Three essays on the economics of smoking

PhD Thesis submitted to the Faculty of Economics at the University of Neuchâtel

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Three Essays on the Economics of Smoking

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Executive summary

Each year, more than 9,000 people die from diseases attributable to smoking in Switzerland. This corresponds to 15% of the total number of deaths per year. According to the OECD/WHO report on the Swiss health system, tobacco use is the leading risk factor for disease, as it accounted for 11.2% of total disability-adjusted life years (DALYs) lost in the country in 2002. Intuitively, as human beings, our primary reaction would be to consider these numbers per se as justifications for intervention in the tobacco market, with a substantial reduction in tobacco consumption as the objective. Yet, is any intervention justified in the economic sense? If yes, what is the optimal level of intervention, and what measures are the most effective and, as we must deal with limited resources, cost-effective? Many of these questions remain unresolved. The economic approach benefits from sophisticated analytical instruments, both theoretical and empirical, that have the virtue of providing fairly objective insights into the decision to smoke.

This dissertation focuses on the influence of tobacco policies on smoking behavior, on the perception of smoking risks of young individuals, and on the valuation of smoking cessation treatments. It is divided into two main parts. In the first part, I discuss the rationale of analyzing smoking decisions from an economic perspective, based on the specificities of the product. I then briefly present the main models of smoking decisions, and I review the recent literature on the "best-practice" interventions aimed at reducing tobacco use, i.e., price increases, information, advertising bans, smoking bans, and cessation support. The second part consists of three empirical essays related to smoking decisions. The first essay sheds light on the ability of tobacco control expenditures to influence individual smoking decisions. In 2007, in Switzerland, approximately 20 million francs, or 2.6 francs per capita, were spent on non-price policy interventions aimed at reducing tobacco use in the population. While I provide evidence that these resources were effective in increasing the number of quitters, it seems likely that they did not have any significant influence on smoking onset. Besides price increases, tobacco control measures implemented in the last decade hardly influenced smoking participation among youths. Another strategy that could potentially influence the behavior of this population is the dissemination of proper deterrent messages. The second essay specifically looks at the relative importance that young individuals put on the consequences of smoking. I show that apart from lung cancer, reduced life expectancy, and cardiovascular

diseases, youths are also concerned by more immediate consequences, such as a reduction of physical capacity and sexual dysfunction. I also show that smoking participation is negatively associated with the level of far-sightedness, defined as the level of concern for long-term health risks. The last essay focuses on smoking cessation. Smokers make repeated attempts to quit and are rarely successful, mainly due to the negative effects of addiction, i.e., physical and psychological craving. One way to improve the cessation rates is to increase the use in the population of an appropriate smoking cessation support. To understand what drives the demand for smoking cessation drugs and how smokers value their potential benefits and disadvantages, I collected data on hypothetical choices and focused on treatment efficacy, minor side effects, price, availability, and ability to prevent smoking-cessation-associated weight intake. I was able to estimate willingness-to-pay for each dimension and for improved medications as a whole and also to point out some individual characteristics that determine the decisions to use such products.

Keywords: smoking, smoking initiation, smoking cessation, tobacco control, public health, health behaviors, health economics, smoking cessation treatments, risk perception, hazard models, discrete choice experiments, best-worst scaling.

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“Tobacco is a dirty weed,
I like it.
It satisfies no normal need,
I like it.
It makes you thin, it makes you lean,
It takes the hair right off your bean.
It's the worst darn stuff I've ever seen.
I like it.”

Graham Lee Hemminger, 1915

1 General introduction

Life is a succession of choices that can have unexpectedly severe consequences. Making informed choices involves being properly informed of the consequences of these choices, even if they may occur only in the distant future. In addition, uncertainty often plays a preponderant role in decisions, especially those related to health. In this regard, smoking is an interesting, and somewhat unexpected, consumption decision made by individuals. Indeed, deciding to consume an expensive product, even in small quantities, that can potentially kill you and harm others' health (including relatives) does not seem trivial. Thus the question that comes to mind is obvious: why do people smoke? Are the immediate rewards provided by consumption so important that they outweigh all perceived costs, including potential future adverse consequences? If this is the case, is it true for any consumption, or only for the initial decision, which subsequently leads to excessive levels of consumption due to addiction? Another explanation lies in the unpredictability of the consequences, significantly reinforced by the important time dimension (indeed, you only potentially will get lung cancer only 50 years after initiation). The corollary is the notion of risk, which can be ignored, inaccurately assessed, or even denied by individuals. Making wise trade-offs between immediate gratification and future, uncertain, and not well-understood consequences is obviously not an easy task, at least for the quarter of the Swiss population that is currently smoking. Economics, as the science of choices, can shed some light on the reasons that push people to take such risky decisions. In his article "Economics of tobacco: myths and realities" Kenneth Warner (2000) concludes with the following sentence: "If the tobacco control community can develop a sophisticated appreciation of the essence of tobacco economics, and convey that understanding to public decision makers, perhaps we can force the issue of tobacco back where it properly belongs, in the domain of public health." This assertion synthesizes the main motivations that prompted me to do research in the field of tobacco economics: applying sophisticated methods rooted in economic theory to a concrete and complex public health issue and developing my ability to convey sound messages to decision makers.

Each year, more than 9,000 people die from diseases attributable to smoking in Switzerland. This corresponds to 15% of the total number of deaths per year. According to the OECD/WHO report on the Swiss health system, tobacco use is the leading risk factor for disease, as it accounted for 11.2% of total disability-adjusted life years (DALYs) lost in the country in 2002. Intuitively, as human beings, our

primary reaction would be to consider these numbers per se as justifications for intervention in the tobacco market, with a substantial reduction in tobacco consumption as the objective. Yet, is any intervention justified in the economic sense? If yes, what is the optimal level of intervention, and what measures are the most effective and, as we must deal with limited resources, cost-effective? Many of these questions remain unresolved. The economic approach benefits from sophisticated analytical instruments, both theoretical and empirical, that have the virtue of providing fairly objective insights into the decision to smoke.

The Federal Office of Public Health (FOPH), in its objectives included in the 2008-2012 "National Tobacco Program," targets a 23% prevalence rate in the general population by the end of 2012; the actual smoking participation rate is currently approximately 27%. To achieve this goal and to ensure that the proportion of smokers does not concentrate more in the most deprived classes of the population, careful measures must be implemented and a good understanding of smoking decisions must be achieved. It is crucial for public health decision makers to rely on scientific findings to make informed decisions, to implement effective policies, and to achieve goals in terms of improved health in the population. Despite the important literature related to tobacco use and tobacco control in the fields of public health and health economics, many issues remain unresolved and much research needs to be done to most efficiently curb the tobacco epidemic. Some issues directly relate to the behavior of individuals, i.e., to the determinants of their consumption decisions. Other issues relate to the extent to which interventions should be implemented to influence individual decisions, i.e., externalities, a lack of information, or even psychological issues that justify interventions. Finally, if a desired level of intervention or a stated objective in terms of a reduction of the prevalence of a risky behavior in the population is determined, also considering equity issues, economics allows evaluating the available policies and then informing policy makers on a sound allocation of resources.

This dissertation delivers novel insights on the influence of tobacco policies on smoking behavior, on the perception of smoking risks of young individuals, and on the valuation of smoking cessation treatments. It is divided into two main parts. The first part sets the scene. I discuss the rationale of analyzing smoking decisions from an economic perspective, based on the specificities of the product. I then briefly present the main models of smoking decisions, and I review the recent literature on the "best-practice" interventions aimed at reducing tobacco use, i.e., price increases,

information, advertising bans, smoking bans, and cessation support. The second part consists of three empirical essays related to smoking decisions.

The first essay (Chapter 3) sheds light on the ability of tobacco control expenditures to influence individual smoking decisions. In 2007, in Switzerland, approximately 20 million francs, or 2.6 francs per capita, were spent on non-price policy interventions aimed at reducing tobacco use in the population. While I provide evidence that these resources were effective in increasing the number of quitters, it seems likely that they did not have a significant influence on smoking onset. Besides price increases, tobacco control measures implemented in the last decade hardly influenced smoking participation among youths. Another strategy that could potentially influence the behavior of this at-risk population is the dissemination of proper deterrent messages. The second essay (Chapter 4) specifically looks at the relative importance that young individuals put on the consequences of smoking. I show that apart from lung cancer, reduced life expectancy, and cardiovascular diseases, youths are also concerned by more immediate consequences, such as a reduction of physical capacity and sexual dysfunction. I also show that smoking participation is negatively associated with the level of far-sightedness, defined as the level of concern for long-term health risks. Chapter 5 focuses on smoking cessation. Smokers make repeated attempts to quit and are rarely successful, mainly due to the negative effects of addiction, i.e., physical (withdrawal) and psychological craving. One way to improve the cessation rates is to increase the use in the population of an appropriate smoking cessation support. To understand what drives the demand for smoking cessation drugs and how smokers value their potential benefits and disadvantages, I collected data on hypothetical choices and focused on treatment efficacy, minor side effects, price, availability, and ability to prevent smoking-cessation-associated weight intake. I was able to estimate willingness-to-pay for each dimension and for improved medications as a whole and also to point out some individual characteristics that determine the decisions to use such products.

I obviously do not pretend to answer all relevant questions that remain open in the field of smoking decisions and its determinants. However, I believe that this work adds to the existing knowledge on smoking decisions and on the appropriateness and effectiveness of interventions to curb smoking.

Part I

Background

In this part, I first define what makes cigarettes such a particular commodity. Then, after giving an overview of the theoretical framework within which the consumption of addictive goods is analyzed, I present the various tobacco-related market failures, and discuss the extent to which governments should intervene in individual smoking decisions. Finally, I review the available policy instruments intended to reduce smoking, their efficacy, and provide some figures related to Switzerland.

2 Economics of smoking and public policy

2.1. Introduction

Cigarettes have particular characteristics that influence the analytical framework within which smoking decisions are analyzed. If we aim to understand the rationale for an economic analysis of smoking decisions, it is essential that we identify these particularities. In short, cigarettes generate adverse health consequences for users and exposed non-users (most of which manifest in the distant future), cigarettes are addictive, and consumption mostly begins during childhood.

It is well known and has been widely documented that even occasional and moderate tobacco use is harmful to health. In other words, smokers cannot achieve a "safe" level of cigarette consumption. The only way to avoid smoking-related health consequences is abstinence and the avoidance of exposure to the smoke of others. Smoking is a major risk factor associated with a large number of diseases, including pulmonary complications (chronic obstructive pulmonary disease, bronchitis, influenza, emphysema, pneumonia, lung cancer), cardiovascular diseases (acute myocardial infarction, stroke), and various other cancers (kidney, mouth, stomach, pancreas, larynx). In addition to causing serious chronic conditions, smoking also has non-lethal health consequences, including the reduction of physical capacity (shortness of breath), sexual impairment, and impact on appearance (teeth, skin). It has been estimated that a lifelong regular smoker will die about 14 years earlier, on average, than a non-smoker with the same characteristics (CDC 2002). Although smoking has some immediate impacts on health, the most serious health consequences manifest late in life. Because of this lag between consumption and its associated risks, individuals naturally do not put much weight on these consequences in making decisions regarding smoking. In economic terms, they are said to discount the future quite heavily, especially while young. Moreover, individuals are not fully aware of the health risks associated with smoking. Some have been extensively communicated, but others, such as COPD, are much less well known. This potential lack of awareness, the over-optimism of individuals who think that they cannot be personally affected, and the time lag between consumption and the impact on health suggest that individuals do not fully incorporate the health consequences of smoking in their decisions. Furthermore, smoking can have adverse health consequences for non-smokers through environmental tobacco smoke (second-hand smoke).

According to economic theory, a good is addictive if its consumption during a particular period depends strongly on past consumption patterns. Cigarette addiction is both physical (because of the impact of nicotine on the brain) and psychological (as associated with gesture, ritual, habits). Three concepts are used to characterize addiction: tolerance, reinforcement and withdrawal. When an individual develops tolerance for a substance, the higher the cumulative past consumption, the less utility is derived from a given level of present consumption. In other words, the body becomes used to the drug, and an increasingly larger quantity is required to satisfy the individual[1]. The notion of reinforcement is directly linked to the benefits of consumption (pleasure, the effects of nicotine, psycho-social effects, the gesture, the "ritual") and the costs avoided (one smokes to avoid cravings). Withdrawal is the body's reaction to a lack of nicotine after the cessation or reduction of consumption. The associated symptoms include nausea, high blood pressure, abnormal heart rate, irritability, nervousness, and anxiety.

Finally, the fact that smoking initiation mostly occurs before the age of 20 has important implications for the analysis of smoking decisions[2]. Individuals in this age group are more short-sighted, are often less informed, and feel the need to be accepted by their peers. Young individuals are usually not fully aware of the addictive potential of cigarettes when they start smoking and are overoptimistic about their ability to quit. They thus often regret their choice later in life.

In summary, smoking is harmful to both direct and indirect smokers (i.e., those who are exposed to "second-hand" smoke). Furthermore, it is essential that we consider the time dimension if we aim to understand smoking decisions, both in relation to the occurrence of health consequences and to the development of addiction over time. In the next section, I describe smoking decisions from an economic perspective, relying on the specific character of this particular commodity as described above.

[1] In the case of tobacco use, consumption increases only up to a certain level and then remains stable

[2] More than 80% of current smokers in Switzerland started before 20 years old, and almost no initiations are observed after the age of 25 (see Chapter 3)

2.2. Theoretical framework

The specific qualities of cigarettes as a consumer good (or rather "*bad*") lead us to extend the standard microeconomic framework of individual behavior. When they face the decision to consume such goods, individuals are assumed to consider the immediate benefits that they draw from consumption in tandem with the monetary (and non-monetary) present and future costs of consumption. The dynamic and temporal dimension is central because of the addictive nature of the good and because of the harmful dimension of cigarette smoking, the consequences of which mostly manifest in the distant future. In his conceptual framework for analyzing smoking decisions, an economist should then take into account the past (addiction, habit formation), the present (price and other non-monetary costs), and the future (the potential disutility associated with smoking-related health risks, the risk of becoming addicted, and the future effects of addiction). Given that the consumption decisions of an individual who has already experienced cigarettes are likely to be influenced by its addictiveness, it is reasonable to separately analyze the decisions of those who have never smoked cigarettes. It also makes sense to distinguish between current and past users. Thus, we can define smoking decisions as the decision to start smoking (new users), to change the quantity consumed or to quit (current users), and to relapse (former users).

The tobacco history of an individual is better understood when divided into several phases. A young individual will look for immediate reward, has low self-control, and has limited information. Youths perceive cigarette consumption as an opportunity to rebel, to show that they belong to a group, or to simply look more mature. Their decision to smoke is likely to be influenced by their peers and will usually not be very costly (at least in monetary terms) because experimentation with cigarette smoking is often not related to the purchase of the product. In this age group, other immediate costs of consumption include bypassing family rules and laws regarding minimum purchase age. Young individuals are likely to be less aware than adults about the health risks associated with smoking, and even if they know some of the risks, they are prone to put little weight on those that are distant in time. This lack of awareness is also related to the addictive potential of the product, which is often deemphasized, leading to over-optimism about future personal smoking status. Once an individual has smoked his first cigarette, he starts to accumulate "addictive capital" that will have a significant impact on his future decisions. Both the effects of nicotine on the body and the psychological gratification associated with smoking reinforcement have a positive impact on utility. Moreover, at least some of the

benefits of consumption come from avoiding the costs that would be associated with reduced consumption. With this in mind, the smoker smokes at least partly to avoid disutility rather than to increase utility. Moreover, the greater the addictive stock, the more the individual will have to consume during the next period to achieve the same level of utility. These considerations have important consequences for the smoking decisions of current and past smokers. Because the marginal utility of cigarettes increases with the addictive capital, new smokers will progressively increase their level of consumption. Furthermore, when a smoker decides whether or not to quit, the perceived benefits of quitting are often offset by the huge perceived withdrawal costs. After an attempt to quit, the withdrawal costs experienced are such that former smokers often relapse. When a smoker ages, two effects compete, and the resulting effect on smoking behavior is unclear. First, long-term smokers have accumulated an important addictive stock, and thus, the associated costs of quitting might then be very important for them. However, as they become older, the health risks associated with smoking become imminent and therefore may have a larger influence on consumption decisions.

Economic models of addiction

Here I present some models of individual behavior that incorporate considerations related to addiction (see also Chaloupka and Warner 2000). In these models, individuals are said to be myopic, fully rational or imperfectly rational. Myopic individuals know that smoking is addictive but do not anticipate the consequences of addiction when they make smoking-related decisions. Fully rational individuals are assumed to be very aware of the future implications of addiction and to incorporate those considerations into their decisions. This point of view, mostly developed by Becker and Murphy (1988), implies perfect foresight. Imperfectly rational individuals have preferences that are not consistent over time.

When we model the demand function for a particular good, the standard method involves defining a utility function that depends on the current consumption of the good of interest (C_t) and on a composite good that reflects all other consumption (Y_t). The utility function at time *t* is then

$$U_t = f(C_t, Y_t) \tag{2.1}$$

The consumer is assumed to maximize this utility function subject to income constraints such that we attain a demand function that depends on current price (and

other usual factors). This model of consumption is not well suited to addictive goods because it does not incorporate the idea that past consumption has an influence on present consumption, which in turn influences future consumption. The concept of habit formation has been introduced by several authors, including Pollak (1970). The idea is to include elements of past consumption in the utility function. In these models, referred as myopic addiction models, a good is addictive if past consumption increases current consumption. Past consumption is summarized in a stock of addictive capital (S_t) that depreciates over time, at rate δ .

$$U_t = f(C_t, S_t, Y_t) \tag{2.2}$$

with

$$S_t = C_{t-1} + (1 - \delta)S_{t-1} \tag{2.3}$$

In addition to conventional current factors, the resulting demand function includes past consumption. In these models, tastes are allowed to change over time in relation to past consumption. However, it is assumed that individuals do not take into account the future implications of their addiction in their current consumption decisions.

Whereas the future consequences of consumption are ignored in myopic models, individuals maximize their lifetime utility in the rational addiction model (Becker and Murphy 1988), taking into account the correlations between past, current, and future consumption. The idea of "*adjacent complementarity*" is introduced, in which the same goods consumed in two adjacent periods are complements. In this framework, the rational smoker knows that he will become addicted and is fully aware of all of the consequences of his consumption. Demand is therefore assumed to depend on past and future anticipated price and on past and future consumption[3]. Chaloupka (1991) presents the rational addiction model in an original way. He defines three elements that are included in the utility function: health capital, H_t, euphoria generated by the consumption of the addictive good, E_t, and a composite good, Y_t:

$$U_t = f(H_t, E_t, Y_t) \tag{2.4}$$

In the model, E_t is assumed to depend on the addictive stock S_t, which depreciates over time (see (2.3)), and on current consumption C_t:

[3] The structural form of the model could be $C_t = \beta_0 + \beta_1 P_t + \beta_2 P_{t-1} + \delta\beta_2 P_{t+1} + \beta_3 C_{t-1} + \delta\beta_3 C_{t+1}$, with δ, the discount factor reflecting the rate of time preferences.

$$E_t = g(S_t, C_t) \quad (2.5)$$

This view allows us to understand the interdependency between past and current consumption based on two aspects of the addictive good: reinforcement and tolerance. It is first simply assumed that current consumption increases utility, i.e., that $\partial E/\partial C > 0$. It is also assumed that the addictive stock has a negative impact on health, i.e. $\partial H/\partial S < 0$. Furthermore, the marginal pleasure provided by additional consumption depends on the stock of past consumption, i.e., $\partial^2 E/\partial C \partial S > 0$ (reinforcement). Tolerance is reflected by the negative relationship between the addictive stock and current pleasure (euphoria), i.e. $\partial E/\partial S \leq 0$. The last characteristic of addictive goods is the important drop in utility associated with zero consumption, reflecting withdrawal. The rational addiction model has many implications for behavior and for the responsiveness of the individual to policies such as price increases or information dissemination. Because of adjacent complementarity, it is assumed that a permanent price increase will have a greater effect in the long run than in the short run. Perfect foresight, as assumed here, does not exclude individual heterogeneities in terms of time preferences; therefore, the extent to which individuals incorporate the future into their decisions has an important impact on the interpretation of the model. Some subgroups within the population are assumed to have greater rates of time preference (they are assumed to be more present-oriented), e.g., young, less educated individuals. These individuals will be more sensitive to immediate changes in product cost. Less present-oriented individuals are likely to assign more weight to the future consequences of their current consumption and will thus be more responsive to changes in risk perceptions.

In their review of models of addiction, Chaloupka and Warner (2000), cite a quotation by Winston (1980) that summarizes the criticism of rational models of addiction: "*The addict looks strange because he sits down at period j=0, surveys future income, production technologies, investment/addiction functions, and consumption preferences over his lifetime to period T, maximizes the discounted value of his expected utility, and decides to be an alcoholic. That's the way he will get the greatest satisfaction out of life. Alcoholics are alcoholics because they want to be alcoholics, ex ante, with full knowledge of its consequences.*" Moreover, the rational addiction model assumes exponential discounting of future consequences. As an alternative, an emerging literature proposes another category of models that includes elements of behavioral economics in the formalization of smoking decisions and

particularly in the evolution of preferences over time. In the rational addiction framework, utility at time *t* equals the exponentially discounted lifetime utility:

$$U_t = U(C_t) + \sum_{i=1}^{T-t} \delta^i U(C_{t+i}) \quad (2.6)$$

Exponential discounting implies that the consumer is time-consistent, i.e. that he puts the same relative weight on utility between two consecutive periods in the immediate future than between two consecutive periods in the distant future. Consumer time-inconsistencies were formally introduced by Gruber and Koszegi (2001, 2004). The authors assumed another type of discounting – hyperbolic discounting – under which the relative weight of the future changes over time (see also Phelps and Pollak 1968, Laibson 1997). Specifically, the discount factor between two periods in the future is higher than the discount factor between time t and t+1. The consumers therefore put a higher relative weight on immediate rewards and costs than on future consequences. Formally, a quasi-hyperbolic discrete discount function is used:

$$U_t = U(C_t) + \beta \sum_{i=1}^{T-t} \delta^i U(C_{t+i}) \quad (2.7)$$

With $\beta = 1$ we are back to exponential discounting. Hyperbolic discounting occurs when $0 < \beta < 1$, reflecting the degree of orientation toward the present. "*Impatience*" in the short run ($\beta\delta$) is then in conflict with "*patience"* in the long run (δ), and the story repeats at each period (Gruber and Koszegi 2004). This type of time-inconsistency leads to consumption levels than are in conflict with the preferences of the "future self".

Two alternative approaches to modeling departure from rationality are proposed by Orphanides and Zervos (1995 and 1998). At the age of smoking initiation, people are not legally allowed to take part in many processes (they cannot vote, drive, etc.). Their status in this way reflects their lack of ability to decide for themselves and lack of consumer sovereignty as recognized by the society. Most young people who try smoking are not aware of the risks of addiction, and they will probably regret their decision later in life. This consideration is formally presented by authors who consider the subjective probability that young individuals will become addicted to cigarettes (Orphanides and Zervos 1995). The same authors (Orphanides and Zervos 1998) model the potential impact of random shocks on the discount factor (i.e., in time preferences). Some critical life events might have an important influence on individual time-preferences, and these events are often not perfectly anticipated.

The discount factor depends on the stock of addictive consumption and on these random shocks:

$$\theta = f(S_t, \eta_t) \tag{2.8}$$

This modeling leads to discontinuities in optimal consumption patterns induced by brutal changes in the discount factor. Other models of imperfect rationality include studies by Bernheim and Rangel (2004 and 2005) in which the authors assume the cue-triggered use of addictive substances, leading to heterogeneous price responsiveness among individuals. Gul and Pesendorfer (2004) have also developed a model of addiction that includes notions of self-control (temptation, irresistibility).

General conceptual framework

To analyze smoking decisions and related policies, I use a simple analytical framework that incorporates the main issues raised above about the particularities of tobacco consumption. The decision to start, quit, or relapse depends on the perceived net benefits of this decision over those of the alternative (not starting, continuing smoking, and continuing not to smoke). The individual is assumed to weigh the benefits and the immediate and potential futures costs of the decision. For current (former) smokers, utility derived from additional (potential) consumption is influenced by past consumption (through the addictive stock).

While immediate costs of smoking - mainly market price and time costs - are easily assessed, the appraisal of future consequences is much more complex. They have a perceived probability of occurrence, have particular perceived implications, and are discounted by individuals. I assume here that the consumer only knows a fraction of the potential costs that his consumption could induce and that he does not precisely know his personal probability of being affected. I define the discounted expected costs of cigarette smoking for an individual *i* as follows:

$$E[Cost]_i = \delta_i \sum_{j=1}^{m} \rho_{ij} \pi_j^* H_j^* \qquad j = 1, \ldots, m \text{ consequences} \tag{2.9}$$

Where δ is the individual discount factor, π_j^* is the true probability that consequence j occurs, H_j^* are the true costs of consequence j, and ρ_{ij} reflects the individual over- or under-estimation of the risks and of the costs of consequence j. Individual heterogeneities are thus included in parameters δ and ρ. For never-smokers deciding whether or not to start smoking, the uncertainty is not limited to health consequences

but instead also concerns the extent to which they will become addicted (in other words, the higher the perceived subjective ability to quit in the future, the lower the perceived future consequences).

For potential "starters", the perceived benefits of smoking include peer acceptance, rebellion, self-esteem, pleasure, and experimentation. The present costs are market price, time costs, and access limitations (including family rules). We expect individuals, mostly youths, to under-estimate future consequences because of their lack of information, over-optimism (leading to a small ρ_{ij}) and high orientation toward the present (high δ). If we look at smoking cessation, the benefits are mainly averted costs (lower expenses, diminution of future long-term and short-term consequences) and the costs depend strongly on the addictive stock and are mostly associated with withdrawal.

This framework allows us to understand how public policies should be developed to influence smoking-related decisions. The objectives might be to prevent potential new smokers from starting, to encourage current smokers to quit or at least to cut down consumption, and to prevent relapse among former smokers. These objectives can be accomplished by increasing present costs of consumption, e.g., raising taxes to raise market prices, implementing access limitations (minimum age at purchase), reducing the number of points-of-sale (including vending machines), and smoking bans (it is less "comfortable" to smoke). Policies might also be targeted at increasing perceived future costs, mainly by increasing ρ_j. In other words, policies can be targeted at improving the personal risk perceptions of individuals and increasing knowledge about the real consequences of the various health risks. Another strategy is to reduce the positive influence that tobacco industry advertising has on the perceived benefits of smoking. Additionally, to reduce the costs of smoking cessation, policies might facilitate access to cessation support, including pharmaceutical products. The extent to which the government should intervene to influence smoking-related decisions is discussed in section 2.3, and evidence about the effectiveness of various tobacco control policies is reviewed in section 2.4.

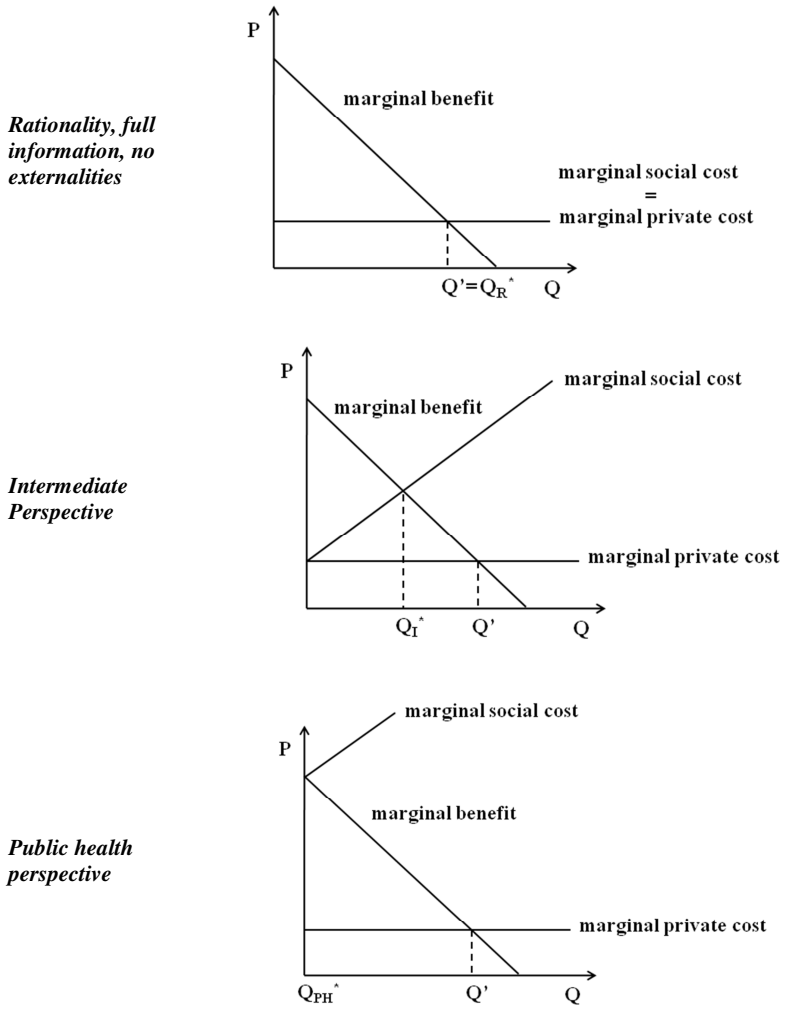
2.3. Market failures and rationale for a government intervention

If one assumes that smokers are forward-looking and rational, have perfect information about the consequences of tobacco use with respect to both its impact on health and its addictive potential, and support the entire cost of their consumption,

then from an economic perspective, there is no room for government intervention. However, this description does not reflect reality. The tobacco market involves numerous market failures that make the efficient market viewpoint inapplicable and that justify tobacco control interventions. I classify the main market failures of tobacco use into three broad categories: external costs, lack of information, and limited rationality. The last category is related to departures from the rationality assumption that leads to what is referred to as "internalities" (or intrapersonal externalities).

The rational addiction (Becker and Murphy 1988) model posits that because the consumer takes all future consequences of his consumption into account in his decisions, the only justification for government intervention is the costs that smokers impose on others (external costs). However, whether these costs are really important is still subject to debate. Thus, with perfect information, and if rational and forward-looking smokers do not impose large costs on others, the government should not intervene too much. At the other extreme, some public health advocates suggest that even the smallest level of consumption is unacceptable and therefore that taxes should be set accordingly, i.e., at a very high level. The "intermediate" level of intervention (or rather the "efficient" level) lies somewhere between these two approaches. The three conceptual cases are presented in Figure 2.1 and lead to different desirable levels of consumption. The first diagram presents the extreme case for which there is no room for intervention. The consumer is rational and forward-looking and has full information; the externalities (and thus the external costs) are inexistent. The diagram in the center shows the intermediate description, with lower optimal consumption because of a lack of rationality, imperfect information, and a broader view of external costs. Finally, the last diagram depicts the public health approach, for which zero consumption is the optimal level.

Figure 2.1: Optimal level of cigarette consumption - three perspectives



The three approaches can be assessed with respect to the difference between marginal private and social cost at the equilibrium (i.e., at Q_R^*, Q_I^*, and Q_{PH}^*, depending on the perspective), that reflect the desirable degree of intervention. If the first perspective is considered, the level of intervention is null, whereas from the public health perspective, the government should implement very intensive and somewhat paternalistic interventions to reach the zero level of consumption. The two extreme cases seem difficult to justify economically, the efficient level of intervention probably lies in-between.

External costs, lack of information, and lack of rationality

The external costs are the costs that a smoker imposes on other individuals or on the society as a whole without paying the full cost, i.e., the costs that are not reflected in the price paid by the smoker. The most salient types of external costs are those related to the health impact of environmental tobacco smoke (ETS, or passive smoking). Whereas the costs of ETS mostly include the medical costs of heart diseases and prenatal effects (low birth weight), the exact burden of ETS remains unclear and is still under debate (see section 2.4.4). Other classical external costs are damage to property, fire and pollution caused by cigarette smoking. Smoking-related health expenditures are also often presented as a major source of smoking externalities. Each year in Switzerland, the health care sector devotes approximately 3% of its resources to treating the four most prevalent smoking-related illnesses (the direct costs of smoking, Jeanrenaud *et al.* 2010). In the United States, Warner *et al.* (1999) estimate that 6-8% of health care resources are used to treat tobacco-related diseases. Smoking imposes a high burden in terms of years of life lost and loss of quality of life[4], and the average smoker costs more in terms of medical expenditures than the average non-smoker. By reducing smoking, a country could reduce that spending and reallocate the funds to treat other diseases. However, the excess medical costs of smokers should be considered an external cost only if medical expenditures, or a portion of them, are borne by the society and not the individual himself. Smokers do not pay higher premiums in Switzerland, which means that they do not fully bear (internalize) the excess costs that they incur for the group insurance. Moreover, a portion of health expenditures is publicly funded. However, there is still an important debate taking place about the net impact of smoking on lifetime medical expenditures. This is because premature death among smokers reduces high expenditures at an advanced age. The "benefits" of smoking in terms of avoided future medical costs could even offset excess costs resulting from smoking-related conditions. The impact on the pension system should also be taken into consideration in a complete analysis of the net costs of smoking. It is often argued that smokers, in dying earlier, subsidize non-smokers' pensions and do not fully benefit from their pensions. So, on the one hand, smokers have higher health expenditures due to expensive smoking-related diseases, whereas on the other hand, they die earlier, resulting in lower health expenditures. However, if we use the argument that the peak in health expenditures always occurs in the last year(s) of life, non-smokers will just "shift" their peak

[4] It has been estimated that 11.2% of the total disability-adjusted life years (DALYs) in Switzerland in 2006 were attributable to smoking (WHO 2006).

expenditures several years later (in other words, most of their additional years of living as compared with smokers will not be very costly).

Studies have investigated the net cost approach, which compares the "lifetime" costs of smokers and non-smokers. The results presented in the literature are quite mixed because of the variety of approaches used and assumptions made, but they tend to confirm that smoking imposes additional health costs, albeit at a relatively low level. In Switzerland, Leu and Schaub (1985) find that the ratio of the lifetime costs of smokers to the lifetime costs of non-smokers is around 0.95 and thus conclude that smoking leads to lower health expenditures (a ratio of 0.85 was found in the Netherlands, as presented in Barendregt *et al.* 1997). Manning *et al.* (1991) estimates that each pack of cigarette increases the net present value of health costs in the United States by approximately 30 cents. Also in the US, Hodgson (1992) estimates that the population of smokers in 1992 will increase health care costs by US$500 billion over the remaining years of their lives. In Australia, Collins and Lapsley (1996) show that avoided costs because of premature death represent only half of the gross health care costs of smoking. In addition, many social costs studies include production losses. Production losses are caused by smoking-related disability (sick leave) and by premature mortality (loss of productive life years). In conclusion, even if lifetime health care costs were consistently higher for non-smokers and not offset by production losses, it would be difficult to argue that society would be better off with more people dying earlier. Life absolutely has a value *per se* that should be accounted for in cost calculations. In Switzerland, smoking-related health care costs in 2007 were estimated at CHF 1.7 billion, production losses at CHF 3.9 billion, and human costs at CHF 4.3 billion (Jeanrenaud *et al.* 2010).

The second category of market failures is related to the lack of information about the consequences of smoking. Individuals are not fully aware of smoking-related risks, and they are often over-optimistic about how they will be personally affected by smoking. Moreover, non-smokers, mainly young people, do not fully understand the addictive properties of cigarettes. As a result, smokers often later experience unexpected future difficulties trying to quit. Information-related costs, or uninformed costs (Chaloupka 2002), result in greater consumption than would be observed if individuals had perfect information on health risks and addiction.

Beyond classical externalities, part of the cost that a smoker imposes to himself can be considered external, depending on the assumed degree of rationality. If the smoker is fully rational, he fully takes into account the impact that his consumption has on himself in his current decisions, the costs are thus internalized.

However, under limited rationality, preferences are not consistent over time, and there might be important gaps between what an individual decides today and what his "*future self*" would decide. Individuals are time-inconsistent and then impose unexpected costs on themselves because today's individual differs from the individual in the long term. For instance, the individual today might postpone attempting to quit, as he is confident in his ability to quit later, but later, that same individual might postpone the decision again. This time-inconsistency is formally incorporated in the behavioral economics model of smoking decisions developed by Gruber and Koszegi (2004) (see also Laibson 1997, O'Donoghue and Rabin 1999a 1999b). In this framework, the more the individuals are time-inconsistent, the more important the intervention should be. Interventions such as tax increases are seen as a remedy for this lack of self-control and thus should be important if limited rationality is widespread in the population. In contrast, other models that incorporate psychological aspects, such as cue-triggered consumption, or temptation and irresistibility conclude that, for some types of individual, price increases would be clearly welfare reducing (Bernheim and Rangel 2004 and 2005, Gul and Pesendorfer 2004).

In summary, the level of tobacco consumption might be too high because individuals do not take into account the full consequences of their own consumption on others and on themselves. Moreover, the less informed a smoker is about the smoking-related health adverse effects, the higher is the excess consumption. Many aspects of smoking externalities and internalities are even better justified when we look at youth smoking. Indeed, orientation toward the present, lack of self-control, lack of information, and underestimation of the risk of addiction are more likely in this subgroup of the population.

Smoking inequalities

An important feature of the tobacco epidemic model proposed by Lopez *et al.* (1994) is the widening of socioeconomic differences in the context of smoking prevalence. In the early stages of the process, smoking prevalence was higher in upper socioeconomic groups. Today, however, this trend has reversed, resulting in major socioeconomic inequalities in terms of both smoking prevalence and smoking-related morbidity and mortality. Smoking has been identified as a primary cause of inequalities in death rates between different social classes (Jha *et al.* 2006). In a study conducted among European men, Mackenbach *et al.* (2004) find that 20% of the educational differences in those who suffer premature mortality are attributable to

smoking. Extensive international literature offers evidence that tobacco does not affect all socioeconomic subgroups of the population equally (it is estimated that smoking prevalence is about 50% higher in lower socioeconomic groups than in higher groups (Mackenbach *et al.* 2007)). Giskes *et al.* (2005) analyzed trends in smoking behavior by education level between 1985 and 2000 in Western Europe. They find a greater decline in smoking prevalence and consumption levels among more educated individuals. Huisman *et al.* (2005) also find that education is a strong predictor of smoking in Europe. In a study among British women, Harman *et al.* (2006) identify socioeconomic gradients for ever-smoking, quitting and current smoking. Using six socioeconomic indicators, Laaksonen *et al.* (2005) identify a strong association between education, occupational status and current smoking. Cavelaars *et al.* (2000) find higher rates of current and ever-smoking among less educated individuals in northern European countries.

Barbeau *et al.* (2004) find the same type of association in the United States, where they note an increased prevalence of current smoking and an independent association between current smoking and lower-paid jobs, low education levels and lower income levels. Moreover, they find a positive association between success in quitting and socioeconomic resources. This last finding is supported by the studies of Borland *et al.* (1991), and more recently Lee and Kahende (2007), in which the authors find an association between certain socioeconomic indicators and the probability of successfully quitting. In a recent review by Schaap and Kunst (2009), the authors notice that the majority of studies on socioeconomic inequalities in smoking were focused on education and used smoking prevalence as the outcome of interest. The authors emphasized the importance of analyzing smoking inequalities with respect to other socioeconomic indicators and various smoking outcomes related to initiation and cessation. In Appendix A, I briefly show the results of the analysis of pooled cross-sectional Swiss data that indicate an evidence of a socioeconomic gradient in successful cessation with respect to education level and income. These inequalities justify an intervention of the government if we rely on a more normative approach of economics.

2.4. Policies

This section is intended to describe the most recommended policies aimed at reducing tobacco use. The focus is threefold: How does the policy influence smoking decisions? What is the existing evidence? What is the situation in Switzerland?

2.4.1. Tobacco taxation

Following the Ramsey Rule (Ramsey 1927), relatively price-inelastic goods are good candidates for taxation. For such commodities, important tax increases will lead to a less than proportionate drop in consumption and will therefore generate additional revenues. Historically, this has been the central argument for cigarette taxation, and it remains important nowadays (with cigarettes an inelastic good consumed by one of every four individuals). The increasing awareness that smoking is harmful has encouraged the use of cigarette taxation as a health policy tool for reducing consumption and smoking-related harm. As mentioned earlier, the extent to which it seems this policy tool should be used depends on the perspective used to analyze tobacco taxation. Based on the *public health* perspective, the right tax level is the highest that is politically acceptable, whereas within the *economic* framework, the optimal rate should take into account specific market failures related to the consumption of these products, including externalities resulting from secondhand smoke, excess life-time healthcare costs among smokers, lack of information, and lack of rationality. Even in the economics literature, the issue of optimal taxation is left unresolved. Indeed, individual behavior is shown to be consistent using various models of consumption, and depending on which model is used to describe smoking decisions, an increase in the cigarette excise tax that leads to a price increase can be seen as welfare increasing or as an additional burden to consumers for which desired consumption is reduced. The issues surrounding the identification and valuation of the negative externalities and the so-called internalities at play are numerous and complicated.

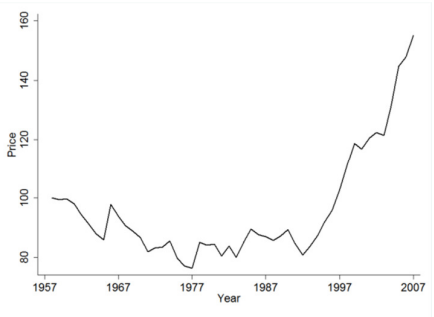


Figure 2.2: Real price of cigarettes in Switzerland (1958-1007, price index 1958=100)

Until the mid-1980s, the real price of cigarettes in Switzerland remained stable, and it even decreased during some periods (Figure 2.2). However, during the last decade, we have witnessed important tax increases. The average price of a cigarette pack in 2009 was CHF 6.90, with taxes representing 64% of the price. In Table 2.1, I show the various components of cigarette price. In addition to the main tobacco tax, with revenues (2.19 billion in 2008) that are used to finance ageing and disability insurance (AVS/AI), two types of taxes are earmarked for specific tobacco-related uses: one for a tobacco prevention fund (to finance prevention programs and prevention-related research) and one to subsidize Swiss tobacco producers (farming).

Table 2.1: Price of a cigarette pack (20 units) in Switzerland, 2009

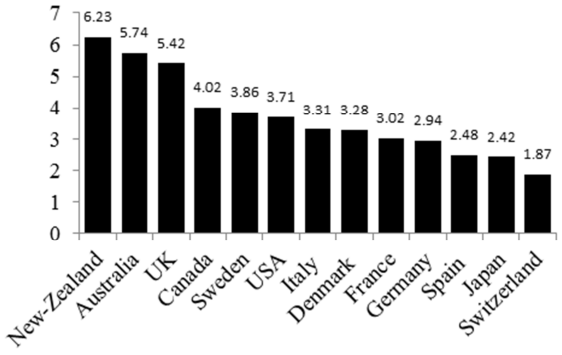
	CHF
Industry share	2.45
Taxes	4.45
Tobacco tax	*3.91*
Value-added tax	*0.49*
Tobacco prevention fund	*0.026*
Tobacco farming	*0.026*
Price	**6.90**
(% tax)	**(64.5%)**

Source: Customs General Directorate (2008), own computations

However, tobacco prices remain quite low compared to those in other countries. In addition, the purchasing power of Swiss citizens is high, making these products highly affordable for them. Guindon *et al.* (2002) illustrates this, using the Economist's Big Mac PPP index as suggested by Scollo (1996) to assess the affordability of cigarettes in different countries in 2001. In Figure 2.3, we see that Switzerland is among the countries in which cigarettes (in this case Marlboros) are relatively cheap. In the same paper, the authors compute that for individuals living in

Geneva, 12 minutes of work are sufficient, on average, to pay for a pack of cigarettes, whereas 18-30 minutes are needed in other OECD countries.

Figure 2.3: International brand prices of a 20-unit pack at Big Mac PPP, 2001



Source: adapted from Guindon *et al.* (2002)

In this section, I review some issues related to tobacco taxation as a health policy tool under the general framework presented in Figure 2.4, and I illustrate some of the concepts using Swiss data.

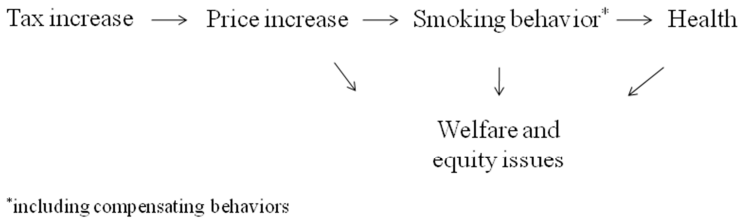
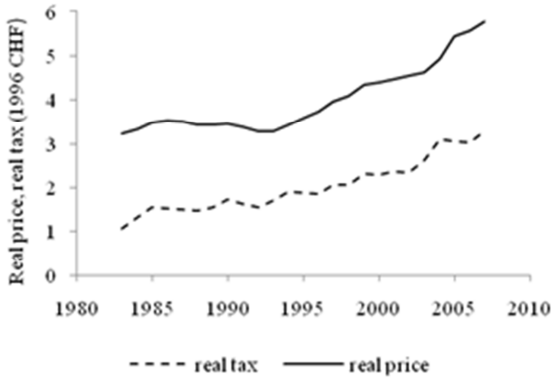


Figure 2.4: Tax as a health policy tool

The relevant policy tool for influencing price-to-consumer numbers (which in turns can lead to a change in the demand) is the taxation of tobacco products. One essential question is whether tax increases lead to price increases. In Switzerland, the tobacco market is mainly held by three firms, and this has important implications for the tax-price relationship. Chaloupka *et al.* (2000), in their chapter on tobacco taxation, conclude that "i*ncreases in cigarettes taxes, because of their addictive nature and because of the oligopolistic structure of the industry, will lead to increases in the prices of tobacco products that are likely to match or exceed the increase in the tax in most countries.*" Considering alcohol tax hikes, Kenkel (2005) provides empirical evidence that the policy tool (a tax increase) has led to more than proportional increases in price ("*taxes are more than fully passed through price*"). In

Figure 2.5, I show the evolution of the real price and real tax of tobacco products. In addition, in Table 2.2, I show the last important tax increases and the subsequent price increases that were observed. The value of 1.57 (Table 2.2.) does not reflect the exact tax to price rate because other influential factors, such as trends in cigarette prices and increases in production costs, should also be considered. However, this number suggests that the pass-through rate is likely to be greater than one. Similarly, Keeler *et al.* (1996) find that a one cent increase in the cigarette tax will lead to a price increase of 1.1 cents. However, the average price does not reflect the potential heterogeneity in unit prices in the country. A concern lies in the promotional reductions ("buy one get two"), mostly targeted at young individuals, and the consumption behavior of heavier smokers that often benefit from unit price reduction in buying cartons of cigarettes.

Figure 2.5: Tax and price increases in Switzerland



Source: Customs General Directorate (2008), own computations

Table 2.2: Tax and price increases in Switzerland

Date	Tax increase	Subsequent price increase	Ratio price increase/ tax increase
01.01.1999	0.3	0.4	1.33
01.01.2001	0.1	0.2	2.00
01.10.2003	0.3	0.5	1.67
01.12.2004	0.5	0.6	1.20
01.01.2007	0.3	0.5	1.67
		Average	**1.57**

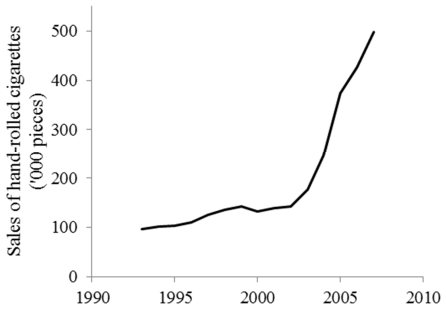
Source: Customs General Directorate (2008), own computations

Once the price has increased, the relevant question is whether or not it has an influence on smoking behaviors. An extensive body of international literature provides evidence that taxes are an effective policy tool for changing behaviors. Many empirical studies have shown a significant negative link between price increases and tobacco consumption. Chaloupka and Warner (2001) provide an

excellent review of the studies of the demand for tobacco products and show that, independently of the method used, most studies conclude to a price-elasticity of consumption around -0.4, confirming the idea that cigarette demand has relatively low price responsiveness. As reduced overall quantity consumed may be a consequence of reduced individual consumption or of lower smoking participation, the authors also list some empirical studies that have separated the impact of price into its effects on participation and consumption (conditional on participation). These studies mostly conclude that the effect is split equally between the two (Harris 1994, Chaloupka *et al.* 1996). Moreover, the data on tobacco consumption have been extensively used to provide empirical applications for new econometric techniques such as double-hurdle models or, more recently, the zero-inflated ordered probit model (Jones 1989, Yen and Jones 1996, Labeaga 1999, Harris and Zhao 2007). Because reduced smoking participation (stock of smokers) is achieved by reducing the flow of new smokers (preventing initiation) and increasing the flow of new quitters (enhancing cessation), an increasing number of studies has separately considered the impact of price on smoking initiation and smoking cessation. These studies conclude that there is a significant impact of price on smoking cessation. However, despite evidence that young individuals are more responsive to taxes than adults (see, e.g., Glied 2003, Farrelly and Bray 1998) results are mixed concerning the impact of price on smoking initiation (Douglas 1998, Douglas and Hariharan 1994, Lopes-Nicolas 2002, DeCicca *et al.* 2002, Cawley et al. 2004, Tauras et al. 2001). In the third chapter of this dissertation, I provide evidence that tobacco prices are effective in increasing the probability of initiation and cessation, taking tobacco control spending into account. Under the behavioral economics framework, Fletcher *et al.* (2009) recently showed that the extent to which adolescents were price responsive was partly determined by self-control and by the degree to which individuals discount the future. Recently, DeCicca *et al.* (2008a) used various approaches to study the impact of price on smoking onset and cessation among young adults. After controlling for a antismoking sentiment, the authors found no evidence that tax increases deter individuals from starting and some evidence that they are effective in enhancing cessation rates. Similar conclusions were obtained in DeCicca *et al.* (2008b), in which the authors show that price might be a more relevant determinant of cessation and consumption decisions than it is for smoking initiation. Liu (2009) finds an important influence of price on smoking cessation and relapse, whereas there is no apparent effect on its ability to prevent smoking initiation.

Significant tax increases might also have an impact on the consumption of less-taxed tobacco products, such as self-made cigarettes. Hanewinkel *et al.* (2008) highlight the significant cross-price elasticity between cigarettes and less taxed cigarettes and therefore provide support for the view that "*the availability of low-taxed loose tobacco may undermine the public health benefits of higher cigarette prices*". To develop a preliminary sense of this phenomenon in Switzerland, I gathered some data about hand-rolled cigarette sales in Switzerland. Based on the quantity of hand-rolled cigarette tobacco sold in Switzerland (in tons), I estimated the consumption of hand-rolled cigarettes nationally. For this purpose, I assumed that 0.75 grams of tobacco were needed to make one cigarette. The results are presented in Figure 2.6. We observe a sharp increase in the sale of such products beginning in 2003/2004 (years in which there were important tax hikes).

Figure 2.6: Sales of hand-rolled cigarettes in Switzerland



Source: Customs General Directorate (2008), own computations

Compensating behavior by smokers in response to tax increases have also been studied by Evans and Farrelly (1998), who showed that tax hikes can result in increased nicotine intake. Similar findings are presented in Farrelly *et al.* (2004). More recently, Irvine (2008), cited by Gospodinov and Irvine (2009), proposed a model in which smokers experience a trade-off between the quantity smoked and the intensity of smoking. Tax increases could also lead to smuggling. In Switzerland, unlike in the United States, there are no cigarette price differences across regions. There, smuggling is much more likely to occur from Switzerland to other countries; cigarette prices in neighboring countries are higher or are very close to Swiss prices. Additionally, according to Joossens and Raw (1998), smuggling is not a significant issue in Western Europe, where "*it is not caused by market forces*" but rather "*by the illegal evasion of import duty*".

Efficiency and equity issues

In Switzerland, as in many other Western countries, smoking is more prevalent among more disadvantaged socio-economic groups. Moreover, low-income smokers spend a larger share of their income on cigarettes than do their more affluent counterparts. To illustrate this issue, I computed the share of monthly net household income spent on cigarettes in different income groups. We see that in the lowest income group, the share of income spent on cigarettes reaches 4.3% on average, whereas it is only 0.7% for individuals with monthly income higher than CHF 10,000 (Table 2.3).

Table 2.3: Spending for cigarettes as a share of household income

	Net monthly household income groups				
	<4000	4000-6000	6000-8000	8000-10000	>10000
Share of income	4.3%	2.2%	1.4%	1.1%	0.7%
N	*312*	*575*	*553*	*394*	*377*

Source: Swiss Health Survey 2007. Spending on cigarettes was estimated using data on daily consumption and cigarette price in 2007

The tax burden is thus higher for individuals in the lowest income group, and the issue of vertical equity (according to the ability-to-pay principle) must therefore be raised. The real regressivity of cigarette taxes has been widely debated and depends on the viewpoint used to analyze the issue. Although the tax burden is undoubtedly higher for low-income groups, some authors suggest that equity can be maintained if the consumption of more deprived individuals is more sensitive to price changes. Some authors have found that low-income and less educated individuals are much more price responsive (see, e.g., Farrelly and Bray 1998, Townsend *et al.* 1994). Such results have encouraged a "dynamic" way of looking at regressivity in which a proportionately higher reduction in consumption among the poor occurs after a price increase, resulting in a greater reduction of the burden in this subgroup. A tax increase might then reduce inequalities, with a more rapid decline of the burden among deprived smokers. However, this argument is also subject to debate. We see that two dimensions must be taken into account and considered in tandem to analyze equity: the share of income spent on the specific good and price responsiveness. Nevertheless, when relying on this way of assessing progressivity, we do not take into account the fact that people who "must" cut back consumption are probably worse off (because they derived some utility from using tobacco). It is also important to consider horizontal equity, i.e., equity in a particular group within the population (the poor). The central idea is that tax increases are a high burden for smokers who do not quit. Remler (2004) illustrates this issue using an example of three smokers who react

differently to a tax increase. Smoker A quits smoking and therefore bears no financial burden. Smoker B continues smoking the same amount, resulting in a high financial burden, and smoker C cuts back smoking such that the tax burden is exactly the same as before. The authors show that whatever point of view we use to analyze the response of these three individuals following a tax increase, the individuals who do not quit smoking or diminish consumption are always worse off. The tax burden would then be excessively large for strongly addicted poor smokers. Another debate exists in response to the question of whether, and to what extent, the welfare losses associated with lower cigarette consumption should be taken into account in an analysis of the impact of a tax (price) increase. The traditional view is simply that people who still consume the good after a tax increase are worse off because they pay higher price. Additionally, one should take into account the fact that people who consume less are worse off (because they had a positive willingness to pay (WTP) for those goods). However, we must ask whether WTP for addictive goods such as cigarettes really reflects true WTP. Weimer *et al.* (2009) study this question and find that welfare losses because of reduced consumption of an addictive good represent only a fraction of the "traditional" WTP (only 75%). The issue of welfare and cigarette taxes is raised in an original way by Gruber and Mullainathan (2002). The authors investigate the relationship between tax increases and self-reported well-being using survey data and find that smokers are better off (in terms of self-reported happiness), after a tax increase. The field of behavioral economics also presents some arguments that support the view that WTP for cigarettes does not reflect value for smokers. These arguments rely on time-inconsistency. Based on this point of view, smokers are motivated to quit but cannot kick the habit and always postpone their quit attempts. Gruber and Koszegi (2004) and O'Donoghue and Rabin (2006) argue that taxes play the role of a self-control "device" for individuals and thus should be substantially increased. Hersch (2005) also argues that taxes are useful self-control mechanisms. In contrast, other authors argue that taxes will have no impact on behavior because smoking decisions result from cue-triggered behaviors (Bernheim and Rangel 2004 and 2005), i.e., because environmental "cues" trigger mistaken tobacco use or because of temptation and inability to resist (Gul and Pesendorfer 2004). Another recent paper looks carefully at the regressivity of cigarette taxes (Gospodinov and Irvine 2009). The authors find no evidence to contradict the regressivity argument against taxes using data from Canada, in which prices were high in comparison with those presented in previous studies (mostly for the US). The authors conclude that a tax increase probably does not benefit low socio-economic subgroups. They argue that when cigarette prices reach a particular level ($7-$8),

public health authorities should focus on alternative ways to curb the smoking epidemic (other tobacco control intervention programs). In this study, the authors also point out that low-income individuals are likely to look to the illegal market. One way to circumvent the regressivity problem associated with cigarette taxes would be to dedicate part of the tax revenues to developing smoking cessation programs (smoking cessation therapies, for instance) targeted at lower income populations.

2.4.2. Information

Information dissemination about the adverse consequences of tobacco use has always been part of the tobacco control strategy in developed countries and is usually seen as being less "paternalistic" than smoking bans or tax increases. Such intervention is economically justified if one assumes that the population, especially young individuals, might not be fully aware of the risks associated with smoking. This potential lack of information includes information on short-term and long-term health effects, the addictive nature of the product, and the health benefits of smoking cessation. The tobacco industry is also a key actor in the dissemination of information about smoking risks and can spread misleading facts or attempt to mitigate the negative impression that available information on smoking should create. These facts make the use of information dissemination as a tobacco control tool a challenge. The messages in question must be carefully selected, targeted at specific groups within the population, and spread efficiently. The issue of tobacco industry advertising is the subject of the next section.

In the framework presented in section 2.2, the diffusion of information about the health-related and non-health-related consequences of smoking are intended to increase the perceived costs of consumption, leading fewer individuals to begin smoking and more to stop. The relevant messages, if effectively disseminated, are assumed to have a direct impact on risk awareness and perception, which in turn should have an impact on behaviors. Here, I make an important distinction between the level of awareness of the population regarding the negative consequences of tobacco use and the accuracy of their subjective assessment of these risks. Knowledge about smoking-related health consequences is not limited to knowledge about what types of diseases and other negative effects are associated with smoking. Individuals should also know how smoking affects the probability of one's being hurt. Moreover, there is an important discrepancy between the true, objective probability of being affected and the perceived, subjective probability of being affected. In addition, if

people's understanding of the adverse effects of smoking within a population is better, it is likely that that population will become more inclined to accept new anti-smoking policies (e.g., increases in tobacco control spending or smoking bans), which will create indirect benefits of information. The objective of this section is to indicate how new information can influence risk assessments among the population and to what extent this can leads to changes in smoking-related behaviors. For this purpose, I present notions related to risk awareness and perception, I list the various channels of information dissemination, and I review some empirical evidence of the effectiveness of new information in reducing tobacco use within the population.

Risk awareness and risk perception

A comprehensive assessment of the risks associated with tobacco use first involves the knowledge of all existing risks and their implications in terms of increased mortality and morbidity (i.e., decreased quality of life). This information forms what I call risk awareness as opposed to risk perception. Risk perception reflects the extent to which individuals understand the true risks, i.e., the subjective absolute or relative probability of being affected. The relative notion of risk is complex and is often not well understood, giving rise to the underestimation of risk. The question arises of what one's own risk is relative to that of other individuals and how important this risk is in comparison with risks associated with other causes of mortality or morbidity. Another central issue is the addictive nature of cigarette consumption. In other words, individuals should be aware of the high addictive potential of the product and of how difficult future cessation attempts will be.

That smoking is bad for one's health is not really subject to debate. There is a consensus within the scientific community and the population at large that tobacco use is harmful. Since the early 1960s, general information has been widely disseminated about the lethal health risks of smoking, including lung cancer and cardiovascular diseases. However, the routinely available knowledge is far from complete. For instance, individuals often underestimate their personal likelihood of being affected. Moreover, a number of other negative effects are not widely discussed, and it is likely that the true impact of smoking-related disease on quality of life is not well understood. As shown by Sloan *et al.* (2003), the idea of disability (i.e., that of being more dependent on relatives and friends) as related to a particular smoking-related condition (COPD), is highly repulsive and is a matter for concern among smokers. Recent scientific findings have also identified various other ailments

for which smoking is a risk factor, including subarachnoid hemorrhage (Anderson *et al.* 2004) and multiple sclerosis (Riise *et al.* 2003).

Risk perception in the population and its impact on behavior have been assessed in a large number of empirical studies. Research by Viscusi (1990, 1991 and 1992) has been widely cited and criticized. The author assesses risk perception using the answer to the following question: *"Among 100 cigarette smokers, how many do you think will get lung cancer because they smoke?"* The results indicate that smokers and non-smokers both overestimate the risk of getting lung cancer. With these results in mind, and using a microeconomic model, Zweifel (2001) argues that more accurate information about health risks would lead to increased consumption. However, Viscusi's measure is an absolute measure of the risks and focuses only on lung cancer, the most famous smoking-related lethal condition. It is less likely that individuals really understand the consequences of lung cancer in terms of loss of quality of life, for instance. Moreover, smokers are often said to be overoptimistic about their personal risk of being affected by a serious health condition in the future. In a study conducted in the US, Weinstein *et al.* (2005) find evidence that smokers underestimate their personal risk of getting lung cancer as compared to non-smokers and other smokers. Sloan *et al.* (1999) use another measure of risk perception, comparing the subjective probability of survival at age 75 to the "true" probability (based on life-tables) and showing that smokers overestimate this probability. A recent study by Heikkinen *et al.* (2010) shows that smokers, even if they are aware of the health risk associated with smoking, try to justify their behavior using arguments such as "*moderate use is not harmful*" or "*my own consumption is not harmful to me*".

Slovic (2001) shows that, consistent with Viscusi's findings (1992), young individuals overestimate the risk of getting lung cancer. However, the authors also show that individuals underestimate the consequences of lung cancer in terms of mortality and the number of years of life lost because of smoking. Moreover, when comparisons are made between smoking and other lethal risks, young individuals tend to underestimate smoking risks. They also witness an optimism bias among young smokers regarding their future ability to quit. Several authors have studied the impact of risk perception on behavior. Liu and Hsieh (1995) find that greater risk perception has a negative impact on the probability of smoking. Slovic (2001) disentangles the effect of risk perception into two parts: the effect on smoking initiation and the effect on cessation. The results indicate that risk perception plays a more important role in cessation decisions than in initiation decisions. Without addressing the question of causality, a cross-sectional study by McCoy *et al.* (1992) shows that smokers who

have higher risk perceptions are more likely to be engaged in smoking cessation treatment (in clinic). A study by Jonhson *et al.* (2002), shows that the association between young individuals' risk perceptions and their involvement in risky behaviors (smoking and unprotected sex) is sensitive to the way in which the question about risks is formulated (in terms of absolute or comparative risk). Slovic (2001) also shows that the level of risk perception of smokers depends on the formulation of the risk assessment question. Furthermore, it is indicated that individuals think that "others" are more likely to be affected than themselves. Using Swedish data on adolescents, Lundborg (2007) shows that greater perceptions of the mortality risk and the addictiveness of cigarettes are both associated with lower levels of smoking participation. These results are confirmed by Lunborg and Andersson (2008), who go a step further in showing that risk perceptions differ by gender. Although girls seem to put more weight on mortality, they seem to perceive the addictive potential of tobacco less clearly. The authors also show a negative association between these perceptions and smoking behavior. Finally, Song *et al.* (2009) find that the degree of personal risk perception among adolescents is negatively associated with smoking initiation. Interestingly, although most studies focus on perceptions regarding the negative effects of tobacco use only, these authors have also investigated the effect of perceptions regarding the benefits of smoking initiation. They find that high perceived benefits of smoking (including looking cool, feeling relaxed, and becoming popular) are associated with higher initiation rates. Another important issue is that risk perception is heterogeneous in the population, with the lack of information more pronounced among the most deprived (Siahpush *et al.* 2006).

Vectors of information diffusion and their effectiveness

The relevant vectors of information diffusion can be classified into two broad categories: public and private. The public sources include official public reports on the health risks involved (such as the Surgeon General's report in the US), scientific articles (relayed by the media), warning labels on cigarette packs, information campaigns, and school-based programs. Private information sources include observations regarding the adverse consequences of smoking for friends or relatives, personal experience with a negative consequence of tobacco use, or more generally, informal discussions. Here, I review some empirical findings related to the impact of these vectors on reducing tobacco use.

The most widely cited scientific work about the link between smoking and lung cancer is that of Doll and Hill (1954 and 1956). This information, along with information on chronic bronchitis, was relayed in the US Surgeon General's report of 1964. Later, the Surgeon General's reports progressively conveyed information about other health risks, including other types of cancers and cardiovascular diseases (see Slovic 2001 for a good review). The Royal College of Physicians in the UK conveyed the same type of information in 1962. In the US, Blaine and Reed (1994) have shown that the publication of the 1964 Surgeon General report led to an independent decrease of 1-1.3% in per capita cigarette consumption the following year. In the UK, the short-term decrease was found to be stronger (4.6%), but a subsequent increase of 1% a year was also identified (Atkinson and Skegg 1973). In Switzerland, Leu (1984) has studied the impact of the dissemination of various antismoking and health information messages on consumption. The results indicate that the publication of the 1964 report led to an immediate 15% reduction in consumption that consequently partly faded away. In 1966, in parallel to a large tax increase, antismoking messages were disseminated in the mass media in Switzerland, and a temporary reduction of 11% in consumption was observed. The results presented in these studies consistently indicate that the impact of the information depreciates over time.

Warning labels on cigarette packs have been introduced in many countries and range from rather simple messages such as *"smoking is hazardous"* to pictures depicting the shocking health consequences of smoking. In Switzerland, the first set of information was mandatory in 1978 *("smoking can be bad for your health"*). In 2004, the law was amended to require text to cover at least 50% of the pack; the use of the terms "*light"* and *"mild"* was also banned. More recently (beginning in 2008 with a transitional period of two years), it has been required that cigarette packs show colored pictures developed by the Federal Office of Public Health and include a short paragraph of information about the following negative consequences of smoking: shorter life expectancy, lung cancer, the impact on children, the danger for pregnant women, addiction, mouth cancer, skin problems, fertility, the presence of chemicals, impotence, and heart attack. Packs also contain contact information on cessation support (FOPH 2009). Hammond *et al.* (2003), in trying to assess the effectiveness of warning labels at changing behavior, find that smokers who have carefully thought about the new labels are more likely to have quit and have attempted to quit or reduced their smoking after a three-month follow up period. The results indicate that more than 90% of smokers have already seen the warnings and pay attention to them. The impact of the labels on knowledge about tobacco-related risks has also been

assessed by Hammond *et al.* (2006). They study the beliefs of smokers from the USA, the UK, Canada, and Australia about several smoking-related risks. Their results indicate a lack of knowledge about these risks among smokers and show that to communicate the risks efficiently, the warnings should be large, graphic, and should focus on diverse issues. They show that smokers who have stated that they have noticed the warnings are more aware about the corresponding smoking risks. In contrast, Robinson *et al.* (1997) find no evidence that warning labels are effective in reducing smoking among young individuals. Most of them do not even read or remember the labels. Some studies did not provide evidence of changes in behavior but rather indicated weaker intentions to smoke and indicated a significant perceived efficacy of the information in changing behaviors (Vardavas *et al.* 2009, White *et al.* 2008, Moodie *et al.* 2010, Nascimento *et al.* 2008). O'Hegarty *et al.* (2006) also indicate the perceived efficacy of graphic labels to be higher than that of text-only labels.

Information campaigns and school-based programs are also vectors of information dissemination. In Switzerland, national and regional campaigns are regularly implemented. The evaluation of these campaigns is based on intermediate indicators, such as recall rates and awareness, and not on their ability to influence behaviors. Most of the empirical studies that make the link between campaigns and behavior have been conducted in the US. Lewit *et al.* (1981) studied the first national information campaign (1966-1970). The authors found that the diffusion of anti-smoking messages reduced youth smoking participation. Later studies have investigated the impact of California's statewide anti-smoking campaign (Hu et al 1995a and 1995b). The authors find an elasticity of cigarette sales with respect to media campaign expenditures of approximately -0.05 (in other words, a 10% increase in media campaigns expenditures should lead to a 0.5% decrease in cigarette sales). More recently, Farrelly *et al.* (2009) have found the US youth smoking prevention campaign truth® to have a significant negative impact on the probability of smoking initiation among adolescents age 12-17 years old. Davis *et al.* (2009) consider the influence of recall related to two antismoking campaigns (the truth® campaign and one industry-sponsored campaign, "Think Don't Smoke) on beliefs, smoking intentions and smoking initiation. They find that although higher recall for the truth® campaign was associated with more virulent antismoking beliefs, lower smoking intentions and lower smoking initiation, recall for the tobacco-industry sponsored campaign was not associated with tobacco beliefs or smoking initiation (and was even associated with greater intention to smoke). Several other studies found no

association between recall for specific campaigns and smoking behavior. The impact of two antismoking ads on smoking cessation (attempts to quit and abstinence) is studied in Niederdeppe *et al.* (2008). The authors do not find any impact of recall on smoking behavior in the general population. However, they show that the impact on more educated individuals is significantly higher, suggesting a link between cognitive ability and the effectiveness of information diffusion.

Lee *et al.* (2010) have recently shown that increased dissemination of information on smoking-related health risks has reduced consumption in Taiwan. Their information measure was based on the number of journal articles published between 1980 and 2004 that contained information about the health risks associated with smoking (such as lung cancer and emphysema). Wakefield *et al.* (2008) use a time-series analysis of smoking prevalence to assess the impact of several tobacco control policies, including antismoking advertising on television, on smoking behavior. They find that sufficient exposure (almost 4 times per month) to antismoking messages on TV can lead to a 0.3 percent reduction in smoking prevalence. Increasing the costliness of tobacco products should have a similar effect. There is not much evidence that school-based prevention programs are effective in the long term (Wiehe *et al.* 2005, Thomas and Perera 2006). Other tobacco control policies, such as smoking bans, advertising restrictions, or access limitations, also play the role of signals (information vectors), contributing to the idea that smoking is not the norm. Finally, the impact of general spending on tobacco control in Switzerland on tobacco use, which at least partly reflects the impact of information dissemination, is reviewed and analyzed in Chapter 3.

It is worth noting that information shocks are not merely conveyed by public information. Private experience with the health consequences of smoking through the experience of friends, colleagues, or relatives or through personal experience with such consequences is likely to have a stronger impact than public information. Because the probability of experiencing such an event is higher at higher ages, the studies that have aimed to assess the impact of health shocks on smoking decisions have focused on the population of individuals aged 50 and over. Smith *et al.* (2001) find that smokers are more sensitive to smoking-related health shocks than are non-smokers. A study by Clark and Etilé (2002) provides some evidence that health changes influence smoking later in life.

2.4.3. Advertising, and advertising bans

In 1993, Swiss citizens voted on a modification of the Constitution that would create a comprehensive tobacco advertising ban. The ban was strongly rejected, mostly because of the influence of numerous interest groups that campaigned against it (the tobacco industry, the media, and cultural events organizers) and because of the unbalanced financial resources of the proponents and opponents (Cornuz *et al.* 1996). Further investigations showed that, contrary to one of the main arguments of the opponents, a ban would have had only a limited impact on the economy (FOPH 2007). One argument that was also frequently advanced by the tobacco industry is that advertising is only effective in modifying the market share of competing brands and does not increase the number of consumers. However, it seems likely that without advertising and with a steady smoking cessation rate (estimated at around 4-5% in Switzerland (see Chapter 3)) there would have been a sustainable reduction in the number of consumer that could have had long-term consequences for the industry.

Cigarette advertising does not aim to convey objective information about the product but rather seeks to create positive emotions and feelings associated with smoking. This notion is especially important for young people because it leads to increased experimental smoking and then to increased regular consumption. More generally, as mentioned by Chaloupka and Warner (2000), advertising "*contributes to a social environment in which smoking is perceived to be socially acceptable*". Tobacco advertising spending falls into the following categories: traditional media (i.e., in the press, at the movies[5], and on billboards in public places), sponsorship (at music festivals, night clubs, and cultural events), direct marketing, and promotion at the point of sale. Also included are promotional activities related to price, including "*buy one get two*" promotions. Despite the increasingly restrictive legislation of tobacco advertising in traditional media in the cantons – mostly limiting billboard advertising – the tobacco industry spent more than CHF 15 per capita to advertise their products in 2007 (Jeanrenaud *et al.* 2010). Although the amount that the tobacco industry has spent to advertise using traditional media fell by approximately 30% between 1997 and 2007 (FOPH 2007), the use of sophisticated strategies to circumvent the legislation is growing. For instance, it has been estimated that in the 2007-2008 period, almost one third of young individuals aged 14-19 received a gift (cigarettes, lighters, or other promotional products) from the tobacco industry (Radtke *et al.* 2008). Gifts with purchase have also been investigated by Slater and Chaloupka

[5]In a recent study, Sargent and Hanewinkel (2009) showed the importance of exposure to movie smoking as a predictor of smoking initiation in Germany.

(2001) and have been found to be more frequent in states with stricter tobacco control legislation, indicating a willingness of the tobacco industry to actively act against antismoking efforts.

In the US, after the implementation of the MSA Billboard advertising ban, Wakefield *et al.* (2002) showed the shift that occurred in the industry toward point-of-sale advertising. Another strategy, one that is again mostly aimed at encouraging initiation, uses promotional activities to directly change consumer prices. An important shift towards the use of this promotional tool has been observed in Switzerland, and Pierce *et al.* (2005) investigate its influence on smoking initiation in the US, noting that this strategy has offset the effect of price increases for youth.

Chaloupka and Warner (2000) provide a good review of the link between tobacco advertising and smoking. They review both econometric and non-economic evidence and show that there was no strong consensus about the effect of advertising on behavior. A detailed analysis of past results on this issue is also conducted by Saffer and Chaloupka (2000), who classify past studies into three categories and highlight the main shortcomings of each approach. The categories are time-series, cross-sectional, and ban studies that have as their main limitations the small amount of variation in the data, the expansive and difficult data collection processes, and the substitution of types of advertising in response to partial bans, respectively. The same paper provides evidence that a complete ban can reduce tobacco use but that partial bans have little to no impact, mainly because of the re-allocation of resources to non-banned vectors. A review focused on ban studies that uses time-series data indicates comparable conclusions (Quentin *et al.* 2007). Similar conclusions have been drawn for developing countries, with an even higher impact discovered than found in OECD countries (Belcher 2008). Other empirical studies have shown the impact of advertising on behavior. Nine longitudinal studies provide evidence that tobacco advertising increases smoking initiation among youth (Lovato *et al.* 2003). Moodie *et al.* (2008) show that the implementation of the Tobacco Advertising and Promotion Act (advertising ban) in the UK in 2003 had a negative impact on marketing awareness, perceived prevalence, and intention to smoke among youth. In the US, Keeler *et al.* (2004) estimate a demand function for cigarettes and find that an increase of 10% in tobacco advertising should lead to an increase of 2.7% in consumption (i.e., an advertising elasticity of demand equal to 0.27).

2.4.4. Protection against passive smoking

Environmental tobacco smoke (ETS), or passive smoking, is known to affect health and is a source of smoking-related externalities. Protection against ETS is considered a best practice in most comprehensive tobacco control strategies in developed countries. In Switzerland, smoking bans in public places were only recently implemented at the cantonal level. The first canton to adopt a comprehensive ban was Ticino in 2007[6]. At the national level, a general smoking ban (including some exceptions) came into force in April 2010 only. A smoking ban has several potential implications, and a comprehensive assessment of this policy intervention requires that we take into account all related considerations. Do smoking bans reduce exposure to ETS? Do smoking bans have any immediate health impact besides reducing long-term effects on health through reduced exposition to ETS? Is this policy effective at deterring people from smoking or encouraging them to quit? Does it have any impact on the economic activity of bars and restaurants? And finally, is this policy cost effective?

Evidence that exposure to environmental tobacco smoke (ETS) increases the risk that adults will develop fatal diseases first emerged in 1981 (Hirayama 1981, Trichopoulos 1981). Since then, many epidemiological studies have been carried out, and reviews have now concluded that passive smoking is a cause of serious disease in adults and children (U.S. Department of Health and Human Services, 2006, Gerbase *et al.* 2006). As findings from Ireland, Spain and the USA suggest, smoking bans are effective in reducing ETS in indoor air (Goodman *et al.* 2007, Lopez *et al.* 2007, Repace *et al.* 2006). Evaluating the impact of the Finnish national smoke-free work-place legislation, Heloma and Jaakkola (2003) find that employee exposure to ETS for at least 1 hour per day decreased during a 4-year follow-up period: from 51% in 1994 to 17% in 1995 and 12% in 1998. Edwards *et al.* (2008) demonstrate that the New Zealand smoke-free regulations resulted in a 12% decrease in self-reported ETS exposure. Similarly, Verdonk-Kleinjan *et al.* (2007), who examined the consequences of the workplace smoking ban in the Netherlands, find a significant decline in self-reported ETS exposure.

To assess the health impact of smoking bans in bars and restaurants, several international studies have examined the decrease in self-reported sensory symptoms (eye, throat and nose irritation) and respiratory symptoms (cough, shortness of breath, increased mucus production) (Schaller and Pötschke-Langer 2005). In Ireland, the

[6] Smoking bans were implemented in 2007 in Ticino, in 2008 in Grisons, in seven cantons in 2009 and in the rest of the country in 2010.

percentage of bar staff reporting any respiratory symptoms has declined significantly, from 65% to 49%, and reporting of sensory symptoms has declined from 67% to 45% (Allwright et al, 2005). In Scotland, sensory and respiratory symptoms in bar workers decreased from 79.2% to 53.2% after only 1 month of follow-up (Menzies *et al.*, 2006). Farrelly *et al.* (2005) find a significant decrease of sensory symptoms in New York hospitality workers (from 88% to 38%). Goodman *et al.* (2006) find a 28% decline in respiratory symptoms and a 50% decline in sensory symptoms among pub workers in Dublin. It has also been shown that reductions in exposure to environmental tobacco smoke had a negative short-term impact on hospital admissions for coronary heart disease (Khuder *et al.* 2007). Smoke-free legislation affecting workplaces, restaurants, and childcare facilities has been shown to be effective in reducing death by Sudden Infant Death Syndrome (Markowitz 2008).

Effects on the behavior of current smokers are also of interest, as it is important to determine if these bans were effective in reducing tobacco use. Several studies report positive effects of smoking bans on intentions to quit smoking, smoking cessation, and sales of tobacco products (Asthma and Respiratory Foundation of New Zealand 2005, Fong *et al.* 2005). A review of 26 studies on the effects of smoke-free workplaces by Fichtenberg and Glantz (2002) concludes that workplaces that are completely smoke-free are associated "*with a reduction in absolute smoking prevalence of 3.8%*". The impact of protection against passive smoking on smoking behavior has been investigated in previous studies, mostly with respect to smoking bans on the workplace and with a focus on the health behaviors of workers in the hospitality sector rather than those of the general population (Longo *et al.* 2001, Evans *et al.* 1999, Fichtenberg *et al.* 2002, Bitler *et al.* 2009). These studies have rather heterogeneous conclusions regarding policy effectiveness. Gallus *et al.* (2007) examine the effects of the Italian smoke-free regulations and find a significant decrease in the prevalence of smoking in the Italian general population between the pre- and post-ban surveys (from 26.2% in 2004 to 24.3% in 2006). Also, the number of cigarettes smoked per day decreased from 15.4 in 2004 to 13.9 in 2006. Heloma and Jaakkola (2003) show that the Finnish smoke-free legislation has resulted in a drop in prevalence of 5%. Further evidence comes from Levy *et al.* (2004), who review studies on the effect of tobacco control policies on smoking rates. They estimate the magnitude of the effects of different tobacco control policies and conclude that clean air laws, in addition to higher taxes, can have a large impact on smoking rates. Hyland *et al.* (2008) examine whether smoke-free regulations will cause customers to transition from smoking inside pubs to smoking inside homes.

They find that smoking at home is not more frequent in a smoke-free country (Ireland) than in the United Kingdom, where there are no smoke-free laws in place.

An exhaustive review of 97 studies assessing the economic impact of smoking bans on the hospitality sector revenues is presented by Scollo *et al.* (2003). The authors focus on the methodological quality and the funding sources of the studies. Quality is assessed using four criteria (Siegel, 1992), i.e., whether the study uses objective data (tax receipts, turnover, employment statistics), multiple points in time (before and after the law was created), statistical methods that control for random fluctuation and statistical methods that control for overall economic trends. The authors find that none of the tobacco industry-funded studies meet all four criteria and that only 3% of studies funded by an independent source report that a smoking ban has had a negative impact. In the studies published in peer-reviewed journals, two main methodologies emerge. When many longitudinal observations are available (for example, monthly data on turnover several years before the law and for the whole period after the law), time-series analysis is usually used. The models estimated account for underlying economic trends, and the data are seasonally adjusted (Wakefield *et al.*, 2002; Bartosch and Pope, 2002; Lal *et al.*, 2004). However, when such data are not available, other econometric techniques are used. Adda *et al.* (2007) measures the impact of a smoking ban in Scotland as the net difference between the outcomes (turnover, clients) before and after the law for a treatment and a control group.

To date, only a few studies have analyzed the health economic effects of a smoking ban. Glantz and Ong (2004) make projections regarding the cardiovascular health and economic effects of a smoke-free law one year after implementation and also estimated its evolution after 7 years. They estimate that the law will prevent 1,500 myocardial infarctions and 350 strokes in the USA in one year. This represents savings of $49 million in medical costs. Other studies have also provided an estimate of the savings that would be possible if exposure were prevented. Zollinger *et al.* (2002) estimate the economic costs of second-hand smoke exposure for the residents of Marion County in Indiana (USA). The morbidity and mortality costs are assessed separately for both adults and children. Using the costs related to seven different illnesses, the authors isolate total costs of $316.3 million that would be avoided if exposure is prevented. A similar study by Waters (2008) based on data from Maryland indicates $597.5 million in total estimated costs that could be avoided, including the cost of physician visits, visits to the emergency room, hospitalizations, and premature death.

The first-best policy for reducing exposure to ETS is clearly to ban smoking in public places. However, such measures do not resolve the problem entirely because exposure in private homes still remains a key concern. Because it seems difficult to ban smoking at homes, a second-best policy such as an increase in taxes or the provision of information about the consequences of ETS might therefore be essential.

2.4.5. Smoking cessation support

A significant proportion of current smokers express a desire to quit. In 2007, 54% of Swiss smokers wanted to quit, but only 10% wished to do so within the next thirty days and 30% within the next 6 months (Keller *et al.* 2008). These numbers indicate a significant desire to quit among smokers but also reflect the high perceived cost of quitting. A large proportion of these individuals eventually make an attempt to quit, but long-term success rates are quite low, and individuals often make several attempts before successfully quitting. The justification for smoking cessation intervention has often been debated, with the main counter-argument being, regardless of the effectiveness of the measure employed, that resources should not be used to correct unwise past (informed) decisions on the part of particular individuals (i.e., smokers are seen as responsible for their consumption).

The benefits of smoking cessation have often been underrated. Smoking cessation has both immediate and long-term health benefits. Short-term benefits include decreased blood pressure, improved sense of taste and smell, and better breathing. Long-term benefits include a significant drop in the risk of premature death (mainly associated with coronary heart disease, stroke, and lung cancer), especially if individuals quit in early adulthood (Doll *et al.* 2004). However, even later in life, cigarette smoking remains one of the most preventable causes of disease and premature death (Allen 2008), and there is compelling evidence of benefits of smoking cessation for older individuals (Vaupel *et al.* 2003, Doll *et al.* 2004). The perceived costs of smoking cessation - mainly withdrawal symptoms such as craving, insomnia, or irritability – are important and can be lowered via appropriate smoking cessation support. In addition, potential weight gain after cessation – with the average gain reaching approximately 4-5 kg (Froom *et al.* 1998, Klesges *et al.* 1997, Williamson *et al.* 1991) - can seriously deter those who otherwise might attempt to quit (Meyers *et al.* 1997).

Smoking cessation interventions include any intervention that aims to improve the long-term abstinence rate and to prevent relapse. A large number of

intervention programs exist, some of which have proven to be highly effective at improving long-term abstinence rates. The most widely used smoking cessation method is unaided cessation, often referred as "*cold-turkey*" quitting. The long-term success rate of cold-turkey cessation is around 5% and can be significantly improved with effective cessation intervention devices, including pharmaceutical cessation support. However, it is likely that underlying individual characteristics that are positively correlated with successful cessation might also be correlated with use of smoking cessation medical help. Among the wide range of smoking cessation intervention tools, non-pharmaceutical methods should be distinguished from pharmaceutical ones. Non-pharmaceutical methods include numerous strategies besides *cold-turkey* cessation. For instance, one might reduce in consumption gradually in preparation for stopping smoking, seek self-help sources (i.e., web-based programs, books), find a substitute (i.e., smokeless tobacco, an electronic cigarette), use quit lines, engage in medical counseling (i.e., brief clinical interventions), attend group therapy, or use alternative medical approaches (i.e., acupuncture and hypnosis). There is conflicting evidence or even no scientific evidence of the effectiveness of some of these approaches. Falba *et al.* (2004) provide some evidence that reduced consumption can increase the probability of quitting, but a recent Cochrane review indicates no difference between the quit rates associated with suddenly quitting and gradually reducing consumption (Lindson *et al.* 2010).

Table 2.4: Effectiveness of smoking cessation interventions

Intervention	**Improved long-term abstinence rate vs. no intervention, OR (95 % C.I.)**	**N**[a)]
Advice to quit by a physician	1.3 (*1.1-1.6*)	7
Clinical intervention		43
Minimal counseling	1.3 (*1.01-1.6*)	
Low intensity counseling	1.6 (*1.2-2.0*)	
High intensity counseling	2.3 (*2.0-2.7*)	
Counseling		58
Self-help	1.2 (*1.02-1.3*)	
Telephone counseling	1.2 (*1.1-1.4*)	
Group counseling	1.3 (*1.1-1.6*)	
Individual counseling	1.7 (*1.4-2.0*)	
Acupuncture	1.1 (*0.7-1.6*)	5
NRT	1.7 (1.6-1.9)	70
Bupropion SR	1.6 (*1.1-2.2*)	12
Varenicline	3.0 (*2.1-4.1*)	4

Source: Fiore *et al.* (2000) and Wu *et al.* (2006). a) Number of studies used in the meta-analysis.

Pharmaceutical interventions include nicotine replacement therapies (NRTs) and nicotine-free medications. NRTs partially relieve the withdrawal symptoms that people experience when they quit by compensating for the lack of nicotine in the organism. There are several NRTs currently available over the counter in Switzerland, including patches, gum, inhalers, lozenges and nasal sprays. Two nicotine-free medications are available in Switzerland by medical prescription only (A-list): bupropion (brand name Zyban ®), the exact mode of action of which is still unclear (Compendium of Swiss Drugs 2002), and varenicline (brand name Champix ®), which relieves symptoms of nicotine withdrawal and blocks the reinforcing effect of continued nicotine use through an antagonist and agonist action (Gonzales *et al.* 2006). Bupropion and varenicline have been found to be effective versus a placebo in several randomized controlled trials. Fiore *et al.* (2000) and Wu *et al.* (2006) provide a comprehensive review of the effectiveness of various approaches. The results of these treatments, indicated in terms of their effect on the treatment group as compared to that of a placebo on a control group, are summarized in Table 2.4.

Smoking cessation drugs has been found to be cost-effective in several studies (Bertram *et al.* 2007, Hall *et al.* 2005, Warner 1997, Cornuz *et al.* 2006). In comparison with other cessation interventions, the use of SCT has a higher cost per life-year, but it is essential to a comprehensive tobacco control strategy and might be the only effective way for long-term smokers to quit. Other economic considerations focused on the effect of price (Tauras and Chaloupka 2003), OTC status conversion (Keeler *et al.* 2002), health insurance coverage (Halpin *et al.* 2007), or advertising (Avery *et al.* 2007). The analysis of smokers' preferences for such products constitutes one of the empirical areas of study of this dissertation (see Chapter 5). The flexibility of public health policy with respect to pharmaceutical products is limited because they are privately delivered (produced and sold by private firms). One can argue that because of excess regulation and limited financial resources, access to such products is not optimal (Novotny *et al.* 2000), providing a justification for government intervention. However, the perceived benefits of these products could be enhanced by better information on the benefits of smoking cessation. Governments could also create less strict regulations for some of these products by converting them to OTC status, facilitating the drug registration process, deciding on the reimbursement by the social health insurance (Curry *et al.* 1998, Burns *et al.* 2004), and creating incentives for innovations (Novotny *et al.* 2000). Public intervention could also be used to adjust the high price of these products, which currently limits

access for disadvantaged individuals among whom smoking is more prevalent and cessation often less successful.

Appendix A: Successful cessation, education, and income

I pooled data from the 2001-2007 editions of the Swiss Tobacco Monitoring Survey (Keller *et al.* 2008), a nationwide, cross-sectional survey of 14–65 year-olds conducted annually in Switzerland since 2001. Each quarter about 2,500 individuals are interviewed by phone in French, German or Italian, resulting in a total of about 10,000 observations per year[7]. Combined, the seven cross-sections consisted of 70,216 respondents. In addition to demographic and socioeconomic information, the database contains a large number of variables related to smoking history and current smoking behavior. From the base sample, I constructed one subsample which consisted of current and former smokers, aged 18 and over, who had recently attempted to quit. To distinguish between successful and unsuccessful quitters I had to exploit information about individual smoking history. I based the construction of this variable on the work of Lee and Kahende (2007), who conducted a similar type of analysis in the United States. Unsuccessful quitters were defined as current smokers who had tried to quit at least once during the last 12 months, *i.e.*, current smokers who answered yes to the question "Did you seriously try to quit smoking during the past 12 months?" Successful quitters were defined as ex-smokers who quit between seven and sixty months ago[8]. As suggested by Lee and Kahende (2007), I excluded smokers who quit in the past six months because the risk of relapse is often very high for these individuals. To study the association between education level, income, and successful cessation, I conducted multivariate logistic regressions for men and women separately, and controlled for age, marital status, alcohol use, and interest in healthy diet. Year dummies were included to account for potential trend.

Estimation results are shown in Table A.1. We observe a significant socioeconomic gradient in successful cessation with respect to both education level and income. In the group with higher education, the odds of being a successful quitter in comparison with the reference category (compulsory education) reached 1.39 for men and 1.78 for women. The influence of higher income levels is comparable in size for both subgroups (OR_{men} = 1.65 and OR_{women} = 1.47). We observed that the odds of being a successful quitter were linked with marital status for both men and women (OR_{men} = 1.36 and OR_{women} = 1.36).

[7] Several subgroups of the population were oversampled—men aged 14–24, women aged 14–44 and individuals from the Italian and French linguistic regions.

[8] The analysis focuses on recent cessation activity, which is the reason why I did not include individuals who quit more than five years ago.

Table A.1: Successful cessation—Multivariate logistic regressions

	Odds of successfully quitting	
Variables	**Men**	**Women**
Education (reference category: compulsory)		
Secondary	1.13 (0.15)	1.40** (0.15)
Higher	1.39** (0.21)	1.78*** (0.23)
Household income (reference category: up to CHF 4,000)		
CHF 4,000-8,000	1.13 (0.12)	1.27** (0.11)
More than CHF 8,000	1.65*** (0.21)	1.47*** (0.16)
Age (reference category: 18-24 years old)		
25-44 years old	2.20*** (0.30)	1.32** (0.15)
45-65 years old	2.59*** (0.37)	1.18 (0.15)
Married	1.36*** (0.12)	1.36*** (0.10)
Heavy drinking ("regular drinker")	0.91 (0.08)	1.00 (0.09)
Interest in healthy diet	1.08 (0.11)	1.50*** (0.18)
N	**2,691**	**3,599**

Standard errors in parentheses;***significant at 1%; **significant at 5%;*significant at 10%.

Part II

Empirical essays

This section consists of three empirical essays looking at different aspects of smoking-related decisions. In Figure I, I present these decisions as taken successively over time in order to visually locate the three contributions. In the first essay, I investigated at the impact of tobacco control expenditures on smoking behavior. Specifically, I used retrospective information on smoking behavior of individuals from a cross-sectional sample to reconstruct their smoking history. Individual smoking status over time was linked to national price changes and to per capita tobacco control spending in the Swiss regions, controlling for a set of individual characteristics. The second essay uses best-worst scaling, a survey based method, to rank the adverse effects of tobacco use according to their potential to deter 14-19 years old individuals from smoking. The relative importance of 15 items, including long-term and short-term health and non-health consequences, were assessed. The third essay analyzes the demand for smoking cessation drugs using stated preferences data from a discrete choice experiment. Such medications are aimed at relieving withdrawal symptoms associated with smoking cessation in order to prevent relapse, i.e., to increase the chance of successfully quitting in the long term. I assessed the relative importance of the most important characteristics of such treatments (i.e. price, efficacy, side-effects, weight gain attenuation and availability) and was able to attach monetary values to these characteristics and to medications as a whole.

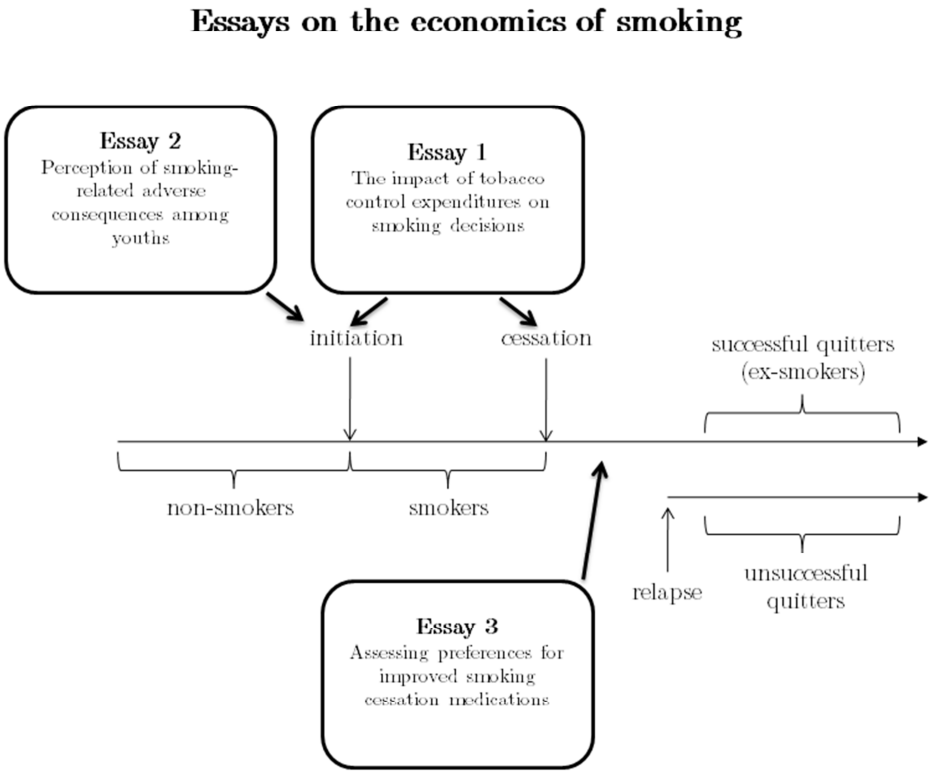


Figure I: Overview of the empirical essays

3 The impact of tobacco control expenditures on smoking initiation and cessation

Abstract

In 2007, regular and occasional smokers accounted for 28% of the Swiss population aged 15 and above, whereas the proportion was significantly higher ten years earlier (33 %). This paper uses data from the 2007 edition of the Swiss Health Survey to investigate the association between overall tobacco control expenditures and the decline in smoking prevalence. Smoking initiation and cessation were analyzed separately using discrete and continuous time hazard models. After controlling for prices and individual characteristics, I find evidence that tobacco control expenditures significantly increase the probability of smoking cessation. In contrast, in most specifications the impact of tobacco control spending on smoking initiation is not statistically significant.

Keywords: tobacco control expenditures, smoking initiation, smoking cessation, hazard models

3.1. Introduction

The epidemiologic transition from communicable diseases to chronic diseases such as cancers and cardiovascular diseases that occurs in developed countries has given rise to increasing worry about unhealthy behaviors like smoking as a public health issue (Kenkel 2000). In Switzerland, smoking-related conditions accounted for more than 11% of all disability-adjusted life years lost in 2002 (OECD/WHO 2006), making it the major risk factor for burden of disease; indeed, its importance significantly outweighed that of alcohol misuse or high cholesterol. In 2007, regular and occasional smokers accounted for 28% of the Swiss population ages 15 and above, whereas the proportion was significantly higher (33 %) ten years earlier. This decline in tobacco use has many potential explanatory factors, including tobacco control, cultural changes, or even demographic effects. During the same period (1997-2007), there was a substantial increase in the resources devoted to tobacco control, which allowed the implementation of various interventions aimed at preventing initiation, enhancing cessation and lowering exposure to environmental tobacco smoke at both the national and the local levels. In addition to regular increases in cigarette prices, tobacco control interventions include information campaigns, advertising restrictions, cessation support, smoking bans in public places, and knowledge management. Overall spending dedicated to tobacco control amounted to approximately 2.7 Swiss Francs[9] (CHF) per capita in 2007, with the Tobacco Prevention Fund, financed by a special tax on cigarettes, as the main funding source.

The aim of this study is to assess if, and to what extent, recent tobacco control efforts are independently associated with the decline in smoking prevalence. Because changes in prevalence (i.e., the "stock" of smokers) are the result of changes in smoking initiation and cessation rates (i.e., the "flows" of new/former smokers) and because both decisions may have substantially different determinants, I separately analyzed the association between tobacco control efforts and the propensity to start and quit smoking. The best way to study the initiation-cessation process would be to exploit a panel dataset that covers a sufficiently long time period and that contains detailed information about smoking behavior. Because such a database is not available in Switzerland, I used an alternative approach. Drawing from the works of Douglas and Hariharan (1994), Douglas (1998), Forster and Jones (2001) and López Nicolás (2002), I constructed a pseudo-panel using individual retrospective information about smoking behavior from a cross-sectional survey (smoking status,

[9] 1CHF ≈ 1 USD.

age at initiation, and time elapsed since cessation) and analyzed the data using hazard models. This type of analysis has numerous advantages over a simple cross-sectional approach. First, as cigarette prices are uniform in Switzerland, it is not possible to identify the effect of price in a cross-sectional framework. Second, this type of analysis is well suited to the theoretical framework in which an individual makes the decision to start (or to quit) smoking at each point in time by comparing the utility he derives from starting (quitting) and the utility he derives from staying abstinent (continuing to smoke). Finally, the longitudinal nature of the data allowed me to control for potential time-invariant unobserved regional factors that might influence both smoking outcomes and tobacco control spending. Several studies that have used hazard models in the field of tobacco consumption have been conducted in the UK, USA and Spain, but such studies have never been conducted in Switzerland, and none accounted for overall tobacco control expenditures.

I used individual data from the 2007 edition of the Swiss Health Survey in addition to price and tobacco control information to assess the extent to which tobacco control expenditures influence the probability of initiation and cessation. I modeled both decisions separately using continuous time and discrete time hazard models, controlling for gender, education, nationality and cohort effects. The results consistently show that tobacco control spending have a positive impact on smoking cessation rates, but I do not find compelling evidence that tobacco control spending influenced smoking onset. In the next two sections, I provide an overview of the related literature and of tobacco control in Switzerland. I then present the empirical methodology, describe the data and present the results along with a sensitivity analysis. Finally, I discuss the policy implications and the limitations of the study.

3.2. Related work

There is an extensive body of international literature that discusses the relationship between cigarette price changes and tobacco use, making it the most documented economic determinant of smoking. Despite the diversity of the applied methods – i.e. time-series, cross-sections, aggregated data, individual-level data – most of the studies identify relatively similar figures for the price elasticity of tobacco consumption in the general population (with the results clustered around -0.4) (Chaloupka and Warner 2000). The effect of cigarette prices on smoking among young people has also been extensively investigated, but the results are more ambiguous. Some arguments indicate that young people are more responsive to price changes: e.g., they are less addicted and have fewer financial resources (DeCicca *et al.* 2002). However, other factors could explain the potential lack of responsiveness of youth to price changes, such as their need to be accepted by their peers at almost any cost. In contrast, only a few econometric studies have assessed the impact of tobacco control expenditures on smoking prevalence or consumption. Most of these studies were conducted in the United States and were limited to particular states (CDC 2001, Hamilton *et al.* 2000). Some of them are focused on youths (e.g., Tauras *et al.* 2005), or do not account for price changes. In a study by Farrelly *et al.* (2003), the authors compare the data for states in which large-scale programs were implemented with data for the rest of the country and show that increases in funding for tobacco control reduce tobacco use. In another recent study, Farrelly *et al.* (2008) examine the association between tobacco control program expenditures and changes in adult smoking prevalence, controlling for price, and find an independent association between expenditures and reduced smoking prevalence. Tauras *et al.* (2005) estimate a two-part model of cigarette demand using repeated cross-sections to investigate youth smoking decisions. They find that per-capita funding for tobacco control has a significant and negative effect on smoking participation and on the number of cigarettes smoked per day. In contrast, Marlow (2010) finds no association between tobacco control spending and smoking participation.

These analyses, however, do not indicate what portion of the reduction in tobacco use is due to reduced initiation and what part is attributable to enhanced cessation. Previous studies using retrospective information on smoking to estimate hazard models focus on the effect of price (Douglas and Hariharan 1994, Douglas 1998, Forster and Jones 2001 and López Nicolás 2002). These authors, in line with a recent study by DeCicca *et al.* (2008a), find a positive association between price changes and the probability of quitting and identify a weak or non-existent effect of

price increases on smoking initiation. Contrariwise, Tauras *et al.* (2001) find that higher prices induce fewer initiations. Focusing on young adults and also using time-to-event data, Tauras (2004) find that increases in cigarette prices significantly increased the number of quitters in this age group.

Using discrete-time hazard models, Farrelly *et al.* (2009) investigated the effectiveness of a specific national smoking prevention campaign targeted at youth. The authors find that greater exposure to the campaign decreased the probability of initiation. A recent study by Ciecierski *et al.* (2010) considers the impact of state tobacco control program expenditures on young adults' smoking behaviors and finds that increased expenditures are associated with a larger number of quit attempts. In Europe, Schaap *et al.* (2008) shows that countries with better developed tobacco control policies have higher cessation rates. No study of this type has been previously conducted in Switzerland, and no study has considered the impact of price and tobacco control spending on both initiation and cessation.

3.3. Tobacco control in Switzerland

According to the WHO, the best practices in tobacco control include five categories: price increases, the dissemination of information, advertising bans, protection against environmental tobacco smoke (ETS) and cessation support (WHO 2003). These measures not only are effective in influencing smoking-related behavior but also have been proven to generate high returns: i.e., their benefits in terms of disability-adjusted life years (DALY) are high compared to their costs. Table 3.1 presents estimated cost effectiveness ratios in dollars per DALY saved as computed by Shibuya *et al.* (2003) for the western European region.

Table 3.1: Cost effectiveness of tobacco control interventions

Intervention	**Average cost-effectiveness ratio (USD/DALY)**	
Doubling the highest tax	13	[10-17]
Smoking ban in public places	358	[263-503]
Comprehensive advertisement ban	189	[140-266]
Information dissemination	337	[248-479]
Nicotine replacement therapy	2,164	[1,604-3,024]

Source: Shibuya *et al.* (2003); 95% confidence intervals in brackets.

Switzerland was late to enter the field of tobacco control in comparison to other developed countries. In 2006, a scale was constructed to evaluate the national efforts dedicated to tobacco control (i.e., the price of cigarettes, smoke-free public places, information campaigns, advertising bans, health warning labels and accessibility of cessation treatments). Among 30 OECD countries, Switzerland was ranked 18th, mainly due to its relatively low prices and fairly permissive legislation regarding product availability, tobacco advertising and ETS (Joossens and Raw 2006). In recent years, we have observed a clear political will to strengthen tobacco control at both the federal and the cantonal level. This tendency is well illustrated by the recently implemented smoking bans, by more informative pack labeling and by important price increases. In Appendix A, I present a brief overview of tobacco control in Switzerland.

The actors in tobacco control in Switzerland are numerous and can be sorted into three categories: the federal government, the cantonal governments and non-governmental organizations (e.g., AT, the Swiss Cancer league, CIPRET). Broad policies for tobacco control are defined at the federal level, and as a result, nationwide

programs involving a series of measures have been implemented. The first large national program, the *"Global Tobacco Program,"* was in place from 1996 to 1999. Although it did not achieve its prevalence reduction goal, the program funded research projects and helped to construct a network of partners that are active in tobacco control. The second nationwide program, conducted from 2001 to 2008, was built on three main objectives: preventing initiation, supporting cessation and protecting against ETS. In line with its objectives, legislative measures were adopted and information campaigns were launched. In Table 3.2, I list some behavioral and legislative measures that were implemented within the national programs.

Table 3.2: Selected list of tobacco control interventions

Behavioral interventions	**Description**	**Year(s)**
New enjoyment – without tobacco	Nationwide campaign	1992-2000
Smoking hurts	Nationwide campaign	2001-2003
Smoking hurts – more air!	Nationwide campaign	2004-2005
BRAVO, life, not smoke	Nationwide campaign	2006-2007
Life, not smoke	Nationwide campaign	2008
Life, not smoke – makes sense, doesn't it	Nationwide campaign	2009
Stop smoking site	Help to stop smoking	As of 1997
Smoke-free workplace	Help geared toward businesses	2006-2009
Non-smoking experience	Help geared toward schoolchildren	2000-2010
Cool and clean	National tobacco control program for sports	2004-2009
Legislative interventions	**Source**	**Enactment on:**
Warning on cigarette packs; obligation to declare the tar and nicotine content; prohibition of advertising aimed at those under 18 years old	Ordinance on tobacco (OTab) from 1st March 1995	01.07.1995
Fixing maximum nicotine, tar and carbon monoxide levels with mandatory declaration on the packet; warning labels printed in large and explicit letters on the packet; prohibition of the terms « light » or « mild »;	Ordinance on tobacco (OTab) from 27th October 2004 (complete revision of OTab 1995)	01.11.2004
Prohibition of smoking in trains and enclosed public areas and in open public areas and anywhere in underground railway stations and shopping malls.	Measures adopted by the Swiss Federal Railways and enterprises affiliated with the Public Transport Union (UTP)	11.12.2005
Additional warnings: color photographs, visual warnings (« stop smoking »)	Ordinance of the FDI (Federal Department of the Interior) on the combined warnings on tobacco products of 10th December 2007	01.01.2008

An important turning point for tobacco control in Switzerland was the creation of the Tobacco Prevention Fund (TPF) in 2004, which was intended to subsidize large information campaigns, specific interventions and research projects. While former interventions had been funded via general revenues, TPF revenues come from a CHF 0.026 tax on each cigarette pack. Overall, we estimate that total investments in tobacco control at all levels amounted to CHF 20.6 million in 2007 or CHF 2.63 per capita. It is worth noting that in its 2007 report on best practices for comprehensive tobacco control programs, the U.S. Center for Disease Control and Prevention (CDC) recommended minimum average per capita expenditures of USD 8.43 in the following fields: state and community interventions (USD 3.99), health communication interventions (USD 1.30), cessation interventions (USD 2.04), surveillance and evaluation (USD 0.73) and administration and management (USD 0.37). By comparison, we estimate that in 2007, the tobacco industry spent approximately CHF 120 million (i.e., CHF 15.3 per capita) in the following categories: traditional media, sponsorship (music festivals, nightclubs, and cultural events), direct marketing (hostessing), and promotion at the point of sale. We observe that the tobacco industry shifted its promotional activities toward new vectors to circumvent legal limitations on advertising. We also note that the tobacco industry acquired a very comprehensive knowledge of the behavior and motivations of smokers and was able to develop complex strategies to counter tobacco control efforts (Jeanrenaud *et al.* 2010).

Evaluations of the programs as listed in Table 3.2 did not provide clear evidence of an independent link between prevention efforts and changes in tobacco-related behavior (Rudolf *et al.* 2009, Boggio and Zellweger 2007, Honegger and Rudolf 2004, Ensmann *et al.* 2002). In fact, these evaluations were based on intermediate indicators (e.g., recall rates, understanding, and awareness) and provided evidence of an adequate level of smoking-related risk perception within the population, a high acceptance of tobacco control programs and clear intentions to change behavior. This study is intended to fill a gap in evaluations of the association between tobacco control efforts and smoking-related behaviors in Switzerland.

3.4. Empirical strategy

Framework and construction of the outcome variables

The retrospective information on smoking included in the Swiss Health Survey allowed me to reconstruct the smoking history of individuals - e.g. the year of initiation, the number of smoking years, and the date of smoking cessation - until the year of the survey (i.e. 2007). Therefore, I know the yearly smoking status of each individual in the sample from his birth to 2007. At each time point, an individual is whether smoking or not smoking and our interest lies in modeling the probability of transition between the two possible states[10]. The decisions to start and to quit smoking are analyzed separately. We first focus on the years before smoking initiation, and then on the years preceding smoking cessation. In the initiation analysis, we follow never-smokers that are assumed to start smoking at a given time point if the utility they derive from starting is higher than the utility they derive from staying abstinent. Similarly, the cessation analysis focuses on smokers who are supposed to quit if the utility they derive from quitting is higher than the utility they derive from continuing to smoke (see DeCicca *et al.* 2008a for a formal presentation of this framework). We are thus interested in the probability that an individual chooses to start (quit) smoking, given that he runs the risk of starting (quitting) that year. In other words, we are dealing with conditional probabilities of starting (quitting) at a given time point given that one has not started (quit) at that point, which is the definition of the hazard of starting (quitting). For comparison purpose, I use two different modeling approaches to deal with this time-to-event data: discrete and continuous time hazard models. In both frameworks the same information is needed to construct the outcome variables, and to end up with a data set that has the appropriate format.

We first define the period, usually called a *spell* or *episode*, during which individuals face the risk that an event or *failure* will occur. In the initiation analysis, I analyzed during what time never-smokers are at risk of starting smoking. The relevant *spell* is thus the non-smoking period, and *failure* is associated with smoking initiation. I first had to distinguish between all individuals who had ever smoked before[11] (current and former smokers) and never-smokers. The length of the non-smoking period for never-smokers is simply their age in 2007, minus ten[12]. Because they did

[10] Unfortunately, the data do not allow us to identify a detailed history of quit attempts and relapses.

[11] Individuals who answered yes to the question "Have you smoked more than 100 cigarettes in your lifetime?"

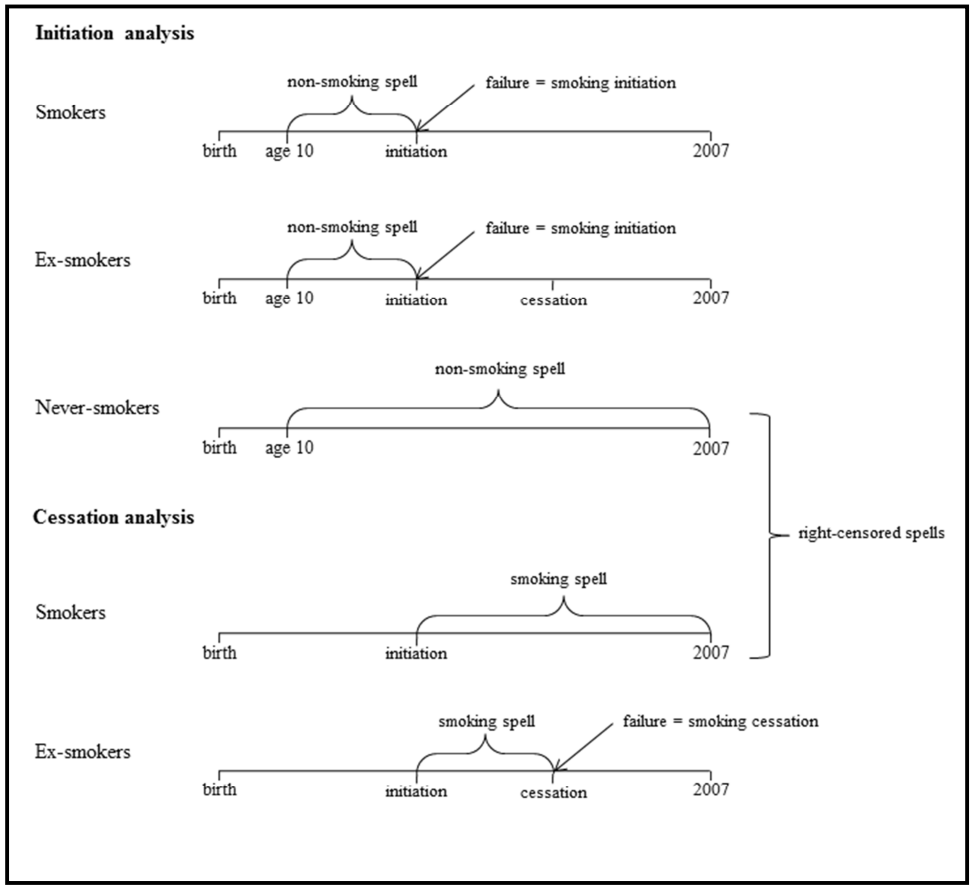
[12] I make the assumption that individuals are at risk of smoking at the age of ten years old (in the Swiss Health Survey, only three individuals over 18,760 started before that age).

not begin smoking, the spells for never-smokers are not complete; they are said to be *right-censored*. For both current and former smokers, the relevant duration is defined as the age at which the individual started smoking, minus ten. In the cessation analysis, only current and former smokers are included. The measure of interest is the number of smoking years: i.e., the period during which individuals face the "risk" of quitting. For current smokers, the duration corresponds to their current age minus the age at which they started smoking. These spells are not complete[13] (*right-censored*). For ex-smokers, the figure is their actual age minus the number of years since they quit minus the age at which they started[14]. In Figure 3.1, I schematically present the spells and failures for both analyses.

[13] We assume that these individuals never quit previously. As mentioned above, our data does not contain information about possible previous quit attempts or relapses of current smokers.

[14] For example, the smoking spell of a 42-year-old ex-smoker who started at age 18 and quit 10 years ago, is equal to 14.

Figure 3.1: Duration variables – Spells and failures



In both frameworks – continuous and discrete time – the aim is to estimate the impact of covariates on the hazards of starting (quitting). The main difference between the two approaches lies in the functional form of the underlying (or baseline) hazard rate. In the continuous time framework, the baseline hazard is a continuous function of time, whereas in the discrete time framework it takes discrete values at each observation time. However, I expect both approaches to lead to similar results. The main covariate of interest is the amount of per-capita tobacco control spending. The identification strategy was based on the fact that amounts allocated to tobacco control vary over years and across regions. This allowed me to assess the impact of overall tobacco control expenditures on the probability of smoking initiation and cessation, controlling for price changes and a set of individual characteristics. I present the two modeling approaches separately.

Continuous time semi-parametric hazard model

Several parametric and semi-parametric regression models are available to investigate the association between the independent variables and the hazards of starting and quitting in the continuous time framework. Parametric models require the researcher to make an assumption about the shape of the hazard function; they provide inconsistent estimates if the distribution of the hazard is misspecified. Some parametric specifications are flexible enough to overcome this problem (e.g., the generalized gamma model), but they are often difficult to estimate. Semi-parametric models are less restrictive because they do not impose any assumptions about the shape of the hazard over time. For this reason, I chose to use the Cox proportional hazard (Cox 1972) semi-parametric regression model in both smoking initiation and cessation analyses. In addition, its results are easily interpretable, and, as mentioned by Greene (2003), it is "*a good compromise between the strictly non-parametric Kaplan-Meier estimator and the excessively structured parametric models."* Within this framework, it is assumed that there is a common baseline hazard function and that the variables shift this baseline hazard multiplicatively. We have the following general specification:

$$h(t \mid x(t), z) = h_0(t)\phi(x(t), z) \tag{3.1}$$

Where $h_0(t)$ is the baseline hazard that only depends on time (t). The function $\phi(x(t), z)$ includes both time-varying ($x(t)$) and time-invariant (z) covariates. An interesting feature of this model is that no parameterization is needed for $h_0(t)$. However, functions related to $h_0(t)$ can be retrieved after the estimations conditional on the coefficients estimated from the Cox model. The functional form for $\phi(x(t), z)$ must be fully specified and is usually exponential. With k time-varying and j time-invariant covariates, we end up with:

$$\phi(x(t), z) = exp(\beta_1 x_1(t) + ... + \beta_k x_k(t) + \delta_1 z_1 + ... + \delta_j z_j) \tag{3.2}$$

I employed the following general specification for an individual i at year t in region r:

$$h_i(t) = h_0(t)exp(\beta_1 P_t + \beta_2 TC_{t,r} + \delta' Z) \tag{3.3}$$

Where $h(t)$ is the hazard of starting (or quitting), $h_0(t)$ is the baseline hazard, P_t is the real price of cigarettes at year t, $TC_{t,r}$ is the per-capita tobacco control expenditures at year t and in region r, and Z is a vector of individual characteristics. Our main

coefficient of interest is β_2. The exponentiated coefficients are interpreted as the factor by which the hazard is multiplied following a 1-unit increase of the covariate.

Discrete time hazard model

We focus on the conditional odds of starting (quitting) smoking at each time point, given still being in the sample at that time. Keeping the same notation as above, we have:

$$\frac{h(t\,|\,x(t), z)}{1 - h(t\,|\,x(t), z)} = \frac{h_0(t)}{1 - h_0(t)} exp(\beta_1 x_1(t) + ... + \beta_k x_k(t) + \delta_1 z_1 + ... + \delta_j z_j) \tag{3.4}$$

After taking the logs, we obtain the logit of the hazard as dependent variable:

$$ln\left(\frac{h(t\,|\,x(t), z)}{1 - h(t\,|\,x(t), z)}\right) = ln\left(\frac{h_0(t)}{1 - h_0(t)}\right) + \beta_1 x_1(t) + ... + \beta_k x_k(t) + \delta_1 z_1 + ... + \delta_j z_j \tag{3.5}$$

Practically, the time is treated as discrete, and a dummy variable for each analysis time point is introduced, giving rise to discrete values of the baseline hazard. We thus have the following general specification for an individual *i* at year *t* in region *r*:

$$logit\left(h_i(t)\right) = \alpha_t + \beta_1 P_t + \beta_2 TC_{t,r} + \delta' Z \tag{3.6}$$

where α_t are time dummies. The effects of the covariates on the outcome are straightforward to interpret.

Dealing with recall bias

When providing retrospective information in self-reported surveys, responding to questions such as "How long ago did you stop smoking?" or "How old were you when you started smoking?", individuals are likely to give answers that are clustered in specific years (values), leading to what is called recall bias or recall error. I illustrate this issue using Figure 3.2, in which I show the distribution of years since the individuals in our sample quit. From ten years since quitting, we observe a high density of responses that are multiples of 5. Because the survey was conducted in 2007, the corresponding "problematic" years are 1997, 1992, 1987, etc. When we look at the reported age at smoking initiation (Figure 3.3), we observe clustering of responses at ages 16, 18, and 20 years old.

Figure 3.2: Reported years since quitting

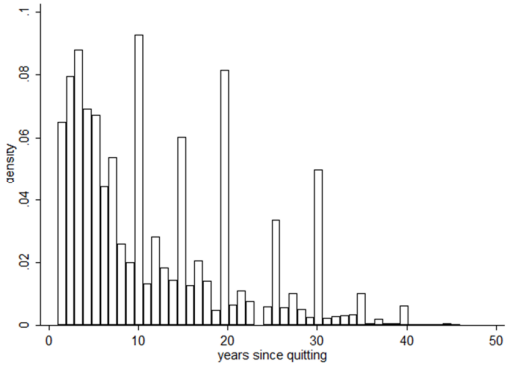
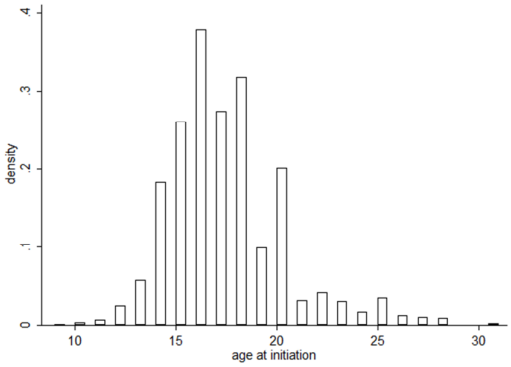


Figure 3.3: Reported age at initiation



Kenkel *et al.* (2004) shows that reporting errors produce downward biased estimates of the effect of price on smoking decisions. As suggested by Lopéz Nicolás (2002), I simply control for recall error using indicator variables that equal one for years at which recall error is more likely, i.e. for years corresponding to 10, 15, 20, 25, and 30 years since quitting in the cessation analysis. Kenkel *et al.* (2004) show that smokers consistently report the age at which they began smoking, even 20 years later. However, it seems likely that initiation ages such as 15, 17, or 19 years old are underreported in favor of 16, 18, and 20 years old. The excess probability of starting at these ages is already accounted for in the value of the baseline hazard for 6, 8, and 10 years at risk.

Dealing with potential endogeneity

It is likely that unobserved region-specific factors influence both smoking outcomes and the evolution of tobacco control spending. For instance, the attitude of the general population towards smoking might also influence political decisions

regarding the implementation of anti-smoking policies[15]. In order to reduce the potential upward bias of the tobacco control spending coefficient if stronger attitudes against smoking influence both the implementation of policies and smoking outcomes, I exploit the longitudinal nature of the data in including region fixed-effects (FE) in every model. In the continuous time framework I also use an alternative approach, assuming that the differences in attitudes towards smoking might be included directly in the baseline hazard. I therefore conducted a stratified Cox estimation in which the baseline hazard is allowed to differ by region. In other words, with the stratified approach, we relax the assumption that everyone faces the same baseline hazard $h_0(t)$. Stratifying by regions, we obtain the following:

$$
\begin{aligned}
h_i(t) &= h_{01}(t)exp(x(t), z, \beta, \delta) && \text{if individual } i \text{ is in region 1;} \\
h_i(t) &= h_{02}(t)exp(x(t), z, \beta, \delta) && \text{if individual } i \text{ is in region 2;} \\
&\ldots && \ldots \\
h_i(t) &= h_{06}(t)exp(x(t), z, \beta, \delta) && \text{if individual } i \text{ is in region 6.}
\end{aligned}
\tag{3.7}
$$

It is worth noting that the issue of endogeneity is probably not completely solved here. There are other potential sources of bias, such as the influence that changes in smoking participation might have on the acceptability of new tobacco policies.

Estimated models

I first conducted a simple analysis of smoking prevalence. Using annual prevalence data for the regions from seven waves of the Swiss Tobacco Surveys and price and tobacco control expenditure data for the corresponding years and regions, I conducted a simple panel analysis with region fixed effects. Then I used Cox's partial likelihood estimator to estimate the continuous time models (see Greene (2003) for details), and logistic regression to estimate the discrete-time hazard models. I used the same set of variables in the initiation and cessation analysis, except for recall bias and

[15] DeCicca *et al.* (2008b) propose an explicit measure of the "anti-smoking sentiment" that they use in smoking participation and initiation models.

cohort dummies. All estimations were performed using Stata version 10.0 (Stata Corp., Texas, USA).

3.5. Data

Sources

The data analyzed in this research come from several sources. I distinguish between micro-level data on smoking-related behavior and individual characteristics and macro-level data on tobacco control expenditures and tobacco prices. Micro-level data are drawn from the 2007 edition of the Swiss Health Survey[16], which contains detailed information on 18,760 individuals ages 15 and above. Price data and data on aggregated per-capita tobacco control expenditures come from other sources as described below.

Analysis samples

I restrict the analysis to individuals that face the risk of starting (quitting) in 1980 and later. I therefore end up with a sufficiently long time period to capture the effect of price, without straying too far from the period during which tobacco control spending substantially varies (i.e., 1997-2007). The initiation analysis was focused on individuals with complete relevant information born in 1970 and later, i.e. at risk of starting in 1980 and later (n=4,353). For the cessation analysis we kept all individuals with complete relevant information that were at risk of quitting in 1980 (n=6,464) and later (Table 3.3.)

Table 3.3: Analysis samples corresponding to "at-risk" years 1980-2007

Analysis	At risk since	n	N
Initiation	10 years old	4,353	82,245
Cessation	Smoking initiation	6,464	106,502

n is for the number of individuals; N is for the number of person-years.

Tobacco control expenditures and price data

Various parties are engaged in tobacco control in Switzerland at the national and local levels, including cantonal health promotion services and non-governmental organizations (NGOs). Unfortunately, there is no data source that contains detailed

[16] The Swiss Health Survey has been carried out every 5 years since 1992. The 2007 edition was conducted on a representative sample of about 30,000 households, in which one person aged 15 or above was randomly selected. With a 60% response rate, the whole sample contained 18,760 individuals.

and disaggregated information about tobacco control expenditures. Information is available on overall expenditures, but it is not possible to determine precisely how much was spent on individual interventions. Information on tobacco control expenditures at the national level is fairly complete, especially for years after the creation of the TPF in 2004. At the regional level, data was collected through telephone interviews and questionnaires were sent to the person in charge of health promotion in the 26 cantons. The respondents were asked to indicate the total amount spent on tobacco control for each year between 1997 and 2007 in the following fields: youth information campaigns, information and public awareness, cessation support, protection against ETS and knowledge management. Respondents were also asked to describe the trend of tobacco control expenditures between 1990 and 1997, and if easily available, to provide data on this period.

I aggregated tobacco control data for six of the seven major regions of Switzerland. The seven major regions are the Lake Geneva Region, Mittelland, Northwest Switzerland, Zurich, Eastern Switzerland, Central Switzerland and Ticino. Observations from the Northwest region were excluded due to a lack of accurate information about tobacco control expenditures for the two main cantons in the region. The data were aggregated for two reasons. First, since expenditures in one canton could have some impact in neighboring cantons, there might be some cross-canton influence of tobacco control spending. I assumed that this "overlapping" impact is likely to be more severe between cantons than between larger regions. Second, I did not observe sufficient policy variation within the period for small cantons such as AI or GL. I did not account for the effect of legislative measures such as smoking bans in our analysis because almost all of them came into force at the end of the observation period (in 2007 and later for smoking bans).

To obtain comparable figures, I divided the total tobacco control expenditures in each region by the mean population in the corresponding year. I thus obtained per capita tobacco control expenditures, which reflected the overall resources allocated to tobacco control in each region from 1997 to 2007. For the years prior to 1997, I made the assumption that expenditures were null before 1990, and used the estimated trends about the evolution of expenditures between 1990 and 1997 expressed by the respondents in each region. Other assumptions about pre-1997 expenditures are tested in the sensitivity analysis.

Tobacco control expenditures can be considered as either a flow or a stock variable. For the first variable type, the amount spent during a particular year has an immediate and exclusive effect during that year. However, we can expect that

"measures implemented in any one year have lasting effects on smoking behavior in future years" (Farrelly *et al.* 2008). For these reasons, I constructed two distinct tobacco control expenditures variables that I tested using different models: 1) expenditures in the current year and 2) cumulative expenditures (current expenditures and past expenditures discounted by 25% per year as suggested by Farrelly *et al.* 2008), computed as follows for each year t:

$$cum\_exp_t = exp_t + 0.75exp_{t-1} + 0.5exp_{t-2} + 0.25exp_{t-3} \quad (3.8)$$

I combined information from the Swiss Statistical Office and Swiss Cigarette[17] to obtain a series of price data for the average cigarette pack (20 units) at the country level (there are no regional differences between cigarette prices in Switzerland). I deflated price and tobacco control data by the Consumer Price Index (CPI) to account for inflation.

Individual characteristics

In both the initiation and the cessation analyses, I controlled for gender, nationality (whether the respondent is Swiss or not) and education level (primary, secondary and higher education). To account for potential cohort effects, I added dummy variables corresponding to specific birth periods. In the initiation analysis, the cohort dummies corresponded to the following birth years: 1976-1980, 1981-1985, and 1986-1992 (reference period: 1970-1975). In the cessation analysis, the birth years were: 1941-1950, 1951-1960, 1961-1970, 1971-1980, and 1981-1992 (reference period: 1930-1940). The Swiss health survey contains rich information about individual characteristics such as mental and physical health status, personal and household income and risky behaviors. I did not include these variables because they may have varied significantly during the period of analysis. The use of education level as part of the initiation analysis might be questionable because most people start smoking before they complete their education. Nevertheless, I see it as a proxy for parental education and have therefore decided to retain it as part of the analysis.

To use the information about tobacco control expenditures and price (the time-varying covariates), I had to split the cross-sectional database to obtain a "panel" that contains one observation per non-smoking year for the initiation analysis and one observation per smoking year for the cessation analysis. This approach allowed me to match the values for price and tobacco control expenditures with the corresponding

[17] Swiss association of tobacco producers.

calendar years and regions for each individual. Table 3.4 shows an example of cessation data for two individuals (individual 1 started smoking in 2004 and was still smoking in 2007, individual 2 started smoking in 1997 and quit in 2001).

Table 3.4: Data example

ID	Smoking Duration	Failure (Cessation)	Gender	Region	TC per capita spending	Calendar Year
1	0	0	1	TI	2.120	2004
1	1	0	1	TI	2.698	2005
1	2	0	1	TI	3.345	2006
1	3	0	1	TI	3.486	2007
2	0	0	0	MIT	0.569	1997
2	1	0	0	MIT	0.575	1998
2	2	0	0	MIT	0.649	1999
2	3	0	0	MIT	0.748	2000
2	4	1	0	MIT	1.157	2001

3.6. Descriptive statistics

Outcome variables

To take a first look at the initiation and cessation processes, I constructed the empirical survival and hazard rate functions without restricting the sample. I used the non-parametric Kaplan-Meier (KM) product limit estimator (Kaplan and Meier 1958). For the survival function, we have the following:

$$\hat{S}_{KM}(t) = \prod_{i=1}^{T} \frac{n_i - f_i}{n_i} \tag{3.9}$$

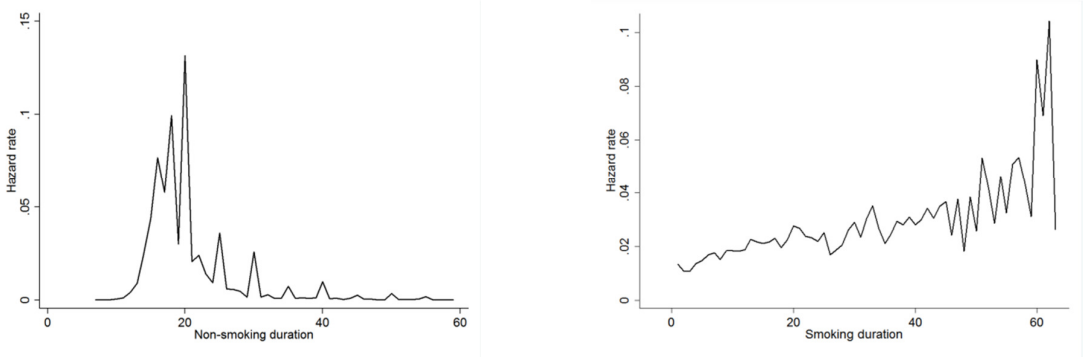
where n_i is the number of individuals who did not quit (or who are "at risk") at time *i* and f_i is the number of failures observed at time *i*. In other words, this formula computes the yearly ratio of the number of people who have not started smoking (or have not yet quit) and the total number of people at risk of starting (or quitting) in the same year. The empirical hazard function is obtained for each failure time by taking the ratio of the number of failures and the number of individuals at risk: i.e., we compute the following:

$$\hat{h}(t) = \frac{f_i}{n_i} \tag{3.10}$$

Figure 3.4 shows the Kaplan-Meier product-limit estimators of the survival and hazard functions for the entire sample. The survival functions represent the proportion of individuals at each point in time who did not start (or quit) smoking, whereas the hazard rate graphs give the probability of starting (or quitting) with respect to the duration of the non-smoking (or smoking) episode.

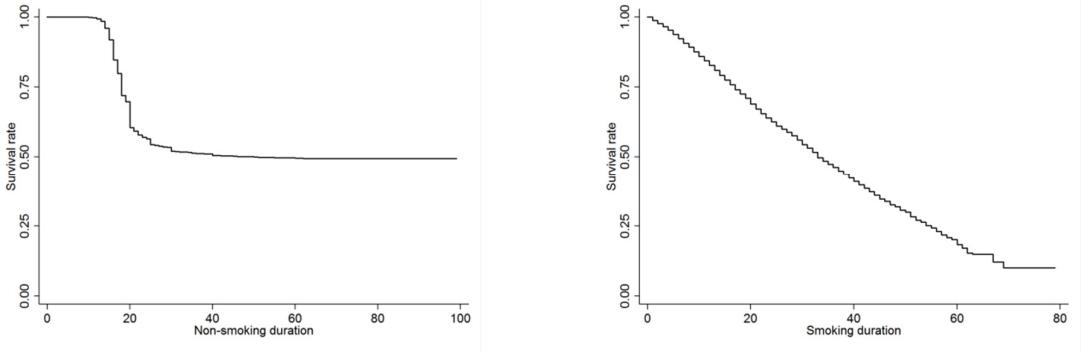
Figure 3.4: Empirical Kaplan-Meier hazard and survival functions – Initiation and cessation

Empirical hazard rate



Initiation Cessation

Empirical survival function



Initiation Cessation

We observe that the survival function for smoking initiation decreases sharply between 15 to 20 years of age and then stabilizes. We obtain the same information in observing the hazard rate function, which increases sharply between the ages of 15 to 20 and then also drops sharply. This means that the probability of initiation is high for people between 15 and 20 years old and then decreases to a figure close to zero. The hazard rate (the survival function) is monotonically increasing (decreasing) in the case of the cessation analysis. This implies that the probability of quitting increases steadily with respect to smoking years. The peaks that can be observed in the initiation graph are due to the above-mentioned problem of recall bias. In Appendix B, I show the empirical hazard rates of initiation and cessation by region and keeping only individuals used in the analyses, i.e. using restricted samples as presented in Table 3.3.

Independent variables

Summary statistics for individual characteristics are presented in Table 3.5 for both subsamples (initiation and cessation analysis).

Table 3.5: Individual characteristics

	Initiation analysis sample (%)		Cessation analysis sample (%)	
Gender				
Men		46.8		49.3
Women		53.2		50.7
Nationality				
Non-Swiss		17.8		14.0
Swiss		82.2		86.0
Education				
Compulsory		9.0		10.9
Secondary		65.0		63.5
Higher		26.0		25.6
Birth cohort	*1970-1975*	36.2	*1930-1940*	4.9
	1976-1980	22.8	*1941-1950*	19.8
	1981-1985	16.5	*1951-1960*	20.7
	1986-1992	24.5	*1961-1970*	24.6
			1971-1980	17.6
			1981-1992	12.4
N		**4,353**		**6,464**

Figure 3.5 presents the evolution of the real price of a pack of cigarettes (100=1980), and Table 3.6 shows the evolution of aggregated tobacco control expenditure between 1997 and 2007. Expenditures rose substantially during the last ten years, increasing from about 0.70 to 2.70 CHF per capita at the national level.

Figure 3.5: Real price of cigarettes (1980-2007)

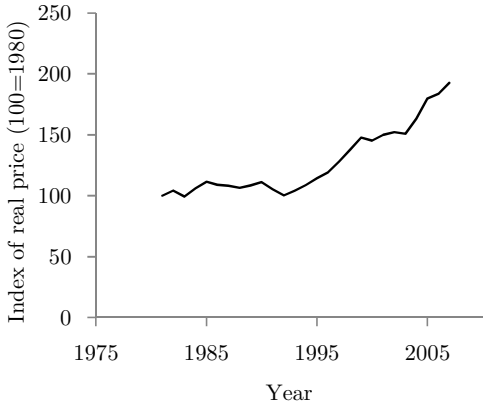


Table 3.6: Per-capita tobacco control expenditures in the Swiss regions (1997-2007)

	Period average	1997-2007 increase
Lake Geneva	1.93	185.5%
Mitteland	1.49	360.5%
Zürich	1.47	281.2%
East	1.15	475.6%
Center	1.14	342.6%
Ticino	1.96	223.4%

The Northwest region is excluded due to a lack of accurate data.

3.7. Results

In Table 3.7, I first present the results of the simple analysis of changes in prevalence between 2001 and 2007 in the six regions. Both price and per capita tobacco control expenditures seem to have a negative impact on smoking prevalence in the general population. However, only the impact of price is significant. Even if it provides some insight into the impact of price and tobacco control spending on smoking decisions, this result must be interpreted with caution because many potential confounding factors are not accounted for.

Table 3.7: Analysis of smoking prevalence (2001-2007)

	General population
Real per capita tobacco control expenditures	-1.09 (-1.59) [-0.086]
Real price of cigarettes	-2.07** (-2.53) [-0.395]
N	42

Dependant variable: smoking prevalence among 14-64 years old individuals (current and occasional smokers). The model includes region FE. Standard errors in parentheses, elasticities in brackets. ***significant at 1%; **significant at 5%;*significant at 10%.

In Table 3.8 and 3.9, I present the estimation results for the initiation analysis obtained with both modeling approaches. For the continuous time case (Table 3.8), I reported the exponentiated coefficients, also known as hazard ratios[18]. I find that tobacco control expenditures did not influence the probability of smoking initiation (except in Models 4, 8, and 10, i.e. in FE and stratified models that used cumulative expenditures). The results for the cessation models (Table 3.10 and 3.11) consistently show that tobacco control expenditures are positively associated with the probability of smoking cessation. The resulting cessation elasticities vary from 0.05 to 0.11 depending on the nature of expenditures (annual or cumulative) and on the specification used. A 10% increase in per capita tobacco control spending would then result in a 1% to 1.1% increase of the probability of smoking cessation according to models using annual expenditures. In most initiation models (again, except in Models 4, 8, and 10), real price has a significant negative impact on smoking initiation (elasticity of initiation varies from -0.64 to -0.88). In the cessation analysis, real cigarette price has a positive and significant impact on the cessation probability. An

[18] Hazard ratios represent the factor by which the expected initiation (or cessation) probability is multiplied as a result of a one-unit increase in the corresponding covariate. A hazard ratio of 1.10 associated with a continuous independent variable indicates that an increase of 1 unit in the variable will result in a 10% increase in the expected probability.

increase of 10% in real cigarette price would result in a 9.4% to 12.7% increase of the cessation probability. Education level has a significant impact on both decisions. Individuals with higher education are approximately 30% less likely to start smoking than individuals with only compulsory education. Individuals with secondary (and tertiary) education are about 10% (respectively 18%) more likely to quit than the less educated individuals. Men are more likely to start smoking (hazard ratio of about 1.13, $p<0.01$), and they are less likely to quit (hazard ratio around 0.89, $p<0.05$). Whether or not an individual is Swiss does not have any significant effect on the onset and the termination of smoking.

Table 3.8: Initiation analysis – Discrete time hazard models (logit)

	Without region fixed-effects		**With region fixed-effects**	
	Annual exp.	Cumulative exp.	Annual exp.	Cumulative exp.
	Model 1	*Model 2*	*Model 3*	*Model 4*
Tobacco control	0.0178	-0.0307	-0.0629	-0.0900***
	(0.059)	(0.0340)	(0.080)	(0.035)
	[0.01]	[-0.04]	[-0.04]	[-0.11]
Price	-0.9152***	-0.6630**	-0.6663**	-0.2606
	(0.262)	(0.256)	(0.300)	(0.256)
	[-0.88]	[-0.64]	[-0.64]	[-0.25]
Education				
Secondary education	-0.1278	-0.1327	-0.1317	-0.1367
	(0.095)	(0.096)	(0.099)	(0.101)
Higher education	-0.3990***	-0.4031***	-0.4256***	-0.4324***
	(0.094)	(0.095)	(0.105)	(0.107)
Gender				
Male	0.1405***	0.1413***	0.1371***	0.1387***
	(0.031)	(0.032)	(0.0300)	(0.031)
Nationality				
Swiss	-0.0232	-0.0269	-0.0041	-0.0032
	(0.032)	(0.032)	(0.038)	(0.038)

N=4353. Robust SE in parentheses (adjusted for clustering within regions). Elasticities in brackets. Models include one dummy variable for each possible observation time. Models also control for birth cohort (1970-1975, 1976-1980, 1981-1985,1986-1992). Omitted categories are compulsory education, female, and non-Swiss. ***significant at 1%; **significant at 5%;*significant at 10%.

Table 3.9: Initiation analysis – Continuous time hazard models (Cox)

	Without region fixed-effects		**With region fixed-effects**		**Stratified by region**	
	Annual exp.	Cumulative exp.	Annual exp.	Cumulative exp.	Annual exp.	Cumulative exp.
	Model 5	*Model 6*	*Model 7*	*Model 8*	*Model 9*	*Model 10*
Tobacco control	1.0136	0.9731	0.9438	0.9233***	0.9518	0.9269**
	(0.046)	(0.025)	(0.066)	(0.026)	(0.070)	(0.029)
	[0.01]	[-0.04]	[-0.04]	[-0.10]	[-0.03]	[-0.09]
Price	0.4204***	0.5211***	0.5247**	0.7448	0.5106***	0.7230
	(0.098)	(0.124)	(0.133)	(0.1655)	(0.129)	(0.166)
	[-0.86]	[-0.64]	[-0.64]	[-0.29]	[-0.66]	[-0.32]
Education						
Secondary education	0.8944	0.8908	0.8914	0.8881	0.8874	0.8839
	(0.071)	(0.072)	(0.074)	(0.075)	(0.073)	(0.074)
Higher education	0.7000***	0.6975***	0.6838***	0.6802***	0.6808***	0.6768***
	(0.054)	(0.054)	(0.059)	(0.060)	(0.059)	(0.060)
Gender						
Male	1.1317***	1.1324***	1.1274***	1.1288***	1.1250***	1.1265***
	(0.029)	(0.030)	(0.028)	(0.028)	(0.026)	(0.027)
Nationality						
Swiss	0.9816	0.9786	0.9973	0.9980	0.9984	0.9991
	(0.027)	(0.027)	(0.033)	(0.033)	(0.034)	(0.034)

Coefficients are expressed in hazard ratios. N=4353. Robust SE in parentheses (adjusted for clustering within regions). Elasticities in brackets. Models also control for birth cohort (1970-1975, 1976-1980, 1981-1985,1986-1992). Omitted categories are compulsory education, female, and non-Swiss. Model fit discussed in Appendix C. ***significant at 1%; **significant at 5%;*significant at 10%.

Table 3.10: Cessation analysis – Discrete time hazard models (logit)

	Without region fixed-effects		**With region fixed-effects**	
	Annual exp.	Cumulative exp.	Annual exp.	Cumulative exp.
	Model 11	*Model 12*	*Model 13*	*Model 14*
Tobacco control	0.1604***	0.0555***	0.1462***	0.0398**
	(0.037)	(0.017)	(0.044)	(0.016)
	[0.11]	[0.08]	[0.10]	[0.06]
Real price	0.9210***	1.0791***	0.9813***	1.2170 ***
	(0.217)	(0.226)	(0.170)	(0.128)
	[0.94]	[1.10]	[1.00]	[1.24]
Education				
Secondary education	0.0888**	0.0889 **	0.0979 **	0.0982 **
	(0.041)	(0.041)	(0.038)	(0.038)
Higher education	0.1659***	0.1663***	0.1741***	0.1743***
	(0.032)	(0.032)	(0.037)	(0.037)
Gender				
Male	-0.1081**	-0.1089**	-0.1095**	-0.1096**
	(0.052)	(0.052)	(0.050)	(0.049)
Nationality				
Swiss	-0.0691	-0.0709*	-0.0760	-0.0761*
	(0.045)	(0.045)	(0.048)	(0.047)

N=6464. Robust SE in parentheses (adjusted for clustering within regions). Elasticities in brackets. Models include one dummy variable for each possible observation time. Models also control for birth cohort (1931-1940, 1941-1950, 1951-1960, 1961-1970, 1971-1980, 1981-1992) and recall bias (indicators for the following calendar years: 1997, 1992, 1987, 1982, 1977). Omitted categories are compulsory education, female, and non-Swiss. ***significant at 1%; **significant at 5%;*significant at 10%.

Table 3.11: Cessation analysis – Continuous time hazard models (Cox)

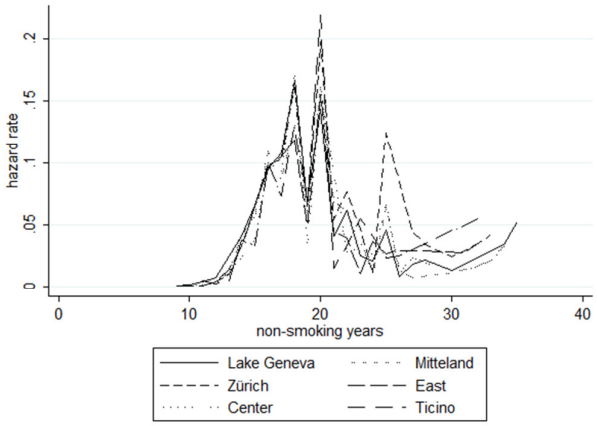
	Without region fixed-effects		**With region fixed-effects**		**Stratified by region**	
	Annual exp.	Cumulative exp.	Annual exp.	Cumulative exp.	Annual exp.	Cumulative exp.
	Model 15	*Model 16*	*Model 17*	*Model 18*	*Model 19*	*Model 20*
Tobacco control	1.1672 ***	1.0542***	1.1510***	1.0377**	1.1471***	1.0360*
	(0.043)	(0.017)	(0.050)	(0.016)	(0.054)	(0.019)
	[0.11]	[0.08]	[0.10]	[0.06]	[0.10]	[0.05]
Real price	2.4646***	2.8897***	2.6153***	3.3153***	2.6502***	3.3606***
	(0.527)	(0.637)	(0.440)	(0.412)	(0.495)	(0.503)
	[0.94]	[1.11]	[1.00]	[1.25]	[1.02]	[1.27]
Education						
Secondary education	1.0906**	1.0907**	1.1004**	1.1008**	1.1043***	1.1046***
	(0.044)	(0.044)	(0.041)	(0.041)	(0.041)	(0.041)
Higher education	1.1759***	1.1764***	1.1855***	1.1857***	1.1944***	1.1946***
	(0.037)	(0.037)	(0.043)	(0.043)	(0.044)	(0.044)
Gender						
Male	0.8999**	0.8992**	0.8987**	0.8986**	0.8970**	0.8970**
	(0.046)	(0.045)	(0.044)	(0.044)	(0.042)	(0.042)
Nationality						
Swiss	0.9348	0.9331	0.9285	0.9285	0.9249*	0.9249*
	(0.041)	(0.041)	(0.043)	(0.043)	(0.041)	(0.041)

Coefficients are expressed in hazard ratios. N=6464. Robust SE in parentheses (adjusted for clustering within regions). Elasticities in brackets. Models also control for birth cohort (1931-1940, 1941-1950, 1951-1960, 1961-1970, 1971-1980, 1981-1992) and recall bias (indicators for the following calendar years: 1997, 1992, 1987, 1982, 1977). Omitted categories are compulsory education, female, and non-Swiss. . Model fit discussed in Appendix C. ***significant at 1%; **significant at 5%;*significant at 10%.

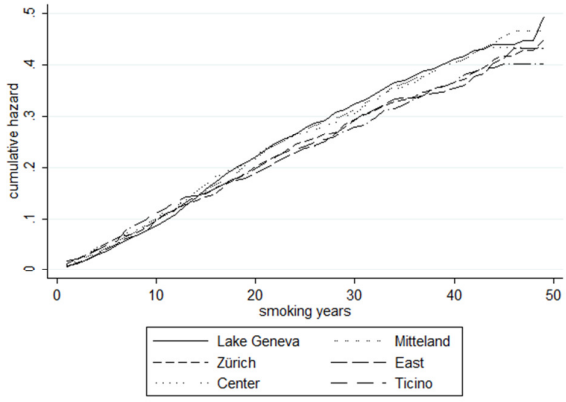
Figure 3.6 shows the baseline hazard in each region (strata) retrieved after the estimation of the stratified models (see Cleves *et al.* 2008 for details). Hazard rate is presented for the initiation analysis, while cumulative hazard rate is presented for the cessation analysis. In a region, a lower baseline hazard in the initiation analysis and a higher baseline hazard in the cessation analysis could reflect the influence of unobserved factors such as stronger anti-smoking sentiment.

Figure 3.6: Estimated baseline hazard by region

Initiation analysis



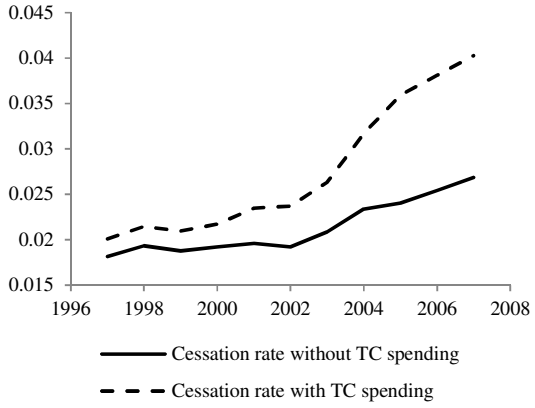
Cessation analysis



I perform a simple computation to estimate the number of avoided smokers attributable to tobacco control efforts in the country between 1997 and 2007. For this purpose, I used the Cox model with annual expenditures and region fixed-effects (Model 17) to predict the cessation probability of each individual in the sample. I also used the model to predict these probabilities assuming zero tobacco control expenditures on the period. The resulting average cessation probabilities, by year, are

presented in Figure 3.7. The black line depicts the cessation rate that would have been observed without any tobacco control spending. The difference between the two lines is multiplied each year by the number of potential quitters in the 15 and over population of smokers to obtain a rough estimate of the quitters attributable to tobacco control. If we sum all these quitters over years, we end up with approximately 110,000 additional quitters on the period. The total TC spending over the period amounted approximately to 95 million Swiss Francs. In other words, tobacco control generated an additional quitter for each CHF 875 spent.

Figure 3.7: Impact of tobacco control (TC) spending on smoking cessation rates (1997-2007)



Sensitivity analysis

In this section, I investigate the sensitivity of our main coefficient of interest to changes in some assumptions. I focused the sensitivity analysis on the case of smoking cessation, because most of initiation models conclude to a non-significant impact of tobacco control expenditures. The robustness of our results was investigated according to two issues: the assumption about the level of tobacco control expenditure between 1990 and 1997 and the use of the semi-parametric Cox PH model. I estimated models using the following assumptions: 1) tobacco control expenditures were set to zero for all years before 1997; 2) tobacco control expenditures were set at the 1997 level between 1990 and 1997; 3) to address the influence of the Cox PH specification, I estimated the model in the parametric framework using the Weibull distribution for the baseline hazard; 4) I estimated the discrete time model using generalized linear model with binomial link and complementary log-log distribution. The sensitivity analysis gave rise to four new estimations of the tobacco control elasticity of smoking cessation, as presented in Table 3.12.

Table 3.12: Cessation models – Sensitivity analysis

	Evolution of TC spending between 1990 and 1997	
	No expenditure	*1997 level*
Continuous time model		
Weibull	1.30***	1.19***
(hazard ratios)	(0.093)	(0.042)
	[0.14]	[0.07]
Discrete time model		
Complementary log-log	0.23***	0.10***
	(0.074)	(0.026)
	[0.15]	[0.08]

Annual TC expenditures and region FE used in all models. All models control for price, education level, gender, nationality, cohort dummies, and recall bias indicators. Robust SE in parentheses (adjusted for clustering within regions). Elasticities in brackets. *** significant at 1%; **significant at 5%;*significant at 10%.

3.8. Discussion

Using retrospective individual information about smoking-related behavior from a large nationally representative health survey, I assessed the influence of tobacco control expenditures on the propensity to start and to quit smoking. Smoking initiation and cessation decisions were modeled separately using several discrete and continuous time hazard models. I found no convincing evidence of a significant impact of tobacco control expenditures on smoking initiation, whereas the cessation analysis reveals a positive and significant association between tobacco control and the probability of cessation in all specifications. I also find evidence that cigarette price influences both the decisions to start and to quit smoking. However the effect of price has a stronger impact on cessation than on initiation. Our results are in line with those of Schaap *et al.* (2008), who showed that European countries with more developed tobacco control policies have higher cessation rates. Switzerland spends only about 2% of its health financial resources on prevention in general, whereas some neighboring countries spend up to 3%. Moreover, if we compare the CDC recommendation that at least USD 9 per capita should be spent on tobacco control with the actual CHF of 2.7 (or USD 2.35) per capita spent in Switzerland, we highlight that the degree to which resources are allocated toward tobacco control in the country are limited. This could partly explain the current degree of prevalence of smoking, which is still high in international comparison. However, our results do not indicate the extent to which tobacco control spending have decreasing marginal returns, it is therefore difficult to decide on an optimal level of expenditure.

The reader must take into consideration the following shortcomings. First, the use of self-reported retrospective information from a cross-sectional survey involves several problems, including that of inaccurate recall, and the impossibility to take account of a more comprehensive set of time-varying individual characteristics. Moreover, despite having clustered tobacco control spending in the regions, there might still be some "cross-border" effects that are not accounted for here. Another important point is that the decrease in prevalence observed during the period could have been more prominent if it had not been curbed by substantial tobacco industry promotion and advertising expenditures. Due to lack of data, I did not control for different degrees of exposure to tobacco industry advertising in the regions.

A true panel (longitudinal) data set that includes the complete smoking history of individuals (initiation, cessation and relapse) and contains a set of individual characteristics that are evolving overtime, such as disposable income, residence, marital status or employment status, would improve the analysis of

initiation, cessation and relapse decisions and provide informative figures useful in developing effective tobacco control policies. In Europe, the SHARE[19] dataset, which is similar to the American HRS, is in development, and will allow within and between countries analyses of the smoking behaviors of individuals aged 50 and over. This should provide interesting insights concerning the impact of tobacco control policies on this specific age group. Further research should also focus on the factors that drive smoking decisions – especially initiation – among young individuals. For this purpose, more recent data about youth smoking behavior and more detailed information about the tobacco control interventions targeted at this age group should be gathered. Moreover, the focus of the tobacco industry is moving towards young people. Traditional media campaigns account for a decreasing share of promotion expenditures for tobacco products, whereas direct marketing strategies are rapidly evolving. Future studies should also account for these changes.

[19] Survey of Health Ageing and Retirement in Europe

Appendix A: Overview of tobacco control in Switzerland

Measure	Situation
Price increase (through excise tax)	50% increase of real price from 1997 to 2007. Excise tax represented 56% of cigarette price in 2008, which is quite low in international comparison.
Labelling of cigarette packs	Since 2004, the use of "light" and "mild" terms is banned. Since 2008 (with transitional dispositions until end of 2009), picture health warnings on cigarette packs and other tobacco products are mandatory. In addition, the quitting help line contact information must be clearly mentioned.
Information campaigns	National information campaigns targeted at the general population ("Smoking hurts" 2001-2005, "BRAVO, life, not smoke" 2006-2008), school-aged children ("Non-smoking experience" 2000-2010) or sportive people (Cool & Clean). Smaller campaigns were regularly implemented in some cantons.
Advertising ban	Advertising bans that are in force in Switzerland are considered as partial bans whose effect on tobacco consumption is low or even null (Saffer and Chaloupka 2000). Some cantons took some more stringent regulation but they came into force only at the end of the period (in 2006 or 2007).
Protection against environmental tobacco smoke (ETS)	Launched in 2006, the "Smoke free work place" program encouraged firms to offer their employees a smoke-free environment. A federal law about ETS was discussed and voted on by the parliament in 2008. Although moving in a positive direction, the corresponding legislation is not very strict as it leaves room for several exceptions (e.g. smoking rooms are permitted). Some cantons, especially Ticino (Italian part of Switzerland), have taken the lead in terms of smoking bans in public places, but the corresponding measures came into force in 2007 only.
Product accessibility	Some cantons have taken provisions to reduce accessibility for young people (fewer than 16 or 18). Again, the measures came into force only at the end of our observation period (2006 or 2007).
Cessation support	Smoking cessation therapies are not reimbursed by the social health insurance. A quitting help line is available at the national level since 2005. A website (www.stop-tabac.ch) is also available and provide council and information about smoking cessation.

Appendix B: Kaplan-Meier hazard rates by region

Figure B1: Empirical hazard rate of initiation by region

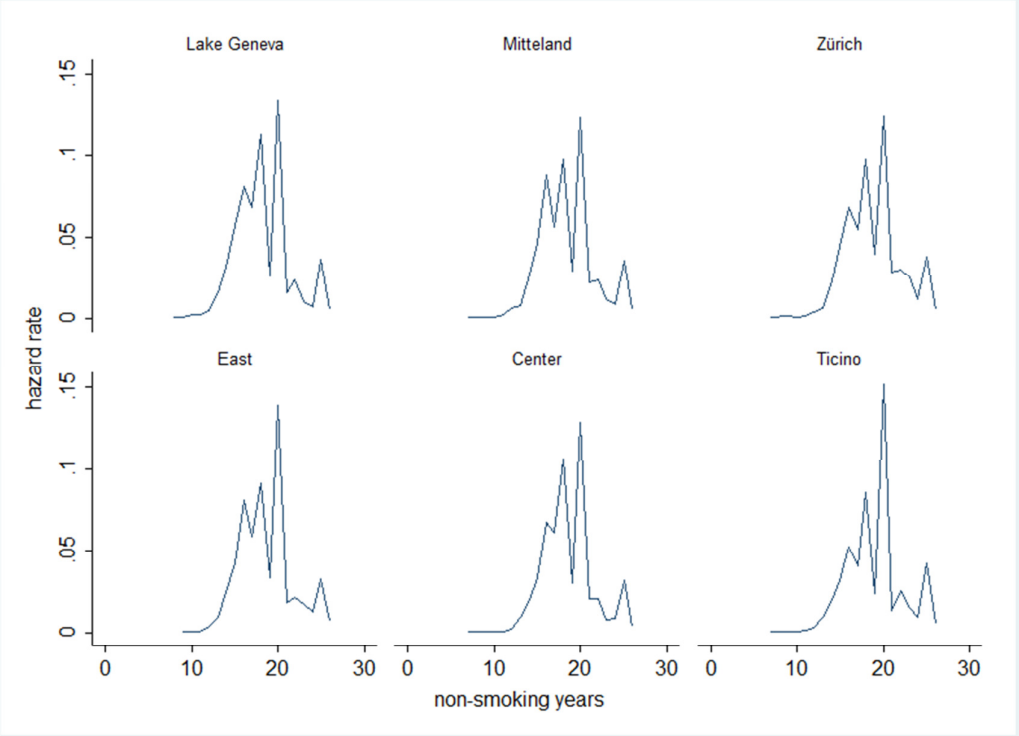
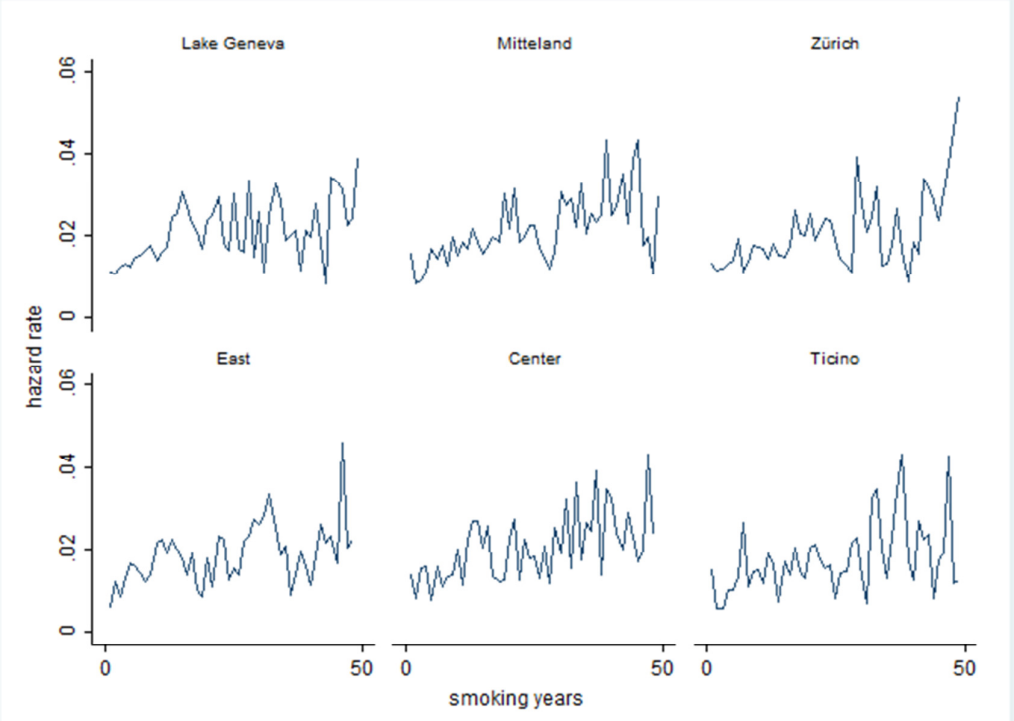


Figure B2: Empirical hazard rate of cessation by region

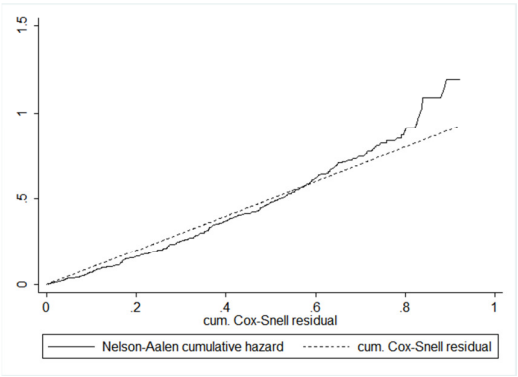


Appendix C: Cox model fit

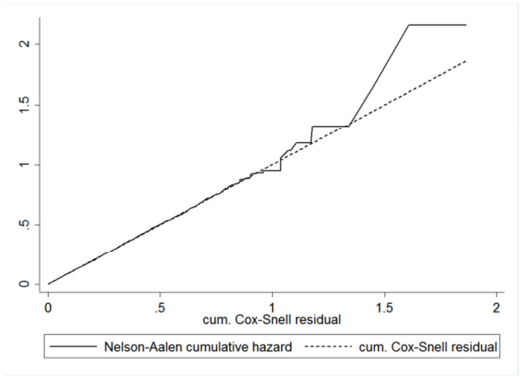
Model fit of Cox models was assessed by computing the cumulative Cox-Snell residuals (Cox and Snell 1968) and representing them against the cumulative hazard. A well-fitted model should produce a line with a slope of 1 that passes through the origin. In Figure C1, I present the results of this procedure for the models with fixed-effects and annual expenditures (I obtained figures similar to those achieved using other models). We observe that the line departs from the 45-degrees line on the right side of both graphs. This phenomenon is mostly due to the lack of observations for high exposure times.

Figure C1: Model fit (cumulative Cox-Snell residuals)

Initiation analysis



Cessation analysis



The proportional hazard assumption was systematically tested by means of tests based on the analysis of residuals. I found no evidence of violation of the proportional hazard assumption.

4 Perception of smoking-related adverse effects among youths: a best-worst scaling approach

Abstract

This paper uses best-worst scaling, a survey based method, to rank the adverse effects of tobacco use according to their potential to deter 14-19 years old individuals from smoking. The relative importance of 15 items, including long-term and short-term health and non-health adverse consequences, was assessed. The results indicate that apart from lung cancer that is consistently rated a being of most concern, less mentioned health risks such as reduced physical capacity and sexual and fertility problems are of significant importance. Using subgroup analysis and results from a random parameter model, I highlight substantial heterogeneity in preferences. Also, using estimates of the relative importance of the items at the individual level, I show that respondents that have a higher level of concern for long-term health risks are less likely to be involved in unhealthy behaviors.

Keywords: youth smoking, adverse effects, risk perception, best-worst scaling, random parameter logit

4.1. Introduction

The last decade witnessed an important reduction in tobacco use in Switzerland. Smoking among the population aged 15 and over decreased by five percentage points during the period, to reach 27% in 2009. This reduction is the combined result of changes in smoking initiation and cessation rates. While there is evidence that the increasing resources allocated to tobacco control in this period played a role in increasing cessation rates, there is only weak evidence that tobacco control efforts have influenced smoking initiation in Switzerland (see Chapter 3). I advance several arguments that could explain why, despite growing prevention efforts, the smoking initiation rate among 14- to 19-year-old individuals – i.e., the ages at which 80% of initiations occur – remains high. First, it is likely that young people are overoptimistic about their future smoking status or about their personal likelihood of being affected by tobacco-related risks, even if they are properly informed about these risks. Second, information campaigns may not emphasize the negative effects of smoking that are of greatest concern to young people. This argument holds especially regarding messages that focus on long-term health risks, to which present-oriented youths do not attach much importance. These factors may lead to an estimation of the marginal net benefit of consumption that does not reflect the true risks, resulting in excessive initiations.

In this study, I assess the health and non-health adverse effects associated with tobacco use that are of primary concern to youths and that might deter them from smoking. In addition to focusing on the health risks that are cited most often (i.e., lung cancer and cardiovascular disease), I investigate the importance of less frequently mentioned health implications (e.g., effects on teeth, appearance, skin, weight and sexual dysfunction) and other negative effects that are unrelated to health, such as cost, dependence, or manipulation by the tobacco industry. I use a best-worst scaling methodology to investigate the relative importance of 15 negative effects associated with tobacco use. The sample consisted of 376 young people between 14 and 19 years old living in the French-speaking part of Switzerland. The young people were presented with a series of best-worst choice situations and asked to pick the most and the least deterrent smoking-related negative effects for each situation. Data on past and current smoking behavior and on demographics were also collected.

The results show that in addition to lung cancer, which is consistently rated as being of highest concern, other less frequently mentioned risks such as sexual dysfunction and reduction of physical capacity are of great importance to young people. In a subgroup analysis, I show that, as noted by Hastings and MacFayden

(2002), "*There is no ultimate deterrent in smoking, no mother of all health warnings*." It is therefore important not to focus on conveying one single message to the entire population, but rather to find the most suitable message for specific subgroups. Finally, I exploit results from a random-coefficient approach to study the association between individual levels of concern for four types of risks (long-term health risks, short-term health risks, externalities, and product-specific issues) and the smoking status of respondents. I find a significant negative association between the level of concern about long-term health risks and the probability of smoking. I find similar results when looking at the impact of the level of concern about long-term health risks on the frequency of alcohol use. Young individuals who are more concerned with long-term health risks are thus less likely to be involved in unhealthy behaviors. The level of concern for long-term health risk may then at least partly reflect how far-sighted the individual are.

4.2. Background

Youth smoking in Switzerland

Smoking-related behavior in Switzerland is monitored in two general population surveys: the Swiss Tobacco Survey, which has been conducted each year since 2001, and the Swiss Health Survey, which has been conducted every five years since 1992. Detailed supplementary questions targeted at youths were asked repeatedly in 2001/2002, 2004/2005 and recently in 2007/2008 in the Swiss Tobacco Survey (Radtke et al. 2008). The first striking figure is the high initiation rate in the 14-19 age group, which I illustrate in two graphs. First, I used the 2001 to 2007 editions of the Swiss Tobacco Survey to compute the smoking prevalence in the cohort of individuals aged 14 in 2001 (15 in 2002, 16 in 2003, etc.). We observe a substantial increase in smoking prevalence from about 8% at the age of 14 to almost 40% at the age of 19. This 30-percentage point increase in prevalence does not completely fade at older ages (Figure 4.1).

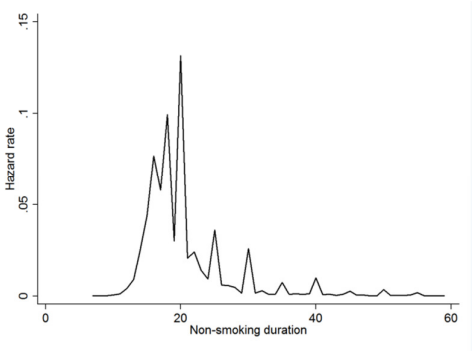
Figure 4.1: Smoking prevalence by age (cohort of youth aged 14 in 2001)

Using retrospective information about smoking behavior included in the 2007 edition of the Swiss Health Survey, I computed the probability of initiation at each age, conditional on not having started smoking. The x-axis of Figure 4.2 is the number of non-smoking years and the y-axis is the empirical Kaplan-Meier hazard rate, computed as follows:

$$\hat{h}(t) = f_i / n_i \ . \qquad (4.1)$$

The rate corresponds to the yearly ratio of the number of people who have not started smoking (f_i) and the total number of people at risk starting the same year (n_i). We observe that the probability of initiation increases sharply from the age of 14 and decreases precipitously after the age of 20. Another interesting figure is that 80% of current and former smokers started at the age of 20 or earlier.

Figure 4.2: Initiation probability by age



The most recent youth module of the Swiss Tobacco Survey provides detailed additional information about youth smoking-related behaviors and beliefs. The data show an association between education level and smoking participation, indicating that prevalence was 36% among individuals involved in an apprenticeship and only 24% among high school students at the same age. The data also show that young individuals are overoptimistic about their ability to quit. Indeed, 44% of young smokers think they will probably no longer smoke within two years, even though we know that smoking prevalence among youth increases with age. Moreover, the data provide evidence of a strong link between the social environment and smoking-related behavior. If both parents smoke, youth smoking prevalence is almost three times higher. Similar figures are found if one sibling smokes. We can also observe that smokers have a higher proportion of smokers among their friends. In the survey, young non-smokers were presented a Likert scale to rate several smoking-related negative effects that prevent them from smoking. The higher rated negative effects are the following: 1) smoking is unhealthy (95% strongly agree or agree); 2) I don't want to become addicted (84% strongly agree or agree); 3) smoking causes a bad smell (80% strongly agree or agree). About 75% of young non-smokers say that they do not smoke because it is expensive. To summarize, the data described above show that the initiation rate in this age group is high, that there is a clear educational gradient, that there is some evidence of inter-temporal inconsistencies, and that young non-smokers are aware that smoking is unhealthy and creates addiction.

Strategies to reduce youth smoking

From an economic perspective, a young individual compares the benefits he draws from consumption (i.e., pleasure, peer acceptance, self-confidence) with the

present and future costs of tobacco use[20] and decides to smoke if the benefits outweigh the costs. In this framework, possible strategies to curb smoking are aimed at increasing immediate monetary and non-monetary costs, improving youths' awareness of the various risks of smoking and limiting youth exposure to tobacco industry advertising. While the existing literature provides insights about the efficiency of all of these approaches, the effect of price has been the most widely studied. Despite some opposing evidence (e.g., DeCicca et al. 2008a), a large number of studies have concluded that price increases influence smoking participation among youth and that this subgroup of the population is even more price-responsive than adults are (Chaloupka and Grossman 1997).[21] Although the body of evidence supporting a negative effect of price on smoking participation among youth is significant, only a few studies have separated the effect on reduced initiation from that on increased cessation. Results related to the initiation decision are heterogeneous. Some studies conclude a negative effect of price on smoking initiation (Cawley et al. 2004, Tauras et al. 2001, Chapter 3), and an important number of other studies have found a modest or nonexistent impact of price on smoking onset (Lopes-Nicolas 2002, Douglas 1998, DeCicca et al. 2002, Sen and Wirjanto 2009, DeCicca et al. 2008b). In a recent study on youth smoking, Fletcher et al. (2009) found that adolescents (grades 7 to 12) differ in their responsiveness to cigarette price changes depending on measures of self-control and time preferences. Their results support the development of strategies other than price changes to reduce smoking in this age group.

Other non-monetary costs of tobacco consumption might influence the smoking decisions. Access restrictions were not proven to be very effective in reducing smoking participation (see Ficthenberg and Glantz 2002 for a review). Moreover, Schnohr et al. (2008) found that a purchase age limit for tobacco products could increase the probability of daily smoking. In Switzerland, 67% of young smokers aged 14-15 indicated that they buy cigarettes on their own, although sales to individuals under 16 are forbidden (Radtke et al. 2008). Another feature of the Swiss

[20] Present costs include the market price of the product and other "non-monetary" costs such as bypassing the parental ban, restriction of access, immediate health and non-health negative effects, and the costs associated with smoking bans. Future costs include health costs, i.e., potential loss of life expectancy and loss of quality of life. Future health costs are uncertain, however, and individuals do not face the same risks. Another central point concerning future costs is that they are not perceived equally by all individuals in terms of importance and probability of occurrence. Moreover, because youth are more present-oriented, they are more likely to heavily discount these costs when making their smoking decisions.

[21] The authors suggested that youth would be more price-sensitive for several reasons. First, the "addictive stock" of youth is not very important, so they are more prone to quit when the price changes. Second, they advanced that price changes have a multiplicative effect for youth due to strong peer effects. Third, a larger share of young people's income is spent on cigarettes. Finally, if we rely on the rational addiction model (Becker and Murphy 1988), the fact that young people are more present-oriented leads to a greater sensitivity to price changes.

context is that the tobacco industry operates freely and aggressively towards teenagers. In the 2007/8 period, it is estimated that almost one-third of young individuals aged 14-19 received a gift (i.e., cigarettes, lighter) from the tobacco industry (Radtke et al. 2008).

An important body of empirical literature has studied the impact of information dissemination on the risks related to youth smoking. This information was disseminated to influence young people's risk perception and to ultimately influence their smoking-related decisions. The link between risk perception and behavior was recently assessed by Song et al. (2009). The authors found that the 12- to 17-year-olds who had the lowest level of risk perception of long-term and short-term health risks (measured by their subjective probability of experiencing a particular adverse effect, such as trouble breathing, lung cancer, etc.) were significantly more likely to start smoking. Different vectors of information dissemination exist, including media campaigns, school-based programs, and health warnings (Koval et al. 2005). Some studies have focused on particular campaigns. For instance, numerous studies have investigated the impact of the U.S. National Truth® campaign. Thrasher et al. (2004) showed that attitudes and beliefs against the tobacco industry increased significantly following the onset of this campaign. Changes in attitudes and beliefs resulting from the Truth® campaign and from an industry-funded campaign ("Think, don't smoke") were analyzed by Farrelly et al. (2008) and Davis et al. (2009). The authors found evidence that the Truth® campaign was effective and that the industry-funded campaign had counterproductive effects. In a recent study by Farrelly et al. (2009), the authors found an association between the degree of exposure to the campaign and a lower probability of smoking initiation. They estimated that more than 450,000 individuals avoided becoming new smokers thanks to this specific campaign in the United States. Other studies focusing on the impact of general budgets on youth smoking prevention have found a positive association between tobacco control spending and the number of quit attempts among college students (Ciecierski et al. 2010). Tauras et al. (2005) found a negative and significant association between state tobacco control spending and youth smoking prevalence. In Chapter 3, I provide some evidence that tobacco control expenditures do not have a major impact on smoking initiation.

Pechman and Reibling (2000), also cited by Farrelly et al. (2003), argued that to be effective in changing behavior, an information campaign should have the correct content and be targeted to the appropriate population (i.e., it should rely on the most relevant message for the concerned subgroup). The content should be clearly

disseminated, and various messages should be used. Further, the budget should be large enough to allow adequate exposure of the target group. Several studies have attempted to assess the ability of different specific anti-smoking messages to change beliefs or behaviors. Using a focus-group approach, Goldman and Glantz (1998) asked adolescents and adults about the perceived effectiveness of several message "themes" in reducing tobacco use and denormalizing smoking. The themes studied were industry manipulation, secondhand smoke, addiction, cessation, youth access, short-term effects, long-term health effects, and romantic rejection. The authors conclude that industry manipulation and secondhand smoke have the highest perceived efficacy for achieving denormalization and a reduction in consumption. In a comprehensive review on youth tobacco prevention, Farrelly et al. (2003) classified the types of messages delivered by media campaigns on youth smoking. Their classification includes consequences (short-term, long-term, family and addiction), social norms and imagery, role models (e.g., celebrities), industry and product focus, secondhand smoke and youth access. The authors review the existing evidence concerning the effectiveness of various thematic content and conclude that it is currently difficult to highlight one particular message that would be more effective.

In the present study, I focused on the thematic content of prevention messages and, more specifically, on the potential of various health and non-health smoking-related consequences to act as deterrents to smoking for youths aged 14-19. This method has the virtue of providing a detailed assessment of the relative importance that young people attach to these consequences. Moreover, the estimation procedure allowed me to investigate preference heterogeneity and to relate the level of concern about certain type of risks to the smoking status of respondents.

4.3. Method

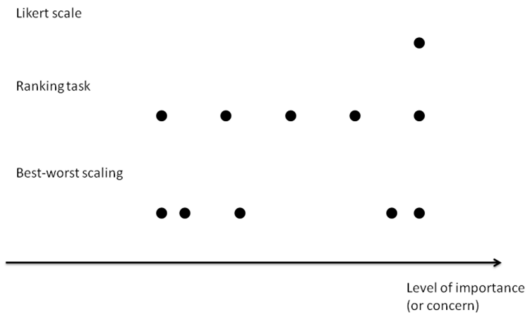
Best-worst scaling

Best-worst scaling (BWS) was originally introduced by Finn and Louviere (1992), and the theoretical foundations of the associated probabilistic models were developed in a reference paper by Marley and Louviere (2005). Recently, Flynn et al. (2007) provided a comprehensive overview of the method and its associated models with a focus on health economics. Some applications of BWS are presented as an alternative to traditional choice-based conjoint analysis. For instance, Flynn et al. (2008) studied patients' preferences toward various aspects of dermatology consultations. Swancutt et al. (2008) described a BWS study protocol to assess the relative importance of the various attributes of a colonoscopy among women. Outside of health economics, an increasing number of studies use the BWS method to examine various topics (e.g., Auger et al. 2007, Cohen 2009, Louviere and Islam 2008, Jaeger et al. 2008).

A best-worst survey contains a series of choice tasks, each of which contains a different set of items. In each choice situation, respondents are asked to choose the "best" and the "worst" item. The terms "best" and "worst" can be replaced by any expression that is relevant to locate the item on the dimension of interest (e.g., "most important" and "least important" or "most useful" and "least useful"). The analysis of the choice data allows the researcher to measure each item on a common scale and to assess its relative importance. In this study, the respondents were presented with a series of "best-worst" tasks that required them to pick the most and the least deterrent adverse effect of smoking.

In Figure 4.3, I schematically present the advantage of the best-worst scaling methodology over a Likert scale and a ranking task. In this example, it is assumed that the respondent had to evaluate 5 items. With a standard Likert scale, each item might be rated as important. If we ask the respondents to rank items, the answers will be essentially ordinal, without any assessment of the relative level of importance. Moreover, a ranking task is very demanding. The BWS methodology provides sufficient information to develop a precise scale and even to develop individual-level scales.

Figure 4.3: Comparison between Likert scale, ranking tasks and BWS



We see that the information that can be obtained using BWS is much richer and more complete than the information that can be obtained using conventional methods. Furthermore, the BWS task has the advantage of being quite simple for respondents in comparison, for instance, with the traditional discrete choice paired comparisons for which the respondent must evaluate all dimensions simultaneously.

The level of concern expressed by respondents may have different determinants. Specifically, I assume that it depends on the perceived probability to be affected, the perceived disutility associated with the consequences, and an individual discount factor. For an individual *i* rating an item *j*, we have:

$$Concern_{ij} = \delta_i^{t_j} \pi_{ij} u_j \tag{4.2}$$

Where δ is the discount factor of individual *i*, *t* reflects the distance in time of the consequence, π is the subjective probability of individual *i* that consequence *j* occurs, and *u* is the perceived disutility associated with consequence *j*.

Development of the survey

On the basis of an extensive review of the literature about smoking-related consequences and interviews with tobacco prevention specialists,[22] I developed an initial list of 36 negative effects of smoking, including long-term and short-term health risks, impacts on physical appearance, financial burden, impact on other individuals, and others. I then constructed a preliminary survey designed to evaluate these 36 implications independently using Likert scales. The surveys were completed

[22] In particular, I am thankful to Verena El Fehri at the Swiss Association for Smoking Prevention (AT-Suisse) and Dr. Pascal Gygax at Fribourg University.

by a sample of 50 young smokers and non-smokers between 14 and 19 years old. This procedure allowed me to select a sub-sample of items to include in the final analysis. After additional discussions with specialists to limit the questionnaire to a reasonable number of choice tasks, I chose to keep 15 negative implications. The final list of negative implications is provided in Table 4.1.

Table 4.1: Final list of smoking-related negative effects

Negative effects
Lung cancer
Skin problems
High expenditures
Oral and dental problems
Inhalation of chemicals
COPD
Addiction
Weight gain after cessation
Endangering relatives
Sexual and fertility problems
Tobacco industry manipulation
Cardiovascular diseases
Reduced life expectancy
Disturbance of non-smokers
Reduction of physical capacity

To obtain a survey in which all issues occur equally often and in which the occurrence of one issue is independent of the occurrence of all other issues, I used an orthogonal main effects design based on an orthogonal array obtained from Sloane's website (Sloane 2010). I show the complete design in Appendix A. The surveys contained 4 choice sets with 5 negative effects, 6 choice sets with 7 negative effects, 4 choice sets with 9 negative effects and 2 choice sets with 11 negative effects, resulting in a total of 16 choice sets. For each choice situation, I provided a brief description of the items. An example of a choice set is shown below (Figure 4.4). The survey also included individual-specific characteristics such as gender, age, education, smoking status, smoking history, parental smoking status, and information on alcohol use. The survey was pre-tested with 20 individuals aged 14-19. No major understanding problem was detected, and the vast majority of respondents considered the choice tasks to be easy (18/20).

Figure 4.4: Example of a choice task

MOST DETERRENT		*LEAST DETERRENT*
☐	**Lung cancer** (smokers have a much higher risk of getting lung cancer than non-smokers)	☐
☐	**Addiction** (smoking creates addiction and craving symptoms are uncomfortable (headache, nervousness, etc.))	☐
☐	**Oral/dental problems** (smoking is bad for teeth and gums and causes bad breath)	☐
☐	**Weight gain after cessation** (individuals who quit gain 2-3 kilos on average)	☐
☐	**Endangering relatives** (second-hand smoke is harmful to other individuals, especially relatives)	☐

Data collection

Respondents were selected according to three criteria to achieve proportionality with the Swiss population aged 14-19: age, sex, and education level. Educational institutions were first contacted and surveys were collected in different classes. We collected 384 surveys between March and June in secondary schools, high schools, technical and professional schools, and tertiary education institutions.

Econometric analysis

The BWS task implicitly models the following process: in each choice situation, "*respondents choose the pair that exhibits the largest perceptual difference on an underlying continuum of interest*" (Finn and Louviere, 1992). In our case, the underlying dimension is the "degree of concern" related to the various negative effects of tobacco use. In terms of choice theory, it is assumed that the probability that a respondent chooses a pair in a particular choice set is proportional to the difference between the "most" and the "least" item on the scale of interest. Individuals are assumed to behave according to the following process: 1) identification of all possible pairs; 2) evaluation of the difference on the underlying dimension for every pair; 3) choice of the pair that maximizes this difference.

In a choice set containing K items, there are K(K-1) possible "most-least" combinations that the respondent could select. Each choice set corresponds to K(K-1) lines in the database. The dependent choice variable equals one for the chosen pair and zero for other pairs in the choice set. In Table 4.2, I show an example of data output for a choice set containing 5 items (20 possible pairs). Each line corresponds to a particular "most-least" pair. Here, the respondent chose lung cancer as the item of

most concern (coded "1") and endangering relatives as the item of least concern (coded "-1").

Table 4.2: Data output example

Choice	Lung cancer	Addiction	Oral	Weight gain	Relatives
0	1	-1	0	0	0
0	1	0	-1	0	0
0	1	0	0	-1	0
1	1	0	0	0	-1
0	0	1	-1	0	0
0	0	1	0	-1	0
0	0	1	0	0	-1
0	0	0	1	-1	0
0	0	0	1	0	-1
0	0	0	0	1	-1
0	-1	1	0	0	0
0	-1	0	1	0	0
0	-1	0	0	1	0
0	-1	0	0	0	1
0	0	-1	1	0	0
0	0	-1	0	1	0
0	0	-1	0	0	1
0	0	0	-1	1	0
0	0	0	-1	0	1
0	0	0	0	-1	1

The probability of choosing a given pair is related to the distance on the underlying scale. In other words, it is assumed that the respondent will choose the two items that are most distant from each other. I first define the latent unobservable distance between items *m* (most) and *l* (least) as:

$$D_{ml} = \delta_{ml} + \varepsilon_{ml}, \tag{4.3}$$

where δ_{ml} is the measurable difference between item *m* and *l* on the underlying scale, and ε_{ml} is an error component. The probability of choosing the pair *ml* in a choice set *C* is therefore given by

$$P(ml \,/\, C) = P(\delta_{ml} + \varepsilon_{ml} > \delta_{ij} + \varepsilon_{ij}),\ for\ all\ ij \neq ml\ in\ C \tag{4.4}$$

The researcher has to make an assumption about the distribution of the error terms. If one assumes that they are iid Type 1 Extreme Value distributed, we end up with the multinomial logit (MNL) model:

$$P(ml \,/\, C) = \frac{exp(\delta_{ml})}{\sum_{ij} exp(\delta_{ij})},\ for\ all\ ij \neq ml\ in\ C \tag{4.5}$$

One can reformulate this expression by rewriting the observable difference as the difference between two locations (*L*) on the scale of interest:

$$\delta_{ml} = L_m - L_l \tag{4.6}$$

The probability is then expressed as:

$$P(ml / C) = \frac{exp(L_m - L_l)}{\sum_{ij} exp(L_i - L_j)}, \text{ for all } ij \neq ml \text{ in } C \tag{4.7}$$

In the estimation procedure, a reference location must be defined from which other items will be evaluated. Practically, the *L* value for the reference item is set to zero, i.e., the reference item is simply removed from the estimations. The level of concern for each negative effect is therefore estimated relative to one negative effect of reference.

In using the MNL model, one assumes that each individual put the same weight on the negative effects, i.e., that the estimated coefficients are the same for each individual in the sample. Moreover, the MNL specification does not take into account that choices may be correlated because each respondent makes a series of choices. To overcome these limitations, we estimated the more flexible random parameter logit (RPL) model as suggested by Lusk and Briggeman (2009). With this specification, the estimated coefficients are assumed to be random. The estimation procedure provides an estimate of the mean and the standard deviation for each coefficient. We obtain the average weight that individuals place on each items plus an individual deviation from those average weights for each respondent *a*:

$$L_a = \bar{L} + \eta_a \tag{4.8}$$

A statistically significant standard deviation for a coefficient indicates preference heterogeneity in the population with respect to the specific item. The RPL model has to be estimated using simulation methods (see Train 2003 and Chapter 5). An interesting feature of the RPL model is that it allows the retrieval of individual-specific estimates of the coefficients.

Finn and Louviere (1992) showed that a simpler method to exploit BWS data leads to results similar to those obtained with logit models. The procedure involves counting, for each item, the number of times it was picked as being "of most concern" minus the number of times it was picked as being "of least concern." These "most minus least" totals (or B-W totals, hereafter) are consistent with the Luce (1959) model, which is close to the MNL model. Below, we compare the results obtained from these two competing approaches.

4.4. Results

Individual characteristics

Among the 384 surveys collected, 8 were dropped due to missing data or incorrect responses in the BWS choice tasks (e.g., two items chosen as being of most concern), resulting in 376 surveys used in the analyses. Descriptive statistics of the whole sample and of variables collected only among smokers are presented in Appendix B. The mean age is 16.2 years old, and 47.1% are boys. More than one-third (35.7%) of the respondents are smokers, among which 61.8% are daily smokers. Among smokers, 67.1% think they will certainly or probably quit in 5 years, and 72.7% feel that they are able to quit, reflecting an optimism bias regarding future smoking status. Interestingly, almost one-third of the smokers (the youngest) do not buy their cigarettes but receive them from another individual. Almost 30% of respondents drink alcoholic beverages at least once a week.

Choice models

Table 4.3 shows the relative importance of the 15 negative effects associated with tobacco use as estimated by the MNL and RPL models. The importance of each item was estimated relative to the item "weight gain after cessation," which was consistently rated as the least important item. In both models, the results show that the two negative effects that are of greatest concern to young individuals are lung cancer and cardiovascular diseases. Reduction of physical capacity, sexual dysfunction and reduced life expectancy are the next most important negative effects. All of the other items seem to be of intermediary importance except tobacco industry manipulation and disturbance of non-smokers, which are close to the reference item. The results of the RPL model, especially the standard deviations of the coefficients, reveal substantial heterogeneity regarding the relative importance of the negative consequences.

Table 4.3: MNL and RPL models and B-W total

Negative implication	MNL	RPL	*Std. dev. of coefficients (RPL)*	B-W total
Lung cancer	2.73*** (52.6)	3.29*** (46.3)	*1.18*** *(16.8)*	1259
Cardiovascular diseases	2.05*** (38.4)	2.55*** (42.2)	*0.21** *(2.22)*	588
Sexual dysfunction	2.01*** (38.0)	2.43*** (36.6)	*1.07*** *(16.0)*	571
Reduction of physical capacity	2.00*** (37.9)	2.48*** (32.4)	*1.47*** *(24.2)*	541
Reduced life expectancy	1.97*** (37.2)	2.31*** (34.2)	*1.13*** *(15.0)*	526
COPD	1.33*** (25.0)	1.63*** (27.4)	*0.12* *(1.6)*	62
Endangering relatives	1.21*** (23.6)	1.55*** (24.4)	*0.99*** *(17.8)*	0
Addiction	1.20*** (22.9)	1.47*** (22.8)	*1.02*** *(16.0)*	-46
Inhalation of chemicals	1.06*** (20.3)	1.32*** (22.0)	*0.67*** *(11.32)*	-78
Oral and dental problems	1.00*** (19.4)	1.22*** (21.1)	*0.08* *(0.8)*	-194
High expenditures	0.96*** (18.7)	1.24*** (18.3)	*1.31*** *(20.0)*	-159
Skin problems	0.93*** (17.8)	1.11*** (18.8)	*0.31*** *(2.7)*	-270
Tobacco industry manipulation	0.17** (3.5)	0.26*** (4.4)	*0.96*** *(17.6)*	-925
Disturbance of non-smokers	0.07 (1.4)	0.16* (2.33)	*1.30*** *(20.5)*	-924
Weight gain after cessation (origin)	-	-	-	-991

***significant at 1%; **significant at 5%;*significant at 10%.

In Figure 4.5, I present a comparison between the logit coefficients (both MNL and RPL) and the B-W totals. We see that there is a good linear relationship between the logit coefficients and the figures obtained from the simpler method. Using these B-W totals, I represent the underlying scale of the level of concern for the different items. The origin of the scale is the item "weight gain after cessation" (Figure 4.6).

Figure 4.5: Comparison between logit coefficients and B-W totals

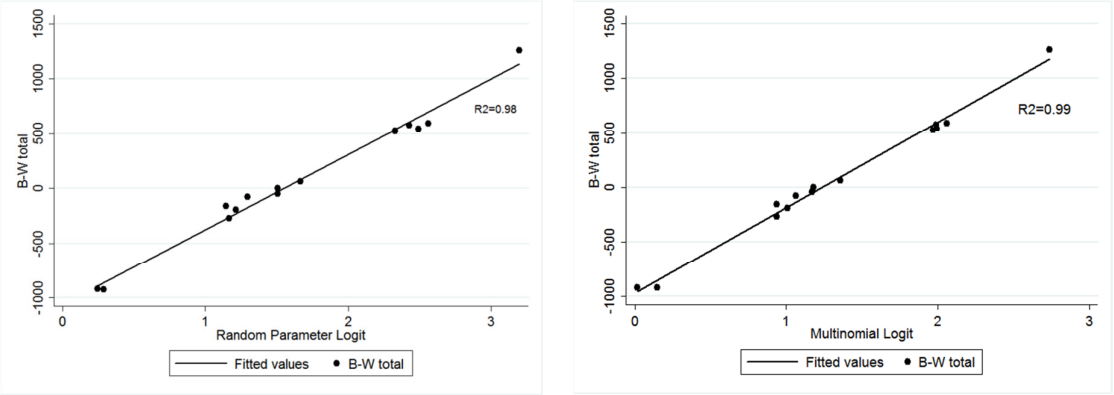
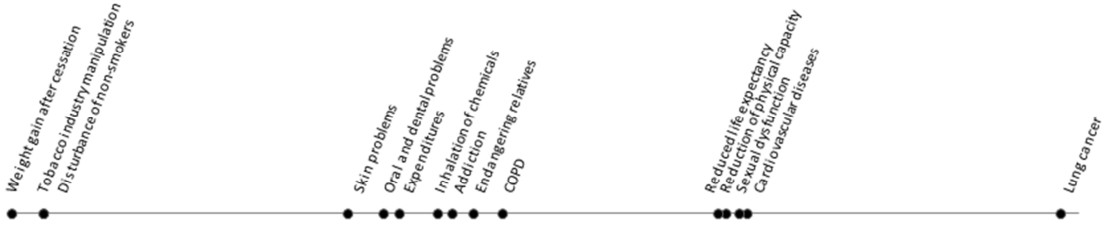


Figure 4.6: Graphical representation of the underlying scale ("level of concern")



The size of the estimated coefficients is difficult to interpret directly due to scale factors (Train 2003). To overcome this problem, I estimated the probability for each item to be chosen as being of "most concern," as suggested by Lusk and Briggeman (2009). Looking at the results for the RPL model in Table 4.4, we see that the item "lung cancer," if present in a choice set, will be selected as the most important item 25% of the time. Moreover, lung cancer is twice as likely to be selected as the four following items (cardiovascular diseases, reduction of physical abilities, sexual dysfunction, and reduced life expectancy). Even if COPD, inhalation of chemicals and high expenditures have relatively low coefficients, they are still at least twice as likely to be chosen than the seven least negative effects.

Table 4.4: Estimated probability of being chosen as "of most concern"

	Estimated probability	
Negative implication	**MNL**	**RPL**
Lung cancer	22.0%	25.1%
Cardiovascular diseases	11.1%	9.6%
Sexual dysfunction	10.7%	11.5%
Reduction of physical capacity	10.7%	13.8%
Reduced life expectancy	10.3%	10.8%
COPD	5.4%	3.8%
Endangering relatives	4.9%	4.8%
Addiction	4.8%	4.4%
Inhalation of chemicals	4.1%	3.3%
Oral and dental problems	3.9%	2.5%
High expenditures	3.8%	4.2%
Skin problems	3.7%	2.3%
Tobacco industry manipulation	1.7%	1.5%
Disturbance of non-smokers	1.5%	1.6%
Weight gain after cessation	1.4%	0.7%

Heterogeneity

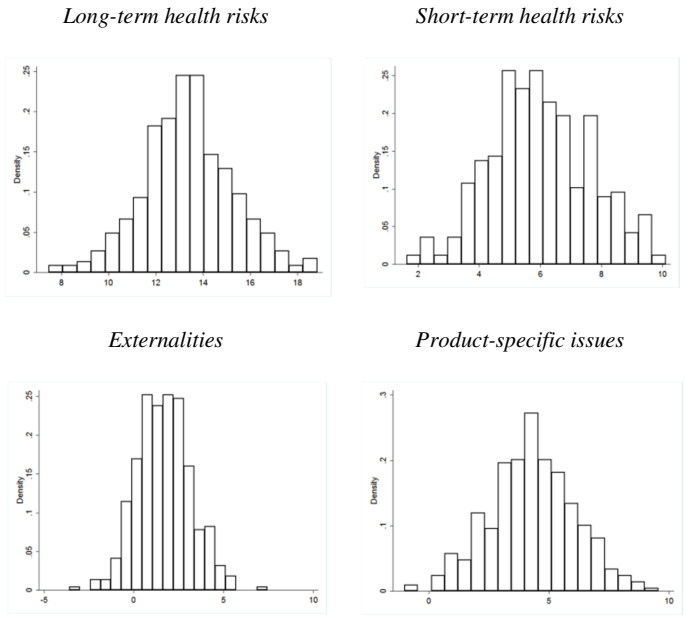
Results from the RPL model indicate the presence of substantial preference heterogeneity in the sample. I first investigate the issue by estimating the simple MNL model for various subgroups and by comparing the resulting choice probabilities. I successively compared boys and girls, smokers and non-smokers, individuals in three different age groups, and finally individuals with "high" and "low" mortality risk perception[23] (Appendix C). We observe that girls have a higher level of concern regarding two long-term health risks (lung cancer and cardiovascular diseases) while boys are more concerned about physical capacity and sexual dysfunction. Older individuals seem to attach more importance to physical capacity and sexual dysfunction and less importance to life expectancy and lung cancer than their younger counterparts. Non-smokers are more concerned with long-term health risks (except COPD) than smokers, and smokers seem more concerned with short-term consequences. Individuals with a high mortality risk perception attach more importance to the impact of tobacco on life expectancy than individuals with lower mortality risk perception.

Heterogeneities were further investigated using the results of the RPL model. I assessed the association between the smoking status of individuals and the individual-specific estimates of their level of concern for the items, which were grouped into 4 categories: long-term health risks, short-term health risks, externalities

[23] Risk perception here is measured by the answer to the following question: "Among 100 smokers, how many do you think will die as a consequence of tobacco use?"

and product-specific issues. Long-term health risks included lung cancer, cardiovascular disease, COPD, reduced life expectancy, inhalation of chemicals, and skin problems. Short-term health risks included reduction of physical capacity, oral and dental problems (bad breath, etc.), and sexual dysfunction. Externalities included disturbing non-smokers and endangering relatives. Finally, product-specific issues are issues directly related to cigarettes, including addiction, expenditures, and tobacco industry manipulation. For each category, I added the individual-specific values of the corresponding coefficients, resulting in four indices that reflected individual-specific levels of concern associated with the category. The distributions of the four variables are shown in Figure 4.7.

Figure 4.7: Distribution of the level of concern by category



I used logistic regression to assess the association between individual smoking status (daily or occasional smoker vs. non-smoker) and the four indices, controlling for age, gender, peer smoking (parents, siblings and friends), and pocket money. I also used class indicators to control for class-specific unobserved characteristics. The results of the regression are given in Table 4.5.

Table 4.5: Association between level of concern and smoking status

Category (level of concern)	Smoking status (Logit)
Long-term health risks	0.85* (-2.01)
Short-term health risks	1.34** (2.38)
Externalities	0.86 (-1.73)
Product-specific issues	1.05 (0.65)

Coefficients for gender, age, peer smoking, pocket money, and class dummies not reported. Logit coefficients are expressed in odd-ratios.***significant at1%; **significant at 5%;*significant at 10%.

We observe a significant negative association between the level of concern about long-term health risks and the probability of being a smoker, whereas a higher level of concern about short-term health risks is associated with a higher probability of smoking. In Appendix D, I present the results of an ordered probit regression of the frequency of alcohol consumption on the indices related to long-term and short-term health risks. I find similar results, i.e., individuals who put more weight on short-term health risks are more likely to be involved in unhealthy behaviors.

I used an alternative strategy to construct an index that reflects how far-sighted individuals are, and I assessed its association with respondents' smoking status. I assumed that individuals have an unobserved underlying level of "far-sightedness" that is correlated with their level of concern for items related to long-term health risks (i.e., lung cancer, cardiovascular disease, COPD, reduced life expectancy, inhalation of chemicals, and skin problems). I conducted a factor analysis using the individual-specific estimates of the level of concern for these items as variables. In Table 4.6, I present the eigenvalues obtained for the resulting six factors. I decided to keep only the first factor in the analysis due to the substantial eigenvalue reduction between the first two factors. The resulting factor loadings for each dimension of the first factor are presented in Table 4.7.

Table 4.6: Eigenvalues

Factor	Eigenvalues	Proportion
1	0.27712	2.4977
2	0.07275	0.6557
3	0.02550	0.2299
4	0.00025	0.0022
5	-0.10597	-0.9551
6	-0.15871	-1.4304

Table 4.7: Factor loadings

Item	Factor loading	
	Complete set	Restricted set
Lung cancer	0.325	0.312
Cardiovascular diseases	0.248	0.291
Reduced life expectancy	0.255	0.249
COPD	0.100	-
Chemicals	0.100	-
Skin problems	0.075	-

Keeping the three items with the highest factor loading (lung cancer, cardiovascular diseases, and reduced life expectancy), I conducted the factor analysis again, resulting in the restricted set presented in the last column of Table 4.7. The result is then used to compute individual-level factor scores that I interpret as individual-level "far-sightedness" and that I relate to respondents' smoking and drinking behavior while controlling for age, peer smoking, pocket money, and class membership (Table 4.8). Again, the results indicate that more far-sighted individuals are less likely to be involved in unhealthy behaviors.

Table 4.8: Far-sightedness, smoking, and drinking behavior

	Smoking status (Logit)	Level of alcohol consumption (ordered probit)
"Far-sightedness"	0.53**	-0.26**
	(0.281)	(0.131)

Logit coefficient is expressed in odd-ratio. Coefficient for gender, age, peer smoking, pocket money, and class dummies not reported. Standard error in parentheses. ***significant at 1%; **significant at 5%;*significant at 10%.

4.5. Conclusion

Using best-worst scaling, which is a choice-based survey method, I assessed the relative importance assigned by young individuals aged 14 to 19 years old to health and non-health smoking-related adverse effects. Subsamples of fifteen items were presented in choice sets that required respondents to choose the items that were most and least likely to deter them from smoking. Results show that developing lung cancer is consistently rated as being of most concern, followed by cardiovascular diseases, sexual dysfunction, reduction of physical capacity, and reduced life expectancy. Items such as impact on relatives, addiction or expenditures were rated as moderately important. Weight gain after cessation is consistently the least likely to deter respondents from smoking. Subgroup analyses show that girls are more concerned about long-term risks such as lung cancer, whereas boys seem more concerned about sexual dysfunction and physical capacity. These analyses also show that a higher risk perception of smoking mortality seems to be related to a higher level of concern about the impact of smoking on life expectancy. Using results from random-parameter logit (RPL) estimation, we find that more present-oriented individuals, defined here as the individuals who are most concerned about short-term health risks, are more likely to be involved in unhealthy behaviors. Messages used in youth-targeted prevention campaigns should therefore concentrate on the more immediate negative consequences of smoking and should address different themes for the various population subgroups, especially boys and girls. However, our method has some important limitations. A high level of importance associated with one item can result from a high level of concern or simply from high level of awareness. We must therefore think carefully about the implications of the results. It may be that health risks such as lung cancer, cardiovascular diseases, and reduced life expectancy are highly rated in part because past communication about these risks has been intense.

Appendix A: Experimental design

Two levels and strength 2 (16.15.2.2.4) on N.J.A Sloane's website

Items	**Choice sets**																**Number of appearances in the survey**
	CS1	*CS2*	*CS3*	*CS4*	*CS5*	*CS6*	*CS7*	*CS8*	*CS9*	*CS10*	*CS11*	*CS12*	*CS13*	*CS14*	*CS15*	*CS16*	
I1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	**8**
I2	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	**8**
I3	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	**8**
I4	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	**8**
I5	0	1	0	1	1	0	1	0	0	1	0	1	1	0	1	0	**8**
I6	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	**8**
I7	0	1	1	0	1	0	0	1	0	1	1	0	1	0	0	1	**8**
I8	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	**8**
I9	1	1	1	0	1	0	0	0	0	0	0	1	0	1	1	1	**8**
I10	0	0	1	0	1	1	1	0	1	1	0	1	0	0	0	1	**8**
I11	0	0	1	1	1	0	0	1	1	1	0	0	0	1	1	0	**8**
I12	1	0	1	1	0	1	0	0	0	1	0	0	1	0	1	1	**8**
I13	0	1	0	1	1	1	0	0	1	0	1	0	0	0	1	1	**8**
I14	0	1	1	0	0	1	0	1	1	0	0	1	1	0	1	0	**8**
I15	1	0	0	0	1	1	0	1	0	1	1	1	0	0	1	0	**8**
Number of items in the choice set	**5**	**7**	**7**	**7**	**9**	**7**	**5**	**9**	**7**	**9**	**5**	**9**	**7**	**5**	**11**	**11**	

Appendix B: Sample characteristics

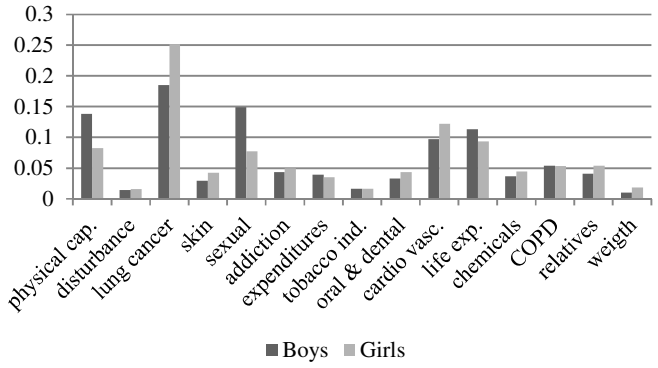
Table B1: Descriptive statistics – whole sample (N=376)

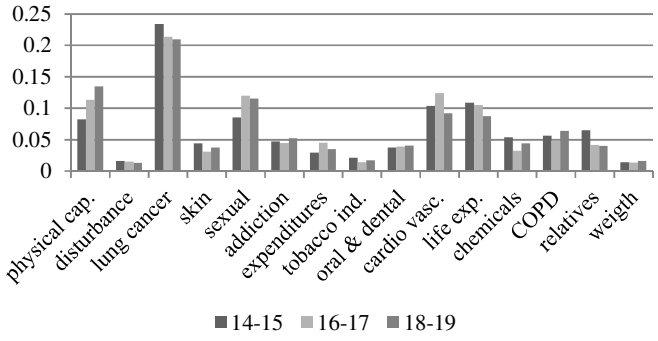
Variable	Definition	Mean	Std. dev.
GENDER	=1 if resp. is a male	0.47	
AGE	Age in years	16.2	1.4
SWISS	=1 if resp. is Swiss	0.81	
EDUCATION			
	Mandatory school (secondary school)	0.38	
	Apprenticeship or professional school	0.30	
	High school or College	0.32	
SMOKE	=1 is resp. is a smoker (occasional or daily smoker)	0.36	
PARENTS	=1 if at least one parent smokes	0.45	
SIBLINGS	=1 if at least one sibling smokes	0.28	
FRIENDS	=1 if at least one friend smokes	0.90	
FUTURE	Will you be a smoker in 5 years?		
	Certainly not	0.49	
	Probably not	0.33	
	Yes, probably	0.14	
	Yes, for sure	0.04	
RISK	Among 100 smokers, how many will die from a consequence of tobacco use?	0.46	27.1
POCKET MONEY	How much money do you have, per week, for your personal expenditures?		
	0 CHF	0.07	
	1-20 CHF	0.40	
	21-50 CHF	0.27	
	51-100 CHF	0.17	
	101-200 CHF	0.04	
	More than 200 CHF	0.05	
ALCOHOL	How often do you drink alcoholic beverages?		
	Never	0.18	
	Once a month	0.29	
	Several times a month	0.24	
	Once a week	0.18	
	Several times a week	0.10	
	Every day	0.01	

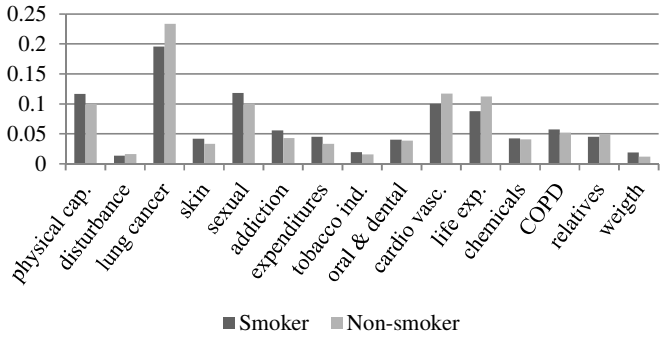
Table B2: Descriptive statistics – smokers (N=134)

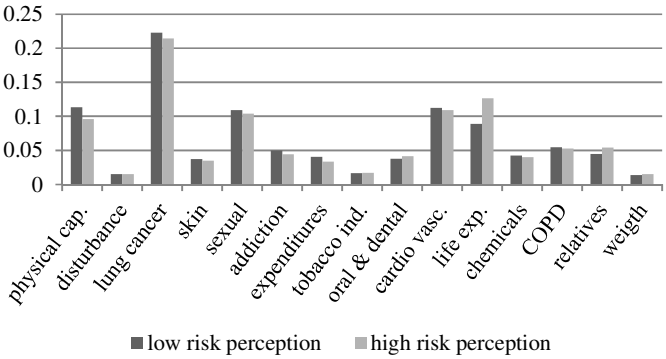
Variable	Definition	Mean	Std. dev.
DAILY	Respondent is a daily smoker	0.62	
QTT_CIG	Number of cigarettes smoked, in average, per day		
	Less than 1 per day	0.27	
	1-5	0.27	
	6-10	0.24	
	11-20	0.20	
	More than 20	0.02	
AGE START	How old where you when you smoked for the first time?	14.6	1.4
BUY_CIG	Where do you buy your cigarettes (multiple answers allowed)?		
	Kiosk	0.78	
	Supermarket	0.28	
	Vending machine	0.28	
	Internet	0.01	
	Someone buy them for me	0.11	
	Someone give them to me	0.31	
QUIT_TRY	Have you ever tried to quit smoking?	0.52	
QUIT_WILL	Do you want to quit smoking?	0.61	
QUIT_CAN	Do you feel able to quit smoking?	0.73	
FUTURE	Will you be a smoker in 5 years?		
	Certainly not	0.12	
	Probably not	0.45	
	Yes, probably	0.34	
	Yes, for sure	0.09	
RISK	Among 100 smokers, how many will die from a consequence of tobacco use?	41.1	27.4

Appendix C : Estimated relative importance across groups









Appendix D: Present orientation and alcohol use

Table D1: Association between level of concern and alcohol use – ordered probit

Category (level of concern)	Alcohol consumption [a)]
Long-term health risks	-0.12** (-3.08)
Short-term health risks	0.17** (3.12)

Coefficient for gender, age, pocket money, and class dummies not reported. [a)]ordered categories for alcohol consumption are: never, once a month, several times a month, once a week, several times a week, and every day. ***significant at 1%; **significant at 5%;*significant at 10%.

5 Assessing smokers' preferences for smoking cessation medications: A discrete choice experiment

Abstract

The use of smoking cessation medications can enhance long-term abstinence rates at a reasonable cost, but only a small proportion of quitters seek medical assistance. The objective of this study is to evaluate the factors that influence the decision to use such treatments, and the willingness-to-pay of smokers for improved cessation drugs. For this purpose, I conducted a discrete choice experiment among smokers in the French-speaking part of Switzerland. The choices consisted of two hypothetical medications described via five attributes (price, efficacy, possibility of minor side effects, attenuation of weight gain and availability) and an opt-out option. Various discrete choice models were estimated to analyze both the factors that influence treatment choice and those that influence the overall propensity to use a smoking cessation medication. The results indicate that there is potential demand for improved smoking cessation medications. Smokers are willing-to-pay for higher efficacy, less-frequent side effects and prevention of weight gain. Whether the drug is available over-the-counter or on medical prescription is of secondary importance. Broader usage could be reached through lower out-of-pocket price and greater efficacy. Secondary aspects such as side effects and weight gain should also be taken into consideration. In addition, I show that there are several individual-specific factors influencing the decision to use such medications, including education level.

Keywords: discrete choice experiments, smoking cessation, nested logit, random parameter logit, preference heterogeneity

5.1. Introduction

Smoking is the leading preventable cause of death in most developed countries. Switzerland is no exception, with more than nine thousand deaths attributable to tobacco use each year (FSO 2009). The proportion of daily or occasional smokers in the population between 14 and 65 years old was approximately 27% in 2009, which is quite high in comparison with other countries (Keller *et al.* 2010). This high rate is partly due to permissive tobacco legislation. This was confirmed in a study by Joossens and Raw (2006) grading tobacco control intensity at the country level, in which Switzerland was ranked 18th among 30 European countries, mainly due to low prices and a lack of restrictions.

A lower prevalence of smoking could be achieved by increasing the success rate of individuals who try to quit. Indeed, many smokers are motivated to quit and do make the attempt,[24] but only a few succeed over the long term. One reason is that few seek assistance, even though the long-term abstinence rate can be considerably enhanced with appropriate cessation support. The estimated cold turkey (i.e., smoking cessation without assistance) quit rate is approximately 5%, while a 10-20% long-term quit rate can be achieved with the most effective interventions (Fiore 2000). Among the wide range of smoking cessation interventions, we distinguish non-pharmaceutical interventions (including medical counseling, group therapies, books, help lines, and acupuncture) from pharmaceutical treatments (nicotine replacement therapies[25] (NRTs) and nicotine-free medications[26]). This study focuses on nicotine-free smoking cessation medications, and its main objective is to assess smokers' preferences for such products. I used a discrete choice experiment (DCE) – a stated preferences (SP) technique – which consists of presenting a sample of smokers with choices between several hypothetical treatments. The medications were described with respect to five attributes (price, efficacy, side effects, effect on weight gain, and availability). The respondents were asked to choose several times between two alternative treatments and an opt-out option. I analyzed choice data starting from the simple multinomial logit model (MNL) as the benchmark model. I then estimated more complex models that were able to take into account the specifics of the choice

[24] In 2007, 54% of Swiss smokers wanted to quit, but only 10% within the next thirty days and 30% within the next six months (Keller *et al.* 2010).

[25] NRTs partially relieve the withdrawal symptoms that people experience when they quit by compensating for the lack of nicotine in the organism. There are several NRTs currently available over-the-counter in Switzerland, including patches, gum, inhalers, lozenges and nasal sprays.

[26] Two nicotine-free medications are available in Switzerland by medical prescription only (A-list): bupropion (brand name Zyban ®), whose exact mode of action is still unclear (Compendium of Swiss Drugs 2002), and varenicline (brand name Champix ®), which relieves symptoms of nicotine withdrawal and blocks the reinforcing effect of continued nicotine use through antagonist and agonist actions (Gonzales *et al.* 2006).

process and the panel structure of the data (i.e. each respondent makes several choices). Using the nested logit (NL) framework, I analyzed both the influence of the product's characteristics on choice and the impact of individual characteristics on the propensity to use such medications. Then, random parameter logit (RPL) models allowed me to take unobserved heterogeneity into account. The results consistently show that smokers value medications that have improved efficacy and less frequent side effects and that prevent weight gain after cessation. In addition, I show that there are several observed and unobserved individual-specific factors that influence the decision to use such medications. I also show the importance to account for unobserved heterogeneity when analyzing choice data. This information should help guide the efforts of smoking cessation actors (pharmaceutical industry, public health decision makers) to improve treatment acceptance and usage and thereby achieve higher cessation rates in the population.

5.2. Related work

Researchers have applied DCE extensively in the fields of marketing, transport, and environmental economics. In health economics, the number of DCE studies has sharply increased during the past decade (see e.g., Berchi *et al.* 2006, Brau and Bruni 2008, Ryan *et al.* 2006, Zweifel *et al.* 2005, Kerssens *et al.* 2005). More specifically, many DCE applications have aimed to evaluate the health and non-health dimensions of medical treatments. In Table 5.1, I provide a non-exhaustive list of empirical papers using DCEs to value medical interventions (mostly preventive interventions) along with the dimensions that were valued.

Pharmaceutical smoking cessation treatments have been analyzed from an economic point of view, especially with respect to cost-effectiveness (Bertram *et al.* 2007, Hall *et al.* 2005, Warner 1997), and all studies have concluded that these treatments lead to a low cost per life-year saved. In a cost-effectiveness study conducted in six western countries, Cornuz *et al.* (2006) found a cost per life-year saved of US$792 for a 45-year-old smoker using Zyban® (bupropion) in Switzerland. Researchers have also examined the demand for smoking cessation medications by focusing on various determinants. Tauras and Chaloupka (2003) found that decreasing the price of NRTs would lead to an increase in sales of these products (estimated average price elasticity of -2.33 for patches and of -2.46 for gums). The effects of conversion to over-the-counter (OTC) status for nicotine patches and gums were analyzed by Keeler *et al.* (2002). These authors estimated that after the conversion, the use of both therapies would increase substantially (78-92% for patches and 180% for nicotine gum). Halpin *et al.* (2007) investigated the demand of the general population for health insurance coverage extension to cover treatment for tobacco dependence, and they found that most people were willing to accept an increase of at least US$3 in their basic health insurance premium to finance the coverage. Avery *et al.* (2007) analyzed the impact of smoking cessation product advertising on the purchasing of such products and on smoking behavior. They found that the probabilities of attempting to quit and of quitting were positively associated with higher exposure to such advertising.

Table 5.1: Published studies using DCE to value medical interventions

Authors	Treatment	Dimension valued
Ryan *et al.* (1997)	Miscarriage management	Pain, time in hospital, time to return to normal activities, cost, complications
Hall *et al.* (2002)	Varicella vaccination	Risk of mild side effects, risk of severe side effects, vaccine effectiveness, health authority support, location for vaccination, price of vaccination
Aristides *et al.* (2004)	Insulin mixtures	Timing of injection before meal, two-hour postprandial blood glucose, effect of prandial dosing, nocturnal hypoglycemic frequency
Mark *et al.* (2003)	Alcoholism medication	% of treated population who remained abstinent, % of patients who had no incidence of heavy drinking, % of patients that experienced mild side effects, % of patients who complied at a high rate, mode of action, route of administration, price per day
Marshall *et al.* (2007)	Colorectal cancer screening	Process, preparation, pain, specificity, sensitivity
Roux *et al.* (2004)	Weight loss programs	Program cost, travel time to program, amount of doctor involvement, program components emphasized, focus of program
Bryan *et al.* (1998)	Knee injury detection	% chance of requiring arthroscopy, time from initial consultation to end of treatment, % chance that knee problem is completely resolved, total cost to the patient
Watson *et al.* (2004)	Lower urinary tract symptoms	Time to symptom improvement, treatment decreases prostate size, sexual side effects of treatment, nonsexual side effects of treatment, treatment cost, % chance of surgery

Two studies used stated preferences methods to investigate individual preferences for smoking cessation treatments. Busch *et al.* (2004) applied contingent valuation (CV) to estimate willingness to pay (WTP) for medications that are more effective and that attenuate weight gain associated with smoking cessation. About 80% of the respondents were willing to pay for greater effectiveness, and two-thirds of these individuals were willing to pay more if the treatment had an impact on weight gain. These authors also estimated that the mean WTP for a 100% effective treatment – i.e., the value of a statistical quit - was US$538. The major limitation of CV is that it does not allow many dimensions of the good to be estimated at a time. The good has a value per se, and it is not possible to assess the relative importance of its dimensions (how individuals are willing to trade off between these dimensions). Paterson *et al.* (2008) overcame this limitation by applying labeled discrete choice experiments to the choice of smoking cessation therapies (nicotine gum, nicotine

patch, nicotine inhaler and Zyban®).[27] They used cost, success rate and treatment length as variable attributes, with doses per day and availability as fixed characteristics. The flexibility of the model specifications they applied allowed the authors to investigate preference heterogeneity. They found that effectiveness was a primary consideration. Light and heavy smokers were both willing to pay substantial amounts for improved success rates (i.e. CAN$500 and CAN$300 to achieve a 40% success rate).

[27] Also known as alternative-specific choice experiments. DCEs that use generic titles for the alternatives (such as "A" and "B") are called unlabeled DCEs, contrary to labeled choice experiments, where each alternative refers to a particular commodity (e.g., Zyban®).

5.3. Framework for analysis

A majority of current smokers positively value the benefits associated with smoking cessation, resulting in a desire to quit and in frequent quit attempts. Most of these attempts are made cold turkey and thus have a relatively low long-term success rate (around 5%). Relapses are frequent, particularly because of the significant costs associated with nicotine withdrawal. The use of a smoking cessation drug partially relieves the craving symptoms, resulting in increased success rates.

The demand for such a product depends on the perceived additional net benefits it provides over alternative methods. For simplification purpose, I assume here that the only available alternative method is cold-turkey cessation. The additional benefit of the treatment is the value the individual attaches to smoking cessation multiplied by the increased probability of successfully quitting that the treatment provides. The benefits also include additional features of the medication, such as its ability to reduce weight gain associated with smoking cessation. The perceived value of quitting *u* is defined as "*the difference between the lifetime utility from quitting and the lifetime utility from continuing to smoke*" (Avery *et al.* 2007). The probability of long-term abstinence depends on the withdrawal costs: the higher the withdrawal costs the lower is the success rate. The medication precisely increases the success rate by decreasing these withdrawal costs. I define x as the amount of treatment (x might be continuous, or simply a binary variable indicating medication intake) and w_c as the withdrawal costs. The probability of successfully quitting using a medication is then (with x continuous):

$$P_{med} = P(w_c(x)), \text{ with } \frac{dw_c}{dx} < 0, \frac{d^2 w_c}{dx^2} > 0, \frac{dP}{dw_c} < 0 \tag{5.1}$$

The cold turkey quit rate is defined as:

$$P_{ct} = P(w_c(x) \big| x = 0). \tag{5.2}$$

The additional probability of successfully quitting is the difference between the success rate with medication (p_{med}) and the cold turkey quit rate (P_{ct}). The benefits of the medication over cold turkey are then given by:

$$B = u(p_{med} - p_{ct}) + b_{med}. \tag{5.3}$$

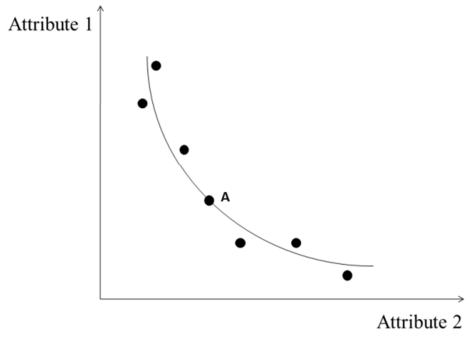
where b_{med} are the additional valuable features of the medication. The benefits are compared to the treatment costs (C), that include both the out-of-pocket cost, and other non-monetary costs such as side effects, and time and effort to purchase the

treatment (which is related to treatment availability). A smoker will decide to use a smoking cessation treatment when making a quit attempt if the perceived net benefits are positive, i.e., if B is higher than C. I expect potential quitters to positively value efficacy and the additional benefits of the medication and to negatively value side effects and access costs.

5.4. Data collection (DCE survey)

The DCE method is based on the hypothesis that any good or service can be described as a set of characteristics or attributes. Consistent with Lancaster's theory of value (Lancaster 1966), individuals do not appreciate commodities globally, but rather as a sum of attributes.[28] In contrast to revealed preference techniques that analyze choices observed in reality, DCEs – as a stated preference technique – consist of presenting hypothetical choice situations ("choice sets," hereafter) to a sample of respondents. Each choice set contains two or more alternatives that vary according to the level of their attributes. It is assumed that individuals select the alternative from which they derive the highest utility. The probability of an alternative being chosen is then modeled in accordance with the random utility framework (McFadden 1981). Applying appropriate econometric techniques to analyze observed decisions, the researcher is able to retrieve the indirect utility functions of individuals in the attribute-space. To illustrate the process simply and to make the link with consumer theory, below I present several choice sets described with only two attributes that can take various levels (Figure 5.1). If the respondent chooses successively between choice set A and all other choice sets, according to the axioms of revealed preferences one can retrieve quite accurately the indifference curve passing through A.

Figure 5.1: Indifference curve in the attribute space



The researcher is then able to estimate the relative importance of the attributes (marginal rates of substitution). When a monetary attribute is included, it is possible to estimate marginal willingness to pay (mWTP) for improvements in attributes and, by extension, global WTP for improved medications. Individual-specific characteristics that might influence the choice can also be included in the

[28] "Goods possess, or give rise to, multiple characteristics in fixed proportions, and it is these characteristics, not the goods themselves, on which the consumer's preferences are exercised" (Lancaster 1966).

models. As mentioned by Ryan *et al.* (2008), a complete DCE study is a complex process that involves three main steps prior to the econometric treatment: 1) definition of attributes and attribute levels; 2) experimental design and construction of choice sets; and 3) data collection.

Definition of attributes and attribute levels

From the existing literature, I initially developed a list of attributes of pharmaceutical smoking cessation treatments (Wu *et al.* 2006, Peters and Morgan 2002, Henningfield *et al.* 2005) that seemed the most relevant to our research goals: price, efficacy, length of treatment, possibility of minor side effects, attenuation of weight gain and availability. Meanwhile, I convened focus groups and conducted pre-tests to identify important attributes and prevent the omission of salient ones. The length of the treatment was found to be of very low importance, and was therefore excluded.

The next step consisted of assigning levels to each attribute. The literature recommends that these should be realistic, well-defined, plausible and should potentially involve trade-offs (Ryan *et al.* 2008). The first three attributes describe continuous dimensions, whereas the latter two are dichotomous. Levels for price were defined on the basis of true market prices. For instance, the out-of-pocket cost of a comprehensive treatment course with Zyban® (bupropion) is about CHF 300 (Compendium of Swiss Drugs 2002). A central advantage of DCE is that it allows larger attribute variability. The price attribute was therefore described with four possible levels within a plausible interval (CHF 200 to CHF 500).

We can express long-term efficacy in an absolute or relative way. Many studies report the efficacy of a medication relative to a placebo or relative to an alternative treatment in terms of odds-ratios (Wu *et al.* 2006), while evaluations of absolute long-term abstinence rate are also possible (Fiore 2000). Because it is difficult for respondents to interpret odds-ratios, I chose to use the following definition of efficacy: the proportion of quitters who still do not smoke one year after treatment. The quit rate at one year is approximately 5% for smokers without assistance (Fiore 2000), 15% for those with bupropion and 22% for those with varenicline (Gonzales *et al.* 2006, Jorenby *et al.* 2006). Selected levels for the medications were 15% (close to bupropion), 25% (close to varenicline), 40% and 50% (improved efficacy). The most commonly reported benign side effects of bupropion and varenicline are insomnia, nausea and dry mouth (Fiore 2000, Gonzales

et al. 2006, McEwen *et al.* 2004), and these are quite frequent (30% for bupropion and 50% for varenicline). In addition to these two side-effect levels, I chose a third (10%) to depict an improved medication. Weight gain is strongly associated with smoking cessation, with the average gain after cessation reaching approximately 4-5 kg (Froom *et al.* 1998, Klesges *et al.* 1997, Williamson *et al.* 1991). Some smokers are discouraged from cessation because of this tendency. An improved medication could include components that prevent weight gain (Meyers *et al.* 1997). Finally, medications are either available over-the-counter or are obtainable only with a medical prescription. All the attributes and their respective levels are presented in Table 5.2.

Table 5.2: Attributes and levels

Attribute	Definition	Levels
Price (*Price*)	Price for the complete treatment	CHF 200, CHF 300, CHF 400, CHF 500
Efficacy (*Eff*)	Abstinence rate at one year	15%, 25%, 40%, 50%
Side-effects (*Side*)	Probability of experiencing minor side effects	10%, 30%, 50%
Weight gain (*Weight*)	Does the treatment prevent weight gain associated with smoking cessation?	yes, no
Availability (*Avail*)	Is the treatment available over-the counter or only under medical prescription?	over-the-counter, medical prescription

Experimental design

The choice sets presented to respondents contained two unlabeled alternatives ("medication A" and "medication B"). Because the target population had not necessarily decided to use such a medication at the time of the study, I also included an opt-out option to allow individuals to be non-demanders (Ryan and Skatun 2004). With two four-level attributes, one three-level attribute and two dichotomous attributes, the full factorial design gives rise to 192 (4^2x3x2^2) possible hypothetical medications. I used a fractional factorial design to reduce the possible combinations. Choice sets were generated starting from a resolution 3 orthogonal array obtained on Sloane's website (Sloane 2007) and using the method proposed by Street and Burgess (2007). The design produced sixteen distinct choice sets that were divided into two blocks of eight choice sets (Hensher *et al.* 2005). Each respondent was then assigned randomly to either of the two blocks.

To verify the consistency of responses, it is customary to add constructed scenarios to the main design. Thus, I created two additional choice sets containing a dominant alternative. Dominance is achieved when one alternative is superior for at least one attribute while the other attributes are at the same level.[29] Respondents are supposed to choose the dominant (or the opt-out) alternative if rationality holds. In summary, I presented ten choice sets to each respondent, two of which were consistency checks (Lancsar and Louviere 2006, Miguel *et al.* 2005).

[29] For instance, if we compare two medications, the one that has a lower price, higher efficacy and fewer side effects with other attributes at the same level is considered dominant.

Data collection

Two hundred and thirty subjects were recruited from the French-speaking part of Switzerland. The main inclusion criteria were age between 15 and 64 years and being a daily or occasional smoker. The respondents also had to express an interest in quitting smoking. The sample was representative of the French-speaking Swiss population of smokers with respect to age, gender and education level.

The questionnaire was divided into two parts: the choice experiments and the collection of individual information. In the DCE part, respondents were asked to imagine the following scenario (in brief):

"You have decided to quit smoking, and you have the possibility to be supported by a smoking cessation medication that can improve your chance of quitting (without any help, the success rate at one year is 5%) … You will be presented with 10 situations in which two medications are described. Please choose, for each situation, if you would buy medication A, medication B or neither."

I then gave a detailed description of each attribute and presented their respective levels. The same information was provided in the presentation of each choice set, an example of which is shown in appendix A. In the second part of the questionnaire, I gathered information about smoking history, quitting history, health status and socio-economic characteristics.

5.5. Econometric analysis

Discrete choice modeling relies on random utility theory, where the utility that individuals derive from an alternative is divided into two components: a systematic (observable) and a stochastic (unobservable) one. It is assumed that the former depends linearly on attribute levels while the latter is due to unobserved information and measurement errors. More formally, we denote the utility that individual i derives from alternative j by:

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \tag{5.4}$$

where V_{ij} is the observable component and ε_{ij} the random error. With k attributes, assuming a linear attribute utility function, we have the following functional form:

$$V_{ij} = \beta_1 X_{ij1} + \beta_2 X_{ij2} + ... + \beta_k X_{ijk} = X'_{ij}\boldsymbol{\beta}. \tag{5.5}$$

Under the assumption of rationality, individuals choose the alternative from which the utility derived is the highest. Therefore, alternative j will be chosen over alternative q if

$$U_{ij} > U_{iq}. \tag{5.6}$$

From this, we derive the probability that individual i chooses alternative j among p alternatives:

$$P_{ij} = Prob(V_{ij} + \varepsilon_{ij} > V_{ip} + \varepsilon_{ip} \forall p \neq j). \tag{5.7}$$

Identically,

$$P_{ij} = Prob(V_{ij} - V_{ip} > \varepsilon_{ip} - \varepsilon_{ij} \forall p \neq j). \tag{5.8}$$

The resulting choice model depends on the way the opt-out option is included and on the assumption made about the distribution of the error terms ε. Below, I present the two approaches used to model the opt-out decision. Then, I describe three choice models that differ in their complexity: the multinomial logit model (MNL), the nested logit model (NL) and the random parameter logit model (RPL).

Modeling the opt-out option

The opt-out option can be seen as an alternative with specific levels for each attribute or as a first-step choice option with no associated attributes. In the MNL and RPL specifications, the opt-out option is considered as an alternative in the choice

sets with the attributes and levels shown in Table 5.3. In this case, the attribute levels of the opt-out option reflect what smokers face when quitting cold turkey. An alternative-specific constant for opting-out (opt-out ASC hereafter) is included in some of our MNL and RPL specifications in order to account for the intrinsic propensity to opt-out among respondents, even when differences in attributes are accounted for.

Table 5.3: Description of the opt-out option

Attribute	**Value for the opt-out option**
Price	CHF 0
Efficacy	5%
Side effects	0%
Weight gain attenuation	No
"Availability"	unrestricted

In the NL specification, the opt-out option is modeled as a dichotomous choice that depends on individual-specific characteristics and on the attributes of the medication alternatives. In this case, the opt-out option has no associated attributes.

Multinomial Logit (MNL)

If we assume that the errors ε are independent and identically distributed (IID) Type I Extreme Value, we obtain the standard multinomial logit (MNL) specification. After some algebraic manipulations (see McFadden 1974 or Train 2003 for details), we obtain the following expression for the choice probabilities:

$$P_{ij} = \frac{exp(X_{ij}'\boldsymbol{\beta})}{\sum_p exp(X_{ip}'\boldsymbol{\beta})}. \qquad (5.9)$$

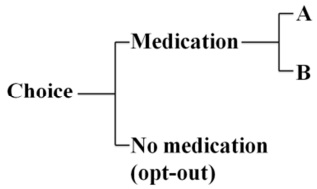
The IID assumption induces the independence from irrelevant alternatives (IIA) axiom, which means that the relative probability of choosing one alternative over another is unaffected by the presence of additional alternatives in the choice set. In other words, the IIA property implies that all alternatives are perfect substitutes. In this case, the choice sets included three alternatives (medication A, medication B and the opt-out option). If IIA holds, this would mean that (for example) an improvement in medication A would lead to proportionate decreases in the frequencies at which medication B and opting out are chosen. Here, it is likely that an improvement in medication A would produce a larger decrease in the probability of choosing

medication B than of choosing the opt-out option.[30] Another limitation of the simple MNL specification is that it does not take into account the fact that each respondent faces several choice situations and that there might be correlation across choice sets faced by a single individual. To handle these limitations, I estimated two additional models allowing for more complex substitution patterns and for possible correlation across choice situations.

Nested Logit (NL)

In this specification, similar alternatives are partitioned into subsets called nests. For any two alternatives (*a* and *b*) in the same nest, ε_{ia} is correlated with ε_{ib}, whereas for any two alternatives in different nests, the unobserved portion of utility is uncorrelated.[31] In our case, the first nest holds the medications (A and B), while the second nest contains only the opt-out option.[32] For clarity, we can visualize each choice as the result of two decisions. First, individuals decide whether or not to opt out. Then, conditional on not having chosen the opt-out option, they choose a medication according to the attribute levels. A suitable way to illustrate the model structure is with a tree diagram (Figure 5.2). The "branches" denote the alternative subsets within which IIA holds, and the "leaves" are the alternatives.

Figure 5.2: Nested logit tree structure



The probability that individual *i* chooses alternative *j* within nest *n* (which contains J_n alternatives) can be depicted as the product of two probabilities (McFadden 1981): the probability of choosing nest *n* among *N* nests and the conditional probability of alternative *j* being chosen (given that nest *n* is chosen):

[30] The medication alternatives (A and B) are more similar to each other than to the opt-out option.

[31] IIA holds in the same nest but not across different nests.

[32] In such a case where one nest contains only one alternative, we talk about a NL model with partial degeneracy.

$$P_{ijn} = P_{nest\,n} \cdot P_{j|nest\,n} \tag{5.10}$$

with

$$P_{nest\,n} = \frac{e^{z_n'\gamma+\tau_n IV_n}}{\sum_{n=1}^{N} e^{z_n'\gamma+\tau_n IV_n}} \tag{5.11}$$

and

$$P_{j|nest\,n} = \frac{e^{x_{j|n}'\beta}}{\sum_{j=1}^{J_n} e^{x_{j|n}'\beta}}, \tag{5.12}$$

Where z is a vector of individual-specific characteristics, x is a vector of medication attributes, γ and β are vectors of parameters, and *IV* is the so-called inclusive-value with its associated inclusive-value parameter τ (see Appendix B for details). The inclusive value (IV) parameter is an indicator of the degree of substitutability between the alternatives. When it equals one, all alternatives are perfectly substitutable. In this case, the model collapses to the simple multinomial logit model (MNL), and there is no need to use a more flexible specification. If the IV parameter equals zero, this means that the choice among nests is completely independent of the choice among the alternatives. In such a case, one independent choice model per decision can be estimated. The use of the NL specification is appropriate when the IV parameter lies between zero and one because this means that alternatives within a nest are closer substitutes for each other than for alternatives in other nests (see Train 2003 for details).

Random Parameter Logit (RPL)

The random parameter logit model (RPL), also referred as mixed logit, allows for more flexible substitution patterns and takes into account the influence of unobserved individual characteristics on choices. In this framework, the choice probability is a weighted average of the multinomial logit choice probabilities, where the weights are the possible values of β. The researcher must then specify a distribution for the coefficients with parameters θ, i.e. $f(\beta|\theta)$:

$$P_{ij} = \int \left(\frac{exp(X_{ij}'\boldsymbol{\beta})}{\sum_p exp(X_{ip}'\boldsymbol{\beta})} \right) f(\beta|\theta)\, d\beta \tag{5.13}$$

Most commonly, it is assumed that the β's are normally distributed. The log-normal distribution is also often use, in particular for the coefficients that are assumed to be strictly positive. We can interpret the RPL model as a model in which the parameters are randomly distributed across individuals. The utility of the *j*-th alternative for an individual *i* can be written as:

$$U_{ij} = X_{ij}'\beta_i + \varepsilon_{ij} \tag{5.14}$$

Where the β_i's are the random coefficients that we can decompose into two parts, as follows:

$$\beta_i = \overline{\beta} + \eta_i \tag{5.15}$$

Where $\overline{\beta}$ is the population mean and η_i is a stochastic deviation representing preference heterogeneity. Re-writing the model, we obtain:

$$U_{ij} = X_{ij}'\overline{\beta} + X_{ij}'\eta_i + \varepsilon_{ij} \tag{5.16}$$

The stochastic portion of utility (i.e., $X_{ij}'\eta_i + \varepsilon_{ij}$) is correlated across choice situations due to the common influence of η_i. Since the integral in (5.13) has no closed-form, simulation is used to estimate the parameters[33].

Final specifications

In all the models, the choice among alternatives depends on the five attributes: price (*Price*), efficacy (*Eff*), side effects (*Side*), effect on weight gain (*Weight*), and availability (*Avail*), all as defined above in Table 5.2. The utility function is simply defined by:

$$U_{ij} = \beta_1 Price_{ij} + \beta_2 Eff_{ij} + \beta_3 Side_{ij} + \beta_4 Weight_{ij} + \beta_5 Avail_{ij} + \varepsilon_{ij}. \tag{5.17}$$

In addition, in the NL model, the opt-out decision is assumed to depend on a series of individual-specific characteristics and on the five attributes (see (11)). Individual-specific variables include the number of years the respondent has smoked (*Years_sm*), the previous use of any smoking cessation help (*Help*), gender (*Gender*), whether the

[33] In short, draws from $f(\beta|\theta)$ are used to get a simulated value of the log-likelihood function. This is done for different values of θ, until we obtain the maximum simulated likelihood (Train 2003).

respondent is anxious (*Anx*), educational level (*Sec* and *Sup*), and the presence of any children in the household (*Child*).

In the RPL model, the parameters were assumed to be normally distributed:

$$U_{ij} = \beta_{1i} Price_{ij} + \beta_{2i} Eff_{ij} + \beta_{3i} Side_{ij} + \beta_{4i} Weight_{ij} + \beta_{5i} Avail_{ij} + \varepsilon_{ij} \quad (5.18)$$

with $\beta_{ki} \sim N(\beta_k, \sigma_k)$.

To go further into the investigation of preference heterogeneity, I estimated models that include interaction terms between individual-specific characteristics and some attributes, as suggested by Ryan *et al.* (2005). I created an interaction between price and indicators corresponding to three levels of monthly income, i.e. *Price x Inc*$_1$, *Price x Inc*$_2$, and *Price x Inc*$_3$, where *Inc*$_i$ is an indicator for the *i*-th of the following income groups: < CHF 4500, CHF 4500 to 8500, and > 8500 CHF. I created an additional interaction term between body mass index and the attribute *Weight***,** using two subgroups (*Bmi*$_1$: up to 25 kg/m^2 and *Bmi*$_2$: over 25 kg/m^2). The general form of the utility function including interaction terms was:

$$\begin{aligned} U_{ij} = {} & \delta_1 Price_{ij} + \delta_2 (Price \; x \; Inc_2)_{ij} + \delta_3 (Price \; x \; Inc_3)_{ij} + \delta_4 Eff_{ij} + \delta_5 Side_{ij} \\ & + \delta_6 Weight_{ij} + \delta_7 (Weight \; x \; Bmi_2)_{ij} + \delta_8 Avail_{ij} + \varepsilon_{ij} \end{aligned} . \quad (5.19)$$

Because individuals with higher income are supposed to have a lower marginal valuation of money, I expect δ_2 and δ_3 to be positive (leading to a smaller negative impact of price on utility in these income groups). I also assume that individuals with BMI over 25 attach a higher value to the *Weight* attribute, i.e., that δ_7 is positive.

5.6. Results

Descriptive statistics

Between March and April 2008, 230 paper-and-pencil questionnaires were mailed. A response rate of 60% was achieved (138 surveys collected). I excluded five respondents due to missing data, making the total number of valid questionnaires 133. Only two individuals failed the dominance test, i.e., chose the non-dominant alternative. I excluded them from the sample, resulting in 131 individuals who were used for the model estimations (yielding 1,048 observations). Among the 1,048 (131x8) choice responses, the opt-out option was selected 491 times (46.9%). In the sample, 24 individuals always chose the opt-out option (no treatment). This subgroup is defined as serial non-participants (Haefen *et al.* 2005). Some authors suggest dropping these individuals from the sample to carry out the estimations, because some of these individuals are likely to opt out as a way of protesting. Deleting these responses can lead to inconsistent estimates, and the nested logit structure used here allows us to explain the factors that influence non-participation; therefore, I did not drop these respondents.

Table 5.4 summarizes statistics about smoking and quitting history, health status and socio-economic characteristics. The mean age of the sample is 38.8 years; the distribution among the different age groups is close to the distribution in the French-speaking Swiss population of smokers. Respondents with higher education levels were slightly overrepresented, to the detriment of the population with only secondary education. Only five respondents had a Fagerström Test for Nicotine Dependence (FTND) score over seven. On average, the respondents had smoked for 20 years, and two-thirds of them had already tried to quit at least once for at least two weeks. Among these unsuccessful quitters, the mean number of quit attempts was 2.63 (std.dev. 2.52), and 23% of the individuals had already used a pharmaceutical smoking cessation therapy, mostly NRT. A large majority of the respondents (67%) were confident about their ability to quit, although only 24% were actually planning to quit within the next six months.

Table 5.4: Descriptive statistics (N=131)

Variable	Definition	Mean	Std.dev.
Smoking history			
Years_sm	Number of years smoking	19.9	11.88
Lowdep	=1 if FTND score <4	0.67	
Middep	=1 if FTND is between 4 and 7	0.29	
Highdep	=1 if FTND >7	0.04	
Smoking cessation			
Help	=1 if have ever used NRT or Zyban	0.23	
Attempts	Number of previous quit attempts	2.72	2.50
Ability	=1 if confident about ability to quit	0.67	
Quit 6 months	=1 if plans to quit within the next 6	0.24	
Health state			
Health	=1 if feels in excellent health	0.22	
Bmi	Respondent's body mass index	23.9	3.29
Anx	=1 if very anxious	0.08	
Household			
Hhinc	Household monthly income (CHF)	6393.1	3021
Child	=1 if there are any children	0.35	
Respondent's characteristics			
Gender	=1 if resp. is a male	0.56	
Age	Age in years	38.7	12.13
Prim	=1 if primary education	0.21	
Sec	=1 if secondary education	0.57	
Sup	=1 if higher education	0.22	

Choice modeling

The results from the MNL and NL models are presented in Table 5.5, results from the RPL models are in Table 5.6, and results of the models that include interactions are presented in Table 5.7. All estimations were performed using Stata version 10.0 (Stata Corp., Texas, USA).

In all models, the coefficients of the utility function are highly significant and of the expected sign except for availability, which is significant only in the RPL model without opt-out ASC (Model 5). The magnitude of these coefficients varies proportionally across models due to a scaling factor (Train 2003). The interpretation in terms of the relative importance of attributes is therefore not affected by this factor.

First, focusing on the results of the simple MNL model (Model 1), we observe that higher price and a higher prevalence of side effects both give rise to lower utility, while long-term efficacy is positively valued. An interesting result is the relative size of the coefficient of the variable *Weight*. Potential quitters attach considerable importance to the presence of an effect on weight gain. The two additional MNL models include an ASC for the opt-out option, as a fixed effect in

Model 2, and as a random effect in Model 3. The ASC is significant and positive in both cases, indicating an intrinsic propensity to opt-out in the population. In the first column of Table 5.5, I provide the results of the Hausman-McFadden test (Hausman and McFadden 1984), which tests the IIA assumption. The procedure consists of re-estimating the model based on a subset of alternatives. If IIA holds, the parameters in both models should be the same. The Hausman-McFadden statistic tests the equality of the parameters, and its associated statistic is assumed to follow a chi-square distribution. The high value of the chi-square statistic indicates that the assumption of IIA (and thus, the MNL model) is not sustainable in this choice context ($p<0.05$). This result supports the use of a more flexible specification.

Looking at the NL specification (Model 4), we notice that the IV parameter associated with the treatment branch is significant and lies between zero and one,[34] indicating that the separation of alternatives into nests is appropriate. Then, I focus on the second part of the NL model (opt-out decision). Because I modeled the probability of opting out, a negative significant coefficient associated with a variable means that an increase of that variable decreases the probability of opting out (or, similarly, increases the probability of choosing any medication). This is the case for the variable *Child* ($p<0.05$); individuals who have children are less likely to opt out. An explanation would be that those individuals are more motivated to quit because they include their children's future health status in their decision process. The coefficient for higher education is also significant and negative ($p<0.01$), the reference category being primary education. This could denote better perception and understanding of the potential benefits of smoking cessation among more educated individuals. By contrast, two variables have a positive and significant coefficient. Smokers who have smoked for a greater number of years are more likely to opt out ($p<0.05$). This result is difficult to explain because these individuals are more strongly addicted and thus should benefit more from a medication that relieves withdrawal symptoms. Possible explanations could be that long-term smokers are simply reluctant to use drugs to handle their smoking habit, that they are overconfident about their future ability to quit, or that their perceived benefits of cessation are low. Anxiety has a positive impact on opting out ($p<0.01$). This could reflect lower perceived benefits of cessation among anxious individuals because of a stronger psychological addiction.

The estimation results of the RPL models are presented in Table 5.6. In Models 5 and 6, all coefficients are assumed to be normally distributed, while in

[34] The IV parameter associated with the opt-out option was set to one.

Models 7 and 8, the coefficients for *Price* and *Eff*, are assumed to follow a log-normal distribution. Unlike in previous models, the coefficient associated with availability is positive and significant ($p<0.05$), but only in Model 5. This result provides some evidence that individuals would positively value a switch to "OTC status" for these drugs. Because we have random coefficients, I also provide estimates of the associated standard deviations. Their significance (except for *Avail*) and their magnitude indicate the presence of preference heterogeneity. Taking this heterogeneity and possible correlation across choices into account seems to bring significant improvements in terms of goodness-of-fit. Model 6 is the preferred specification regarding the log-likelihood, and both the AIC and BIC criteria. Models that include interactions between the price attribute and income and between the weight attribute and BMI are presented in Table 5.7. The results consistently show that the relative importance of the price attribute is lower for individuals with higher income. Moreover, we see that overweight individuals (BMI >25) value the fact that a treatment prevents weight gain more highly, but not significantly.

Table 5.5: Estimation results – MNL and NL models

	MNL	**MNL**	**MNL**	**NL**
Utility function	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Opt-out ASC (fixed)	-	0.6289**	-	-
		(0.2637)		
Opt-out ASC(random)	-	-	0.6675*	-
			(0.4018)	
			[2.78***]	
Price	-0.0044***	-0.0036***	-0.0051***	-0.0033***
	(0.0004)	(0.0005)	(0.0007)	(0.0005)
Eff	0.0543***	0.0590***	0.0821***	0.0434***
	(0.0038)	(0.0044)	(0.0062)	(0.0057)
Side	-0.0358***	-0.0320***	-0.0377***	-0.0266***
	(0.0032)	(0.0036)	(0.0042)	(0.0047)
Weight	0.7545***	0.7653***	0.9347***	0.5610***
	(0.1055)	(0.1085)	(0.1235)	(0.1103)
Avail	0.0124	0.0970	0.0312	0.0004
	(0.0933)	(0.1022)	(0.1169)	(0.0733)
Opt-out choice (NL only)				
Years_sm				0.0126**
				(0.0052)
Help				-0.1243
				(0.1456)
Gender				-0.0316
				(0.1292)
Anx				0.6767***
				(0.2538)
Sec				0.0051
				(0.1479)
Sup				-0.5852***
				(0.1882)
Child				-0.3159**
				(0.1374)
IV parameter				0.6698***
				(0.1136)
IIA test				
Hausman-McFadden chi2	*6.40*			
(p-value)	*(0.011)*			
N	1048	1048	1048	1048
AIC	1904.4	1900.6	1520.5	1884.8
BIC	1934.8	1937.0	1563.0	1975.9
ll	-947.2	-944.3	-753.2	-927.4

In the MNL models, the opt-out option is defined with specific values for the attributes. In the NL model, the opt-out option has no associated attribute value. Standard errors in parentheses. Standard deviation of random coefficients in brackets. ***significant at 1%; **significant at 5%;*significant at 10%.

Table 5.6: Estimation results - RPL models

Utility function	*Model 5*	*Model 6*	*Model 7*	*Model 8*
Opt-out ASC		0.4534		0.5903
	-	(0.4198)	-	(0.4407)
		[2.5180***]		[2.9714***]
Price	-0.0095***	-0.0074***	-0.0093***	-0.0082***
	(0.0011)	(0.0010)	(0.0012)	(0.0011)
	[0.0078***]	[0.0040***]	[0.0111***]	[0.0069***]
Eff	0.1033***	0.1086***	0.1026***	0.1113***
	(0.0092)	(0.0104)	(0.0091)	(0.0090)
	[0.0553***]	[0.0665***]	[0.0532***]	[0.0516***]
Side	-0.0694***	-0.0662***	-0.0583***	-0.0564***
	(0.0077)	(0.0080)	(0.0080)	(0.0070)
	[0.0562***]	[0.0511***]	[0.0515***]	[0.0352***]
Weight	1.3851***	1.2978***	1.1942***	1.1317***
	(0.2274)	(0.2103)	(0.1980)	(0.1904)
	[1.9810***]	[1.6125***]	[1.2652***]	[1.3486***]
Avail	0.3104**	0.2261	0.2050	0.1367
	(0.1416)	(0.1573)	(0.1298)	(0.1426)
	[0.1186]	[0.2147]	[0.0082]	[0.2086]
N	1048	1048	1048	1048
AIC	1463.3	1442.6	1473.7	1451.7
BIC	1524.0	1515.6	1534.5	1524.6
ll	-721.6	-709.3	-726.9	-713.9

In the models, the opt-out option is defined with specific values for the attributes. In Models 5 and 6, all coefficients are normally distributed. In Models 7 and 8, the coefficients for *Price and Eff* are log-normally distributed; all other coefficients are normally distributed. Thus, in Models 7 and 8, the parameters for *Price and Eff* are the means and std. dev. of the coefficients derived from the mean and std. dev. of the logarithm of the coefficients (see e.g. Train 2003 for the appropriate transformation). Standard errors in parentheses. Standard deviation of random coefficients in brackets.***significant at 1%; **significant at 5%;*significant at 10%.

Table 5.7: Estimation results – models with interactions

	MNL	**NL**	**RPL**
Utility function	*Model 9*	*Model 10*	*Model 11*
Opt-out ASC	0.6626* (0.3942) [2.6752***]	-	0.2729 (0.4130) [2.2787***]
Price	-0.0074*** (0.0012)	-0.0052*** (0.0007)	-0.0111*** (0.0015) [0.0053***]
Price x Inc$_2$	0.0027*** (0.0012)	0.0021*** (0.0005)	0.0034** (0.0014) [0.0020*]
Price x Inc$_3$	0.0032*** (0.0015)	0.0033*** (0.0006)	0.0060*** (0.0016) [0.0032]
Eff	0.0826*** (0.0062)	0.0470*** (0.0056)	0.1109*** (0.0097) [0.0457***]
Side	-0.0379*** (0.0042)	-0.0261*** (0.0046)	-0.0582*** (0.0066) [0.0311***]
Weight	0.8116*** (0.1483)	0.5461*** (0.1253)	1.1101*** (0.2331) [1.5877***]
Weight x Bmi$_2$	0.3507 (0.2189)	0.1124 (0.1342)	0.0996 (0.4132) [1.5815***]
Avail	0.0437 (0.1174)	0.0518 (0.0794)	0.2088 (0.3822) [0.3822]
Opt-out choice (NL only)			
Years_sm		0.0142*** (0.0053)	
Help		-0.1074 (0.1509)	
Gender		-0.0678 (0.1340)	
Anx		0.4791* (0.2640)	
Sec		0.0999 (0.1544)	
Sup		-0.3342* (0.1982)	
Child		-0.1041 (0.1443)	
IV parameter		0.7171*** (0.1131)	
N	1048	1048	1048
AIC	1517.5	1850.8	1450.9
BIC	1578.2	1948.1	1560.3
ll	-748.7	-909.4	-707.5

In the MNL and RPL models, the opt-out option is defined with specific values for the attributes. In the NL model, the opt-out option has no associated attribute value. The MNL model include a random opt-out ASC (normally distributed). All coefficients in Model 11 are assumed to be normally distributed. Standard errors in parentheses. Standard deviation of random coefficients in brackets ***significant at 1%; **significant at 5%;*significant at 10%.

Using the simple NL model (Model 4) and the preferred specification (Model 6), I predicted the choice probabilities associated with the opt-out alternative after changes in price, efficacy and prevalence of minor side effects. I then computed the average opt-out probability in the sample that I report in table 5.8. This approximates the evolution of the proportion of non-demanders after the following scenarios: a 20% decrease in price; a 20% increase in efficacy; a 20% decrease in the prevalence of minor side effects; and the three effects combined.

Table 5.8: Average predicted opt-out probabilities. Four scenarios

	NL (Model 4)		RPL (Model 6)	
Scenario	Average opt-out probability	Variation	Average opt-out probability	Variation
Status quo	0.47	-	0.47	-
20% decrease in price	0.40	-0.07	0.43	-0.04
20% increase in efficacy	0.39	-0.08	0.42	-0.05
Side effects 20% less frequent	0.43	-0.04	0.44	-0.03
Three effects combined	0.32	-0.15	0.35	-0.12

In the last line of the table, we see that combined improvements of the attributes would result in a 0.12 to 0.15 decrease in the average probability to opt-out, *ceteris paribus*.

Welfare measures

The ratio between any two coefficients in Equation 17 (or 18) allows us to quantify the relative importance of the corresponding attributes, i.e., the marginal rate of substitution between them. If the price coefficient is included as the denominator, we obtain a marginal willingness-to-pay (mWTP) for the variation of an attribute. For example, we can value the improvement of the efficacy of a treatment by computing $-(\beta_2/\beta_1)$ *ceteris paribus*, i.e., the WTP for a 1-percentage-point increase in efficacy.

To compute mWTP estimates, I rely on the coefficients of the models without interactions (specifically, I rely on estimates from Models 1, 3, 4, and 6). Dividing the estimated coefficients of non-monetary attributes by the negative of the price coefficient gives rise to mWTP estimates. These are presented in Table 5.9. As suggested by Hole (2007), I applied the Krinsky-Robb method (Krinsky and Robb

1986) to compute confidence intervals. This method, which is also referred to as parametric bootstrap, consists of taking draws from a multivariate normal distribution with means and covariance given by the estimated coefficients and the associated variance-covariance matrix. In our case, I performed 10,000 draws to obtain 10,000 values of the coefficients from the joint distribution. I used these values to compute 10,000 mWTP estimates for each non-price attribute. The 95% confidence interval is then defined by taking the upper and lower 2.5 percentiles of the distribution.

Table 5.9: WTP estimates

Attribute	Model 1	Model 3	Model 4	Model 6
Eff	12.3	16.2	13.0	14.6
	[10.8;14.1]	[12.7;21.5]	[10.5;16.8]	[11.2;19.6]
Side	-8.1	-7.4	-7.6	-8.9
	[-10.6;-6.2]	[-10.0;-5.4]	[-10.4;-5.5]	[-12.2;-6.4]
Weight	170.9	184.0	164.8	174.9
	[125.1;221.8]	[133.8;252.9]	[115.4;224.8]	[121.4;246.4]
Avail	0	0	0	0
	[-]	[-]	[-]	[-]

95% Krinsky-Robb confidence intervals in brackets.

We see that an individual is willing to pay from CHF 12.3 to CHF 16.2 for a 1-percentage-point (p.p.) increase in efficacy. Individuals also value the absence of side effects and would be willing to pay between CHF 7.4 and CHF 8.9 for a 1 p.p. reduction in the probability of occurrence of minor side effects. The fact that the medication prevents weight gain associated with smoking cessation is valued between CHF 164.8 and CHF 184.0, depending on the specification. In Table 5.10, I report the estimates of marginal WTP in the three income groups that stem from the RPL model with interactions (Model 11).

Table 5.10: WTP estimates by income group

Attribute	Income groups (CHF)		
	<4,500	**4,500-8500**	**>8,500**
Eff	8.6	14.8	22.6
	[6.4;12.5]	[11.4;20.4]	[14.5;45.8]
Side	-5.3	-9.0	-13.7
	[-7.8;-3.7]	[-12.8;-6.4]	[-28.6;-8.4]
Weight	117.8	201.9	307.8
(individuals with bmi<=25)	[76.4;182.0]	[132.9;296.7]	[182.7;610.4]
Weight	123.4	211.5	322.4
(individuals with bmi>25)	[76.2;196.8]	[137.4;318.4]	[179.0;668.1]

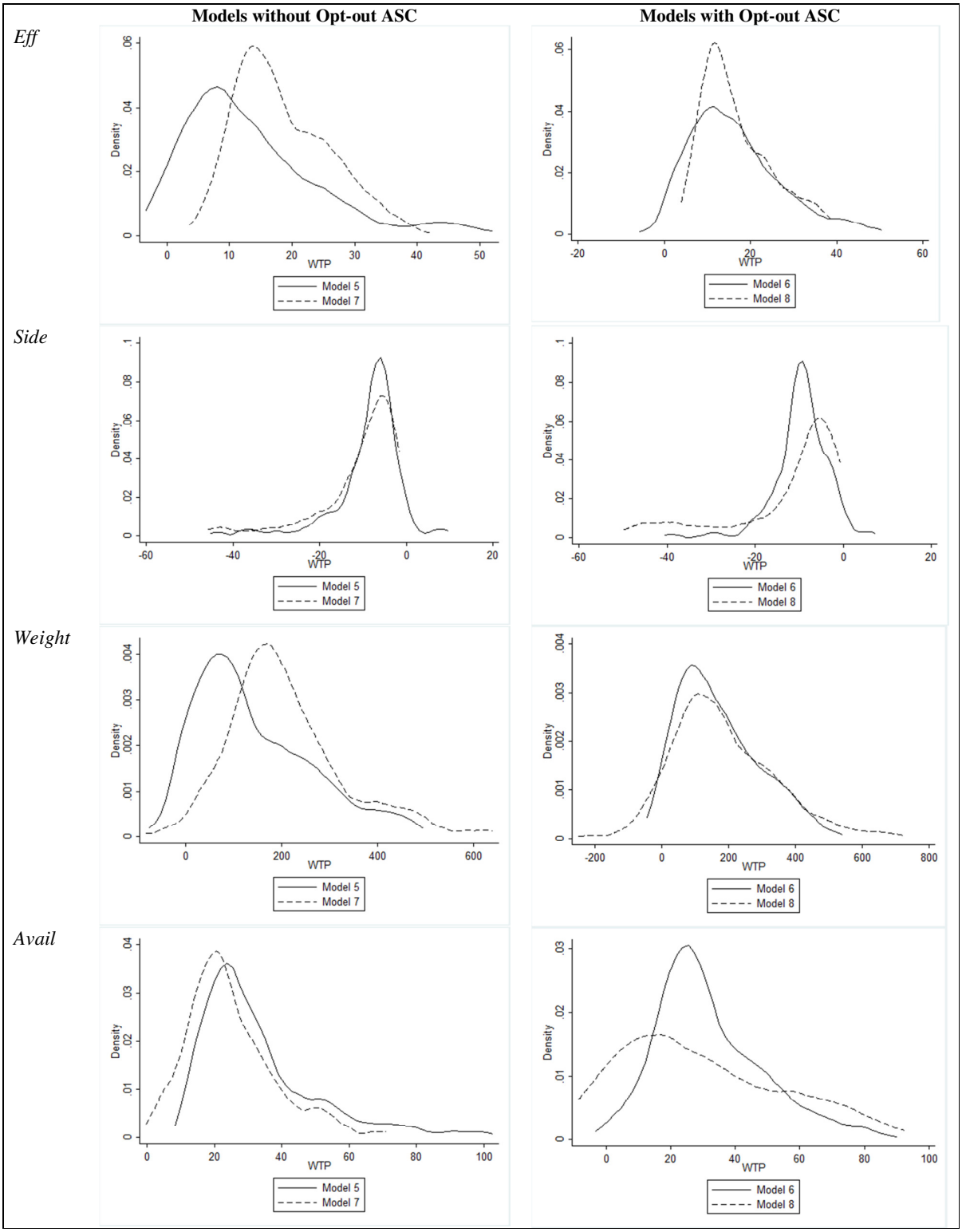
95% Krinsky-Robb confidence intervals in brackets. Estimated coefficients and variance-covariance matrix from the RPL model with interaction used (Model 11). WTP for *Avail* not reported (the associated coefficient is not significant).

Making some simple computations, one can derive from the estimated WTP the incremental value of a smoking cessation medication over cold-turkey smoking cessation. Using WTP estimates from the preferred specification (Model 6) and assuming a linear relationship between WTP and increased efficacy and between

WTP and the prevalence of minor side effects, I compare cold-turkey cessation (for which the attributes are shown in Table 5.3) with a medication that has the following characteristics: 50% efficacy, 10% prevalence of minor side effects, attenuation of weight gain and restricted availability (medical prescription). I then multiply this amount by 0.54 (i.e., 1 minus the estimated proportion of non-demanders). I obtain an incremental value of the improved hypothetical smoking cessation treatment over cold-turkey cessation of around CHF 400. It is worth noting that I make the conservative assumption that the treatment has a value of zero for all non-demanders, as in Busch *et al.* (2004).

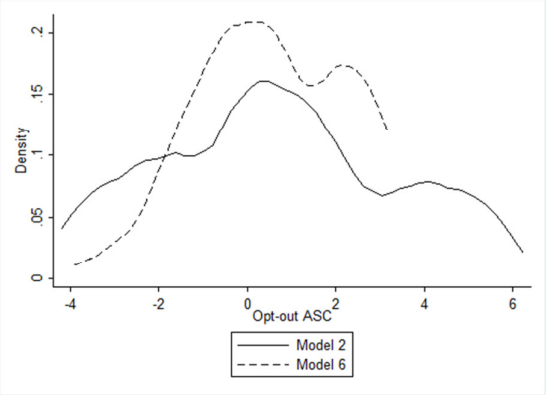
From the RPL models estimated, it is possible to obtain individual-specific values for the coefficients conditional on the choice actually made and the value of the attributes (Train 2003, Hole 2008). I exploit this information in two ways. First I use individual-specific values of the coefficients to plot distributions of WTP (Figure 5.3). Moreover, to further investigate the opt-out decision, I use the results from the models that include a random opt-out alternative-specific constant to retrieve individual values that reflect individual levels of the intrinsic propensity to opt-out (Figure 5.4), and regress them on the same respondents' characteristics used to model the opt-out decision in the NL specifications (Table 5.11). We see that the number of smoking years and the variable *Anx* have a positive impact on the intrinsic propensity to opt-out. Having already used a smoking cessation support, having child in the household, and the level of education have a negative impact on opting-out.

Figure 5.3: Distributions of WTP



The corresponding models are those presented in Table 5.6.

Figure 5.4: Distributions of opt-out ASC



The corresponding models are presented in Table 5.5 and 5.6.

Table 5.11: Determinants of the intrinsic propensity to opt-out (OLS)

	Model used to obtain the individual-level values of the opt-out ASC	
Variables	Model 2	Model 6
Year_sm	0.1167***	0.0074***
	(0.0038)	(0.0025)
Help	-0.3173***	-0.3612***
	(0.0982)	(0.0634)
Gender	-0.0968	-0.4236***
	(0.0883)	(0.0576)
Anx	0.977***	0.9486***
	(0.1694)	(0.1104)
Sec	-0.3797***	0.0306
	(0.1196)	(0.0779)
Sup	-1.2629***	-0.4732***
	(0.1394)	(0.0908)
Child	-0.7331***	-0.2013***
	(0.0925)	(0.0603)
Constant	1.2660***	0.7951***
	(0.1534)	(0.0999)

The dependent variable is the value of the opt-out ASC obtained from Model 2 in one case and from Model 6 in the other case. SE in parentheses. ***significant at 1%; **significant at 5%;*significant at 10%.

5.7. Discussion

I used discrete choice experiments to analyze smokers' preferences for hypothetical cessation medications. My goal was threefold: to assess the value that smokers attach to attribute improvements, to highlight the most important factors that influence the decision to use such treatment, and to compare multinomial models. My results clearly show that there is potential demand for improved smoking cessation medications. Even if a considerable proportion of smokers who express interest in quitting are not willing to purchase such medications (opt-out rate of 47%), individuals are willing to pay substantial amounts for ameliorations of the relevant attributes. In line with the findings of Busch *et al.* (2004) and Paterson *et al.* (2008), I find that the probability of success (quit rate) is a fundamental characteristic. Indeed, according to the preferred specification, smokers are willing to pay CHF 14.6 for a 1 percentage point increase in the long-term success rate. Furthermore, I estimate that smokers are willing to pay to reduce the chance of experiencing minor side-effects (WTP of around CHF 8 to decrease the probability by 1 p.p.), and that weight gain prevention associated with smoking cessation is highly valued (WTP between CHF 164.8 and CHF 184 for a medication that prevent cessation-associated weight gain, depending on the specification). Broader usage could therefore be reached through lower out-of-pocket price and greater efficacy. Secondary aspects such as side effects and weight gain should also be taken into consideration. Models including interactions between the price attribute and household income show that the marginal valuation of money declines with income, the resulting WTP for improved attributes therefore increase with income. Coverage of such treatments by the basic health insurance plan, or a subsidy targeted at the most deprived smokers, whose average rates of successful cessation are significantly lower than those of the rest of the population, are some of the possible policy options that are likely to lead to higher smoking cessation rates.

The results also highlight the limitations of the simple multinomial logit model when analyzing data from an unlabeled discrete choice experiment that includes an opt-out option, and they support the use of more sophisticated models. Using the NL framework, I was able to analyze two interdependent decision processes: whether to choose a treatment and which treatment to choose. Concerning the decision to opt out, I showed that long-term smokers are more likely to opt out and that higher-educated individuals have a smaller probability of choosing the opt-out option. Using the RPL specification, I show the central importance of accounting

for unobserved preference heterogeneity and potential correlation across choices, when analyzing choice data from a DCE.

However this study has notable limitations. First, the respondents did not stem from a random national sample and the sample is not very large; their preferences may therefore not be representative of those of the general Swiss population of smokers. Further investigation should be carried out on the national level. Second, the use of a stated preference method raises the issue of hypothetical bias. With this in mind, it could be useful to use real market data (revealed preferences (RP) data) about smoking cessation medication sales and merge them with stated preference data resulting from a DCE. This would combine the advantages of both methodologies, i.e., the real market equilibrium assessment of RP data with the analysis of trade-offs between attributes of SP data. Other extensions would be to analyze preferences using a labeled DCE as Paterson *et al.* (2008) did, including Champix® (varenicline) as an additional alternative, and to apply Latent Class Models to further investigate preference heterogeneity (Mentzakis *et al.* 2010).

Appendix A: Example of choice set

Attributes	Medication A	Medication B	Neither
Price Price of the comprehensive treatment in CHF	500 CHF	200 CHF	
Efficacy % of quitters who still do not smoke one year after the treatment	25%	40%	
Side effects % of patients who encounter minor side effects (insomnia, dry mouth and so forth)	30%	50%	
Does the medication prevent weight gain associated with smoking cessation?	no	yes	
Availability	Over-the-counter	Medical prescription	
Your choice:	☐	☐	☐

Appendix B: Nested Logit and the IV parameter

I define factors (attributes or individual-specific variables) that influence nest choice by z_n and factors that influence specific alternative choice by x_{jln}. The unconditional probability of choosing alternative *j* (among J_n alternatives) in nest *n* (among *N* nests) is:

$$P_{jn} = \frac{e^{x_{jln}'\beta + z_n'\gamma}}{\sum_{n=1}^{N}\sum_{j=1}^{J_n} e^{x_{jln}'\beta + z_n'\gamma}} \tag{B1}$$

We can re-write this expression as the product of two probabilities,

$$P_{jn} = P_{jln}P_n = \left(\frac{e^{x_{jln}'\beta}}{\sum_{j=1}^{J_n} e^{x_{jln}'\beta}}\right)\left(\frac{e^{z_n'\gamma}}{\sum_{n=1}^{N} e^{z_n'\gamma}}\right)\frac{\left(\sum_{j=1}^{J_n} e^{x_{jln}'\beta}\right)\left(\sum_{n=1}^{N} e^{z_n'\gamma}\right)}{\left(\sum_{n=1}^{N}\sum_{j=1}^{J_n} e^{x_{jln}'\beta + z_n'\gamma}\right)} \tag{B2}$$

We define the inclusive value (IV) for the *n*-th branch as:

$$IV_n = ln\sum_{j=1}^{J_n} e^{x_{jln}'\beta} \tag{B3}$$

From this we get:

$$P_{jln} = \frac{e^{x_{jln}'\beta}}{\sum_{j=1}^{J_n} e^{x_{jln}'\beta}} \; and \; P_n = \frac{e^{z_n'\gamma + \tau_n IV_n}}{\sum_{n=1}^{N} e^{z_n'\gamma + \tau_n IV_n}} \tag{B4}$$

where τ_n is the inclusive value (IV) parameter, which is an indicator of the degree of substitution between the alternatives.

6 Concluding remarks

This dissertation addresses various aspects of smoking-related decisions from an economic perspective. The document consists of three empirical essays, preceded by an introductory chapter in which I present the decision to smoke from an economic perspective and review the recent literature on the available policies aimed at reducing tobacco use, with references to the current situation in Switzerland. The objective of this chapter is to provide a brief overview of the dissertation, to summarize the main findings related to the three essays and to highlight the various difficulties and challenges encountered while conducting the research. I also present the main limitations of each study and propose potential extensions and suggestions for future research.

6.1. Introductory part

The traditional microeconomic framework, with its underlying assumptions of utility maximization, rationality, and stability of preferences, has prompted substantial amounts of empirical work on smoking decisions and has allowed for the development of a sophisticated understanding of the determinants of tobacco use. However, the recent theoretical contributions pertaining to substance use tend to depart from the standard settings, in particular from the rational addiction model proposed by Becker and Murphy in 1988, and deliver novel insights on the determinants of addictive consumption, the potential impact of policies, and their economic justification. Recent studies incorporate aspects of behavioral economics, such as time-inconsistencies and lack of self-control. The incorporation of psychological aspects in consumption models also leads to the extension of the notion of externalities to "*intrapersonal externalities*" or internalities. The lack of rationality of individuals can justify stronger policy intervention, which is therefore seen in this context as a desirable commitment device. In contrast, some authors also relying on behavioral theories conclude that interventions such as price increases would not be effective for certain types of individuals and would therefore be clearly welfare reducing. The various models lead to important differences in policy prescriptions. The optimal level of intervention is therefore still subject to debate and remains an open theoretical and empirical question.

On the empirical side, the recent literature on the "best-practice" interventions aimed at reducing tobacco use and exposure to ETS provides many interesting insights and has implications for Switzerland. The literature agrees that price has a significant effect on behavior. However, concerns are raised regarding compensatory behaviors, such as the use of substitutes (hand-rolled cigarettes), and equity issues following a tax increase. Tax regressivity is of particular concern due to the concentration of consumers in the most deprived subgroups of the population and the potential lack of price responsiveness for some types of individuals. Importantly, while the authors widely agree on the impact of price on smoking cessation, the results are mixed with respect to smoking initiation.

Information dissemination on smoking-related risks has had a significant impact on the reduction of smoking rates in developed countries, but it is likely that the conventional messages are no longer effective in changing behaviors. Choosing the right messages, ensuring a proper understanding of the future consequences of consumption (including addiction and the potential loss of quality of life), targeting the right groups of the population, and finally, measuring the impact of the measures implemented is challenging. Additionally, there is a clear imbalance between the resources of producers of prevention messages and those of tobacco advertisers. This raises the issue of advertising by the tobacco industry. The literature shows that partial bans, such as those implemented in Switzerland, are not effective because the industry develops indirect and sophisticated means of communication to circumvent legal restrictions.

Exposure to environmental tobacco smoke (ETS) is the most obvious traditional externality associated with tobacco use. The literature mostly shows that smoking bans in bars and restaurants are effective in reducing exposure without negatively affecting the hospitality sector. However, concerns are raised about ETS exposure at home that could be handled only by second-best policies, such as information on the consequences of ETS and tax increases. In Switzerland, the gradual implementation of smoking bans in the cantons, and finally at the national level since April 2010, still needs to be evaluated, both from a public health perspective (reduction in ETS exposure, smoking rates, and short-term health risks) and with respect to the economic activity of the hospitality sector.

Finally, economic studies on smoking cessation devices show that pharmaceutical products, such as NRT and nicotine-free cessation drugs, are effective in increasing successful cessation rates and generate a good value for money. However, their use is still low in Switzerland in comparison with the substantial

number of individuals who express a desire to quit. As these products are privately delivered and advertised if sold OTC, a public intervention in this market must be cautiously justified.

6.2. Empirical essays

Each of the three empirical essays looks at specific aspects of smoking-related decisions and tries to shed some light on some of the issues mentioned above. The first essay looks at the impact of tobacco control spending on smoking behavior, which in part reflects information dissemination. In 2004, Switzerland devoted approximately 2.2% of its health care spending to prevention and health promotion expenditures of all types. This proportion is 2.7% on average in OECD countries, with up to 4.8% in Germany and 5.5% in the Netherlands (WHO 2006). The main federal prevention programs are related to tobacco, alcohol, illicit drug use and HIV/AIDS. In the field of tobacco, the recently implemented national smoking ban indicates a clear political will to strengthen tobacco control in the country. In the meantime, the Federal Office of Public Health (FOPH) recognized the lack of economic evaluation of prevention interventions in the country and mandated several studies aimed at laying the foundations for more systematic assessments, with the upcoming development of a law on prevention in mind. I developed the first essay as a part of the mandate on tobacco, with a main objective of assessing whether spending on tobacco control has impacted behavior and also of highlighting the difficulties and shortcomings associated with such evaluations.

The study addresses the impact of overall financial resources dedicated to tobacco control on smoking-related decisions, exploiting the regional differences in tobacco control efforts and their evolution over time. Specifically, the objective was to assess whether and to what extent prevention expenditures incurred mainly between 1997 and 2007 in Switzerland influenced the probability of smoking initiation and the probability of smoking cessation. Large panel data sets that include information on smoking-related behaviors are not available in Switzerland. Therefore, I resorted to a second-best strategy and used self-reported retrospective data on smoking from the cross-sectional Swiss Health Survey to reconstruct individual smoking histories, which I then analyzed with discrete and continuous time hazard models. An important work of data collection was also necessary regarding tobacco control expenditures as there is no centralized information source on this issue.

In 2007, approximately 2.6 Swiss Francs per capita were spent on tobacco control interventions, including information and public awareness campaigns, cessation support, protection against ETS, and knowledge management. In comparison with the counterfactual of zero expenditure, I estimate that between 1997 and 2007, non-price-related tobacco control interventions produced roughly 110,000 additional quitters in the country. I find a cessation elasticity of 0.10 in the preferred specification. In contrast, I do not find convincing evidence that tobacco control expenditures have influenced smoking onset. The results consistently show that price matters both with respect to smoking initiation and cessation. In terms of elasticity, price effects are of greater magnitude than tobacco spending effects. I find a price elasticity of smoking initiation of around -0.6, and a unit price elasticity of smoking cessation. I also find evidence of a significant educational gradient in both initiation and cessation decisions. In comparison with their less educated counterparts, individuals with higher education are 30% less likely to start smoking and 17% more likely to quit. In addition, I show that males are more prone to start smoking and less prone to quit than women.

Both continuous and discrete time proportional hazard models give rise to similar results. However, the estimated effects are sensitive to the assumptions made on the impact over time of tobacco control expenditures, i.e., between using current or cumulative expenditures. The use of region fixed-effects to account for potential unobserved heterogeneity improves the models and therefore seems appropriate. Additionally, the use of a stratified Cox regression as an alternative to region fixed-effects brings additional insights with respect to unobserved heterogeneity.

One can also read the results in light of production theory, where the inputs are prevention measures and the output is the modification of behaviors. In this framework, the public authorities and the NGOs are seen as producers of prevention. In reality, the inputs are heterogeneous, whereas I only have information on the overall resources dedicated to tobacco control, a homogeneous measure. Clearly, our data do not allow us to identify the effectiveness of specific interventions in changing behavior. In other words, although I was able to show that the overall inputs produced additional quitters in the population, I was not able to assess the allocative efficiency of the "production" process. Are the right combinations of inputs used in terms of the nature of the measures implemented and in terms of targeted sub-populations? The difficulties faced in collecting the data and the lack of accuracy of certain information highlighted a need for a more centralized monitoring of prevention measures. Moreover, the results do not allow for the identification of the possible diminishing

marginal impact of prevention spending. It is therefore difficult to determine an optimal level of expenditure. Nevertheless, we can rely on the CDC minimum recommendations of USD 8.43 per capita and on the CHF 15 per capita spent on advertising by the tobacco industry to infer that the actual level of expenditure in still relatively low in the country. The World Health Organization, in their 2006 report on the Swiss Health System, pointed out the lack of a clear designation of responsibilities in the field of prevention and also a lack of incentives to invest in prevention activities. Financial resources used in a certain year that will produce improved health effects only in the distant future and the lack of evaluation regarding the effectiveness of the measures are obviously the central deterrents.

In addition to the obvious problems related to the impossibility of breaking down our tobacco spending data into more specific categories, the study has several other limitations. I assumed that tobacco control expenditures were nonexistent before 1990, which is a reasonable assumption regarding the scarcity of prevention intervention in this period. In contrast, the assumption regarding tobacco control expenditures between 1990 and 1997 is more debatable. I relied on a body of information to reconstruct the trend over the period in each region. The resulting data are therefore inaccurate, but I provide a sensitivity analysis according to two extreme assumptions at the end of the chapter. Finally, the use of self-reported retrospective data on smoking from a cross-sectional survey raises the problem of recall bias. Additionally, it makes it impossible to use time-varying individual data, such as income, marital status, self-assessed health status, self-control measures, and individual rate of time-preferences that could potentially have a significant impact on decisions. Data available on prevention spending are clearly not sufficiently accurate or detailed enough to conduct a more systematic, targeted, and comprehensive evaluation of the implemented programs. I would recommend a more systematic and mandatory monitoring of tobacco control expenditures. Further research should also focus on the political economy of prevention and on the forces and incentives that could lead to a better allocation of resources in the domain.

The lack of evidence of any impact of tobacco control expenditures on the initiation decision has prompted the second strand of research. I apply best-worst scaling–a survey-based stated preferences method–to assess how adolescents between 14 and 19 years old consider the potential negative consequences of tobacco use. The method allows for the construction of a scale that reflects the degree of concern and therefore allows for the consideration of the relative importance of the negative consequences. The motivation was also to develop the first application of best-worst

scaling in the field of tobacco. From a methodological point of view, the choice tasks were seen as simple for the vast majority of respondents and were well understood. The resulting data provides rich information on the relative importance of the items considered and even allows for the assessment of individual-level preference scales. I also illustrate how such choice data can be easily analyzed with a simple technique that does not necessitate the estimation of any statistical choice model.

The relative importance of 15 items, including long-term and short-term health and non-health consequences, was assessed. In addition to focusing on the health risks cited most often (e.g., lung cancer and cardiovascular disease), I also investigated the importance of less-mentioned health implications (e.g., effects on teeth, appearance and sexual dysfunction) and other negative non-health effects, such as cost, or dependence. Lung cancer was consistently ranked first, followed by concern about the loss of physical capacity, cardiovascular disease, sexual dysfunction, and reduced life expectancy. Items of more moderate but still significant importance include addiction, COPD, endangering relatives, inhalation of chemicals, expenditures, oral and dental problems, and skin problems. The disturbance of non-smokers, tobacco industry manipulation, and concern about weight gain after smoking cessation were of weaker importance.

Heterogeneities in the rankings of the items were first assessed by comparing choice probabilities for boys and girls, smokers and non-smokers, different age groups, and different levels of smoking-related mortality perception. I find that boys, smokers, and older individuals tend to put more weight on short-term health risks, while girls, younger individuals, and non-smoking respondents tend to be more concerned by lung cancer. I also find that the higher the mortality risk perception, the higher is the level of concern for reduced life expectancy. Then, grouping the items in different categories and exploiting the results from the random-coefficient approach, I show that current smoking is positively associated with the level of concern for short-term health risks and negatively related with the level of concern for long-term health risks. I find a similar association between the frequency of alcohol consumption and the same covariates. Finally, I used a factor analysis to construct an index of far-sightedness among individuals and show that, controlling for gender, age, peer smoking, discretionary income (pocket money), and class membership, the more far-sighted the individuals are, the less likely they are to engage in unhealthy behaviors.

However, the study has several caveats that must be kept in mind. First, even if respondents were asked to choose the greatest and least deterrent in each choice set, the true underlying motivation for them to pick a given item is unclear. The lower

relative concern of long-term health risks may be observed among smokers because they start to experience short-term consequences and the perceived potentially underestimated disutility of these risks becomes a true experienced disutility. Or instead, the significantly and consistently higher level of concern for lung cancer may be partly explained by the disproportionate media communication on this specific health risk, which leads to the overestimation of the perceived risks. An extension of this research would be to collect data on subjective probabilities for the relevant consequences and to have a measure of individual time-preferences to isolate the perceived disutility associated with each item. Another extension would be to rate the perceived benefits of smoking to better understand the motivation of youth to engage in such behavior.

The third essay focuses on the valuation of improved pharmaceutical smoking cessation drugs. Such treatments primarily act by reducing the withdrawal symptoms of smoking cessation, therefore leading to increased success rates among users compared to "cold-turkey" quitters. However, these products are costly, they are not yet reimbursed by social health insurance, they cause frequent minor side-effects, and they are not available over the counter. I used a discrete choice experiment to assess smokers' preferences for hypothetical smoking cessation medications described with five attributes: the price of a complete treatment, the efficacy measured in terms of the probability of becoming a successful, long-term quitter, the occurrence of minor side-effects, whether the drug prevents weight gain associated with smoking cessation, and whether the product is available OTC. The method allows for the estimation of the relative importance of each attribute. In addition, the use of a price attribute allows for the estimation of willingness-to-pay for marginal variations of each non-price attribute.

In line with previous findings, efficacy is a central feature. Individuals are willing to pay approximately CHF 12 to 16 for a one percentage point increase in the long-term success rate. This result indicates that the perceived net benefits of quitting are important, at least for demanders. Potential minor side effects, such as dry mouth or nausea, for instance, dampen usage and are thus negatively valued. A one percentage point reduction in the probability of experiencing minor side effects is valued at around CHF 8 by respondents. A striking figure is the substantial value (between CHF 160 to CHF 180, depending on the specification) that smokers attach to the fact that the drug contains an active ingredient that prevents cessation-related weight gain. The impact on weight gain of smoking cessation, as an immediate "cost"

of smoking cessation, seems to be of central importance in the smoking cessation decision.

I also find a substantial opt-out rate (47%) in the survey. I show that opting-out is influenced by several individual characteristics. Longer-term smokers and individuals reporting frequent anxiety are more likely to opt-out, whereas individuals with higher education and with children in the household are less likely to opt-out. Even current smokers who previously used a smoking cessation support (i.e., unsuccessful quitters) are less likely to opt-out. This may indicate that they better perceive the potential benefits of using such products or simply that they have particular underlying characteristics that influence their choice and that are not altered by previous experience with the good. The monetary value of significantly improved hypothetical cessation drugs is approximately equivalent to the actual market price of available drugs. This pinpoints a substantial problem of affordability, especially among the most deprived smokers. Moreover, I show that WTP decreases quite sharply with income. Potential subventions to match actual price and WTP should therefore be consequential to enhance use among low-income smokers.

From a methodological point of view, I show the limitations of the simple multinomial logit model and therefore the importance of using more sophisticated models to study data from a discrete-choice experiment. Taking unobserved heterogeneity into account significantly improves the models. Of course, the main limitation is related to the use of stated preference data, which raises the problem of hypothetical bias. However, the method provides many insights about the determinants of choice and allows for the capturing of the effects of features that are simply not available on the market or that do not vary enough across current alternatives.

It is important to keep in mind that I focus here only on the preferences of potential consumers. A number of other agents are involved in the smoking cessation drug market, including pharmaceutical companies that have incentives to promote their products, general practitioners that have a central influence in delivering the right to purchase (at least for drugs that are not sold OTC), and also public health authorities, who play a role in increasing the perceived benefits of smoking cessation and in deciding drug reimbursements. According to the 2007/2008 Swiss Tobacco Survey results, almost 80% of all smokers have already discussed tobacco use with their general practitioner or dentist. One in five smokers in Switzerland has been proposed cessation support from their physician; a vast majority of advice was focused on NRTs (35%) and books (25%). Zyban® and Champix® were proposed

only 8% and 5% of the time, respectively. A potential extension of this research would be to study physicians' behavior and incentives to prescribe such drugs and to assess what part of the decision is induced by potential quitters and what part is caused by the physician. The implications of a possible reimbursement contingent on successful cessation that could provide the best incentive for people to engage in quitting behavior should also be analyzed in the Swiss setting.

6.3. Potential future projects

The research conducted in this dissertation, the attendance at international conferences, the interesting talks with other Ph.D. students and professors during the doctoral courses in health economics at the Swiss School of Public Health, and the contacts with Federal Office of Public Health have sprouted a large number of ideas for future research and collaborations. Some of these research projects are concretely on the agenda and will be started this year, while others are only ideas.

I plan to exploit the quasi-experimental setting offered by the gradual implementation of smoking bans in Switzerland to study their impact from an overall perspective. Indeed, while previous studies have looked separately at different outcomes, my aim is to develop a detailed assessment of this policy in terms of the reduction of health risks and the impact on the economic activity of the industry. I also plan to study smoking cessation behavior among individuals aged 50 and over in Europe, particularly with respect to the various tobacco control policies implemented in the countries and with respect to the potential "private" information on the smoking risks they experience, with a focus on heterogeneities in responsiveness to personal health shocks. This research will be possible with the availability of the recent longitudinal Survey on Health Aging and Retirement in Europe (SHARE), which includes detailed information, including retrospective life events. I also plan to exploit the recently available Transitions to Education and Employment (TREE) dataset, which contains longitudinal data on youths in Switzerland. The objective will be to relate cognitive abilities, schooling and employment decisions, critical life events, and substance use (mainly tobacco, cannabis and alcohol). Working on other topics in health economics, such as obesity, efficiency measurement, and DCE applied to other questions, is also part of my research objectives.

7 References

Chapter 2

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Chapter 5

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