a more rigorous way then it was done in the literature. Our parent measures are drawn from not only parents' smoking behavior but also through a parent-child relationship index that was constructed by taking the perspective regarding the relationship from the parents as well as the adolescents point of view. Peer effects were measured by identifying the individual's nominated friends and using their report. We also control for self-reported peer measures. We find that using our constructed peer measures significantly alters the effect of prices, by making it insignificant.

From our result we can conclude that relying on prices and state policy alone are not sufficient to reduce smoking for all subgroups – in particular for those with the greatest propensities to become addicts. Increase in prices will not achieve target reductions of adolescent smoking among those who continue to be around peers who smoke and live in household were accesses to cigarettes are easy. Thus increased social awareness regarding the adverse effect of smoking is more likely to contribute towards a reduction in smoking.

To my parents, Mir Mostaque Ali, Minu S. Nahar and my wife Faria Sharmeen, with all my love

Contents

List of Tables

List of Figures

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Chapter 1

Introduction

Youth smoking is an important public health policy concern today. According to the 'Youth and Tobacco Use' report released by the Center for Disease Control and Prevention (CDC) in December 2003, 4000 youths aged 12-17 try their first cigarette each day in the United States. About 80 percent of adults who are smokers started smoking before they were 25 (Liang et al., 2001)and epidemiological evidence suggest that individuals who avoid smoking in adolescence or young adulthood have significantly lower probabilities of being addicted to smoking. Even though smoking prevalence has decreased steadily over the years, this decrease is due to more people quitting rather than due to fewer people initiating (National Center for Health Statistics, 1995). Thus, a prime factor behind policies designed to curtail adolescent smoking, besides the obvious concerns regarding smoking related mortality and morbidity, is the assumption that reducing youth smoking initiation will reduce lifetime smoking propensities (Glied, 2002). In such a regard, a key policy concern is how policies aimed at tobacco control towards adolescents are effective in affecting smoking behavior when the adolescents are at an initial stage of smoking or have just made a transition into being addicted. In other words, are we only reducing smoking among adolescents for whom addiction is a less likely outcome, suggesting that polices to increase prices are not target efficient.

Although an extensive literature in economics has been devoted towards understanding the addictive behavior of adolescents and adults, the question of initiation and the relationship between adolescent initiation and addiction has received relatively little attention. In other words, smoking in most studies have been defined as a binary variable where smok-

ers are defined as individuals smoking at least one day out of the past thirty days. This definition fails to accurately account for the different stages of progression a person goes through before becoming an addict, thus modelling the different stages of addiction only as a choice rather than an outcome. Higher cigarette prices thus have emerged as the main policy tool in the effort towards reducing youth smoking. However if such a policy merely defers the initiation into later adolescence or young adulthood, it will not be an efficient strategy and will eventually have very little, or no effect, on the long-term smoking rates (Auld, 2005).If the youth at the margin of smoking take-up who respond to the tax policy are those with a lower propensity for addiction and long-term use, policy gains will be exaggerated. In this paper we aim to examine the effectiveness of prices and tax policies as a tool for not only preventing early initiation but also to analyze its efficiency in reducing eventual addiction.

The rational addiction model by Becker and Murphy (1988) is often used to develop and test hypothesis aimed at devising effective policies for reducing smoking rates. Under the rational addiction model an individual maximizes his/her discounted life-time utility subject to a life-time budget constraint where consumption of an addictive good is a choice variable. Under this model, an individual optimally decides upon his current consumption of cigarettes given past behavior and knowledge of future propensity to become addicted. They tradeoff consumption today for health tomorrow rationally with full information. Empirical applications of the rational addiction model have confirmed that smoking is an addictive good and an increase in cigarette prices leads to a reduction in smoking (Chaloupka and Warner, 2000), although younger individuals were found to be more myopic than their adult counter part under the rational addiction model(Chaloupka, 1991). However evidence of a higher price elasticity of demand for cigarettes among the young compared to older individuals was also found(Lewit and Coate, 1982). Later studies also found evidence of a negative and statistically significant price affect on adoslecent smoking behavior(Chaloupka and Grossman, 1996; Chaloupka and Wechsler, 1997; Hana and Chaloupka, 2003). This has lead many to conclude that since adolescents are responsive to prices after controlling for other anti-smoking state policies, an increase in price via taxation will be the most effective method to discourage them to take-up smoking which in turn will result in a reduction of life-time smoking rates.

There are other theories for modeling smoking addiction which have been largely ignored

in the literature. By doing so our specifications could be wrong, thus leading to potentially inconsistent estimated effects. One such theory is the stage conceptualization of smoking, i.e. taking into account the fact that an individual's smoking behavior evolves through a sequence of several development stages characterized by different smoking frequencies and intensities (Kathryn et al., 2000; Lloyd-Richardson et al., 2002). Another overlooked theory that can be applied to adolescent smoking behavior is the Social Learning Theory.[1] It states that the adolescents' acquisition behavior and values are based in large part on a complex web of interpersonal social relations (family and peers) in which the individual is fixed (Burgress and Akerson, 1966). In other words, an adolescent is influenced by his/her peer and family and such influences are reflected by his/her engagement in certain activities, i.e., an adolescents' smoking initiation might be influenced by his peers and family. Thus the response to price differs based on this type of heterogeneity. Incorporating the stage conceptualization of smoking and the social learning theory in our model of addiction will enable us to capture more accurately the factors that play a role in smoking initiation and the transition into an eventual addiction. These other factors will shape preferences for choosing smoking today over health implications later. They can be incorporated into the Becker-Murphy framework even if we continue to assume full rationality of decision makers. Even in the rational addiction framework, this improvement in model specification will enable us to more precisely estimate the influence of price on smoking, i.e. do current estimated effects of the price overestimate its impact by picking up the peer and family influence?

Modeling addiction as a stage specific phenomenon and incorporating the social learning theory into it will help us in identifying a number of important concerns that would need to be addressed in devising policies aimed towards reducing the long-term smoking rates. From our analysis we would be able to identify the factors that play a more significant role in adolescent smoking behavior. We would also be able to identify the roles that prices, state policies, peer effects and family influence plays when a transition between addictive states are made.

To date only few studies have attempted to analyze the relationship between smoking

[1]Edwin Sutherland (1939) first developed a 'differential association theory' to analyze deviant or criminal behavior of adolescent. The theory was later reformulated by Burgess and Akerse (1966)which became the basis for the social learning theory formulated by Bandura (1969).

initiation and addiction and they have two prime limitations: the non-incorporation of stage conceptualization of smoking and accounting for the social learning theory, that have not been addressed together. Both Glied (2002) and Auld (2005) relied on the conventional binary indicator of smoker. Liang et al.,(2001) reported that more intense smokers respond more to price and Cawley et al.,(2004) found that intense smoking initiation (smoked at least 15 days of the past 30 days) is more likely among females who are overweight. Therefore, incorporating the intensity of smoking, i.e. categorizing stages of smoking based on smoking frequency and intensity, in our analysis is expected to provide greater insights regarding initiation and its relation to addiction.

Although Auld(2005) controlled for peer effects, he relied on self-reported measures of the number of friends smoking as a instrument for peer pressure. A problem of relying on such measures is that adolescents tends to project their own behavior onto other and this leads to an inaccurate estimate of peer effects(Alexander et al.,2001; Norton et al.,2003). Auld(2005) made no attempt to account for such reporting bias. Only an indicator of parents' smoking behavior was used to proxy for the influence of parents. However, besides parents smoking behavior, the parent-child relation is also an important determinant of adolescent smoking. Powell and Chaloupka(2005) found that an improvement in parent-child relation in terms of better communication and importance of parents' opinion, plays a significant role in youth smoking decision. Emery et al.,(2001) and Ross et al.,(2006) categorized smokers based on their stage of addiction to measure the effectiveness of prices as a smoking reduction mechanism. However, both these studies did not adequately account for the peer and family influence.

Understanding the relationship between initiation and addiction, and evaluating the effectiveness of prices as a smoking reduction mechanism, warrants an investigation about the elasticity of demand for tobacco. The evidence of a more elastic demand among youth has been the pivotal reason in advocating prices as the most effective policy tool. However, those measure of elasticities were for overall price elasticities with no distinction being made between the elasticity at different stages of addiction. It might very well be that individuals might exhibit different elasticities at different stages of addiction. For example, elasticity at an initial experimentation stage is likely to be different from the elasticity when an individual is transformed into a regularly established smoker. Finally what drives the response to prices more might be the heterogeneity that was not included in the model.

Incorporating social learning theory will serve as controls for observed heterogeneity.

In sum, in this dissertation we aim to analyze the effectiveness of prices as a smoking reduction mechanism in terms of its ability to not only defer smoking initiation but also to prevent eventual addiction. The remainder of the dissertation is organized as follows. Chapter 2 provides a comprehensive literature review regarding smoking addiction among adolescent drawing insights from not only the field of economics but also from sociology and public health. This chapter will also demonstrate how a combination of various theories from these fields (namely economics, public health and sociology) helps us to devise better model specifications and understand adolescent smoking. Chapter 3 contains discussions about the data set that is the utilized in this study, and how our main variables of interest were constructed. The chapter also focuses on some of the features of the data set that makes it very suitable for our study. Chapter 4 presents the two competing conceptual frameworks that are utilized to devise our econometric models and test various hypotheses to evaluate the effectiveness of prices. Chapter 5 analyzes whether prices and tobacco state policies as a tool to reduce adolescent smoking are an overestimate and suggest target inefficiency, i.e. reduce smoking among adolescents from whom addiction was a less likely outcome. Chapter 6 examines how prices individuals face in their adolescent impact their smoking status as they make a transition into adulthood. This chapter will also help us to understand whether the price an individual face reduce their likelihood of becoming a smoker irrespective of their propensity of addiction. Finally conclusions and policy implications are provided in Chapter 7.

Chapter 2

Literature Review

One of the most important policy implications derived from the literature on smoking is the repeated emphasis on prices as an effective smoking reduction technique, and it is largely due to results from studies that found youth smokers to be more responsive to price change, i.e. the demand for cigarettes among adolescents are more price elastic compared with their adult counter part. This is a likely conclusion when the basis of our analysis is inclusive only of price and public policy measures. The emphasis has been more on the cost side of smoking and less on the benefit (factors that influence willingness to pay). In other words, holding cost factors constant not preferences. However, the non-economics literature (namely psychology, sociology and public health) have reached a different conclusion regarding the factors that play a role in influencing addiction behavior among adolescents, and prices have remained relatively ignored in their analysis. But like economics, all other disciplines, have identified preventing the onset of smoking as a public health concern aimed towards achieving a reduction in smoking prevalence. In this section we will summarize the major findings of both the economics literature and the literature from other disciplines and highlight their differences and how they can work together for a more complete model. We will identify limitations of previous studies and state how our study addresses those limitations.

2.1 Price Mechanism

The most widely utilized model in economics developed to study addictive behavior is the Becker-Murphy model of rational addiction. The model accounts for the dependance of current consumption on past consumption behavior with implications affecting future choices and thus having resulting ramifications on the stock of addiction. In other words, the agents are rational and optimize their utility by making choices with knowledge of their propensity to become addicts. Empirical applications of the model have confirmed the addictive nature of smoking as specified by the model and an overwhelming majority of the studies found increase in prices to play a significant role in reducing the consumption of cigarettes(Chaloupka and Warner, 2000). Although the evidence of a more rational addictive behavior among adolescents have not been documented(Chaloupka, 1991), a large body of literature exists on the effectiveness of prices as a mean to reduce smoking among youths(Lewit, Coate and Grossman, 1981; Chaloupka and Grossman, 1996; Ross and Chaloupka, 2003, 2004). Begining with Lewit et al.(1981) which found younger individuals to exhibit a higher price elasticity than their older counterpart, most studies with a few exception(Chaloupka, 1991; Wasserman et al.1991) have largely been unanimous in adhering to the effectiveness of prices as a means to reduce youth smoking. However, it is likely, that this estimate may be exaggerated since it assumes all smokers to be the same and all non-smokers to be the same as well, in terms of their propensity toward addiction. Thus, a decline in smoking due to an increase in price is inferred as a reduction in addiction. But controlling for any taste-shifters such as peer effects and parent-child relation directly, might be adequate proxies for unobserved heterogeneity among those who smoke and those who respond to higher current price.

2.2 Social Learning Theory

An important modeling distinction that characterizes other disciplines in the study of cigarette addiction is the direct control of such taste-shifters through the incorporation of the Social Learning Theory. According to the social learning theory, all the learning variables that operates as a part of the learning process of the adolescent stems from different reference groups, like friends, family, neighborhood etc. which exercises either direct or

indirect influence on them. But as stated before, although the economics literature in its analysis of addictive behavior haven't ignored the role of social networks, the interpretation of its effect have been quite different. Grossman (1995) stated that peer effects have an indirect influence on adolescents addictive behavior. According to the study, there is a direct price effect and an indirect price effect operating through peer consumption. Increase in the consumption of an addictive good that occurs due to a decline in its prices stimulates future consumption due to the reinforcement property of the addictive good, that reinforcement in turn magnifies the peer effect. Since this affects the willingness to pay a higher price it can be captured directly by the price itself. This however, highlights, a multicoliniarity problem that might be present if we don't control for peer effects and potential omitted variable bias problem. If it is the case that price affects peer effects, then we want price to capture the entire effect since manipulating price impacts the individual and peer response. However, that is an assumption we are not willing to make. Peer effects could drive price responses in which case they are not the outcome but the cause and not an 'indirect price effect'. Although a more recent body of literature have tested for the existence of a social multiplier effect operating via peer and family, they have done so separately for peers and family(Powell et al., 2005, Powell and Chaloupka, 2005). In other words no study was conducted that analyzed the effect of both peer and family along with prices and other anti-smoking state policies together.

2.3 Stage Conceptualization of Smoking

It is important to control for other factors that explain the diverse price elasticities not only by age but by smoking stages as well. While the incorporation of the social learning theory could be combined with the Becker-Murphy model as adding taste-shifters on stock of addiction, it cannot, however, incorporate the stage conceptualization of smoking, an important theoretical contribution to addiction analysis outside of economics. Unlike economics, most of the other studies have identified that before any adolescent becomes dependent on cigarettes, they pass through a stage of experimental use during which they are not committed to its continued usage (Petraits et al., 1995). The stages through which an adolescent goes through before becoming an addict can be classified into the following five categories: (i)Preparation: This involves formation of beliefs and attitudes about smoking

prior to ever trying a cigarette, (ii)Initial Trying: This stage refers to experimentation with the first few cigarettes, (iii) Experimentation: This stage transition is characterized by irregular use of cigarettes with a gradual increase in frequency of smoking in various situations, (iv)Regular Use: Smoking on a regular although still infrequent basis, such as every weekend or weekdays before or after school, and finally (v) Addiction: Here the individual is smoking on a regular(daily) basis, is driven by cravings for nicotine and also experiences withdrawal symptoms. Such stage-conceptualization of smoking allows the dynamic nature of the development of addiction to be captured. So, as a summary, we can say that the limitations of the economics literature can be attributed to the lack of direct control of the affects of social network and non-incorporation of smoking addiction as an evolving process which could bias effect of price given collinearity with omitted controls.

2.4 Rational Addiction vs. Rational Addiction with Learning and Regret

Although the rational addiction model has been widely utilized in studying smoking behavior, it has also often been criticized because of its assumption of perfect foresight and time consistent preferences. The implication of such assumption is that, since individuals makes their decision with complete information regarding their addictive tendencies and have preferences which remains unchanged, there is no room for 'learning and regret'. Orphanides and Zervos (1995) accounted for such limitations by incorporating uncertainty into their model of 'rational addiction with learning and regret'. In their model, each individual possesses a subjective belief regarding his or her addictive tendencies and the harmful side effects of consuming an addictive good. This subjective belief is updated via a Bayesian learning process as the consumption of the addictive good continues. An underestimate of addictive tendency can cause an individual to become an addict because of repeated experimentation, whereas, a realization of the addictive tendency will cause the individual to reverse his or her consumption of the potentially addictive good. This incorporation of subjective believes into the rational-addiction framework helps to explain adolescent experimentation and the importance of social network.

2.5 Limitations of Existing Literature

Most empirical applications of the models of adolescent addiction although have not concentrated explicitly on the ration addiction framework, they however have been formulated to examine the relationship between tobacco price and consumption, with very little concentration on the social network variables and stage conceptualization. Those studies that took the effect of family and peers into account have often relied on highly endogenous measures to do so. Most studies relied on adolescents perception of peer behavior rather the the peers' own reports of their behavior. Questions like 'do you have friends who smoke' or 'what percentage of your friends smoke' have been mostly relied upon to construct peer influence variables (Auld, 2003). A problem of relying on such questions is that if adolescents tend to project their own smoking behavior onto their friends, the peer influence will be inflated (Alexander et al., 2001; Norton et al., 2003). Other studies controlled for peer effects by creating school level smoking prevalence. Powell et al. (2005) constructed school-based peer effects as the 'prevalence of smoking at the individual student's school not including the given individual in the calculation'. In terms of measuring the influence of family, questions regarding the parents smoking behavior was used. Besides the smoking behavior of parents, it is also important to take into account the parent-child communication regarding the use of addictive substances, i.e. if the parents discuss the adverse effect of addiction with their children. These measures will be able to capture the influence of parents with more precision (Ennett et al., 2001).

One of the prime limitations of the literature from the other discipline is their almost complete disregard of prices when modeling addiction. Although it has been found in the literature that most young individuals in their early stage of smoking uptake do not purchase cigarettes but rather obtain them from friends or from other social sources, they however may exhibit some price sensitivity during later adolescence (16 - 18 years old) when they might have made a transition into an addictive state (i.e. smoking on a daily basis). This is when they start to purchase their own cigarettes (Emery et al., 2001). Economists, in their study of cigarette addiction have dealt explicitly with prices and have found a strong correlation between price and quantity of cigarette smoked, thus it cannot be ignored.

While most studies have found youth smoking to be considerably more elastic than adult

smoking (Lewit et al.,1981, Evan and Huang, 1998, Harris and Chang, 1999, Tauras and Chaloupka, 2003), the evidence on cigarette demand elasticities come largely from models that did not control for peer and family influence simultaneously and defined addiction as a dichotomous variable with no distinction made between the various stages of addiction. An inverse relationship between price elasticity of cigarette demand and age is evident in most of the literature (Lewit et al., 1981; Lewit and Coate 1982; Grossman et al., 1993; Chaloupka and Grossman, 1996; Chaloupka and Wechsler, 1997). These studies also found young men and blacks to be more responsive to prices than young women and whites. But most of these studies not controlling for smoking stage were unable to make an appropriate distinction between elasticities at different stages of addiction.[1] In such a context, care should be taken when advocating for price as a tool for reducing smoking initiation among adolescents, since such advocation is made under the implicit assumption of more elastic demand translating into non-addictive outcomes. Such concerns have resulted in studies aimed towards a more rigorous understanding of smoking initiation among youths.

Although not quite large in number most of these studies that were undertaken to analyze participation behavior among adolescents concluded that cigarette prices are uncorrelated with the decision to initiate smoking (Douglas and Hariharan, 1994; Douglas, 1998; Forester and Jones, 2001). The results from studies that used longitudinal data to analyze smoking initiation is mixed and thus inconclusive (Cawley et al., 2004). Tauras et al. (2001) found prices to be negatively correlated, an important deterrent factor in smoking initiation. DeCicca et al. (2002) analyzed the onset of smoking by estimating the probability of smoking at 12th grade conditional on being a non-smoker at 8th grade. They found price and tax effect of smoking onset between 8th and 12th grade to be weak or non-existent. However, these studies did not analyze the smoking initiation separately by gender nor did they have adequate peer effect controls.

Auld (2005) and Glied (2002) in their analysis of initiation behavior concluded that reducing youth smoking through tax policy may not be sufficient to substantially reduce smoking into adulthood, their remains unanswered questions that motivate further analysis. Auld (2005) made no distinction between timing of take-up and the intensity of initiation. Glied (2002)like Auld (2005) also did not take into account the intensity of initiation.

[1]Refer to Chaloupka and Warner, 2000 for a more extensive literature review on price and cigarette demand.

Their models, like most of the literature in economics, were misspecified if we believe the competing arguments such as the social learning theory and stage conceptualization of smoking. Thus initiation analysis by itself is not sufficient when evaluating the effectiveness of price as a mechanism for reducing life-time smoking. The main question to be answered is whether price remains an effective mechanism independent of the stage of addiction the individual is in, after adequate control of peer and family influence. So to investigate such issues will be the pivotal purpose of the paper.

Tauras (2005)noted that 'a better understanding of the determinants of smoking progression among young adults and the impact public policy plays in deterring smoking escalation is needed'. In this study smoking was divided into three progression stage: going from non-daily smoking to smoking one or more cigarettes per day, going from light smoking (1-5 cigarettes per day) to smoking 10 or more cigarettes per day and going from moderate smoking (10 cigarettes per day) to smoking 1 or more packs per day. Although smoking intensity was accounted for in this study and concluded that an increase in price would decrease the number of young adults who progress into high intensity of smoking, it did not control for peer or family effects. Similarly to Tauras (2005), Emery et al.,(2001) and Ross et al.,(2006) did not control for peer or family influence. Emery et al.,(2001) was one of the first study in economics to recognize the importance of categorizing the different stages of youth smoking. The study found prices to be not significantly associated with experimentation. Ross et al.,(2006) categorized adolescent smoking uptake process into four separate stages and found prices to have an impact on adolescents who are further along in their smoking uptake process. However, due to iadequate control for the social learning theory, we can conjecture the effectiveness of prices to reduce adolescent smoking to be inconclusive. Lahiri and Song (2000) concluded that anti-smoking campaigns should target groups who tend to initiate more easily because risk factors for disease are also higher among those group. However, their study was conducted on elderly population, thus peer and family effects were not of significance. Therefore, this paper contributes to the literature by providing the first comprehensive measures of price estimates via proper control of the social learning theory and stage conceptualization of smoking.

2.6 A Comprehensive Approach

In short, a comprehensive study of smoking behavior incorporating the social learning theory, stage conceptualization of smoking, prices and public policies, has not been conducted. Thus in this paper we aim to do so by addressing the limitations of these previous studies. We address those limitations in a few ways. To begin with, we do not rely on the conventional definition of smoking that categorizes individuals as smokers who respond to smoking at least one day out of the last thirty days. Our data is drawn form the National Longitudinal Survey of Adolescent Health (AddHealth). The AddHealth is a longitudinal survey of a national representative sample of adolescents who were between 7th and 12th grade in the first wave (1994). One of the prime advantages of AddHealth is its extensive questions on smoking that were asked. [2] This allows us to more accurately measure the addictive behavior of adolescents, something which is not available in any other data set. Such wide ranges of questions was used to model smoking as a stage-specific concept, something that was very rarely done in previous studies. Also, we include a wide array of social network measures to accurately incorporate the social learning theory. AddHealth has interviewed the respondents parents during the first wave. This will allow us to devise more precise estimates of the influence of parents without relying on the adolescents (the main core of the survey) responses. The respondents were also asked to identify/nominate people who they consider to be their friends. AddHealth allows us to trace those friends from the main in-home survey. This enables us to create more accurate peer effects measures, something that was not done previously in any smoking related studies. AddHealth also has school administrator data which will allow us to construct policy variables at the school level. Finally, we have regional tax data and prices to estimate conditional price elasticities of demand.

Our study, therefore, will be able to capture the addictive behavior with more accuracy compared with other studies in the field. We combine the contributions of various disciplines and are able to improve upon the limitations of the previous work. This study will facilitate more effective policy recommendations based on not only price based model but also the incorporation of the social learning theory and stage conceptualization of smoking.

[2] Due to the sensitive nature of the questions, they were surveyed using a head-phone based audio-computer assisted technology.

Chapter 3

Conceptual Framework

In this section we examine the Rational Addiction model and the Rational Addiction with Learning and Regret model to see how the latter accounts for the limitations of the Rational Addiction model. These two competing models will be used to derive testable hypothesis regarding cigarette consumption that incorporates not only prices but also social networks and the stage-specific nature of smoking behavior.

The most widely utilized framework in analyzing cigarette consumption in economics is the Becker and Murphy (1988) model of rational addiction [R-A from now on]. In this section we present that model, its predictions, empirical evidence and limitations. We also go on to present competing theories that question the identification and interpretation of the empirical findings to date.

3.1 The Rational Addiction Model

The rational addiction model is a dynamic model where individuals maximize discounted life-time utility subjected to a life-time budget constraint. Rationality in this context simply implies a consistent plan to maximize utility over time, i.e. individuals incorporate the interdependence between past, current and future consumption in their utility-maximization process (adjacent complementarity).

The R-A theory models quantity demanded of an addictive good and predicts that it will be negatively related to its current price as well as to its past and future prices. In other words, the cross-price elasticities are negative, i.e., the quantity of an addictive

good consumed in different time periods are complements (Grossman, 1995). So if prices tomorrow are expected to rise, it will impact consumption tomorrow negatively and also consumption today since the behavior is positively correlated. The rational addiction model also successfully captures the psychopharmacological concepts of tolerance, withdrawal and reinforcement. Tolerance refers to the body's adaptation to taking an addictive substance. For most addictive goods, tolerance implies that a given level of consumption yields less utility as cumulative past consumption is higher. In other words, to achieve the same level of satisfaction attained previously, more of the addictive substance must be consumed. Reinforcement represents the learned responses to consumption and the benefits associated with it. Positive reinforcement stems from the satisfaction or utility that results from the consumption of cigarettes, including the pharmacological effects produced by nicotine and the psychological benefits perceived to be associated with it. Withdrawal reflects the negative psychological reactions to cessation, interruption or reduction of the consumption of the addictive good, i.e. cigarettes in our case. For cigarette smoking, the effects may include, but not necessarily be confined to increased irritability, inability to concentrate, increased anxiety, elevated blood pressure and heart rate, cravings for nicotine etc.

Following the R-A model and Chaloupka (1991), the individuals utility at any point in time is a function of health, $H(t)$, the euphoria or relaxation produced by addictive consumption (i.e. reduction of boredom or tension), $E(t)$, and non-addictive composite consumption, $Y(t)$.

$$U(t) = u[H(t), E(t), Y(t)] \tag{3.1}$$

where u is concave with negative second order conditions for each of its arguments.

In accordance with the Grossman (1971) health production fucntion, health is assumed to be a function of investment goods, such as medical care and the individuals own time spent, for example, on exercise and other healthy activities, $M(t)$. These inputs have a positive but a diminishing marginal effect on health. Besides $M(t)$, $H(t)$ is also affected by $A(t)$, the cumulative past consumption or the 'addictive stock'. All else equal, the greater the addictive stock, the lower the level of health:

$$H(t) = H[M(t), A(t)], H_M > 0, H_{MM} < 0, H_A < 0, H_{AA} < 0. \tag{3.2}$$

Euphoria (the psychological and the physiological benefits of smoking) is produced by

the consumption of cigarettes, $C(t)$, and the addictive stock. An increase in the consumption of cigarettes has a positive effects on the production of euphoria, whereas, the greater the past consumption(the addiction)the lower the euphoria. The notion of tolerance is captured by this assumption. Reinforcement is captured by an assumption that the marginal product of cigarettes in the production of euphoria increases with the level of addictive stock:

$$E(t) = E[C(t), A(t)], E_C > 0, E_{CC} < 0, E_A < 0, E_{AA} < 0, E_{CA} > 0. \tag{3.3}$$

The composite good is produced by consuming $X(t)$ inputs, which includes the market goods and the individual's own time. Each unit of $X(t)$ is assumed to have a positive but diminishing marginal productivity:

$$Y(t) = Y[X(t)], Y_X > 0, Y_{XX} < 0. \tag{3.4}$$

A derived instantaneous utility function can thus be obtained as follows:

$$U(t) = U[C(t), A(t), Z(t)] \tag{3.5}$$

where $Z(t)$ is a vector of inputs that includes the inputs that went into the production of the composite good and health. At any point in time, the following will hold:

$$U_C = u_E E_C > 0 \tag{3.6}$$

$$U_A = u_E E_A + u_H H_A < 0 \tag{3.7}$$

$$U_{CA} = u_{EE} E_C E_A + u_E E_{CA} > 0 \tag{3.8}$$

$$U_Z = u_H H_Z + u_Y Y_Z > 0 \tag{3.9}$$

and

$$U_{ii} < 0, i = C, A, Z \tag{3.10}$$

Equation (6) - (8) illustrates the three characteristics of addictive consumption. Equation (6) captures withdrawal since total utility will decline following a reduction in cigarette consumption. Tolerance is captured by the negative marginal utility of addictive stock as shown in (7), which reflects the fact that greater cumulative past consumption lowers current utility. Finally, equation (8) reveals reinforcement,which states that the marginal utility derived from the current consumption is magnified as past consumption is larger or in other words, current consumption is reinforced by past consumption.

The stock accumulation process can be described as:

$$\partial A(t)/\partial t = C(t) - \delta A(t) \tag{3.11}$$

where δ is the constant rate of depreciation of addictive stock over time.

Price enters in through the standard budget constraint so that individuals make choices over consumption of cigarettes verses all other goods based on income and relative prices. Since we assume cigarettes are an ordinary good in terms of its relationship to price, we expect negative effects of price on quantity demanded (a negative price elasticity of demand). What we care about is the magnitude for policy purposes. Given the nature of preferences over time, individuals make their decisions about consumption today based on past and future consumption. This means that the evolution of prices will play a role as well rather than just current prices. Since my consumption today is directly impacted by my addictive stock produced from past consumption, the prices in the past are predictors of my addictive stock today. So the indirect effect of past price on current consumption is negative. It is indirect since it is working through past consumption. So a higher price yesterday will decrease consumption today. This lowers my addictive stock and subsequent consumption today. So really it is consumption yesterday that impacts consumption today, and the negative effect of past prices works indirectly through that past consumption. We predict a direct effect of past prices on consumption today as well. So holding constant the addictive stock and historical consumption, the effect of prices into the future have a positive impact on behavior today. For example, if we anticipate a higher sin tax on cigarettes tomorrow, I will stock up today and the derivative will be positive. The model assumes that agents are able to predict future prices and addictive stock given the current information set well on average (for a discussion of the direct and indirect role of past and future prices on current consumption see Chaloupka (1991) and Grossman (1995). In

sum, empirical test of the B-M model look for positive effects of past and future prices and consumption. After controlling for these other factors influencing consumption today, the effect of current price gives the price elasticity of demand for cigarettes.

Given the assumptions of perfect foresight and time consistent preferences price becomes a sufficient statistic for 'willingness to pay' just like in the standard microeconomic models of behavior. So by examining the effect of past and future consumption and prices we are able to test some of the model's assumptions and simultaneously get a clean estimate of the price elasticity of demand. For policy purposes they want to be able to predict the magnitude of the decline in smoking from implementing a sin tax policy. So regardless of the preferences that drive that willingness to pay, how will consumers respond to the policy? All of the preferences are captured in that effect of price in this framework. Because the emphasis has been on youth initiation, authors typically measures these elasticities by age and then draw inferences regarding the consequential decline in addiction. The empirical test of this model (Chaloupka and Warner, 2000) provide evidence in favor of this framework. However, mostly cross sectional data were available and the role of past and future prices are based on retrospective data that are flawed. In addition, interpretation of some of the findings are questionable. For example, among youth the response in terms of quantity of cigarettes declines with price increase. This was interpreted as a decline in initiation, although initiation was not explicitly measured. It is then inferred that this decline in quantity will reduce overall addiction rates into the future because individuals choose to avoid addiction when prices are higher (Glied, 2002; Auld, 2005). All that can truly be identified in this empirical framework is that on average smoking rates decline. Those who cut smoking may not have had a great propensity toward addiction anyway so that unobserved heterogeneity could be biasing the results. The assumption of perfect foresight avoids this unobserved heterogeneity problem since the propensity for addiction is also captured in one's willingness to pay today and the outcome is still one that maximizes utility. So the interpretation hinges on the theoretical assumptions that are questionable.

One must question the perfect foresight assumption when it comes to addictive products. This is not consistent with observed addictive behavior.[1]If individuals live to regret those choices, then their response to price does not adequately reflect lifetime preferences

[1]Figures from the US released by the CDC in 2000 suggested that over 80 percent of smokers have tried to quit at some stage.

and utility maximization choices. We move to the learning and regret framework of Orphanides and Zervos (1995) that relaxes these strong assumptions and consequently changes the interpretation of price in the empirical work to date. In other words, we can no longer allow price to pick up preferences if they no longer adequately represent them. It is for this reason, that the findings from the social learning theory and stage conceptualization theories will be incorporated in our empirical framework for modeling preferences.

3.2 Rational Addiction with Learning and Regret

Orphanides and Zervos (1995)[O-Z from now on] attempted to reconcile the inconsistencies of the R-A model by incorporating subjective believes into their model. O-Z introduced uncertainty into the model by assuming that inexperienced users are not fully aware of the potential harm associated with consuming an addictive substance. The model assumes that the consumption of addictive goods are not equally harmful to all, individuals possess subjective beliefs concerning their harm and their beliefs are optimally updated with information obtained through consumption. Thus, an individual who underestimates his or her propensity of addiction and experiments with an addictive substance can end up becoming an addict. Becoming an addict requires accumulation of some stock of past consumption beyond a critical level. Once this level is reached addiction results. Individuals who know their addictive tendencies will not accumulate beyond this critical level. Those who experiment and learn their addictive tendency before reaching the critical level reverse their consumption pattern and do not become addicted and those who recognize their tendency too late become addicted. This is quite contrary to the R-A model, where individuals maximize their utility by making fully informed decisions given known addictive tendencies. The O-Z model is also especially suited to incorporate stage conceptualization of smoking and social learning theory to devise empirically testable demand functions for cigarettes that depends not only on the price but also on peer effects, family and other socially intractable reference group that might exert influence on the adolescents.

So following the O-Z framework, at any point in time there are two goods that enter an individual's utility function. c_t measures the quantity of an ordinary good and a_t measures the quantity of a potentially addictive good that are available for consumption at time t. The stock variable, s_t, which depreciates at a rate δ and $0 < \delta < 1$ evolves according to

$$s_{t+1} = \delta s_t + a_t \tag{3.12}$$

Potential addicts and non-addicts are the two distinct groups that are consisted in the population. The stock of past consumption has no effect on the welfare of non-addicts since they receive instantaneous benefits (euphoric effects) from consuming a. However, for potential addicts, this is not the case, and so their stock produces harmful side effects. To categorize the differences across individuals, θ which indicates the presence of addictive tendencies, is equal to 0 for non-addicts and equals 1 for potential addicts. Utility for any individual is separated into two parts:

$$U_t = u(c_t, a_t) + \theta \eta_t v(a_t, s_t) \tag{3.13}$$

where $u(c_t, a_t)$ represents the immediate rewards attributed to current consumption of both the addictive and non-addictive commodity. $v(c_t, s_t)$ denotes the detrimental addictive effects of consumption. η_t is a random variable with distribution

$$\eta_t = \begin{cases} 1 & \text{with probability } \pi(s_t) \\ 0 & \text{with probability } (1 - \pi(s_t)) \end{cases} \tag{3.14}$$

η_t introduces a probabilistic occurrence of addictive effects depending on the level of past consumption.

In the O-Z model, individuals were assumed to have a fixed income y in every period, and the price was fixed at p. However, relaxing such assumptions will help us capture the price sensitivity among the individuals. The fraction of disposable income spend on cigarettes could influence a person's level of consumption (Chaloupka and Grossman, 1996). This fraction does not remain constant for individuals, especially when transitions are made into adulthood. With the price of c normalized to unity, the utility maximization problem faced by any individual with initial stock s_0 and discount factor β is

$$\begin{aligned} \max\ E_0\Big\{\sum_{t=0}^{T}\beta^t[u(c_t,a_t) \ &+\ \theta\eta_t v(a_t,s_t)]\Big\} \\ \text{subject to}\quad c_t + p_t a_t \ &\leq\ y_t, \\ c_t, a_t \ &\geq\ 0 \\ \text{and}\quad s_{t+1} \ &=\ \delta s_t + a_t \end{aligned} \tag{3.15}$$

The expectation involves not only the objective distribution of η_t but also the subjective distribution of θ, when addictive tendencies are unknown. Since θ is binary, a single parameter $P_t \equiv prob\{\theta = 0\}$ describes the subjective distribution of θ at any time t, prior to consumption in that period. Each individual begins with an initial prior P_0 and optimally updates these subjective beliefs as he observes his utility level following consumption. $\theta\eta_t$ is observable subsequent to consumption, so the subjective distribution of θ represented by P is updated via the Bayesian updating rule as follows:

$$P_{t+1} = \begin{cases} \dfrac{P_t}{P_t + (1-P_t)[1-\pi(s_t)]} & \text{when } \theta\eta_t = 0 \\ 0 & \text{when } \theta\eta_t > 0 \end{cases} \tag{3.16}$$

Thus as a person experiences some effects stemming from addiction ($\theta\eta_t > 0$) they realize that they are addicted and $P_{t+1} = 0$, i.e. there is no probability that they are non-addict. However, if $\theta\eta_t = 0$, the individual do not experience any side effects but still there is no guarantee that they are not a potential addict. It could be that they may become an addict in the future and had not experienced any side effects to realize it. This is captured by the term $(1-P_t)[1-\pi(s_t)]$. Thus as each period goes by with a person not experiencing any side effects or not realizing the harmful effects, they may downgrade the possibility of being an addict or equivalently upgrade the possibility of being a non-addict.

The O-Z model, thus, raises important concerns regarding the effectiveness of prices as a smoking rate reduction mechanism. The O-Z model presents initiation and addiction as two distinct states, i.e. not all individuals who initiates smoking becomes an addict. So the participation elasticity and conditional demand elasticity might very well be different for a particular individual. Therefore higher cigarette prices might not result in lower tobacco consumption and a more elastic demand might not necessarily translate into non-addictive

outcomes but could rather imply delayed smoking initiation among adolescents (Glied, 2002; Auld, 2005).

The stage conceptualization of smoking can be adopted in the O-Z model because the stage specific smoking phenomenon presents addiction as an outcome which results through persistent consumption of cigarettes, with the individuals going through a progression of different stages. Similarly, the O-Z model treats initiation and addiction separately, with individuals unaware of their addictive tendencies progressing into a regular smoker.

Chapter 4

Data

4.1 General Overview

The National Longitudinal Survey of Adolescent Health (AddHealth) consists of data on adolescents in 132 schools nationwide between grades 7 to 12. The in-school portion of the Wave-I survey contains cross-section data on about 90,000 adolescents. Additionally, school administrators responded to questionnaires describing characteristics of the school in the sample. These provide the source for our school level measure of anti-smoking policies. A subset of the initial sample(20,745 respondents), was also interviewed in their home(in-home portion of the data). The primary data for our analysis comes from the first wave of the in-home survey portion of AddHealth. Parents were also interviewed in the first wave of the in-home sample. This allows us to control for a wide range of parent-child relationship measures as well as the smoking and drinking behavior of the parents. Besides smoking information, AddHealth contains an extensive range of variables regarding substance use, risky behavior and other behavioral problems. One of the prime advantages of AddHealth, that distinguish it from all other data sets, is that, it allows us to identify the respondents friend from both the in-school portion and in-home portion of the survey. This allows us to utilize peer effect measures that goes beyond the conventional self-reports, but uses the friend's responses instead.

4.2 Categorical Smoking Variables

One of the prime variable in this study is the individual's smoking stage. Its a categorical variable that was created based on the individuals smoking frequency and recency. Following Llyod-Richardson et al.(2002) we categorize people into the following stages of smoking addiction:

(i)Never Smoker - Those respondents who denied ever trying a puff or two of cigarettes. Such adolescents who have never smoked are either unaware of positive reasons to initiate smoking or are ignoring or resisting pressure to smoke(Kathryn et al.,2000).

(ii)Experimental - Those who endorse trying cigarettes, although denied smoking within the past 30 days or ever smoking regularly (i.e. daily smoking). This stage is marked by adolescents trying their first few cigarettes. Experimentation stage has often been characterized of having stronger peer than family influences(Kathryn et al.,2000).

(iii) Intermittent - Those who reported smoking between 1 and 29 out of the past 30 days. This stage is characterized by a gradual increase in the frequency of smoking and an increase in the variety of situations in which cigarettes are used. Adolescents progress beyond the sporadic smoking to smoke on a higher but still infrequent basis.

(iv) Regular or Established - Those who responded smoking on a daily basis within the past thirty days. In this final stage adolescent may experience nicotine dependence, withdrawal symptoms and may find it difficult to quit.

(v)Ex-Smokers - Those who reported quitting smoking; denied smoking with the past 30 days and endorsed regular smoking.

In the previous literature, the most widely used measure of smoking was a dichotomous variable that categorizes smokers as anyone who reported smoking at least one day out of the past thirty days(Chaloupka and Grossman, 1996; Hana and Chaloupka, 2003, 2004;Powell et al., 2005, Powell and Chaloupka, 2005). Price estimates on such binary variables might be an overestimate since it fails to control for the various stages of addiction that a person might go through. From our definition of smoking stages we can see that a person might have smoked zero days out of the past thirty days and yet could fall into the category of someone who has experimented with cigarettes and has the possibility of making a transition into a regular smoker. This is especially true among adolescents, who might not have yet become a regular smoker but enjoys a high probability of doing so. Also,

an ex-smoker is not the same as someone who has never tried smoking. From Table 4.1 we can see that under the widely used conventional definition of smoking, 37.52 percent are experimental smokers and 3.41 percent are ex-smokers. Thus, an overestimation of price is quite likely without distinctions being made among the various stages of addiction.

4.3 Peer Measures

According to the Social Learning Theory, an adolescents' source of influence or habit formation is not confined to either friends or parents, but rather a combination of both and as noted before, previous literature has not controlled for both these measures together. From Figure 4.1, we can see that among those who have friends and parents who smoke only 19.7 percent are never smokers and 46.1 percent and 26.7 percent are regular and intermittent smokers respectively. Whereas among those who only has parents who smoke, 57.2 percent are never smokers, with only 16.6 percent and 15.2 percent as regular and intermittent smokers. This demonstrates that it is important to control for both parents and peer smoking behavior together. AddHealth allows us to construct more accurate measures of friend smoking behavior besides the conventional self-reported measures, like number of friends who smoke. AddHealth asks respondents to nominate five male and five female friends in the survey, and allows us to identify those individuals among the nominated friends who were also part of the interviewed sample.[1] This allows us to capture more accurately the smoking behavior of the respondent's friend without relying only on the individuals self-reported measures. In the literature there is a concern that young people tend to overestimate the extent to which their peers smoke, espicially smokers have a hugher propensity to overestimate the fraction of their peer who smoke(Krauth, 2005). Such a tendency has been termed as the 'false consensus effect' by psychologists. Among the constructed measures of friends are the average number of days in the past 30 days did the respondents nominated friends smoke, the average number of cigarettes did the respondents nominated friends smoke on the days that they smoked, the average number

[1]We were unable to identify those nominated friends who were not part of the in-home survey. Although this reduces our sample size, the randomness of the non-identification is unlikely to posit any concern. After controlling for this non-identification we found comparable results and the control variable was statistically insignificant.

of drinks the respondents nominated friends had each time they drank in the past twelve months and the proportion of nominated friends who fall in each of the five categorical stages of smoking. Our study is among the first study to measure and control for such peer effect variables in the smoking literature. We conjecture these constructed peer measures to play a significant role in our empirical model, and to also have an impact on the role of prices as an effective policy tool.

4.4 Parent Measures

Since AddHealth interviewed one of the parents also, we can control for the parent-child relationship via not only how the child perceives it to be, but also how the parent perceives it. This will allow us to capture with more precision the role that parents play in influencing an adolescents smoking behavior. Besides the smoking behavior of the parents, it is also the relationship that the child has with his/her parents that is expected to play a vital role in influencing their smoking behavior. Apart from controlling for the respondent's perception of whether he/she thinks that his/her parents care, understand, pay attention etc., we also control for the respondents' parents perception of whether they think they get along well with their children, whether they feel they can trust their children etc. Most literature in economics that controlled for the influence of parents mostly relied on parents smoking status and very limited measures of the parent-child relationship from the children's perspective. Powell and Chaloupka (2005)use the importance of parents opinion and dicussion with parents on a daily basis as a measure of parent-child relationship. Thus, our study is among the first study to account for the parent-child relationship comprehensively.

4.5 Policy Measures

Besides prices an extensive array of state policy measures are controlled for. Like prices, state policy measures have been labeled as one of the most effective policy instruments that could be utilized to curtail smoking among adolescents. State policies such as banning cigarettes sales via vending machine, marketing restrictions on billboards, prohibition of distribution of free samples as promotional tools etc. are all likely to contribute towards preventing adolescents from taking up smoking. Besides these, various other state and local

enforcement programs are likely to limit the availability of cigarettes among adolescents.

Along with cigarette prices and various state level public policy measures we also control for school level anti-smoking policy and state level indicators of smoking prevalence. We control for whether smoking is prohibited for both school personnel and students at the respondent's school. This variable was constructed based on the school administrators responses in the school survey. State level indicators of the percentage of 18 and older smoking and percentage of 9 to 12th graders smoking was used to measure possible cohort effects at the state level. It is more likely that the variable indicating percentage in grades 9 through 12 smoking would have a more significant effect since our sample consists of people who are currently in school.

4.6 Demographies

In addition to these measures we also control for socio-demographic factors like age, the grade they are in, gender, family structure and the respondents drinking behavior.[2] Norton et al.(1998) identified that adolescents who drink are also more likely to be smokers. It is also important to control for gender since an adolescent female's reasons for taking up smoking might be different than that of a males', thus affecting the efficiency of the policy measures as well(Cawley et al.,2004).

4.7 Factor Analysis

Instead of relying on multiple indicators to measure the parent-child relationship and state policy measure, we created an index to control for that. The indicators of the parent-child relationship and state policy were obtained after conducting exploratory (principal factor) factor analysis. This is a data reduction technique conducted to minimize correlated regressor problems, collinearity and improve interpretation of mutually exclusive components of responses. Estimates without the indices are unclear in its interpretations, with certain indicators having a negative, certain indicators having a positive relationship and certain indicators being insignificant in explaining the dependent variable. This is likely due to

[2]For a complete list of control variables please refer to Appendix 1.

collinearity that exists among the measures.[3]

Thus factor analysis was utilized as a statistical technique to find an indicator(s) of orthogonal common factor that will linearly summarize a set of original variables related to the parent-child relationship and state policies.

Although there is no agreed upon common criteria to be used in deciding the number of factors to be retained, the Kaiser criterion is one of the most utilized method. According to the Kaiser criterion only factors that have eigenvalues greater than 1.0 is retained. However, in the statistics literature there is a broad consensus that the Kaiser criterion is among the least accurate method for selecting the number of factors to retain (Velcier and Jackson, 1990). We therefore employed the scree test to decide upon the factors that we retained. The scree test involves examining the graph of the eigenvalues and identifying the break point in the data where the curve flattens out. The number of factors above the break point is usually the number of factors to be retained. Figure 4.2 and 4.3 illustrates the scree plot of eigenvalues after running principal component factor analysis on policy and parent-child relationship measures. From these figures we can notice that there is only one factor in each category to be retained. These two factors also has the greatest eigenvalues.

4.8 Descriptive Statistics

Tables 4.2 - 4.5 report descriptive statistics by smoking status using the first wave(1994) of AddHealth data. We can see that individuals at different stages of smoking are not homogeneous. Among those who reported never trying alcohol, only 1.8 percent are regular smokers compared to the 69.2 percent of never smokers, implying that alcohol intake is positively related to smoking. Thus it is important to control for alcohol consumption, which can be a proxy for own propensity of addiction, in analyzing smoking behavior. This was vastly overlooked in the previous studies that attempted to evaluate the effectiveness of prices, although the complementarity between alcohol and cigarette consumption has been established(Bask and Melkersson, 2004). A smaller percentage of individuals who

[3]For estimation results with all the parent-child indicators refer to Appendix 2. The estimates obtained from the probit model demonstrates the difficulties of interpretation based on all the indicators. This difficulty in interpretation also holds true for the state variables.

reported having three or more friend who smoke falls into the never smoker category. A greater percentage of those whose parents smoke are regular smokers compared to those whose parents don't smoke. This indicates the evidence of a social multiplier effect and the possibility that adolescents who are more around smokers are likely to be smokers themselves. By controlling for parent, peer and own addiction tendencies, or smoking patterns, we can separately identify the importance of each.

Table 4.3 shows the relationship with parents by smoking status. In general a greater percentage of individuals who feel their parents care are never smokers, with a steady decline in such percentages as the intensity of the smoking stage increases. The same is true if adolescents feel that their parents understand them and pay attention to them. Adolescents who are able to communicate better with their parents and whose parents talk to them regarding current problems are less likely to be smokers. This is consistent with our hypothesis that a better parent-child relationship is very important for preventing smoking among adolescents. Also parents who feel that they get along well with their children, who feel that they can trust them, also have a lower percentage of children who regularly smoker. Previous studies that attempted to study the effect of the parent-child relationship on adolescent smoking behavior only controlled for variables that reflected the adolescents perspective of the parent-child relation. By controlling for the parents perspective of the parent-child relationship also, we can obtain better estimates of the impact of such relationship on smoking behavior. It picks up any discrepancies in responses which might also be important.

It has often been argued that people seek to associate with individuals that are similar to them in characteristics or who tend to be worse(Weinberg, 2005). In Table 4.4 we compare an individuals own behavior with the mean of their nominated friends' behavior. AddHealth allows us to identify the individuals nominated friends and after such identification, the variables pertaining to the friends were constructed. By presenting the data across smoking stages we notice that it is not always the case that individuals associate with people who are worse than them. The mean of the number of days smoked in the last 30 days and the number of cigarettes smoked are more for their friend than the individuals when respondents falls under never smoker, experimental and ex-smoker. For intermittent and regular smoker, however, the reverse is true. From Table 4.4b we can see that individuals at more intense smoking stages have a greater proportion of friends who

are also at high intensity levels of smoking. This shows that besides controlling for the previously utilized measures of friend variables, like self-report of the number of friends who smoke, directly controlling friends behavior in itself is likely to reflect more accurately the influence that are disseminated by an individuals association. Table 4.5 reports means of state level control variables and we find nothing surprising.

Chapter 5

Rational Addiction, Social Learning Theory and Stage Conceptualization of Smoking: The Price-Addiction Nexus of Adolescent Smoking

5.1 Introduction

In this chapter we seek to identify how prices, state policies, peer effects and parental measures affects smoking status. As discussed, prior research has identified prices to be one of the most effective mechanisms to reduce adolescent smoking. However, most of these studies have been limited by their definition of smoking status and their measurement of peer and family effects.

In this study we categorize smokers based on the frequency and intensity of cigarette consumption rather than relying on the traditional definition of smoking which categorizes anyone who smokes one day out of the past thirty day as a smoker. Such definition of smoking is likely to overestimate the price effect and will fail to distinguish between the types of smoker, i.e. someone who smokes infrequently is not the same as someone who smokes regularly, and that is important to identify when seeking to formulate policies aimed at reducing smoking rates. Unlike previous study we do not rely on self-reported peer measures to identify peer effects but rather use the responses of the nominated peers

to categorize their smoking intensity and frequency. This allows us to identify the level of the smoking status of the peers more accurately. Also besides parental smoking status, we control for the parent-child relationship which we measure based on both the adolescent and the parents perspective.

Under such specification we test our addiction model based on both the R-A and the O-Z framework. This allows us to identify that factors that exerts the greatest influence on adolescent smoking and identify those most at risk of making a transition into a regular smoker.

The remainder of the chapter is organized as follows. In the next section we discuss our econometric models in terms of how they were formulated and what we hope to learn from them. Section 5.3 presents our results and finally Section 5.4 offers conclusions and policy implications of our findings.

5.2 Econometric Specifications

Although the rational addiction model has been widely utilized in studying smoking behavior, it has also often been criticized because of its assumption of perfect foresight and time consistent preferences. The implication of such assumption is that, since individuals makes their decision with complete information regarding their addictive tendencies and have preferences which remains unchanged, there is no room for 'learning and regret'. Orphanides and Zervos (1995) accounted for such limitations by incorporating uncertainty into their model of 'rational addiction with learning and regret'. In their model, each individual possesses a subjective belief regarding his or her addictive tendencies and the harmful side effects of consuming an addictive good. This subjective belief is updated via a Bayesian learning process as the consumption of the addictive good continues. An underestimate of addictive tendency can cause an individual to become an addict because of repeated experimentation, whereas, a realization of the addictive tendency will cause the individual to reverse his or her consumption of the potentially addictive good. This incorporation of subjective believes into the rational-addiction framework helps to explain adolescent experimentation and the importance of social network. These two competing conceptual framework provides the basis of our econometric model and estimation strategy. We estimate models that not only allows us to incorporate these two framework but also

allows us to compare our results with previous studies to check for robustness.[1]

5.2.1 Probit Model

Most studies in the literature on cigarette addiction have usually defined smoking as having a cigarette in at least one day out of the past thirty days. Such a definition of smoking has failed to account for the complex nature of smoking behavior that exhibits a wide dispersion of heterogeneity based on the intensity and frequency of smoking. In addition to this, the relative influence of family and peer effects have remained largely overlooked in the literature until recently (Powell et al. 2005, Powell and Chaloupka, 2005). Even when such influences were accounted for, they were not controlled for simultaneously, thus leaving a gap in the literature in modelling the Social Learning Theory when examining smoking behavior.

In our study we run probit estimates based on the widely utilized conventional definition of smoking to check for robustness and compare to prior research. Relying on real average price per pack (including both brand and generic) in cents, we provide estimates of price effects along with conditional demand elasticities under various model specification to examine how such estimates vary when parents and peer effects are accounted for both separately and simultaneously. Such sensitivity analysis will not only help us in capturing the influence of price on smoking behavior, but will also enable us to compare our results with the previous literature.

5.2.2 Ordered Probit Model

One of the ways in which our study differs from the previous literature is our construction of a categorical smoking variable that accounts for the heterogeneity pertaining to the intensity and frequency of cigarette consumption. However, our two competing conceptual frameworks, the R-A model and the O-Z model, have different interpretations regarding our categorical smoking variable.

The terminology of stage conceptualization implies learning and progression into stages

[1]Our purpose here is not to develop an empirical test of the two competing theories as that is beyond the scope of the main contribution of this work which is primarily a policy evaluation. This is a future research agenda that will focus on the empirical test of whether price is a sufficient statistic or not.

which would mean that there is an ordering to the outcome. This is very much in line with the O-Z model that assumes individuals are not aware of their addictive tendencies and progress into being a regular smoker if the awareness of their addictive nature is realized too late. If such an assumption is correct then an ordered probit model is the more accurate model specification. Otherwise, under the R-A model, the multinomial logit model would be more appropriate since each state has an equal probability of occurring holding all else constant (see Section 5.3). Although we are not undertaking a formal test of the two conceptual models, we can compare model fit and performance to draw some inference. Also performing both the multinomial logit and ordered probit model will help us to understand the price effect and the social multiplier effects better. The ordering of our dependent variable is as follows - Never smoker, Ex-smoker, Experimental Smoker, Intermittent Smoker and Regular Smoker.

It is to be noted that since a progression into an ex-smoker could be made from any addictive stage, we are putting it after never smoker based on the number of cigarettes they are likely to have smoked. An ex-smoker by definition has smoked more than never smokers but historically have not smoke as much as the current smokers.

5.2.3 Multinomial Logit Model

Based on the rational addiction model we can say by assumption, that individuals choose a particular stage with full information assumption. In other words, agents choose quantities knowing addictive tendencies. Thus, being categorized as an experimental, intermittent or regular smoker has more to do with the individual's decision to consume a certain amount of cigarettes in a certain frequency rather than a progression through addictive stages with regular smoking being the state characterized with nicotine dependence. Therefore, under the rational addiction model adolescents knowingly choose a quantity of smoking that can be categorized into stages. In that case a multinomial logit model is the appropriate specification to model the behavior.

Under the multinomial model specification, we will also perform our proposed sensitivity analysis to obtain a clearer understanding of how various factors like price, state policies, peer and family influence are affecting the likelihood of being in certain addictive states. We expect such a categorical dependent variable to more accurately capture the affect of price

on smoking behavior and verify whether the previous price estimates were an over estimate since it may be picking up more of the effects on individuals who have a lower propensity to be on a higher addictive stage. Also individuals who are categorized as experimental and intermittent smokers are more likely to be sporadic in their cigarette consumption and thus could be relying on non-commercial sources to obtain their cigarettes, i.e. they could be social smokers and could be borrowing cigarettes from their peers. In such cases we expect the price effects to be insignificant even without controlling for the social learning theory compared to those who are in the regular smoker category.

By analyzing smoking behavior under all these three model specifications we expect to evaluate the effectiveness of price as a smoking reduction mechanism more accurately and also identify the factors that affect the smoking behavior of adolescents more.

5.3 Empirical Results

Results from probit, ordered probit and multinomial logit models are presented in Tables 5.1 through Table 5.5. The dependent variable in the probit analysis is the conventional 0-1 binary smoking status, whereas in the ordered probit model and multinomial logit the dependent variable is smoking stage, with 1 referring to never smokers, 2 to ex-smokers, 3 to experimental, 4 to intermittent and finally 5 to regular established smokers.

5.3.1 Probit Estimates

We run probit models to check for the robustness with the findings of the previous literature. Several models under different specifications were run to see how price effects vary. We report the price effects only, since that is our variable of interest[2].

Model 1 is our benchmark model and its findings are robust to most of the literature that analyzed adolescent smoking behavior after controlling for prices and public policy effects. Under this specification price is negative and significant, implying that an increase in prices are likely to reduce the probability of being a smoker. Model 2 adds parents' characteristics like parents' smoking behavior and indicators for the parent-child relationship. Prices continue to remain significant, verifying the effectiveness of prices to reduce

[2]Full model estimation results are available upon request

adolescent smoking. In Model 3 we control for peer effects using both self-reported and our constructed measures. Price becomes insignificant under this specification. But when the model was estimated with only the self-reported peer measures, the price effect was statistically significant. This is consistent with Powell et al.,(2005). However, self-reported peer measures are not sufficient to capture peer influence and analysis based on only such measures may not be unbiased (Norton et al.,2003). Our result further confers this and lends support to the fact that the effectiveness of prices were overestimated when only self-reported peer measures were utilized. Lastly, from Model 4 we see an insignificant price effect after controlling for both parent and peer effects. This demonstrates, that while states with higher sin taxes are likely to see short run responses among adolescents, what really drives behavior are attributes of adolescents within states, so that prices might be the consequence of problems in the state but not the cure. Also the conventional binary smoking variable is not adequate to capture the complex nature of addiction.

The remaining portion of this section explores our set of control variables in more details, its resulting ramifications on price coefficients and how altering the dependent variable provides more accurate price estimates and explains addiction with more insights. We also compare results using two competing theories that vary in their assumptions about addiction propensities.

5.3.2 Ordered Probit Estimates

From the results of Model 1 we can see that price has a negative and statistically significant coefficient for all stages of smoking expect for never smokers and ex-smokers. This implies that an increase in prices is likely to reduce the probability of progressing into a higher stage of smoking. Other variables like living with both parents, parents' education and religion have a negative and statistically significant relationship, which can be interpreted as an indication that people living with both parents are less likely to be smokers, with parents' education being negatively related to smoking status. Individuals who are more religious are also more likely to not be in a high level smoking category. Although not all state policy variables were statistically significant, some policies like local enforcement of youth access to tobacco, tobacco marketing restrictions were negative and statistically significant. Such results can be the basis of the conclusion, that along with some state policies, prices

are an affective tool to reduce adolescent smoking. This is similar to what Grossman and Chaloupka (1996) found. However, since they did not model the stage conceptualization of smoking, their estimates were larger in magnitude. Another factor that has a significant impact on smoking is alcohol intake. The complementarity between alcohol consumption and smoking has been documented widely in the literature. Our estimates show that a positive relationship exists between smoking and alcohol consumption. Policies that are aimed towards reducing alcohol consumption among adolescents, might also contribute in reducing smoking behavior.

The estimation from Model 2 shows us that both the parent-child indicator has a negative coefficient for all stages of smoking expect for never smokers and ex-smokers, indicating that a better parent-child relation is likely to reduce the probability of being a smoker. The second index is not statistically significant and this could be due to the high statistical significance of the first factor which could be picking up the entire parent-child relationship effect. We can also see that when adolescents have easy access to cigarettes in their home and have parents who smoke, their likelihood of being never smokers decreases and the likelihood of being at higher levels of smoking increases. However, even after controlling for these parent characteristics prices continue to remain negative and significant.

Under the next model specification (Model 3) we control for peer effects. Both self-reported and constructed peer measures were included. Self-reported measures of number of friends smoking at least one cigarette each day, and the number of friends who drinks at least once a month, is positively related to smoking at all levels, i.e. individuals who have friends who smoke and drink are more likely to progress into being a regular smoker. Our constructed peer measure variable of the number of days the respondents friend smoke is significant and positively related to our categorical smoke variable. This is also an indication of peer smoking positively driving the probability of an individual's likelihood of being a regular smoker. From our results we also notice that if an individual has a greater proportion of friends who are non-smokers, their likelihood of progressing into a higher level of smoking decreases. Similarly if an individual has a greater proportion of friends who are experimental and intermittent smoker, it is more likely that they will not progress into higher stages of smoking. Thus having friends who are regular smokers are more likely to influence the probability of transitioning into higher levels of smoking. Note that the proportions of friend who are regular smokers have been dropped due to collinearity. Price

estimates under this model specification ceases to be significant. This is unlike what the previous literature has found. When Powell et al.(2005) and Auld(2005) analyzed the role of peers in influencing adolescent smoking behavior they relied on either school level smoking prevalence or only-self report of the number of smoking friends. They found prices to be negative and significant. When we exclude the constructed peer measures and only control for self-report and state level smoking prevalence among 9 and 12 graders, prices become significant. Thus price estimates were picking up unobserved peer effects, since self-reported peer effects are not likely adequate. One of the problems of having macro-level smoking prevalence, even if it is school specific, is that not everyone in school is an individual's friend, thus a high smoking rate in school does not directly affect someone if a higher proportion of their friends are non-smokers. Norton et al.,(2003) found that self-reported peer measures are inconsistent due to projection of own behavior onto the group, re-scaling the marginal effect of the group and simple random measurement error.

In Model 4 we include parent variables along with our peer variables. Prices are insignificant under this specification for all levels of smoking. This indicates that an adequate measure of the social learning theory significantly reduces the price effect. However, if we did not include the constructed peer measures in our model the price effect would have remained significant. Estimating the same model with only the self-reported peer measures has verified our result. This is an important finding which suggest that merely controlling for the peer effect is not enough even if we are controlling for parents characteristics. It is not just the number of friends who are smoking, but what stage of addiction that the friends are in that is important. This not only highlights the importance of our constructed peer measures but also shows that policy measures without the stage conceptualization of smoking is an overestimate and might not be as effective as it has been perceived to be. We can also infer from this, that more than the parents' behavior, it is ultimately the peer who tend to exert a greater influence.

It has often been said that the effects of peer smoking on an individual's smoking are due to the endogenity of adolescent selection into their peer group. Endogenity of peer selection suggests that adolescents choose peers with similar habits. Norton et al.(1998) using a two-part probit model with neighborhood characteristics as the instruments found peer selection to be not endogenous and peer substance use to have a positive and significant influence on adolescent smoking and drinking behavior. This study further reinforces our

result of a strong peer influence on adolescent smoking.

5.3.3 Multinomial Logit Estimates

It was under the specification of the O-Z model that an ordered probit model was estimated, implying addiction to be an outcome of experimentation with cigarettes resulting in nicotine dependence. Under the multinomial logit model the individual's frequency and intensity of cigarette consumption is a choice rather than a progression leading to the addictive outcome. This is in tune with the R-A model that assumes perfect foresight and full information of the individuals.

Controlling for only price and state variables we can see that prices are not significant for all stages of smoking. With never smoker as our reference group we can see that price is only significant for regular smoker, implying that when adolescents are in their experimentation and intermittent phase, price can do little to detract them. Thus price might not be an effective measure to reduce smoking take-up. Even the significance of prices under regular smoker could mean a decrease in the level of consumption, not necessarily complete withdrawal. But preventing regular smoking is a key target of policy and could suggest some gain from the sin tax. It isn't clear that this will extend in the long run since only non-smokers are less likely to become smokers later. However, like in prior models, significance of price only holds when we omit other related factors.

Similar to the ordered probit model estimates, controlling for self-reported peer measures only, continues to keep prices significant under all smoking stages. This again implies the price effect picking up the unobserved peer effects. Whereas the inclusion of the constructed peer measures makes prices insignificant. Thus irrespective of model specification, peer influence remains to be a more influential factor in adolescent smoking behavior.

With the full model specification, accounting for self-reported peer, constructed peer, parent smoking behavior and parent-child relationship indicator, price effects becomes insignificant. Peer and family variables remains to be significant, thus highlighting the importance of the social learning theory. With only parents and self-reported peer measures, price is only significant for experimental smokers. This is consistent with our story of reversible cigarette consumption patterns during the early stages of addiction being less dependant on prices.

5.3.4 Bivariate Probit

Whether we assume the R-A model or the O-Z model of behavior, when the model is specified to include the social learning theory, price becomes insignificant. This may suggest that price was picking up the direct causes of smoking choices. However, Grossman(1995) pointed out that price effect consists of both a direct effect and an indirect effect operating through the social multipliers. Thus, from a policy perspective, what is more important is that any recommended policy that reduces smoking is acceptable, regardless of whether we have a dominating direct or an indirect effect. In other words if prices become insignificant under the social learning theory and remain significant when it is not controlled for, we cannot claim the ineffectiveness of prices as smoking reduction mechanism, i.e. an increase in price could lead an individual's peer to reduce smoking, which in turn will result in a reduction of the individual's smoking.

Only if an independent peer influence is prevalent irrespective of prices, can we claim that there is an exaggerated price effect when not incorporating the social learning theory. A bivariate probit model was estimated to allow for this simultaneity concern, with the individual's smoking status and the friends smoking status as the dependent variables. In other words, prices could be affecting peer groups simultaneously so that peer effects pick up responses to price. Percentage of the nominated friends' parents smoking status was used as the exclusion variable which effects only peer smoking directly but not the respondents themselves. We were able to create this variable since AddHealth allows us to identify the nominated friends and also has a parent survey. From the bivariate probit estimates we can see that prices are insignificant while the correlation coefficient ρ is significant. This proves that there is an independent peer effect irrespective of prices, suggesting price alone is not a sufficient incentive mechanism for promoting healthier habits.

5.3.5 Elasticities

A higher elasticity corresponds to a bigger price response, which was the pivotal evidence for the advocacy of a price increase to reduce adolescent smoking. However, such measures of elasticity was under the conventional definition of smoking, that was unable to account for the different stages of addiction. We calculate conditional price elasticities of demand for the stages of addiction. In all the cases the elasticity is lower than the conventional one

that only examines quantity independent of addiction stage. This exhibits an overestimation of the price effect that is likely to persist if the stage conceptualization of smoking is not accounted for. This is further evidence that prices may not necessarily be the best policy instrument to reduce adolescent smoking, especially during the initial experimentation stage and when the transition to being a regular smoker has been made. Initial experimentation is undertaken independent of price, as most consumption sources are non-monetary and also when an individual makes a progression into being an established smoker where cigarette consumption is largely driven by nicotine dependence. When individuals are intermittent smokers, an increase in price might lead to a reduction in theory, but no such empirical evidence exist based on our analysis. Even though this stage has a higher elasticity value compared to the experimental and regular stages, it is still significantly lower than the elasticities obtained under the conventional definition of smokers.

5.4 Conclusion & Policy Implication

Prices have emerged as the main policy instrument to reduce adolescent smoking. The vast majority of the literature has found prices to have a significant negative impact on the probability of being a smoker. In this study we analyze the effectiveness of prices as a longer run smoking reduction mechanism by estimating models that incorporate the stage conceptualization models of smoking and Social Learning Theory. This more complete specification of propensity toward addiction was never adopted in any of the previous literature.

Moving beyond the conventional definition of smoking to a definition that recognizes the complex nature of addiction by categorizing smoking into various stages, we learn that prices are necessarily not the most effective instrument to curtail smoking. From the stage conceptualization of smoking model specification we learn that the effect of prices across the different stages are not homogeneous whether we use the Becker-Murphy(1988) rational addiction framework or the Orpahnides and Zervos(1995) framework, the two main theories of addiction in economics. Under the rational addiction framework after controlling for prices and state policies only, we see that prices do not significantly influence the decision to continue to not participate among those who never smoked. It is also insignificant for experimental and intermittent smokers, implying that an increase in prices might do very

little in deterring adolescents to take-up smoking or experimenting with smoking. Even though prices are significant for regular smokers, this cannot be interpreted as a price increase encouraging cessation, but rather it could only mean a decrease in the number of cigarettes consumed. And all effects go away when we include peer(endogenously) and family effects. So unobserved heterogenity is a problem in previous studies. Under the Orphanides and Zervos(1995) rational addiction with learning and regret model, price is significant if the social multiplier effects are controlled for. Prices ceases to be significant under the full model specification(peer and family influence), implying that price effects have no impact on transitions between different stages of smoking.

Adolescent smoking behavior are not only dependent on their own propensity to be an addict, but are also dependent on an extensive array of learning and regret factors that are influenced by their peer and parents. The subjective judgement on the cost and benefits of smoking plays a very significant role in smoking decision. An individula's prior belief on risk and benefits from smoking is a crucial factor in affecting smoking decision, which depends largely on his demographic and other socio-economic characteristics (Lahiri and Song, 2000). The Social Learning Theory states that the interpersonal social relationship in which the individual is fixed is of primary importance in adolescent acquisitions of behaviors and values. Although, peer effects and parental influence were accounted for in the previous literature, they were never controlled for simultaneously. Not controlling for peer effects and parent's influence together has lead to a continued overestimation of the price effect. In our study we control for the social learning theory by adopting several measures that are unlike what was done before in the literature. To control for the measures of social learning we rely not only on the adolescents self-report but also on instruments obtained from the parents survey and constructing peer effects by identifying the individual's nominated friends and using their reports. Relying only on self-reports fails to accurately capture the social learning effect and prices continue to be significant, thus picking up the unobserved peer and family effects that are not adequately captured by self-reports. After adequate controls based on the social learning theory we find insignificant price effects across all stages of smoking. Peer effects and family influence remains significant across all stages of addiction, but however, it is the peer effects which has a more dominating impact.

From our results we can see that relying on prices alone are not sufficient to reduce smoking. Increases in prices will not achieve target efficient reductions of adolescent smok-

ing among those who continue to be around peers who smoke and live in households where access to cigarettes are easy. Thus increased social awareness regarding the adverse effect of smoking is more likely to contribute towards a reduction in smoking.

Chapter 6

Prices & Addictive Propensities: A Dynamic Model of Price & Addiction

In this chapter we examine whether an increase in cigarette price achieves its target policy objective of not only reducing smoking initiation but also eventual addiction. The previous chapter demonstrated that prices might necessarily not be the most effective policy instrument to reduce smoking rates among adolescents who tend to be around peer and parents who smoke and since price elasticities vary substantially between different types of smoker, a price increase will not be target efficient, i.e. reduce smoking among those adolescents who are more likely to be addicted. However, the question of how policies aimed at reducing smoking during adolescents affect smoking pattern when a transition into adulthood is made has not been extensively studied. This chapter attempts to answer that question and evaluate the effectiveness of prices in terms of its ability to impact adult smoking behavior.

Although not quite large in number, there are few studies which undertook examining the impact of prices faced during adolescent on smoking status at a latter period (DeCicca et al., 2002; Glied, 2002). However those studies were mostly limited by their definition of smoking or by their inadequate control of lifetime smoking. DeCicca et al. (2002) only concentrated on individual smoking between 8th and 12th grade, while Glied (2002) categorized anyone who smokes one day of the last thirty days as a smoker. As discussed previously, such a definition is unable to distinguish between the various types of smokers, which might lead to biased estimates. In this paper we utilize the stage conceptualization

of smoking and study whether prices individuals faced during their adolescents affect their adult smoking behavior. Using all three waves of the AddHealth (1994, 1996 and 2002) we estimate an ordered probit model on the effect of 1994 prices on 1996 and 2002 smoking status. Besides this we also estimate a hazard model to examine how prices faced during adolescents affect people's propensity of becoming a regular smoker. Previous studies that estimated smoking behavior under a hazard framework focused only on smoking initiation and/or quitting (Douglas and Hariharan, 1994; Douglas, 1998; Kidd and Hopkins, 2004). The remainder of the chapter is organized as follows. Section 6.2 describes our econometric models and its specifications. Section 6.3 discusses our empirical results and finally Section 6.4 provides conclusions and policy implications.

6.1 Econometric Model

To estimate the effect of prices faced during adolescent on subsequent smoking status we perform multivariate analysis based on an ordered probit and hazard framework. Apart from controlling for prices we also control for state policies, parental smoking, parent-child relationship and peer effects. The state policy and parent-child relationship index was developed based on exploratory factor analysis, where as parental smoking and peer smoking variables are based on self-reports. We test for whether price faced during 1994 affect smoking status in 1996 and 2002, after controlling for these mentioned variables. In 1996 most of our sample was still between 8th and 12th grade were as in 2002 most of the sample was in their mid twenties and have graduated from college. The 1996 estimates will allow us to infer if any short run effect exist due to prices where as the 2002 estimates will allow us to see if such effect persists into adulthood.

6.1.1 Ordered Probit Model of Addiction

The Orphanides and Zervos (1995) model of rational addiction with learning and regret is the basis for estimating an ordered probit model. Under the O-Z model adolescent have heterogeneous capacities for becoming addicted and their subjective assessment of such capacity evolves with experimentation with cigarettes. Thus progression from one stage of smoking into another is a learning process and regret occurs in the event of an irreversible

smoking stage, i.e. addiction. Thus an ordered probit model is an appropriate specification where each choice variable (in this case smoking stage) is not arbitrary but rather a result of their level of experimentation.

The ordered probit model is estimated both for 1996 and 2002 smoking status after controlling for prices, peer effect, parental characteristics and state policy for 1994. This will allow us to identify if prices faced by adolescents have a significant effect on their smoking status if they continue to be around peers and parents who smoke and also help us to understand if peer and family effects exerts an affect that lasts till their adulthood.

6.1.2 Hazard Model of Transitioning into a Regular Smoker

A policy relevant question that is yet to be empirically estimated is whether an increase in price reduces the likelihood of being addicted when transition into adulthood is made. Thus, for policy evaluation, it is important for us to determine whether prices faced during adolescent will influence the probability of becoming a regular smoker. A regular smoker, as defined in our study, is someone who smoked everyday in the past 30 days, and also those who make a transition into being a regular smoker are the ones who were most at risk of addiction in their adolescent.

We formulate a hazard framework were failure is defined as someone making a transition into being a regular smoker and the onset of risk of becoming a regular smoker is instigated when an individual smokes their first cigarette. Thus the analysis time is the period between trying the first cigarette and the time when an individual becomes a regular smoker. The rest of the sections will explain our choice of non-parametric and parametric estimation techniques.

6.1.3 Non-Parametric Estimation

A non-parametric approach, such as the hazard rates, involves estimating the risk of surviving up to a certain period and this is a good starting point for our analysis since it does not require any distributional assumption on the likelihood function. In our model the hazard function h(t) is the probability that an individual becomes a regular smoker in the given analysis time, conditional upon surviving to the beginning of the interval. Thus the hazard rate is given by

$$h(t) = lim_{\triangle t \longrightarrow 0} \frac{Pr(t + \triangle t > T > t | T > t)}{\triangle t} \tag{6.1}$$

where T is a non-negative random variable denoting the duration time and t is the time period when an individual becomes a regular smoker. The hazard rate can vary from zero (no risk at all) to infinity (the certainty of becoming a regular smoker at that instance). Estimating the hazard conditional upon certain covariates like price, peer and parent smoking will give us an intuitive sense of the various control variables on lifetime smoking propensities. However, even though the hazard rate will inform us about the evolution of the risk of becoming a regular smoker, it does not allow us to perform multivariate analysis which will enable us to obtain the coefficient estimates of various control variables. This limitation leads us to our parametric estimations.

6.1.4 Parameteric Estimation

In order to regress a multivariate model under the hazard framework, a functional form of the hazard function must be specified. The choice of an appropriate functional form is very important, since the results may be very sensitive to its distributional assumption. In this chapter, five hazard specifications are adopted: the Weibull distribution, Exponential distribution, Log-normal distribution, Log-logistic distribution and the Gamma distribution.

The Weibull distribution assumes that the log duration follows the Type II extreme-value distribution. The corresponding hazard function is:

$$h_i(t|x_i) = exp(-x_i \frac{\beta}{\sigma}) \frac{1}{\sigma} t^{\frac{1}{\sigma}-1} \tag{6.2}$$

where β and σ are the parameters to be estimated. If sigma is equal to one, the Weibull model is reduced to the exponential model. Estimates under all five distribution is expected to inform us about how the various covariates effect the duration dependence. However, a common approach to employ in order to select a model is the Akaike Information Criteria (AIC)[1](Stata Reference Manual). The AIC is defined as

$$AIC = -2(loglikelihood) + 2(c + p + 1) \tag{6.3}$$

[1]For a more detailed discussion, see Akaike (1974)

where c is the number of model covariates and p is the number of model specific ancillary parameters or distributional parameters. Although the model with the highest likelihood is the best fitting model, the preferred model is the one with the smallest AIC value.

6.2 Empirical Results

6.2.1 Ordered Probit Estimates

Table 6.1a and 6.1b presents results from the ordered probit model with the 1996 smoking status as the dependent variable. From model I in Table 6.1a we can see that the 1994 prices significantly affected 1996 smoking status and the signs are as expected. A positive sign for never smokers and ex-smoker implies that a higher 1994 price will increase the likelihood of remaining a never smoker and ex-smoker in 1996. Where as a negative sign for all other stages implies that a higher price will reduce the probability of progressing into higher stages of smoking. The state policy index is also significant in influencing 1996 smoking status and the signs are similar to those of prices. However, model I did not take the peer and family effects into account. Estimates from model II reported in table 6.1b shows that if adolescents have at least one parent who smokes their propensity of being a never smoker and ex-smoker decreases while the probability of being an experimental, intermittent and regular smoker increases. The significant parent-child relationship index indicates that adolescents who enjoy better relationships with their parents are more likely to be never smoker and their probability of being at a higher stage of smoking decreases. The peer variable indicates that those who have more friends who smoke are likely to be in a higher stage of smoking. But after taking the peer and parents' variable into account we notice that price cease to be significant. This indicates that a price estimate without controlling for peer and family effects are an overestimate. This is consistent with the findings of our previous chapter. Thus prices will be unable to deter people from progressing into higher stages of smoking if they continue to be around peers and parents who smoke and might not enjoy a good relationship with their parents. This also holds true for the policy index, which also becomes statistically insignificant after controlling for the peer and family effects.

Table 6.2a and 6.2b presents estimates with 2002 smoking status as the dependent

variable, when most respondents have made a transition into adulthood. From model I in table 6.2a we can see that prices ceases to have a significant effect on smoking status where as the state policy index continues to exert a significant influence. Thus it can be argued that a state policy which limits access to cigarettes among adolescents will have a lasting impact in influencing smoking rates than a price increase. An increase in price may deter initiation(without controlling for peer and family measures), as our 1996 model suggests, but it cannot prevent eventual addiction. Thus as conjectured before, prices may not be target efficient, i.e. unable to deter smoking among those who are more likely to be addicted. In model II with parents and peer variables we see that the peer and family effects are significant. Thus having parents and friend who smokes during adolescent will have an impact which will persist till adulthood for all types of smokers. Thus, polices that advocate for price increase will not be efficient in reducing smoking rates since most people who have experimented with cigarettes and are around peers and parents who smoke will eventually become addicted. We also notice that the policy index is still significant. Thus limiting access to cigarettes among adolescents is likely to be more effective. So a policy that aims for creating awareness about the adverse effect of cigarettes and which are targeted towards adolescents who are most at risk is more likely to attain a reduction in smoking rates. Therefore, in sum, an increase in price may be unable to delay initiation among adolescents who are around peer and parents who smoke and also it is unable to prevent eventual addiction, which is widely considered to hold true among proponents of price advocates.

6.2.2 Hazard Estimates

Multivariate analyses based on the hazard framework were estimated to examine how prices faced during adolescents affects the lifetime propensities of becoming a regular smoker. Figure 6.1 illustrates the hazard of smoking initiation and we can see that it reaches a peak when individuals are between 15 - 17 years of age. This has lead many studies to suggest that high prices faced during adolescents will deter initiation, which in turn will also reduce the propensity of ever becoming a regular smoker. To test this assumption will be the pivotal purpose of our hazard framework.

Figure 6.2 illustrates the hazard of becoming a regular smoker. We can see that the

hazard reached its peak for individual after five years of trying their first cigarette. From then on it experienced a steady decline but started to rise once again during a person's middle years and then declined. This demonstrates that a learning mechanism is at work that induces a person to become a regular smoker. So a person might not become a regular smoker the instance he/she tries their first cigarette, but might progress into becoming one after some time, maybe due to continued experimentation. The rise in the hazard during the middle years means that those who experimented with cigarettes might becoming a regular smoker once they start their professional careers or are near finishing their formal years of schooling. Both of these instances are highly correlated with an increase in stress levels which could be contributing to the increase in the hazard rates. This provides further evidence that an increase in price experienced during adolescent years might not deter eventual addiction given the learning mechanism that is involved with becoming a regular smoker.

From figure 6.3 we can see that although those individuals who faced prices which were higher than the national average prices have a lower risk of becoming a regular smoker during the earlier duration periods, but such risk converges with the risk of those who faced either prices which were below or equal to the national average. This illustrates that the benefits of price increase will not have a lasting impact and thus individuals who are more prone to addiction will eventually become addicted irrespective of the prices.

Figure 6.4 and 6.5 shows that the hazard rate by parents and peers smoking. From these diagrams we can notice that individuals who have more friends who smoke and who have parents who smoked during adolescent will always have a higher risk of becoming a regular smoker and such risks will persist into adulthood. Therefore, people who are around smokers will exhibit a higher probability of becoming a regular smoker, with prices having a very little effect.

Even though our non-parametric estimates demonstrated a stronger evidence of peer and family effects than prices, we need to estimate a multivariate analysis to obtain accurate estimates of how all these covariates affects the duration till becoming of a regular smoker. Table 6.3 presents our parametric estimation results.

The reported coefficients are reported log of duration before becoming a regular smoker for each of these observed characteristics. The explanatory variables included in the estimates besides parents, peers, prices, state policy and demography variables are indicator

of whether adolescents have easy access to cigarettes.

The interpretation of the reported coefficients deserves some attention. For example, consider the coefficient estimate of -0.409 on 'peer smoke' under the Weibull distribution. The coefficient means that the predicted log of years before becoming a regular smoker for an individual who has more friends who smoke is 0.409 lower than an individual who has less friends who smoke but has the same other characteristics. This indicates that on average individuals with more smoker friends has higher likelihood of becoming a regular smoker.

Alternatively, the hazard rates can be calculated for each of these variables. For example, the hazard rate of the 'peer smoke' coefficient is 1.57. This means that on average individuals with more friends who smoke are 57 percent more likely to become regular smoker than someone who has fewer friends who smoke [2].

Overall, under all the distributional assumption prices remain to be insignificant where as peer and parents continue to be significant. This confirms our hypothesis of friends and family exerting a greater influence on peoples smoking status than prices. State policy index and easy access to cigarettes all lend support to our claim that restricting access to cigarettes among adolescents coupled with creating more awareness about the adverse consequences of smoking will have a more lasting impact that an increase in prices. Prices and state policies may however be collinear, i.e. states with higher tax rates (which translates into higher prices) may be the states with the strictest anti-smoking polices and this could lead to an underestimation of the price effect. To check for whether the policy index is picking up the price effects, we estimated the model without the policy index. Prices continue to remain insignificant even without the policy index. This reflects that the price effect are not an underestimation[3].

Even though almost all the coefficients under the five distributional assumptions have given us the same estimates in terms of the sign and statistical significance, we must select the most appropriate model to identify the most accurate estimates of the covariates. Table 6.4 presents the AIC index of each model. From there we can see that the mode estimated

[2]The hazard rates under the Weibull and Exponential distributional assumptions are provided in the Appendix 3.

[3]The estimation result without the policy index is provided in Appendix 4 for the best fitted model under the AIC index.

under the Log-Normal distribution has the least AIC index and therefore is our preferred model.

6.3 Conclusion & Policy Implication

Our purpose in this study was to determine whether prices that individuals face during their adolescent affect their propensities of addiction, i.e. does an increase in price during adolescent (the period during which the hazard of initiation is the highest) reduce the lifetime probability of becoming a smoker. Utilizing an ordered probit model we found that prices have an impact that is expected to last in the short run but is not likely to persist till adulthood. Thus even if prices delay initiation, it cannot prevent eventual addiction. Whereas peer effects instigates an affect that lasts till adulthood and individuals who have more friends who are smokers are more likely to progress into higher stages of smoking. The same holds true for parental smoking status, while a better parent-child relationship is more likely to prevent someone from making a transition into a higher stage of smoking. State policies that limits the availability of cigarettes among adolescents and discourages its usage exhibits an effect that persists into adulthood. Thus an increase in prices will not have a significant effect in reducing smoking rates and attain its policy objective of reducing smoking among those who has a higher propensity of addiction.

From our hazard estimates we learned that price effect will eventually decline as transition into adulthood is made, thus having a negligible impact on propensity of becoming a regular smoker. Where as, the peer and parental smoking status exerts an affect that has more persistent long run impact. Therefore, a policy of price increase to reduce smoking rates is not target efficient since it fails to alter the risk of addiction among those who has the highest propensity of addiction, i.e. the regular smokers. Adolescents who have easier access to cigarettes are also likely to exhibit higher propensity of becoming a regular smoker.

Our results indicates that price increase as a policy to reduce smoking rates will not achieve its target objective, where as policies that are designed to create more awareness about the adverse consequences of smoking especially aimed towards the more at risk groups will attain the goal of achieving an overall reduction in smoking rates. Significant effects of peer and parental smoking along with parent-child relationship on lifetime smoking rates

are evidence of that. A better parent-child relationship is an indicator that information regarding the adverse effects of smoking passed on through parents will be more receptive among adolescents. Policies that are designed to limit access to cigarettes and discourage its usage will also be effective in reducing the smoking rates. Thus, price as a policy is not the most effective mechanism to reduce lifetime smoking rates.

Chapter 7

Conclusion and Policy Implications

This thesis examines the effectiveness of prices as a policy mechanism to induce a reduction in both smoking take-up rate and eventual addiction among adolescents. By combining the Social Learning Theory and Stage Conceptualization of Smoking in both a cross-section and a longitudinal dynamic model of addiction we were able to provide accurate estimates regarding the effectiveness of prices as a policy tool. Besides this, we were also able to identify the factors that may exert a greater effect in influencing an adolescent's decision to become a smoker.

After categorizing smokers based on their smoking intensity and frequency we found that the price effects are not homogeneous across different stages of addiction. Thus estimates in the previous literature provided an average effect of prices which are unlikely to translate into lower smoking rates especially among the at-risk group of adolescents. Incorporation of the Social Learning Theory revealed that adolescents are more responsive to their peers and family. Thus an increase in price will be unable to delay initiation or prevent eventual addiction among adolescents who continue to be around peers and parents who smokes. Besides parents' smoking status, a parent-child relationship is vital in influencing addiction. Adolescents who enjoys a better relationship with their parents are less likely to be smokers. This also reflects the effectiveness of smoking awareness methodology to be an effective smoking deterring mechanism given that knowledge about the adverse health consequences of smoking are disseminated mostly to adolescents through parents and children who have a better relationship with their parents will be more receptive to such information.

A significant contribution of this study is policy evaluation based on a dynamic mode of addiction which provides estimates based on following adolescents till they make a transition into their adulthood. Based on a hazard framework by following people into their adulthood we find that although prices may exert some short-run influence in terms of a lower hazard of addiction among those who faced higher prices, but however, such effect goes away as progression into adulthood is made. However, the influence that peers and family exert as adolescent remains till the adulthood and we see that people who had fewer friends who smoked and had parents who were not smokers during their adolescent years have a lower hazard of addiction that persists throughout their lifetime.

These findings raises concern that prices alone may not be enough to reduce adolescent smoking. In our study we find that state policy variables that are designed to restrict adolescent access to cigarettes and discourage its consumption exerts an influence that persist till adulthood. Thus more rigorous state policies aimed at restricting access and discourage usage might yield more dividends in terms of lower long term addiction rates. However, such policy has to be target specific, i.e., designed to target various smokers at various stages of addiction.

In short, our findings suggest that given the long-term policy objective is to reduce adverse health consequences related to cigarette consumption, reliance on an increased prices via taxation may not yield the desired results. This is especially true, given the recent decline in smoking rates in the United States has been because of more people quitting after experiencing dire smoking related health consequences. Adolescent experimentation with cigarette is still widely prevalent and this makes them one of the most important demographic group for policy focus. A target specific smoking awareness policy may have a more lasting impact on adolescents.

Bibliography

[1] H. Akaike. A new look at the statistical model identification. *IEEE Transaction and Automatic Control*, AC-19:716–723, 1974.

[2] C. Alexander, Piazza. M., D. Mekos, and T. Valente. Peers, schools and adolescent cigarette smoking. *Journal of Adolescent Health*, 29:22–30, 2001.

[3] Costello B. Anna and Jason W. Osborne. Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assesment, Research and Evaluation*, 10(7):1–9, 2005.

[4] C. Auld. Causal effect of early initiation on adolescent smoking patterns. *Canadina Journal of Economics*, In Press, 2005.

[5] A. Bandura. Social-learning theory of identificatory processes. In McNally R. Goslin, D., editor, *Handbook of Socialization Theory and Research*. 1969.

[6] M. Bask and M. Melkersson. Rationally addicted to drinking and smoking. *Applied Economics*, 36:373–381, 2004.

[7] G. Becker, M. Grossman, and K. Murphy. An empirical analysis of cigarette addiction. *American Economic Review*, 84(3):396–418, 1994.

[8] G. Becker and K. Murphy. A theory of rational addiction. *Journal of Political Economy*, 96(4):756–700, 1988.

[9] R. Burges and R. Akers. A differential association-reinforcement theory of criminal behavior. *Social Problems*, 14:128–147, 1966.

[10] J. Cawley, S. Markowitz, and J. Tauras. Lighting up and slimming down: The effects of body weight on adolescent smoking initiation. *Journal of Health Economics*, 23(2): 293–311, 2004.

[11] F. Chaloupka. Rational addictive behavior and cigarette smoking. *Journal of Political Economy*, 99(4):722–742, 1991.

[12] F. Chaloupka and M. Grossman. Prices, tobacco control policies and youth smoking. *NBER Working Paper*, 5740, 1996.

[13] F. Chaloupka, J. Tauras, and M. Grossman. Public policy and youth smokeless tobacco use. *Southern Economic Journal*, 64(2):503–516, 1997.

[14] F. Chaloupka and K. Warner. The economics of smoking. In Newhouse J. Culyer, A., editor, *Handbook of Health Economics Volume 1B*. North-Holland, 2000.

[15] F. Chaloupka and H. Wechsler. Price, tobacco control policies and smoking among young adults. *Journal of Health Economics*, 64(2):503–516, 1997.

[16] W. Choi, J. Pierce, E. Gilpin, A. Farkas, and C. Berry. Which adolescent experimenters progress to established smoking in the united states. *American Journal of Preventive Medicine*, 13(5):385–391, 1997.

[17] P. DeCicca, D. Kenkel, and A. Mathios. Putting out the fires: Will higher taxes reduce the onset of youth smoking. *Journal of Political Economy*, 110(1):144–169, 2002.

[18] S. Douglas. The duration of smoking habit. *Economic Inquiry*, 36(1):49–64, 1998.

[19] S. Douglas and G. Hariharan. The hazard of starting smoking: Estimates from a split population duration model. *Journal of Health Economics*, 13(2):213–230, 1994.

[20] S. Emery, M. White, and J. Pierce. Does cigarette prices influence adolescent experimentation?. *Journal of Health Economics*, 20:261–270, 2001.

[21] S. Ennett, K. Bauman, V. Foshee, M. Pemberton, and K. Hicks. Parent-child communication about adolescent tobacco and alcohol use: What do parents say and does it affect youth behavior?. *Journal of Marriage and Family*, 63:48–62, 2001.

[22] W. Evan and L. Huang. Cigarette taxes and teen smoking: New evidence from panels of repeated cross-sections. *American Economics Association Annual Meeting*, Chicago (IL), 1998.

[23] S. Glied. Youth tobacco control: Reconciling theory and empirical evidence. *Journal of Health Economics*, 21(1):117–135, 2002.

[24] M. Grossman. The economic approach to addictive behavior. In Leruill K. Tommasi, M., editor, *The New Economics of Human Behavior*. Cambridge University Press, 1995.

[25] M. Grossman, D. Coate, E. Lewit, and R. Shakotko. Economic and other factor in youth smoking. *National Science Foundation*, Washington, 1983.

[26] J. Harris and S. Chang. The continum of addiction: Cigarette smoking in relation to price among americans aged 15-29. *Health Economics*, 8(1):81–86, 1999.

[27] A. Jones and M. Forster. The role of taxes in starting and quitting smoking: Duration analysis of british data. *Journal of Royal Statistical Society*, 164(Series A):517–547, 2001.

[28] B. Karuth. Peer selection effects on smoking among canadian youth. *Canadian Journal of Economics*, 38(3):735–757, 2005.

[29] Michael P. Kidd and Sandra Hopkins. The hazards of starting and quitting smoking: Some australian evidence. *The Economic Record*, 80(249):177–192, 2004.

[30] K. Lahiri and J. Song. The effect of smoking on health using a sequential self-selection model. *Health Economics*, 9:491–511, 2000.

[31] E. Lewit and D. Coate. The potential for using excise taxes to reduce smoking. *Journal of Health Economics*, 1(2):121–145, 1982.

[32] E. Lewit, D. Coate, and M. Grossman. The effect of government regulation on teen smoking. *Journal of Law and Economics*, 4(3):121–145, 1981.

[33] L. Liang, F. Chaloupka, M. Nichter, and R. Clayton. Prices, policies and youth smoking. *Addiction*, 98(1):105–122, 2001.

[34] E. Lloyd-Richardson, G. Papandonatos, A. Kazura, C. Stanton, and R. Niaura. Differentiating stages of smoking intensity among adolescents: Stage-specific psychological and social influences. *Journal of Consulting and Clinical Pyschology*, 70(4):998–1009, 2002.

[35] K. Mayhew, B. Flay, and J. Mott. Stages in the development of adolescent smoking. *Drug and Alcohol Dependence*, S9(1):S61–S81, 2000.

[36] E. Norton, R. Lindrooth, and S. Ennett. How measures of perception from survey data lead to inconsistent regression results: Evidence from adolescent and peer substance use. *Health Economics*, 12:139–148, 2003.

[37] E. Norton, R. Lindrooth, and Ennett S. Controlling for the endogenity of peer substance use on adolescent alcohol and tobacco use. *Health Economics*, 7:439–453, 1998.

[38] A. Orpahnides and D. Zervos. Rational addiction with learning and regret. *Journal of Political Economy*, 103(4):739–758, 1995.

[39] J. Petraits, B. Flay, and T. Miller. Reviewing theories of adolescent substance use: Organizing pieces in the puzzel. *Psychology Bulletin*, 117:67–86, 1995.

[40] L. Powell and F. Chaloupka. Parents, public policy and youth smoking. *Journal of Policy Analysis and Management*, 24(1):93–112, 2005.

[41] L. Powell, J. Tauras, and H. Ross. The importance of peer effects, cigarette prices and tobacco control policies for youth smoking behavior. *Journal of Health Economics*, 24:950–968, 2005.

[42] H. Ross and F. Chaloupka. The effect of cigarette prices on youth smoking. *Health Economics*, 12:217–230, 2003.

[43] H. Ross and F. Chaloupka. The effect of public polices and prices on youth smoking. *Southern Economic Journal*, 70(4):796–815, 2004.

[44] H. Ross, F. Chaloupka, and M. Wakefield. Youth smoking uptake process: Prices and public policy effects. *Eastern Economic Journal*, 32(2):355–367, 2006.

[45] E. Sutherland. In Third Edition, editor, *Principals of Criminology*. Philadelphia Lippincott, 1939.

[46] J. Tauras. Can public policy deter smoking escalation among young adults?. *Journal of Policy Analysis and Management*, 24(4):771–784, 2005.

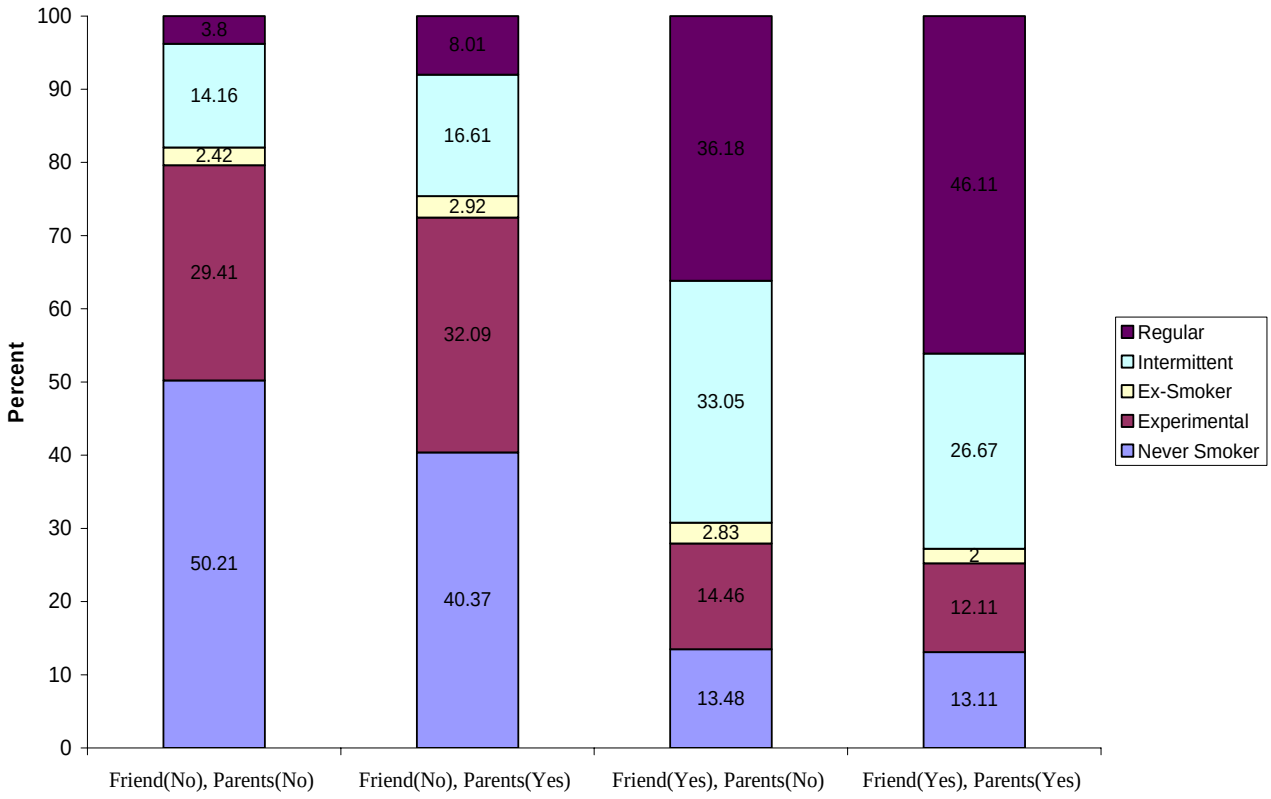
[47] J. Tauras and F. Chaloupka. Price, clean indoor air laws, and cigarette smoking: Evidence from longtitudinal data for young adults. *NBER Working Paper*, 6937, 1999.

[48] J. Tauras, P. Malley, and L. Johnston. Effects of prices and access laws on teen smoking initiation: A national longitudinal analysis. *NBER Working Paper*, 8331, 2001.

[49] J. Wasserman, W. Manning, J. Newhouse, and J. Winkler. The effect of excise taxes and regulations on cigarette smoking. *Journal of Health Economics*, 10:43–64, 1991.

[50] B. Weinberg. Social interactions and endogenous association. *Ohio State University*, Working Paper, 2005.

Figure 4.1: Peer and Family Effects by Smoking Stage



Friend: Does the respondent have 3 or more friends who smoke daily (no = 0 – 2 friends who smokes daily).
Parent: Does at least one of the parents of the respondent smoke.

Figure 4.2: Factor Analysis for State Policy Variables

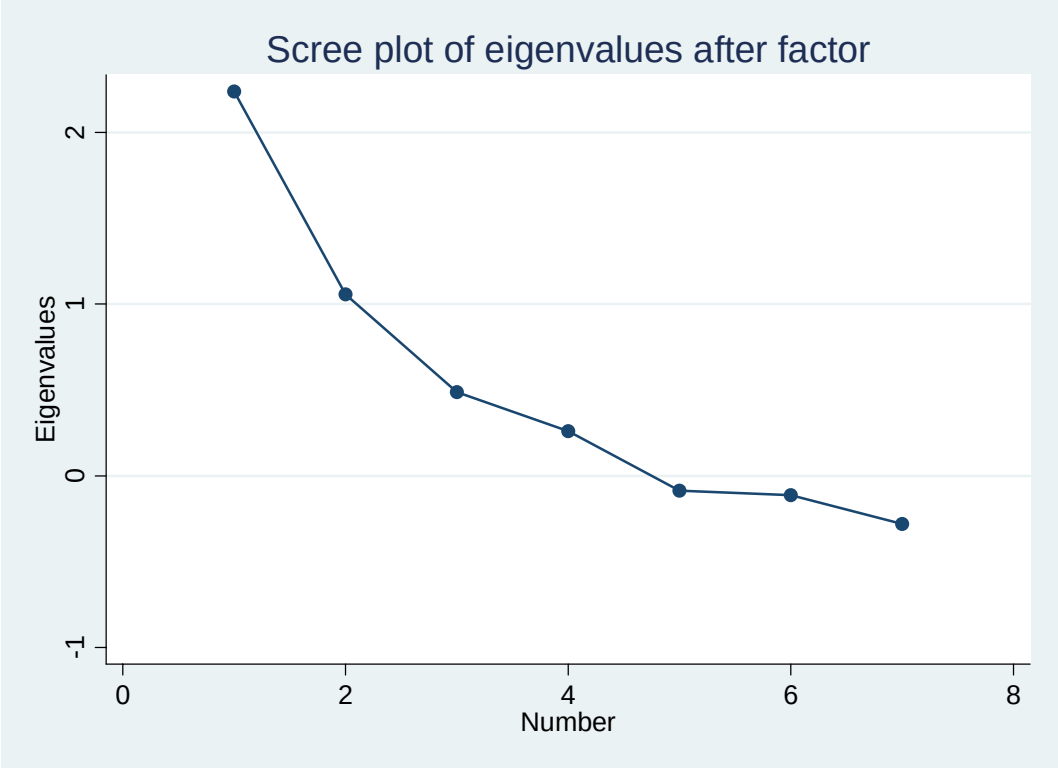


Figure 4.3 Factor Analysis for Parent-Child Relationship

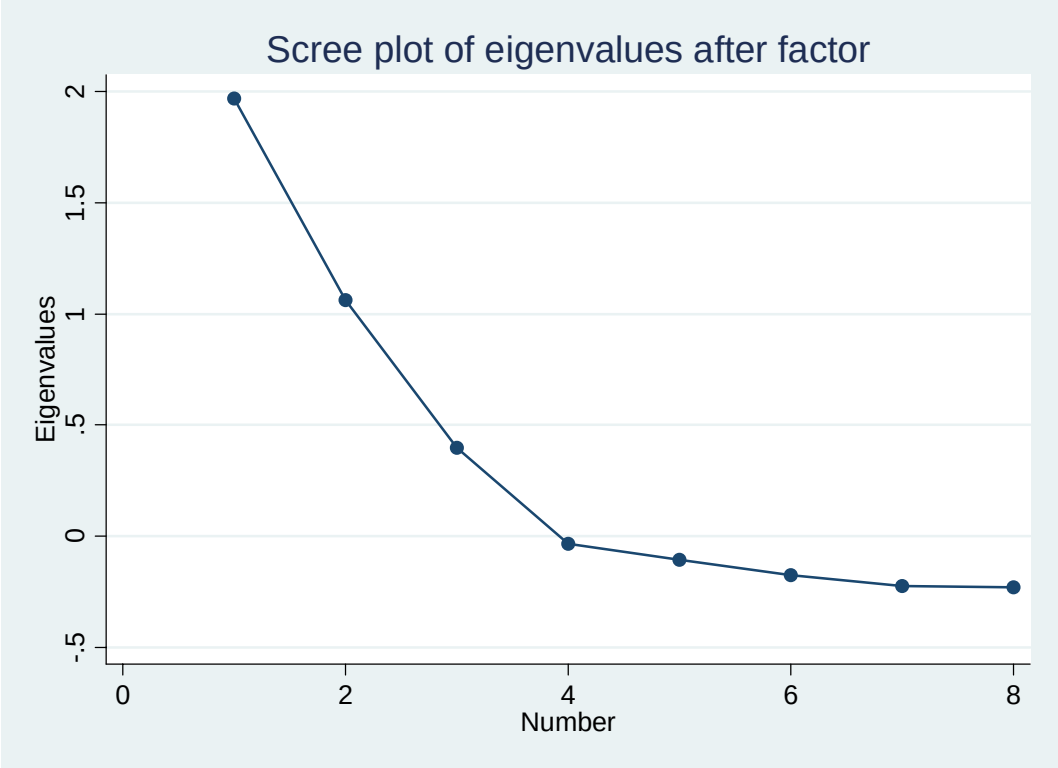


Table 4.1: Stage Conceptualized Smoking vs. Conventional Smoking

	Never Smoker	Experimental	Intermittent	Regular	Ex-Smoker
Conventional Smoker: No (%)	59.07	37.52	-	-	3.41
Conventional Smoker: Yes (%)	-	-	65.22	34.78	-

Table 4.2: Descriptive Statistics by Smoking Stage

Variables (%)	Total Sample *N = 20,745*	Never smoker *N = 9,081*	Experimental *N = 5,813*	Intermittent *N = 3,458*	Regular *N = 1,868*	Ex-smoker *N = 525*
Demography						
Mean Age	15.15	14.87	15.19	15.33	15.91	15.59
				Total % of:		
Gender:						
Male	49.47	43.84	27.68	16.91	9.24	2.34
Female	50.52	43.71	28.35	16.44	8.78	2.72
Race:						
White	51.87	37.42	25.70	19.80	13.73	3.35
Black	22.33	55.26	31.15	10.92	1.68	0.99
Hispanic	16.54	45.23	31.22	15.94	5.39	2.22
Asian	7.64	51.26	27.27	13.64	5.81	2.02
Other	1.62	38.69	30.06	17.26	10.71	3.27
Grade:						
7	13.45	60.35	25.07	11.49	2.14	0.96
8	13.46	49.67	27.78	15.97	4.45	2.13
9	17.93	42.40	27.96	17.60	9.36	2.68
10	19.65	40.26	29.87	18.02	8.87	2.97
11	18.87	38.62	28.59	18.01	12.00	2.78
12	16.63	37.96	29.08	16.90	12.93	3.13
Alcohol						
Never drink	43.57	69.20	22.03	6.08	1.84	0.85
Never in the past 12 months	9.37	40.71	39.98	10.62	4.89	3.80
1 or 2 days in the past 12 months	17.10	29.04	38.53	19.94	8.96	3.54
1 day per month in the past 12 months	12.17	17.96	33.04	29.67	15.08	4.25
2 days per month in the past 12 months	17.79	12.95	23.61	34.50	24.93	4.00
Peer Variables						
Peer Smoking:						
No friends smoke	54.89	57.91	31.28	7.87	1.14	1.80
1 friend smoke	20.83	35.13	30.90	24.11	6.22	3.64
2 friend smoke	11.84	21.00	23.24	32.02	19.42	4.32
3+ friend smoke	12.44	13.35	13.62	30.77	39.72	2.53
Peer Drinking:						
No friends drinks	44.02	62.13	26.50	7.47	2.49	1.41
1 friend drinks	21.32	38.53	33.33	17.48	7.44	3.21
2 friend drinks	14.54	27.69	30.06	25.89	12.50	3.86
3+ friend drinks	20.12	18.23	24.64	30.52	23.10	3.50

Table 2: Descriptive Statistics by Smoking Stage (Contd.)

Variables (%)	Total Sample *N = 20,745*	Never smoker *N = 9,081*	Experimental *N = 5,813*	Intermittent *N = 3,458*	Regular *N = 1,868*	Ex-smoker *N = 525*
			Total % of:			
Parent Variables						
Lives with both biological parents:						
No	50.16	39.78	29.18	16.98	11.31	2.76
Yes	49.84	47.80	26.86	16.36	6.68	2.30
Mothers Education:						
Less than high school	21.01	42.35	29.78	16.83	8.92	2.13
Just high school	52.83	42.65	28.24	17.18	9.45	2.48
College and more	26.16	49.34	26.87	15.34	5.94	2.51
Fathers Education						
Less than high school	21.33	42.53	29.50	17.12	8.36	2.50
Just high school	48.53	43.13	27.53	17.21	9.60	2.52
College and more	30.14	49.61	25.68	16.20	5.90	2.62
Parent Smoke:						
No	75.86	46.42	27.87	16.11	7.14	2.46
Yes	24.14	35.47	28.50	18.41	14.86	2.76
Parent Alcohol Consumption - Never Drink:						
No	61.63	40.64	28.10	18.24	10.36	2.67
Yes	38.37	48.81	27.89	14.15	6.84	2.31
Drink more than 2 days per week:						
No	88.93	44.55	28.14	16.26	8.58	2.47
Yes	11.07	37.54	27.05	19.99	12.41	3.01

Table 4.3: Relation with Parents by Smoking Status

Variables (%)	Full Sample *N = 20, 745*	Never Smoker *N =9,081*	Experimental *N = 5,813*	Intermittent *N = 3,458*	Regular *N = 1,868*	Ex-Smoker *N = 525*
				Respondents *Total % of:*		
Parents Care:						
No	4.44	36.83	22.95	20.98	15.63	3.61
Yes	95.56	43.88	28.39	16.53	8.71	2.48
Parents Understand:						
No	45.79	34.95	28.87	20.29	12.67	3.23
Yes	54.21	50.80	27.53	13.76	5.95	1.95
Parents Pays Attention:						
No	30.30	33.82	29.69	20.81	12.41	3.27
Yes	69.70	47.79	27.50	14.99	7.52	2.19
Communicate:						
No	16.38	33.13	28.27	20.15	14.83	3.62
Yes	83.62	45.86	27.97	15.99	7.86	2.32
Talk:						
No	13.19	34.16	25.83	20.28	15.71	4.02
Yes	86.81	45.24	28.35	16.12	7.99	2.30
				Parents *Total % of:*		
Get Along:						
No	12.43	34.72	28.29	20.18	14.49	2.32
Yes	87.57	45.37	27.98	16.14	7.97	2.54
Understand:						
No	11.75	39.75	27.44	17.21	13.14	2.47
Yes	88.25	44.62	28.15	16.52	8.18	2.53
Trust:						
No	18.04	31.22	26.13	23.17	16.71	2.77
Yes	81.96	46.89	28.41	15.21	7.04	2.46

Table 4.4a: Comparison of Smoking & Drinking Characteristics with Friends

Variables Mean (Std. dev)	Never Smoker		Experimental		Intermittent		Regular		Ex-Smoker	
	Own	Friend	Own	Friend	Own	Friend	Own	Friend	Own	Friend
Days smoked	0	1.93	0.12	3.30	9.03	6.99	30	15.57	0	5.86
	(0)	(5.41)	(0.74)	(7.28)	(8.86)	(9.69)	(0)	(11.77)	(0)	(9.50)
Cig. smoked	0	1.18	0.08	1.67	3.38	3.07	12.49	7.51	0	2.95
	(0)	(6.37)	(0.97)	(6.32)	(5.23)	(6.69)	(9.01)	(9.23)	(0)	(8.92)

Table 4.4b: Comparison of Friends Smoking Stage

Variables	Never Smoker	Experimental	Intermittent	Regular	Ex-Smoker
Proportion Never Smoker	69.04	56.96	39.57	33.79	39.54
Proportion Experimental	13.37	17.22	14.72	8.60	19.61
Proportion Intermittent	12.92	17.46	29.52	26.46	25.69
Proportion Regular	3.34	6.38	13.77	42.20	10.17
Proportion Ex-Smoker	1.33	1.98	2.42	1.51	4.99

Table 4.5: Descriptive Statistics (Economic, Census, Policy)

Variables Mean (Std. dev)	Level of Measurement	Never Smoker	Experimental	Intermittent	Regular	Ex-Smoker
Economic Variables						
Cigarette Price (cents)	State	209.29 (24.69)	208.14 (25.13)	207.33 (25.86)	204.17 (25.92)	206.17 (27.07)
Excise Tax (cents)	State	32.97 (15.51)	32.67 (16.31)	32.69 (16.73)	33.47 (17.99)	32.37 (18.15)
Census Variables						
Median Household Income	County	30387.84 (7924.01)	30328.13 (7800.23)	30560.67 (7861.67)	30442.08 (7533.31)	30631.49 (8114.15)
Population Density (person/sq.km)	County	0.66 (1.73)	0.60 (1.92)	0.51 (1.37)	0.43 (1.32)	0.64 (1.92)
% of 18 and older smoking	State	22.87 (2.70)	23.01 (2.73)	23.20 (2.62)	23.66 (2.62)	23.34 (2.95)
% in grades 9 to 12 smoking	State	13.82 (2.56)	13.88 (2.69)	14.11 (2.76)	14.58 (2.62)	14.17 (2.95)
Policy Variables						
Vending Machine Banned	State	0.36 (0.48)	0.35 (0.48)	0.36 (0.48)	0.33 (0.47)	0.38 (0.49)
Marketing Restrictions	State	0.92 (0.27)	0.92 (0.27)	0.93 (0.26)	0.92 (0.27)	0.91 (0.28)
Billboard Restrictions	State	0.41 (0.49)	0.41 (0.49)	0.38 (0.49)	0.31 (0.46)	0.39 (0.49)
Public Transportations Restrictions	State	0.18 (0.39)	0.18 (0.38)	0.16 (0.37)	0.08 (0.26)	0.16 (0.37)
Free Sample Prohibited	State	0.78 (0.41)	0.80 (0.40)	0.83 (0.38)	0.82 (0.38)	0.83 (0.38)
Tobacco Law Enforcement Programs	State	0.88 (0.33)	0.87 (0.33)	0.87 (0.34)	0.85 (0.36)	0.87 (0.34)
Locally Enforced Youth Access	State	0.71 (0.45)	0.70 (0.46)	0.70 (0.46)	0.76 (0.43)	0.65 (0.48)
Smoking Restricted on school campus for both students and teachers	School	0.82 (0.38)	0.81 (0.39)	0.77 (0.42)	0.75 (0.43)	0.83 (0.37)
Alcohol and Drug use Prevention by School	State	0.72 (0.45)	0.69 (0.46)	0.70 (0.46)	0.75 (0.43)	0.68 (0.47)
Tobacco use Prevention by School	State	0.71 (0.45)	0.70 (0.46)	0.71 (0.45)	0.78 (0.42)	0.69 (0.46)

Table 5.1: Probit Estimates (Marginal Effects) based on Conventional Smoking

Variables	Model 1	Model 2	Model 3	Model 4
Price	-0.0003*** (0.0002)	-0.0005** (0.0002)	-0.0002 (0.0004)	-0.0002 (0.0005)

* - sig. at the 1% level; ** - sig. at the 5% level; *** - sig. at the 10% level.

Table 5.2a: Ordered Probit Estimates based on Smoking Stages

Variables	Model 1: Price & State Policies LR Chi2: 2079.80 Log Likelihood: -25362.95 N: 19,988				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.0004**	$3.53e^{-06}$**	-0.00009**	-0.0002**	-0.0001**
	(0.0002)	(0.0000)	(0.00004)	(0.0001)	(0.0000)
Policy Measures:					
Marketing	-0.013	-0.0001	0.003	0.006	0.004
Restrictions	(0.019)	(0.0001)	(0.005)	(0.009)	(0.007)
Local	0.012	0.0001	-0.002	-0.005	-0.004
Enforcement	(0.011)	(0.0001)	(0.002)	(0.005)	(0.004)
School Restriction	-	-	-	-	-
Census Measures:					
9 to 12 Grade Smoking Prevalence	-	-	-	-	-
Parent Characteristics:					
Mother Smoke	-	-	-	-	-
Father Smoke	-	-	-	-	-
Relation with Parents:					
Index 1	-	-	-	-	-
Index 2	-	-	-	-	-
Peer Variables:					
Peer Smoke	-	-	-	-	-
Peer Drink	-	-	-	-	-
Cigarettes Day	-	-	-	-	-
Cigarettes	-	-	-	-	-
Proportion Never Smoker	-	-	-	-	-
Proportion Ex-Smoker	-	-	-	-	-
Proportion Experimental	-	-	-	-	-
Proportion Intermittent	-	-	-	-	-
Others:					
Religious	0.092*	0.0009*	-0.018*	-0.041**	-0.033*
	(0.006)	(0.0001)	(0.001)	(0.003)	(0.002)
Alcohol	-	-	-	-	-
Easy Access	-	-	-	-	-

Table 5.2b: Ordered Probit Estimates based on Smoking Stages

Variables	Model 2: Price, State Policies & Parents LR Chi2: 7280.51 Log Likelihood: -22762.60 N: 19,988				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.001*	$8.06e^{-06}$*	-0.0002*	-0.0003*	-0.0001*
	(0.000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)
Policy Measures:					
Marketing	-0.010	0.0001	0.003	0.005	0.002
Restrictions	(0.021)	(0.0002)	(0.006)	(0.010)	(0.005)
Local Enforcement	0.015	0.0002	-0.004	-0.007	-0.003
	(0.015)	(0.0002)	(0.004)	(0.007)	(0.004)
School Restriction	0.027*	0.0004**	-0.007*	-0.013*	-0.007*
	(0.009)	(0.0002)	(0.002)	(0.005)	(0.002)
Census Measures:					
9 to 12 Grade	-0.004**	-0.00005**	0.001**	-0.002**	0.001**
Smoking Prevalence	(0.001)	(0.00002)	(0.0004)	(0.001)	(0.0003)
Parent Characteristics:					
Mother Smoke	-0.063	-0.001*	0.018*	0.031*	0.015*
	(0.009)	(0.0002)	(0.003)	(0.005)	(0.002)
Father Smoke	-0.071*	-0.001*	0.019*	0.035*	0.017*
	(0.009)	(0.0002)	(0.003)	(0.005)	(0.002)
Relation with Parents:					
Index 1	0.045*	0.001*	-0.013*	-0.022*	-0.010*
	(0.004)	(0.00007)	(0.001)	(0.002)	(0.001)
Index 2	0.007	0.0001	-0.002***	-0.003***	-0.002**
	(0.004)	(0.0001)	(0.001)	(0.002)	(0.001)
Peer Variables:					
Peer Smoke	-	-	-	-	-
Peer Drink	-	-	-	-	-
Cigarettes Day	-	-	-	-	-
Cigarettes	-	-	-	-	-
Proportion Never Smoker	-	-	-	-	-
Proportion Ex-Smoker	-	-	-	-	-
Proportion Experimental	-	-	-	-	-
Proportion Intermittent	-	-	-	-	-
Others:					
Religious	0.040*	0.001*	-0.011*	-0.020*	-0.010*
	(0.007)	(0.0001)	(0.002)	(0.003)	(0.002)
Alcohol	-0.144*	-0.002*	0.041*	0.071*	0.034*
	(0.002)	(0.0001)	(0.001)	(0.002)	(0.001)
Easy Access	-0.069*	-0.001*	0.018*	0.035*	0.017*
	(0.007)	(0.0002)	(0.002)	(0.004)	(0.002)

Table 5.2c: Ordered Probit Estimates based on Smoking Stages

Variables	Model 3: Price, State Policies & Peers LR Chi2: 3210.49 Log Likelihood: -6949.17 N: 6,497				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.0005	8.12e-06	-0.0001	-0.0003	-0.0001
	(0.001)	(0.00001)	(0.0002)	(0.0003)	(0.0001)
Policy Measures:					
Marketing	-0.041	-0.001	0.013	0.022	0.006
Restrictions	(0.047)	(0.0005)	(0.017)	(0.024)	(0.006)
Local Enforcement	-0.003	-0.00005	0.001	0.002	0.0005
	(0.030)	(0.0005)	(0.009)	(0.016)	(0.005)
School Restriction	0.021	0.0004	-0.006	-0.012	-0.004
	(0.017)	(0.0003)	(0.005)	(0.010)	(0.003)
Census Measures:					
9 to 12 Grade	-0.004	-0.0001	0.001	0.002	0.001
Smoking Prevalence	(0.003)	(0.0001)	(0.001)	(0.002)	(0.0005)
Parent Characteristics:					
Mother Smoke	-	-	-	-	-
Father Smoke	-	-	-	-	-
Relation with Parents:					
Index 1	-	-	-	-	-
Index 2	-	-	-	-	-
Peer Variables:					
Peer Smoke	-0.122*	-0.002*	0.036*	0.067*	0.021*
	(0.007)	(0.0003)	(0.003)	(0.004)	(0.001)
Peer Drink	-0.011***	-0.0002	0.003***	0.006**	0.002
	(0.006)	(0.0001)	(0.002)	(0.004)	(0.0002)
Cigarettes Day	-0.003***	-0.00005**	0.001***	0.002***	0.001***
	(0.002)	(0.00003)	(0.001)	(0.001)	(0.0003)
Cigarettes	-0.0004	-5.84e-06	0.0001	0.0002	0.0001
	(0.001)	(0.00002)	(0.0003)	(0.001)	(0.0001)
Proportion Never Smoker	0.213*	0.004*	-0.063*	-0.117*	-0.036*
	(0.055)	(0.001)	(0.017)	(0.031)	(0.010)
Proportion Ex-Smoker	0.113	0.002	-0.034	-0.063	-0.019
	(0.071)	(0.001)	(0.021)	(0.039)	(0.012)
Proportion Experimental	0.0175*	0.003*	-0.052*	-0.096*	0.029*
	(0.057)	(0.001)	(0.017)	(0.032)	(0.010)
Proportion Intermittent	0.115*	0.002**	-0.034*	-0.064*	-0.019*
	(0.044)	(0.001)	(0.013)	(0.024)	(0.008)
Others:					
Religious	0.043*	0.001*	-0.012*	-0.024*	-0.007*
	(0.012)	(0.0002)	(0.003)	(0.007)	(0.002)
Alcohol	-0.012*	-0.002*	0.036	0.067*	0.020*
	(0.005)	(0.0002)	(0.002)	(0.003)	(0.001)
Easy Access	-	-	-	-	-

Table 5.2d: Ordered Probit Estimates based on Smoking Stages

Variables	Model 4: Price, State Policies, Peers & Parents LR Chi2:3318.75 Log Likelihood: -6895.04 N: 6,497				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.0005	7.71e-06	-0.0001	-0.0003	-0.0001
	(0.0005)	(0.00001)	(0.0002)	(0.0003)	(0.0001)
Policy Measures:					
Marketing	-0.041	-0.001	0.014	0.022	0.006
Restrictions	(0.047)	(0.0005)	(0.017)	(0.234)	(0.006)
Local Enforcement	0.001	9.92e-06	-0.0002	-0.0003	-0.0001
	(0.021)	(0.001)	(0.009)	(0.017)	(0.005)
School Restriction	0.017	0.0003	-0.005	-0.009	-0.003
	(0.017)	(0.0003)	(0.005)	(0.010)	(0.003)
Census Measures:					
9 to 12 Grade	-0.003	-0.0001	0.001	0.002	0.001
Smoking Prevalence	(0.003)	(0.0001)	(0.001)	(0.002)	(0.0005)
Parent Characteristics:					
Mother Smoke	-0.030***	-0.001***	0.009***	0.017***	0.005***
	(0.017)	(0.0003)	(0.005)	(0.009)	(0.003)
Father Smoke	-0.038**	-0.001**	0.011**	0.021**	0.006**
	(0.016)	(0.0003)	(0.005)	(0.009)	(0.003)
Relation with Parents:					
Index 1	0.030*	0.001*	-0.009*	-0.016*	-0.005*
	(0.007)	(0.0001)	(0.002)	(0.004)	(0.001)
Index 2	0.010	0.0002	-0.003	-0.005	-0.002
	(0.008)	(0.0001)	(0.002)	(0.004)	(0.001)
Peer Variables:					
Peer Smoke	-0.117*	-0.002*	0.035*	0.065*	0.019*
	(0.007)	(0.0003)	(0.003)	(0.004)	(0.001)
Peer Drink	-0.011**	-0.0002***	0.003***	0.006***	0.002***
	(0.006)	(0.0001)	(0.002)	(0.004)	(0.001)
Cigarettes Day	-0.003***	-0.0001***	0.001***	0.002***	0.001***
	(0.002)	(0.00003)	(0.001)	(0.001)	(0.0003)
Cigarettes	0.0003	-4.55e-06	0.0001	0.0002	0.00004
	(0.001)	(0.00002)	(0.0003)	(0.001)	(0.0002)
Proportion Never Smoker	0.200*	0.003*	-0.060*	-0.111*	-0.032
	(0.055)	(0.001)	(0.017)	(0.031)	(0.009)
Proportion Ex-Smoker	0.097	0.002	-0.029	-0.054	-0.016
	(0.071)	(0.001)	(0.022)	(0.040)	(0.012)
Proportion Experimental	0.161*	0.003*	-0.049*	-0.089*	-0.026*
	(0.057)	(0.001)	(0.017)	(0.032)	(0.009)
Proportion Intermittent	0.108**	0.002**	-0.032*	-0.060*	-0.017*
	(0.044)	(0.001)	(0.013)	(0.025)	(0.007)
Others:					
Religious	0.029**	0.001**	-0.009*	-0.016*	-0.005*
	(0.012)	(0.0002)	(0.004)	(0.007)	(0.002)
Alcohol	-0.116*	-0.002*	0.035*	0.064*	0.019*
	(0.005)	(0.0002)	(0.002)	(0.003)	(0.001)
Easy Access	-0.074*	-0.001*	0.020*	0.042*	0.013*
	(0.013)	(0.0003)	(0.003)	(0.008)	(0.003)

Table 5.3a: Multinomial Logit Estimates based on Smoking Stages

Variables	Model 1: Price & State Policies LR Chi2: 2801.02 Log Likelihood: -25002.34 N: 19,988			
	Ex-Smoker	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	-0.0001	-0.0001	-0.0001	-0.0001***
	(0.0001)	(0.0002)	(0.0002)	(0.0001)
Policy Measures:				
Marketing Restrictions	-0.006	0.005	-0.003	0.006
	(0.008)	(0.021)	(0.018)	(0.007)
Local Enforcement	-0.010**	-0.013	-0.008	-0.006
	(0.0004)	(0.013)	(0.010)	(0.005)
School Restriction	-	-	-	-
Census Measures:				
9 to 12 Grade Smoking Prevalence	-	-	-	-
Parent Characteristics:				
Mother Smoke	-	-	-	-
Father Smoke	-	-	-	-
Relation with Parents:				
Index 1	-	-	-	-
Index 2	-	-	-	-
Peer Variables:				
Peer Smoke	-	-	-	-
Peer Drink	-	-	-	-
Cigarettes Day	-	-	-	-
Cigarettes	-	-	-	-
Proportion Never Smoker	-	-	-	-
Proportion Ex-Smoker	-	-	-	-
Proportion Experimental	-	-	-	-
Proportion Intermittent	-	-	-	-
Others:				
Religious	-0.002	-0.007	-0.032*	-0.041*
	(0.002)	(0.007)	(0.006)	(0.003)
Alcohol	-	-	-	-
Easy Access	-	-	-	-

Table 5.3b: Multinomial Logit Estimates based on Smoking Stages

Variables	Model 2: Price, State Policies & Parents LR Chi2: 8467.66 Log Likelihood: -22169.02 N: 19,988			
	Ex-Smoker	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	-0.0002*	9.82e-06	-0.0004***	-0.0002**
	(0.0001)	(0.0003)	(0.0002)	(0.0001)
Policy Measures:				
Marketing Restrictions	-0.006	-0.002	-0.007	0.006
	(0.008)	(0.025)	(0.019)	(0.005)
Local Enforcement	-0.012**	0.031***	-0.016	-0.010***
	(0.006)	(0.017)	(0.013)	(0.005)
School Restriction	0.007*	0.009	-0.024*	-0.006***
	(0.002)	(0.010)	(0.008)	(0.003)
Census Measures:				
9 to 12 Grade Smoking Prevalence	-0.0003	0.001	0.003**	0.0001
	(0.0005)	(0.002)	(0.001)	(0.0005)
Parent Characteristics:				
Mother Smoke	0.001	0.036*	0.035*	0.010*
	(0.003)	(0.011)	(0.008)	(0.003)
Father Smoke	0.006***	0.047*	0.036*	0.010*
	(0.003)	(0.011)	(0.009)	(0.004)
Relation with Parents:				
Index 1	-0.004*	0.004	-0.025*	-0.01*
	(0.001)	(0.005)	(0.003)	(0.001)
Index 2	-0.005*	-0.004	-0.008**	0.0004
	(0.001)	(0.005)	(0.004)	(0.001)
Peer Variables:				
Peer Smoke	-	-	-	-
Peer Drink	-	-	-	-
Cigarettes Day	-	-	-	-
Cigarettes	-	-	-	-
Proportion Never Smoker	-	-	-	-
Proportion Ex-Smoker	-	-	-	-
Proportion Experimental	-	-	-	-
Proportion Intermittent	-	-	-	-
Others:				
Religious	0.0003	0.014***	-0.008	-0.018*
	(0.002)	(0.008)	(0.006)	(0.002)
Alcohol	0.009*	0.042*	0.084	0.024*
	(0.001)	(0.003)	(0.002)	(0.001)
Easy Access	-0.002	-0.003	-0.007	0.034*
	(0.002)	(0.009)	(0.006)	(0.003)

Table 5.3c: Multinomial Logit Estimates based on Smoking Stages

Variables	Model 3: Price, State Policies & Peers LR Chi2: 3762.30 Log Likelihood: -6673.27 N: 6,497			
	Ex-Smoker	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	-5.61e-06	-0.001	-0.0001	-0.0001
	(0.0001)	(0.001)	(0.0005)	(0.0001)
Policy Measures:				
Marketing	-0.233	0.058	0.009	-0.002
Restrictions	(0.271)	(0.053)	(0.039)	(0.010)
Local Enforcement	-0.240***	0.028	-0.020	-0.001
	(0.013)	(0.036)	(0.027)	(0.007)
School Restriction	0.004	0.008	-0.016	-0.002
	(0.005)	(0.021)	(0.016)	(0.004)
Census Measures:				
9 to 12 Grade	-0.001	0.004	-0.0002	0.001
Smoking Prevalence	(0.001)	(0.004)	(0.003)	(0.001)
Parent Characteristics:				
Mother Smoke	-	-	-	-
Father Smoke	-	-	-	-
Relation with Parents:				
Index 1	-	-	-	-
Index 2	-	-	-	-
Peer Variables:				-
Peer Smoke	0.003	-0.040*	0.073*	0.022*
	(0.002)	(0.009)	(0.006)	(0.002)
Peer Drink	0.003	0.007	0.010***	0.001
	(0.002)	(0.008)	(0.005)	(0.001)
Cigarettes Day	0.001**	0.001	0.002	0.0001
	(0.0004)	(0.002)	(0.001)	(0.0003)
Cigarettes	0.0002	-0.0003	-0.0006	0.0001
	(0.0002)	(0.001)	(0.0009)	(0.0002)
Proportion Never	0.019	-0.054	-0.029	-0.033*
Smoker	(0.014)	(0.080)	(0.046)	(0.010)
Proportion Ex-	0.049*	0.012	0.043	-0.024***
Smoker	(0.016)	(0.081)	(0.059)	(0.014)
Proportion	0.029**	-0.009	-0.011	-0.031*
Experimental	(0.014)	(0.081)	(0.047)	(0.010)
Proportion	0.023**	-0.056	0.047	-0.018**
Intermittent	(0.011)	(0.066)	(0.037)	(0.007)
Others:				
Religious	0.0003	-0.012	-0.004	-0.012*
	(0.004)	(0.014)	(0.011)	(0.003)
Alcohol	0.009*	0.049	0.076*	0.012*
	(0.001)	(0.006)	(0.004)	(0.001)
Easy Access	-	-	-	-

Table 5.3d: Multinomial Logit Estimates based on Smoking Stages

Variables	Model 4: Price, State Policies, Parents & Peers LR Chi2: 3931.49 Log Likelihood: -6588.67 N: 6,497			
	Ex-Smoker	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.00001	-0.001	-0.0001	-0.0001
	(0.0001)	(0.001)	(0.0005)	(0.0001)
Policy Measures:				
Marketing	-0.024	0.050	0.009	0.003
Restrictions	(0.027)	(0.052)	(0.039)	(0.007)
Local Enforcement	-0.023***	0.030	-0.021	-0.003
	(0.013)	(0.036)	(0.028)	(0.006)
School Restriction	0.004	0.011	-0.015	-0.001
	(0.005)	(0.021)	(0.016)	(0.003)
Census Measures:				
9 to 12 Grade	-0.001	0.003	-0.001	0.001
Smoking Prevalence	(0.001)	(0.003)	(0.003)	(0.001)
Parent Characteristics:				
Mother Smoke	0.001	0.025	0.011	0.005
	(0.005)	(0.020)	(0.015)	(0.003)
Father Smoke	0.012**	0.038***	0.020	0.001
	(0.005)	(0.020)	(0.015)	(0.004)
Relation with Parents:				
Index 1	-0.001	-0.006	-0.015**	-0.005*
	(0.002)	(0.009)	(0.007)	(0.001)
Index 2	-0.003	-0.003	-0.013***	0.0001
	(0.002)	(0.009)	(0.007)	(0.001)
Peer Variables:				
Peer Smoke	0.003	-0.040*	0.072*	0.018*
	(0.002)	(0.009)	(0.006)	(0.002)
Peer Drink	0.002	0.007	0.011***	0.001
	(0.002)	(0.008)	(0.005)	(0.001)
Cigarettes Day	0.001**	0.001	0.002	0.0001
	(0.0004)	(0.002)	(0.001)	(0.0002)
Cigarettes	0.0002	-0.0003	-0.001	0.0001
	(0.0002)	(0.001)	(0.001)	(0.001)
Proportion Never	0.019	-0.047	-0.028	-0.028*
Smoker	(0.013)	(0.080)	(0.046)	(0.008)
Proportion Ex-	0.047*	0.023	0.043	0.021***
Smoker	(0.016)	(0.098)	(0.060)	(0.012)
Proportion	0.028**	-0.002	-0.011	-0.025*
Experimental	(0.014)	(0.082)	(0.048)	(0.009)
Proportion	0.022**	-0.052	0.048	-0.015**
Intermittent	(0.010)	(0.067)	(0.037)	(0.006)
Others:				
Religious	-0.0001	-0.006	0.0001	-0.009*
	(0.003)	(0.015)	(0.011)	(0.003)
Alcohol	0.009*	0.048*	0.075*	0.010*
	(0.001)	(0.006)	(0.004)	(0.001)
Easy Access	-0.006***	0.001	0.009	0.021*
	(0.003)	(0.016)	(0.012)	(0.004)

Table 5.5: Bivariate Probit Estimates

Variables	Smoker	Friend Smoker
Price	-0.001	-0.001
	(0.001)	(0.001)
Rho	0.014	
Prob > Chi2	0.3224	

Table 5.6: Conditional Demand Elasticity by Smoking Stage

	Overall	Experimental	Intermittent	Regular
Elasticity	-0.829	-0.145	-0.455	-0.109

Table 6.1a: Ordered Probit Estimates: 1996 Smoking Status

Variables	Model I: Prices & State Policies LR Chi2: 808.58 Log Likelihood: - 15,264.95 N: 11,620				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.038**	0.000**	- 0.003**	- 0.017**	- 0.018**
	(0.015)	(0.000)	(0.001)	(0.007)	(0.007)
Policy Measures:					
Policy Index	0.011**	0.000**	- 0.001**	- 0.005**	- 0.005**
	(0.004)	(0.000)	(0.000)	(0.002)	(0.002)
Parent Measures:					
Parent Smoke	-	-	-	-	-
Relationship Index	-	-	-	-	-
Easy Access	-	-	-	-	-
Peer Measures:					
Peer Smoke	-	-	-	-	-
Demography:					
Age	- 0.051*	- 0.001*	0.004*	0.024*	0.024*
	(0.003)	(0.000)	(0.000)	(0.001)	(0.001)
Education	0.081*	0.001*	- 0.010*	- 0.037*	- 0.035*
	(0.011)	(0.000)	(0.002)	(0.005)	(0.004)
Male	0.004	0.000	- 0.000	- 0.002	- 0.002
	(0.008)	(0.000)	(0.001)	(0.004)	(0.004)
White	- 0.109*	- 0.001*	0.011*	0.050*	0.049*
	(0.012)	(0.000)	(0.002)	(0.006)	(0.005)
Black	0.099*	0.001*	- 0.012*	- 0.045*	- 0.042*
	(0.015)	(0.000)	(0.003)	(0.007)	(0.006)
Hispanic	0.026**	0.000**	- 0.002**	- 0.012**	- 0.012**
	(0.012)	(0.000)	(0.001)	(0.005)	(0.005)
Other	- 0.103*	- 0.001**	- 0.004	0.047*	0.061*
	(0.029)	(0.001)	(0.005)	(0.013)	(0.022)

- all variables except demographies are for 1994.
* - sig at the 1% level; ** - sig. at the 5% level; *** - sig. at the 10% level.

Table 6.1b: Ordered Probit Estimates: 1996 Smoking Status

Variables	Model II: Prices, State Policies, Peer & Parents LR Chi2: 3,378.57 Log Likelihood: - 13,979.95 N: 11,620				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.023	0.000	- 0.002	- 0.013	- 0.009
	(0.015)	(0.000)	(0.001)	(0.008)	(0.006)
Policy Measures:					
Policy Index	0.002	0.000	- 0.000	- 0.001	- 0.001
	(0.004)	(0.000)	(0.000)	(0.002)	(0.002)
Parent Measures:					
Parent Smoke	- 0.074*	- 0.001*	0.007*	0.041*	0.027*
	(0.009)	(0.000)	(0.001)	(0.005)	(0.003)
Relationship Index	0.054*	0.001*	- 0.004*	- 0.030*	- 0.020*
	(0.005)	(0.000)	(0.001)	(0.003)	(0.002)
Easy Access	- 0.093*	- 0.001*	0.003*	0.053*	0.039*
	(0.008)	(0.000)	(0.001)	(0.005)	(0.004)
Peer Measures:					
Peer Smoke	- 0.166*	- 0.002*	0.012*	0.093*	0.062*
	(0.004)	(0.000)	(0.002)	(0.003)	(0.002)
Demography:					
Age	- 0.002*	- 0.000*	0.002*	0.012*	0.008*
	(0.003)	(0.000)	(0.000)	(0.002)	(0.001)
Education	0.038*	0.000*	- 0.004*	- 0.021*	- 0.014*
	(0.011)	(0.000)	(0.001)	(0.006)	(0.004)
Male	- 0.004	- 0.000	0.000	0.002	0.002
	(0.008)	(0.000)	(0.001)	(0.004)	(0.003)
White	- 0.098*	- 0.001*	0.010*	0.054*	0.035*
	(0.012)	(0.000)	(0.002)	(0.007)	(0.004)
Black	0.053*	0.001*	- 0.006*	- 0.030*	- 0.019
	(0.014)	(0.000)	(0.002)	(0.008)	(0.005)*
Hispanic	0.008	0.000	- 0.001	- 0.004	- 0.003
	(0.012)	(0.000)	(0.001)	(0.007)	(0.004)
Other	- 0.091*	- 0.001**	- 0.004	0.053*	0.043**
	(0.029)	(0.001)	(0.005)	(0.017)	(0.018)

- all variables except demographies are for 1994.
* - sig at the 1% level; ** - sig. at the 5% level; *** - sig. at the 10% level.

Table 6.2a: Ordered Probit Estimates: 2002 Smoking Status

Variables	Model I: Prices & State Policies LR Chi2: 1,000.93 Log Likelihood: - 16,358.31 N: 11,620				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.015	0.003	0.001	- 0.004	- 0.014
	(0.011)	(0.002)	(0.001)	(0.003)	(0.011)
Policy Measures:					
Policy Index	0.015*	0.003*	0.001*	- 0.004*	- 0.015*
	(0.003)	(0.006)	(0.000)	(0.001)	(0.003)
Parent Measures:					
Parent Smoke	-	-	-	-	-
Relationship Index	-	-	-	-	-
Easy Access	-	-	-	-	-
Peer Measures:					
Peer Smoke	-	-	-	-	-
Demography:					
Age	- 0.005*	- 0.001*	- 0.000**	0.001*	0.005*
	(0.002)	(0.000)	(0.000)	(0.001)	(0.002)
Education	0.019*	0.003*	0.001*	- 0.005*	- 0.019*
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Male	- 0.031*	- 0.006*	- 0.002*	0.008*	0.031*
	(0.006)	(0.001)	(0.001)	(0.002)	(0.006)
White	- 0.070*	- 0.012*	- 0.001	0.018*	0.065*
	(0.009)	(0.002)	(0.001)	(0.002)	(0.008)
Black	0.113*	0.017*	- 0.008*	- 0.029*	- 0.093*
	(0.012)	(0.002)	(0.003)	(0.003)	(0.008)
Hispanic	0.072*	0.011*	- 0.003**	- 0.019*	- 0.062*
	(0.010)	(0.001)	(0.002)	(0.003)	(0.007)
Other	- 0.024	- 0.005	- 0.003	0.006	0.025
	(0.023)	(0.005)	(0.004)	(0.006)	(0.026)

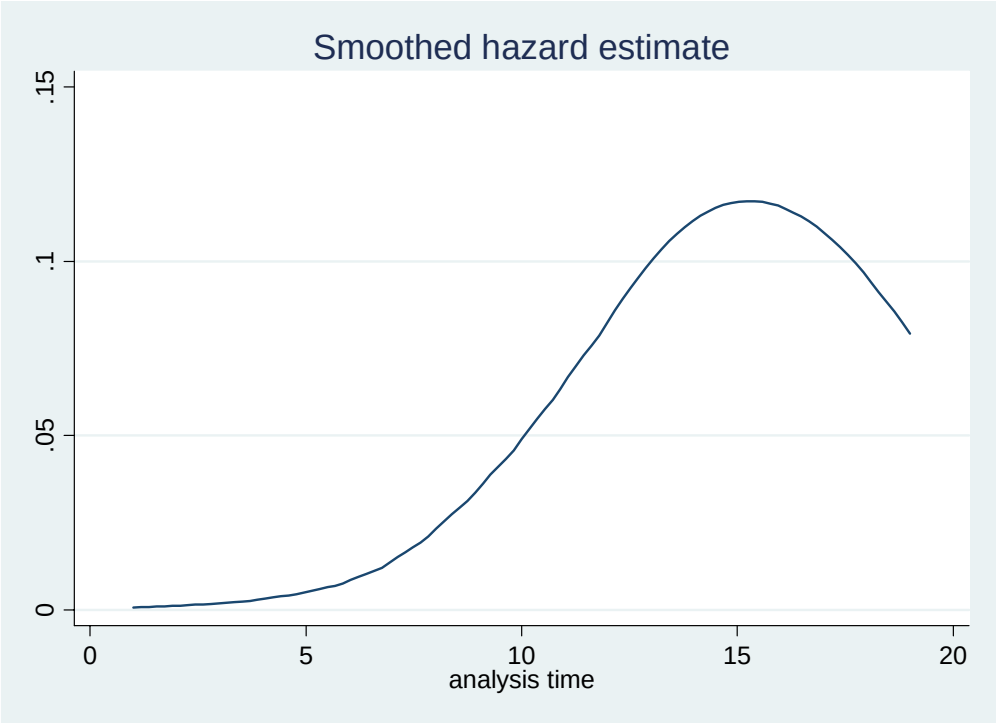
- all variables except demographies are for 1994.
* - sig at the 1% level; ** - sig. at the 5% level; *** - sig. at the 10% level.

Table 6.2b: Ordered Probit Estimates: 2002 Smoking Status

	Model II: Prices, State Policies, Peer & Parents LR Chi2: 2,131.97 Log Likelihood: - 15,792.79 N: 11,620				
	Never Smoker	**Ex-Smoker**	**Experimental Smoker**	**Intermittent Smoker**	**Regular Smoker**
Price	0.007	0.001	0.001	- 0.002	- 0.007
	(0.011)	(0.002)	(0.001)	(0.003)	(0.011)
Policy Measures:					
Policy Index	0.010*	0.002*	0.001*	- 0.003*	- 0.010*
	(0.003)	(0.001)	(0.000)	(0.001)	(0.003)
Parent Measures:					
Parent Smoke	- 0.052*	- 0.010*	- 0.002*	0.015*	0.049*
	(0.006)	(0.001)	(0.001)	(0.002)	(.006)
Relationship Index	0.025*	0.005*	0.002*	- 0.008*	- 0.025*
	(0.004)	(0.001)	(0.000)	(0.001)	(0.003)
Easy Access	- 0.041*	- 0.009*	- 0.005*	0.012*	0.042*
	(0.006)	(0.001)	(0.001)	(0.002)	(0.007)
Peer Measures:					
Peer Smoke	- 0.079*	- 0.016*	- 0.006*	0.024*	0.078*
	(0.003)	(0.001)	(0.001)	(0.001)	(0.003)
Demography:					
Age	0.009*	0.002*	0.001*	- 0.003*	- 0.009*
	(0.002)	(0.000)	(0.000)	(0.001)	(0.002)
Education	0.012*	0.002*	0.001*	- 0.003*	- 0.011*
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Male	- 0.037*	- 0.007*	- 0.003*	0.011*	0.036*
	(0.006)	(0.001)	(0.001)	(0.002)	(0.005)
White	- 0.059*	- 0.011*	- 0.002**	0.018*	0.055*
	(0.009)	(0.002)	(0.001)	(0.003)	(0.008)
Black	0.083*	0.015*	- 0.003	- 0.024*	- 0.071*
	(0.011)	(0.002)	(0.002)	(0.003)	(0.008)
Hispanic	0.057*	0.010*	- 0.001	- 0.017*	- 0.049*
	(0.009)	(0.002)	(0.002)	(0.003)	(0.007)
Other	- 0.017	- 0.004	- 0.002	0.005	0.018
	(0.023)	(0.005)	(0.004)	(0.007)	(0.025)

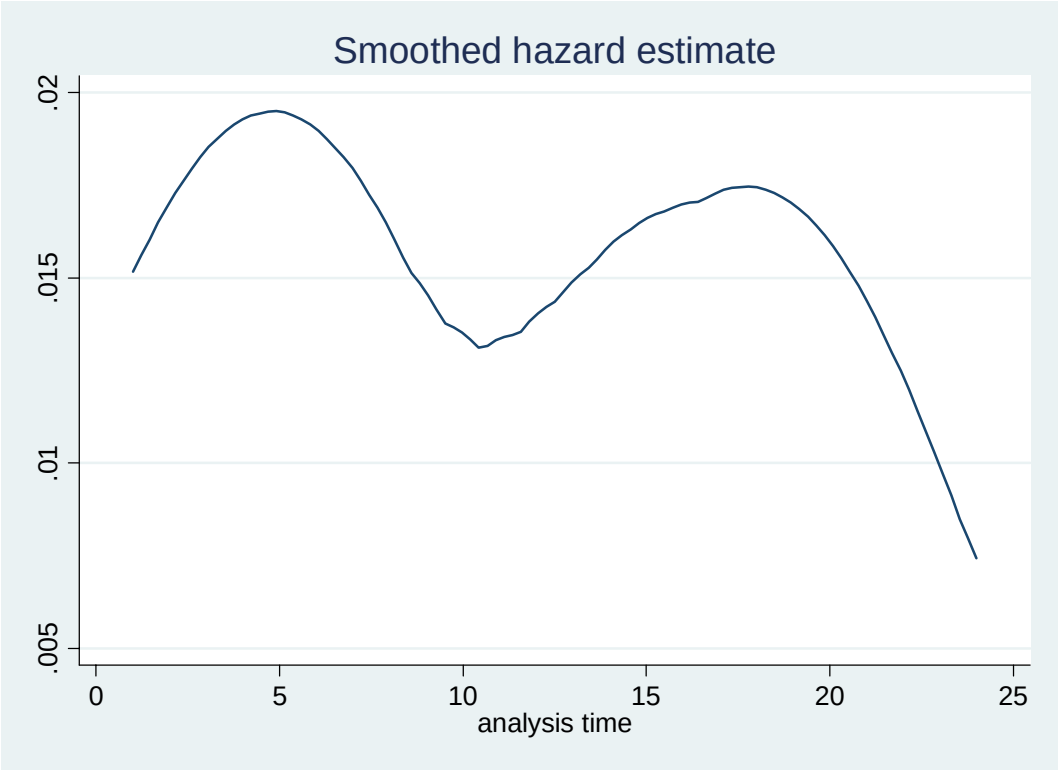
- all variables except demographies are for 1994.
* - sig at the 1% level; ** - sig. at the 5% level; *** - sig. at the 10% level.

Figure 6.1: Hazard of Smoking Initiation



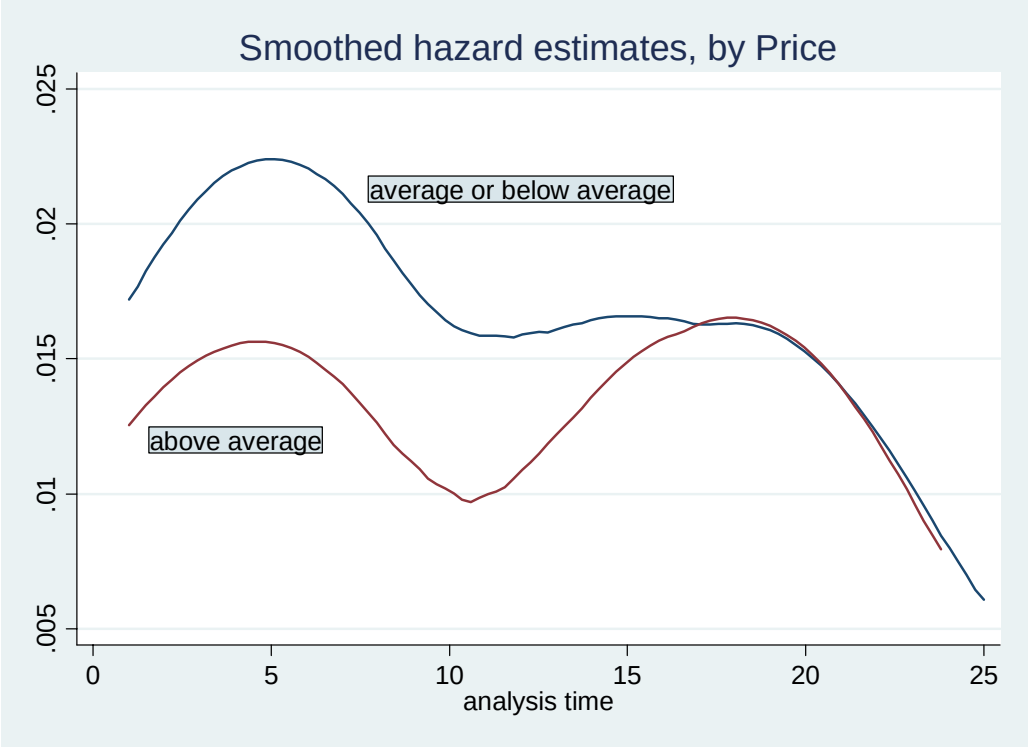
Analysis Time: Age of Initiation

Figure 6.2: Hazard of Being Regular Smoker



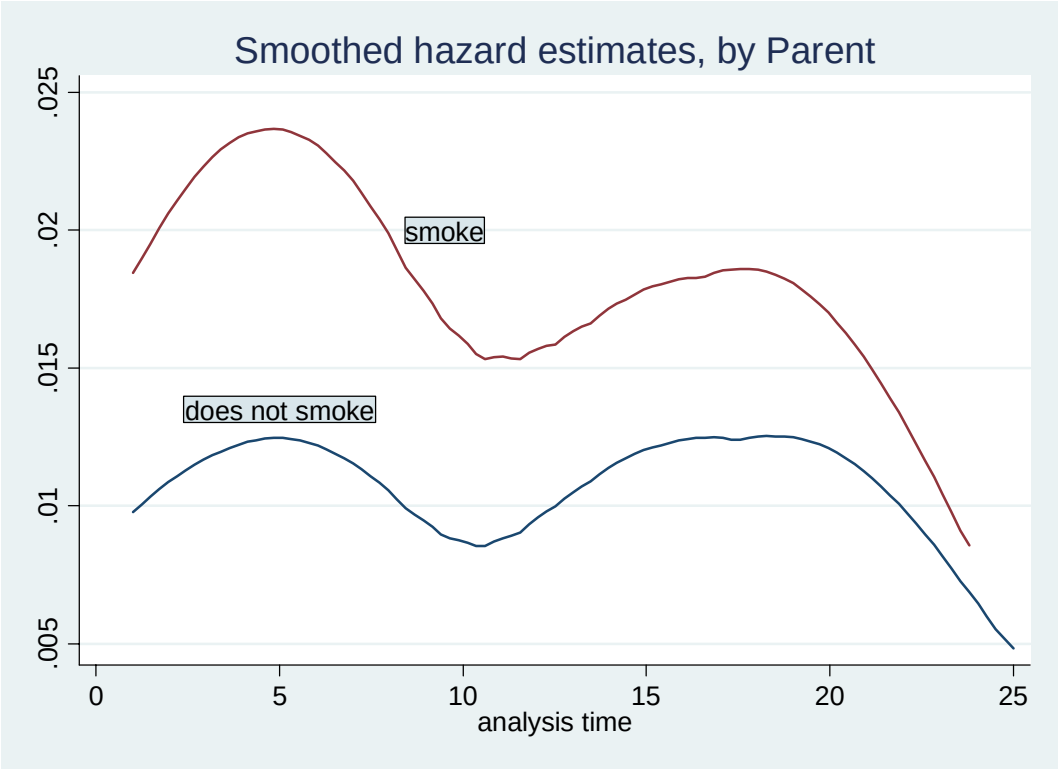
Analysis Time: Years before becoming a regular smoker; Onset of Risk: Age of Initiation

Figure 6.3: Hazard of Being Regular Smoker by Price



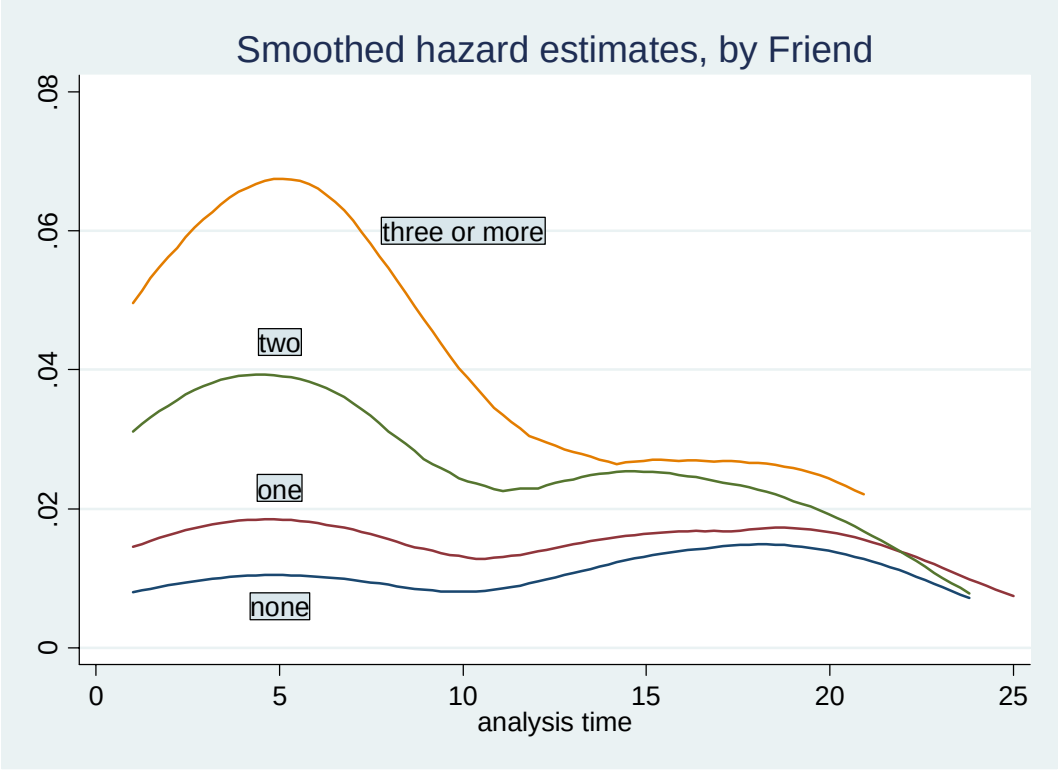
Analysis Time: Years before becoming a regular smoker; Onset of Risk: Age of Initiation

Figure 6.4: Hazard of Being Regular Smoker by Parent Smoking Status



Analysis Time: Years before becoming a regular smoker; Onset of Risk: Age of Initiation

Figure 6.5: Hazard of Being Regular Smoker by Peer Smoking Staus



Analysis Time: Years before becoming a regular smoker; Onset of Risk: Age of Initiation

Table 6.3: Estimation Results for Predicted Log of Years before becoming Regular Smoker (Weibull, Log-Logistic, Exponential, Log-Normal & Gamma Distribution)

Variables	Weibull	Log-Logistic	Exponential	Log Normal	Gamma
Price	0.044	0.060	0.049	0.046	0.048
	(0.068)	(0.071)	(0.076)	(0.072)	(0.071)
Policy Measures:					
Policy Index	0.104*	0.115*	0.114*	0.121*	0.118*
	(0.023)	(0.023)	(0.026)	(0.023)	(0.023)
Parent Measures:					
Parent Smoke	- 0.225*	- 0.207*	- 0.249*	- 0.223*	- 0.218*
	(0.043)	(0.042)	(0.0467)	(0.041)	(0.042)
Relationship Index	0.100*	0.100*	0.109*	0.106*	0.102*
	(0.021)	(0.022)	(0.023)	(0.022)	(0.022)
Easy Access	- 0.143*	- 0.175*	- 0.163*	- 0.186*	- 0.178*
	(0.038)	(0.039)	(0.042)	(0.040)	(0.039)
Peer Measures:					
Peer Smoke	- 0.409*	- 0.431*	- 0.440*	- 0.441*	- 0.435*
	(0.017)	(0.017)	(0.018)	(0.017)	(0.017)
Demography:					
Age	0.083*	0.073*	0.087*	0.069*	0.069*
	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)
Education	0.158*	0.163*	0.173*	0.124*	0.144*
	(0.010)	(0.011)	(0.011)	(0.009)	(0.011)
Male	- 0.138*	- 0.143*	- 0.156*	- 0.159*	- 0.151*
	(0.035)	(0.036)	(0.039)	(0.036)	(0.036)
White	- 0.400*	- 0.375*	- 0.432*	- 0.356*	- 0.362*
	(0.067)	(0.065)	(0.073)	(0.062)	(0.063)
Black	0.660*	0.675*	0.717*	0.618*	0.640*
	(0.082)	(0.079)	(0.090)	(0.074)	(0.076)
Hispanic	0.703*	0.712*	0.765*	0.654*	0.677*
	(0.067)	(0.065)	(0.073)	(0.061)	(0.063)
Other	- 0.112	- 0.069	- 0.121	- 0.064	- 0.066
	(0.154)	(0.156)	(0.170)	(0.156)	(0.156)
Log Likelihood	- 6,326.63	- 6,263.03	-6,345.76	- 6,230.41	- 6,230.49
N	11,095	11,095	11,095	11,095	11,095

- all variables except demographies are for 1994.
* - sig at the 1% level; ** - sig. at the 5% level; *** - sig. at the 10% level.

Table 6.4: Hypothesis Testing of Function Form Assumption: Akaike Information Criterion

	Log Likelihood	AIC
Weibull	- 6,326.63	12,685.26
Log-Logistic	- 6,263.03	12,558.06
Exponential	- 6,345.76	12,721.52
Log-Normal	- 6, 230.41	12,492.82
Gamma	- 6, 230.39	12,494.78

Appendix 1

DEPENDANT VARIABLES:

1. Conventional Smoking - Binary smoking variable based on the conventional definition (smoked at least 1 day out of the last 30 days).
2. Stage Smoking - categorical variable based on smoking stage (0 = Never Smoker, 1 = Ex-Smoker, 2 = Experimental, 3 = Intermittent, 4 = Regular).

PUBLIC POLICY VARIABLES:
(All state level except 13 which is school level).
(0 = no, 1 = yes)

3. Price 94 - real average price of a pack of cig.
4. Vending Machine – Binary variable indicating whether vending machines are banned from location accessible to youth and only allowed in businesses holding liquor license.
5. Marketing Restrictions - Binary variable indicating whether marketing restrictions on cigarettes exist.
6. Billboard - Binary variable indicating whether tobacco marketing prohibited on billboards within 500 feet of school and or churches.
7. Public Transportations - Binary variable indicating whether there are tobacco marketing restrictions on public transportation or state property.
8. sgt94a80 - Binary variable indicating whether free sample of cigarettes are prohibited (through mails, to those under 18, within 500 feet of school or other facilities used by under 18).
9. Enforcement - Binary variable indicating whether tobacco related law enforcement program exists.
10. Local Enforcement - Binary variable indicating whether localities can enforce youth access, respond to complains.
11. Alcohol & Drug Prevention - Binary variable indicating whether schools are required to offer alcohol and drug use prevention program.
12. Tobacco Prevention - Binary variable indicating whether schools are required to offer tobacco use prevention program.
13. School Restriction - Binary variable indicating whether school has policy that restricts both student and other personnel from smoking on school premises.
14. Median Household income - Median household income.
15. Population Density - Population density (person/sq.km).
16. 18 & Older Smoking Prevalence - Percentage of population 18 and older smoking;
17. 9 to 12 Grade Smoking Prevalence - Percentage of population in grades 9 to 12 smoking frequently.

PARENTS VARIABLES:
(Variable 31 – 33 obtained from parents interview portion of the survey).

18. Parents Care – Binary variable indicating whether the individual feel that his/her parents care about him/her.
19. Parents Understand - Binary variable indicating whether the individual feel that his/her parents understand him/her
20. Parents Attention - Binary variable indicating whether the individual feel that his/her parents pays attention to him/her.
21. Talk - Binary variable indicating whether the individual feel that when he/she does something wrong that is important, his/her mother talks about it with him/her and helps him/her understand why it is wrong;
22. Communicate - Binary variable indicating whether the individual is satisfied with the way he/she and his/her mother communicate with each other;
23. Both Parents – Binary variable to indicate whether respondent live with both parents.
24. Mother Only – Binary variable to indicate whether respondent live with mom only.
25. Father Only – Binary variable to indicate whether respondent live with dad only;
26. Mother's Education - Resident mothers' educational level (1 = less than high school, 2 = high school but no college, 3 = college or more).
27. Father's Education - Resident fathers' educational level (1 = less than high school, 2 = high school but no college, 3 = college or more);
28. Parents Smoke – Binary variable indicating whether interviewed parents smoke or not.
29. Parents Never Drink – Binary variable indicating whether interviewed parent never drinks.
30. Parents Drink Week - Binary variable indicating whether interviewed parent drinks more than 2 days per week.
31. Get Along - Binary variable indicating whether interviewed parent thinks that in general he/she get alone well with the respondent.
32. Understand - Binary variable indicating whether interviewed parent thinks that in general he/she understands the respondent.
33. Trust - Binary variable indicating whether interviewed parent in general feels that he/she can trust the respondent.

FRIEND VARIABLES:

34. Peer Smoke - of your three best friends how many smoke at least 1 cigarette a day.
35. Peer Drink - of your 3 best friends how many drink at least once a month.
36. Cigarettes Day - on avg. how many days in the past 30 days did the respondents nominated friends smoke.
37. Cigarettes - on avg. how many cig did the respondents nominated friends smoke on the days that they smoked.
38. Drink - on avg. the number of drinks the respondents nominated friends had each time they drank in the past 12 months;
39. Friend Never Smoker – Proportion of nominated friends who are never smokers.
40. Friend Ex- Smoker – Proportion of nominated friends who are ex-smokers.
41. Friend Experimental - Proportion of nominated friends who are experimental smokers.

42. Friend Intermittent - Proportion of nominated friends who are intermittent smokers.

OTHERS:

43. Age – Age of the respondent in 1994.
44. Grade – Respondents grade level in 1994.
45. Male – Binary variable indicating whether the respondent was male or not.
46. White – Binary variable indicating whether the respondent was white or not.
47. Black - Binary variable indicating whether the respondent was black or not.
48. Hispanic - Binary variable indicating whether the respondent was Hispanic or not.
49. Asian - Binary variable indicating whether the respondent was Asian or not.
50. Other – Binary variable indicating whether the respondent was of other race or not.
51. Alcohol – Categorical variable indicating the level of drinking (0 = never drank in life, 1 = never in the past 12 months, 2 = 1 to 2 days in the past 12 months, 3 = 1 day per month or less in the past 12 months, 4 = more than 2 days per month for the past 12 months).
52. Easy Access – Binary variable indicating whether cigarettes are easily available in the respondents home.

Appendix 2: Probit Estimates with all Parent-Child Relationship Indicators

Respondent Survey:	
Parents Care	0.006 (0.014)
Parents Understand	-0.043* (0.007)
Parents Pay Attention	-0.011 (0.007)
Talk	-0.007 (0.011)
Communicate	-0.009 (0.010)
Parents Survey:	
Get Along	0.022 (0.009)
Understand	0.020** (0.009)
Trust	-0.108* (0.009)

Appendix 3: Hazard Ratio under Weibull and Exponential Distribution

Variables	Weibull	Exponential
Price	0.990	0.991
	(0.068)	(0.069)
Policy Measures:		
Policy Index	0.894*	0.894*
	(0.023)	(0.023)
Parent Measures:		
Parent Smoke	1.284*	1.286*
	(0.060)	(0.060)
Relationship Index	0.894*	0.896*
	(0.020)	(0.020)
Easy Access	1.175*	1.180*
	(0.049)	(0.049)
Peer Measures:		
Peer Smoke	1.574*	1.555*
	(0.028)	(0.027)
Demography:		
Age	0.912*	0.916*
	(0.011)	(0.011)
Education	0.840*	0.841*
	(0.009)	(0.009)
Male	1.165*	1.170*
	(0.045)	(0.045)
White	1.563*	1.547*
	(0.115)	(0.113)
Black	0.483*	0.488*
	(0.044)	(0.044)
Hispanic	0.454*	0.460*
	(0.033)	(0.033)
Other	1.150	1.147
	(0.195)	(0.195)
Log Likelihood	- 8,252.39	- 8,271.39
N	11,095	11,095

Appendix 4: Estimates without Policy Index

Variables	Log Normal
Price	0.0509
	(0.066)
Policy Measures:	
Policy Index	-
Parent Measures:	
Parent Smoke	- 0.227*
	(0.041)
Relationship Index	0.103*
	(0.022)
Easy Access	- 0.195*
	(0.040)
Peer Measures:	
Peer Smoke	- 0.449*
	(0.017)
Demography:	
Age	0.073*
	(0.011)
Education	0.125*
	(0.009)
Male	- 0.158*
	(0.036)
White	- 0.426*
	(0.061)
Black	0.560*
	(0.073)
Hispanic	0.688*
	(0.061)
Other	- 0.088
	(0.156)
Log Likelihood	- 8,169.12
N	11,095