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Price elasticity of demand for cigarettes

The Case of Sweden

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Abstract

Due to health problems and the negative externalities associated with the cigarette consumption, many governments try to discourage it by increasing cigarette price through taxation. However, cigarette, like the other addictive goods, is viewed as that it is not sensitive to demand rules and the market forces. This study analyses the effect of price increase on cigarette consumption. We used Swedish time series data from 1970 to 2010.

Our results reveal that though cigarette is addictive substance, its demand is sensitive to changes in prices. Estimates from this study indicate short-run price-elasticity of -0.29 and long run price elasticity of -0.47.

Keywords: Price elasticity, Cigarette demand, Tobacco, Sweden, Rational addiction, Myopic addiction

Table of contents

1. Introduction

Tobacco use is one of the leading preventable causes of death in the world. Around six million people die for tobacco uses in the world each year. About 600,000 of them die from exposure to secondhand smoke (World Health Organization "WHO", 2012). In Sweden around 6400 people die each year prematurely of diseases related to smoking, the most commonly being cardiovascular diseases and different types of cancer (Swedish National Institute of Public Health *"Statens folkhälsoinstitut"* FHI, 2012). Approximately 200 people die each year in Sweden for health conditions related to secondhand smoking (FHI, 2009). According to FHI (2012), 10% of Swedish men and 12% of Swedish women between 16-64 years smoke daily, while 18% of Swedish men and 15% of the Swedish women are exposed to secondhand smoke daily or some days in the week. Smoking imposes huge cost burden to the Swedish society; in 2007 for example, the estimated total cost of smoking in Sweden that could be avoided was 1.6 billion US Dollars or 181 US Dollars per capita including direct health care costs, the years of potential life lost and years of potential productive years of life lost (Bolin et al., 2011).

In response, Sweden like many other developed countries has adopted several methods to restrict the use of cigarettes and other tobacco products. Among these methods are excise tax on tobacco goods to increase their prices and regulatory measures such as banning of both direct and indirect advertising of tobacco products, setting a minimum age limit for purchases of tobacco goods and banning of smoking in public places, namely, public transportation, bars and restaurants (FHI, 2010).

The rationale behind government restriction of cigarette consumption is to correct two major forms of market failures associated with smoking; The first one is to fix negative "externalities" that cigarette smokers impose on the public such as the overall burden of health costs covered by the public funds, and second hand smoking problems that smokers may impose on none smokers (Chaloupka, 2002). The second one is to correct imperfect information; some smokers especially the young people and the children are not well informed about the health and addiction risks of smoking so that they may regret their current choices later in their lives (Jha and Chaloupka, 2000). For more discussion about the "intra-personal externalities" that young smokers impose on themselves in the long run see also Laux (2000).

Taxation policy is the main control policy that most of the countries in the world including Sweden use to control the consumption of tobacco products including cigarettes. Historically, revenue generation has been the primary objective of tobacco taxation for most of the governments. However, following the discovery of the health risks associated with tobacco use and as the knowledge of tobacco hazards had increased over the past half century, governments began to use tobacco taxation as a policy to promote public health by reducing tobacco use and related diseases (WHO, 2010). The policy aims to increase the price by raising the tax, and the required outcome is the increased price to reduce the demand for cigarettes.

However, there has been a long debate on whether higher cigarette prices can effectively reduce cigarette consumption and whether it can achieve governments' goal of reducing cigarette consumption since cigarettes contain nicotine which is addictive substance. This is a question that many economists and other researchers tried to answer; therefore substantial research has been done on price elasticity of cigarettes using data from different countries. Although the demand for tobacco products have traditionally been considered as rather inelastic that price increases could not have a significant effect on it, most of these researches have proved that there is significant inverse relationship between cigarette consumption and price, see for example Lewit and Coate (1982), Mullahy (1985), Wessarman et al. (1991), Townsend et al. (1994) and Becker et al. (1994).

Nevertheless, there are few or no researches done on the price effect on cigarette consumption in Sweden. The purpose of this thesis is to investigate price sensitivity of cigarette demand in Sweden. We use aggregate time series data from Sweden 1970-2010. When modeling addictive goods such as cigarettes, the most commonly used model is "rational addiction model" developed by Becker et al. (1994). Many economists prefer this model from the other existing models used for modeling the demand for addictive goods, thus, we use this model together with the myopic model in this study.

The rest of the thesis is organized as follows; Section 2 briefly discusses the Swedish tobacco market and Swedish tobacco polices. This section shows the policies that the Swedish government uses to intervene in the cigarette market, namely, banning cigarette advertisement, banning smoking in public places and increasing tax on cigarettes.

Section 3 is the literature review. This section discusses the previous works done by other authors relating to our topic with the aim to identify key variables used in the past studies to model price impacts on cigarette demand, theoretical models, data and econometric tools they haves used so as to establish the basis of our research.

Section 4 is the theoretical framework. It provides and discusses the theoretical model of "rational addiction model" developed by Becker et al. (1994), which is the foundation of our empirical model. In this section, key variables used in the study are defined and data sources for each variable are stated.

Section 5 presents the empirical analyses and discusses the results. Lastly, section 6 concludes the thesis and provides the implications of the findings.

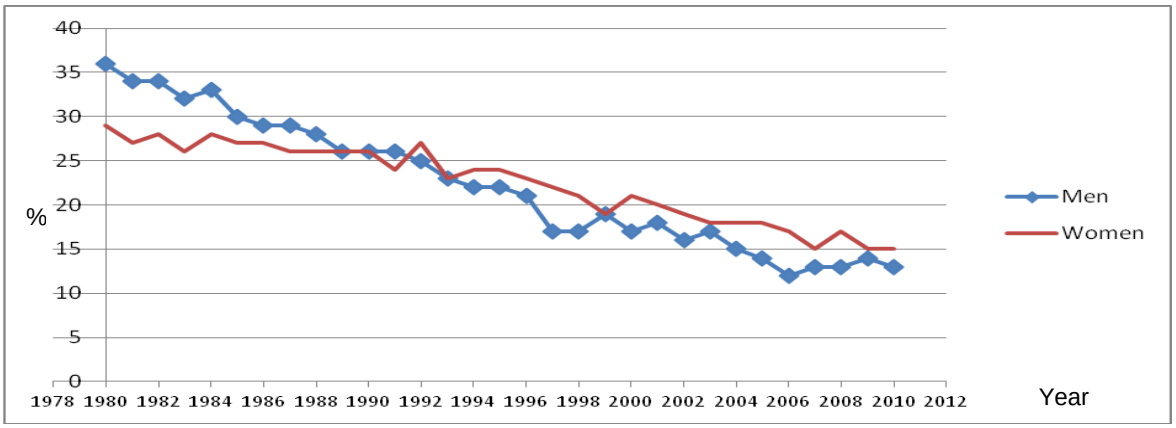
2. Swedish tobacco market and current tobacco polices in Sweden

2.1 Smoking prevalence in Sweden

Sweden has the lowest smoking prevalence in the European countries (Joossens and Raw, 2007) and it has been decreasing over time. Several studies have reported a decline of smoking rate in Sweden (e.g. Rosengren et al., 2000; Lindahl et al., 2003; Bostrom, 2006). Smoking rate in Sweden fell from 33% in 1980 to 19% in 2003. In addition, Sweden achieved to be the first European country to reach the World Health organization's limit of having less than 20% of daily cigarette smokers among the adult population by the year 2000 (Wallskar and Hjordisdotte, 2003).

One of the reasons why smoking rate declined more dramatically in Sweden compared to the other European countries is reported to be the unique availability of less harmful, smokeless tobacco, *snus* (oral moist snuff) which is mostly used by the Swedish men (Foulds et al., 2003).

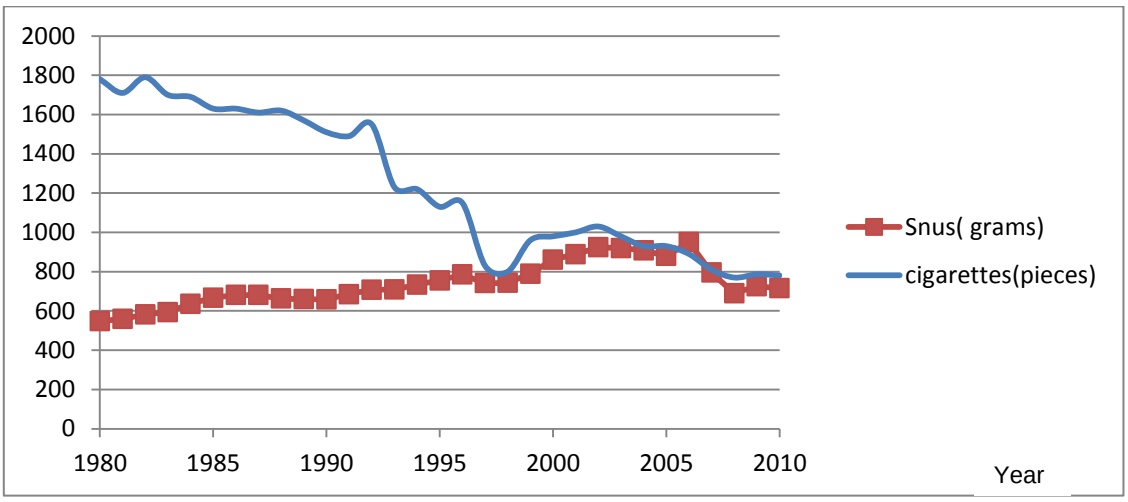
However, the snus use is traditionally common among the Swedish men while it is less common among the Swedish women. Only 3% of Swedish women use the snus while snus prevalence among the Swedish men is 18% (FHI, 2012). Since snus use in Sweden is more common in men than in women, men have less smoking prevalence than women. According to FHI (2012), 10% of Swedish men smoke daily while 12% of Swedish women are daily smokers. The trend of daily male and female smokers in the years between 1980-2010 is shown in figure 1.



Source: The Swedish Council for Information on Alcohol and Other Drugs (CAN) 2012

Figure 1. Daily smokers men and women (16-84 years old) 1980-2010

The Swedish snus, which is placed in the upper lips, is less harmful to health compared to cigarette smoking, and contains less harmful chemicals than other tobacco products; it does not cause cancers and respiratory diseases (Foulds et al., 2003). Study also shows that primary snus users are less likely to start smoking compared to non-primary snus users (Ramström and Foulds, 2006). Despite that Swedish snus has advantages over the cigarettes, it is not without harm. The snus can contribute to little increase of cardiovascular diseases. The snus also contains high amounts of nicotine which can lead to the snus users to develop addiction behavior (Foulds et al., 2003). Figure 2 shows the trend of yearly cigarette and snus sales per person in the years between1980-2010.



Source: The Swedish Council for Information on Alcohol and Other Drugs (CAN) 2012

Figure 2. Trends of yearly cigarette (peices) and snus (grams) sales per person older than 15 years 1980-2010

2.2 Swedish Tobacco policy

The Swedish tobacco policy is influenced by other international and regional tobacco policies. The main international and regional organizations that greatly influence Swedish tobacco policies are the World Health Organization, which is the primary influencer of Swedish control tools, the European Union(EU) and the European Network for Smoking Prevention. These organizations collaborate to produce recommendations, documents, and policies. When a document is eventually produced, it is presented to the countries. Afterwards, the countries, in this case Sweden, decide which documents or policies to adopt on a national level. There are also other non-governmental, local organizations and the media all trying to affect the policy makers' decision. Some of these organizations are anti-tobacco while others are pro-tobacco organizations (Jansson, 2005).

The major policies that Swedish Government uses to control the tobacco use are:

- Regulation policies
- Tax/price policies
- Cessation intervention and information campaign policies.

2.2.1 Regulatory policies

In order to limit the harmful effects of tobacco, the Swedish government has developed different tobacco control regulations at different times. In 1977 the Swedish government for the first time prohibited tobacco advertising and imposed mandatory warning labels and product labels on tobacco packages (Tobaksfakta, 2012). In 1993 The Swedish tobacco act was implemented replacing the earlier legislation on health warning and partial ban on tobacco advertising. The act was further strengthened in July 1994 by prohibiting the advertising of most types of tobacco products and banning on selling a pack of cigarettes containing less than 19 cigarettes. In 1997 the Swedish government set an age limit of 18 years for purchasing of tobacco goods. Additional restrictions of tobacco products were adopted in 2002. Among these restrictions include prohibition of indirect advertising of tobacco; this forbids marketing of any item such as clothes and shoes that carry tobacco product trademark. Again, the restriction act was strengthened in 2004 with the decision of the Swedish parliament by including some more restrictions such as banning of smoking in bars, restaurants and cafes as of June 2005 (Tobaksfakta, 2012).

Sweden ratified WHO Framework Convention on Tobacco Control in July 2005, which means that the Swedish tobacco laws should be harmonized with the minimum requirement of guidelines in WHO tobacco convention 2003. The amendment introduces stricter regulations on tobacco marketing and better control of that minors cannot purchase tobacco products. Outdoor advertising at point of sale is prohibited as well as sponsorship of events and activities to the general public that may lead to the sale of tobacco promotion (Tobaksfakta, 2010). In January 2008 Sweden introduced smoke free rules in prisons; that is, all inmates of the prison including the staff and prisoners were prohibited to smoke indoors to avoid risks of passive smoking and fires (Swedish prison and probation service, 2011). In addition, some Swedish municipalities introduced smoke free working environment which means that employees of these municipalities are not allowed to smoke during their paid working hours except the lunch hour which is the only time that the municipality employees

are allowed to smoke during the work. Swedish municipalities are among the biggest employers in Sweden and employ 800,000 employees which 80 percent of them are women. For that reason, smoke free working hours policy is an effective way that they can reach a large group of smokers. In January 2009, 67 municipalities out of the 290 municipalities in Sweden introduced smoke free working hours (Tobacco control, 2009).

2.2.2 Tax polices

Most of the countries in the world impose different kinds of taxes with different sizes on various kinds of tobacco goods. Countries have taxed tobacco goods for decades if not for centuries while the magnitude and structure of the tobacco tax has been changing over time (WHO, 2010).

Sweden like many other countries has long taxed tobacco products since 16th century for revenue and public health reasons (Swedish Tax Agency /Skatteverket, 2012). The excise tax on cigarettes and other tobacco goods contains two components: Specific rate per cigarette and percentage variable rate of the retail price (included the VAT tax) known as ad valorem tax. Today, tax is the largest component in the price of a packet of cigarettes comprising 72% of the retail price. Table 1 describes the breakup of selling price of a pack of cigarette in 2012.

Table 1. Break up of selling price of a pack of cigarette 2012

	SEK	**%**
Pre-Tax price	15.45	28%
Fixed tobacco tax (1.40 per cigarette)	28.00	51%
Variable tobacco tax (1% of retail price)	0.55	1%
VAT 25% of pre VAT price	11.00	20%
Consumer retail price	**55.00**	**100%**

Source: Swedish Tax Agency "*Skatteverket*" (2012)

The Swedish government increased tax on tobacco several times since 1990s. Two consecutive tax increases took place in December 1996 and in August 1997. As a result, the price of a packet of cigarettes rose by 43%. The price increase caused dramatic increase of cigarette smuggling and consequently the Swedish parliament in 1998 lowered the taxes to the level of July 1997 (Joossens, 1999).

From January 2011, ad valorem excise tax on tobacco was lowered and at the same time specific tax was increased. The reason is to prevent the manufacturers producing cheaper brands that make tax burden on consumers lower (Euromonitor internaltional, 2012).

2.2.3 Cessation intervention and information campaigns

Tobacco cessation intervention focused on those who want to quit tobacco use including cigarettes. Sweden developed intervention strategies during 1970s and 1980s. The most common interventions used in Sweden are self-help manuals, training of health care professionals, group cessation sessions at local health care facilities and easily available nicotine replacement therapies (NRT). Furthermore, Quit and Win campaigns have been launched and many cessation centers have been established around Sweden (Jansson, 2005).

Quitline services locally called as *Sluta Röka Linjen* (SRL) has been available since May 1988 (Tomsom, 2005). Quitlines are telephone based tobacco cession services that tobacco users can call to get individual consultations, tobacco cession services, assisters such as self-help manuals, free or low price Nicotine Replacement therapy (NRT) and referrals to other smoking cessation local programs (Jansson, 2005). In its earlier years, the Swedish quitline was receiving financial support from several local organizations including Swedish Cancer Society, Swedish National institute of public health, Swedish national pharmaceutics (*Apoteksbolaget*) and Swedish Lung and Heart Association. However, since 2004, the Swedish ministry for health and social affairs has financially been supporting SRL (Tomsom, 2005).

2.3 Cigarette smuggling

A considerable amount of cigarettes consumed in Sweden are smuggled from cheaper countries to Sweden through illegal channels. Price difference between cigarette market in Sweden and markets of some foreign countries attract the eyes of criminals and encourages them to bring illegal cigarettes from cheaper countries to Sweden; in addition, they avoid tax.

Despite the fact that cigarette prices in Sweden are high, the smuggling level of cigarettes was small and increasing gradually as prices of cigarette in Sweden increases. In 1996 a report from the Swedish national police estimated that the non-taxable cigarette market was 2% of the total cigarette market. The Swedish government increased tax on

cigarettes in December 1997 and in August 1998 which caused a rise in the price of a packet of cigarettes by 43% within eight months. In response to the increase in price, the number of smuggles seized by the Swedish custom authorities rose from 17 million cigarettes in 1996 to 39 million cigarettes in 1997. In 2003 the seizure reached its peaked level when 74 million cigarettes were seized by the Swedish custom authorities. In the year 2009 the customs police seized 57 million cigarettes corresponding to 98 million SEK in tax. The proportion of cigarettes that are not taxed accounts for 11% of the Swedish cigarette market (Arnberg and Junkka, 2011).

Illicit cigarettes in the Swedish market can be divided into two categories:

1. **Illicit Whites** are cigarettes with genuine brands and legally manufactured in other cheaper countries but illegally smuggled to Sweden and not taxed. These cigarettes are sold in the Swedish illicit market with prices below the legitimate cigarettes.

2. **Counterfeits** are cigarettes that are illegally manufactured by using fake, copy brands of some well-known companies. These cigarettes look more like the originals. Counterfeits are usually made in China and Eastern Europe and smuggled to Sweden. To illustrate, the majority of cigarette smuggles seized by the Swedish custom police in 2010 (more than 38.4 million) were *Counterfeits* (Arnberg and Junkka, 2011).

Cigarette smuggling undermines government policies on smoking. First the availability of cheap cigarettes through smuggle raises the overall consumption of cigarettes compared to when there are no cigarette smuggles. Second the problem of smuggling may discourage the government from raising tax on cigarettes (Joossens et al., 2000) as in the case of Sweden where in 1998 the government lowered the tax on cigarettes due to increased smuggling (Joossens, 1999).

3. Literature review

Since when the harmful health effects from smoking cigarettes has come to be greatly understood, cigarette consumption was a major focus on health economics. Thus, many researches have been done in many countries mostly relying on econometric analysis so that a broad literature on price impact on cigarette consumption exists. Nevertheless, the literature on Sweden is limited.

This section presents the most important findings of the previous literature on cigarette consumption and how it is affected by prices. The first part shows how increase in cigarette prices affects the demand for cigarettes, and the key variables used by the previous researches. The second part critically reviews the different models in the literature used to estimate the demand for addictive substances such as cigarettes and the last part of the section summarizes the key findings in the literature.

3.1 Estimating cigarette demand

One of the basic laws in economics is that normally the demand for a particular good is inversely related to its price and generates downward sloping demand curve. However, some previous researchers thought that demand for addictive goods like cigarettes does not follow this law of demand (Elster, 1979; Winston, 1980; Schelling, 1984). These researchers believed that the addictive behavior is irrational and consumers of addictive goods behave myopically. Yet, many other researchers have revealed that demand for addictive goods respond to price changes and other determinants of the demand (Lewit and Coate, 1982; Wasserman et al., 1991; Chaloupka and Warner, 2000).

Nevertheless, there is slight variation in the estimates of price elasticity of cigarette demand reported in the literature. Thus, different researchers have reported slightly different results. National Cancer Institute (1993) reviewed the studies on price elasticity of cigarette demand, both in US and internationally available at that time, and estimated it to be between -0.14 to -1.23 but mostly fall in the range between -0.3 to -0.5 which means that 10% increase in the price of cigarettes decreases the aggregate adult consumption of cigarettes by approximately 4%. Furthermore, the price elasticity of cigarette demand varies with age. For instance, Lewit and Coate (1982) estimated price elasticity of demand using united states data

from 1976 national health interview survey and found that youth are more sensitive to price changes in cigarettes than adults.

In addition, Wasserman et al. (1991) found that price elasticity of cigarette demand is higher in the long run than in the short run. Similarly, Keeler (1991) found that price responsiveness of cigarette consumption varies with the time trend. Price sensitivity of cigarette demand is not consistent for all countries; some studies have shown demand for cigarettes is more sensitive to the price in poorer countries than in richer countries (e.g. Warner, 1990; Xu, Hu and Keeler, 1998; Vander Merwe, 1998).

Demand for cigarettes does not only depend on its price but also depends on other variables that are needed to be taken into account when constructing a demand function for cigarette consumption. One of these variables that appears to have a significant effect on cigarette consumption is the income variable. Economists are not much interested in income elasticity of cigarette demand, but they use it as control variable when estimating price elasticity of cigarette demand which receives much attention from the economists and policy makers because of its relevance for the excise tax in cigarette consumption control (Kenkel, Schmeiser and Urban, 2012). Some earlier researchers of cigarette demand have argued that cigarettes are normal goods and show positive income elasticity (Ippolito et al., 1979; Fujii, 1980). On the other hand, later researches have shown that cigarettes are inferior goods and negatively respond to income changes (Townsend et al., 1994; Wasserman et al. 1991; Cheng and Kenkel 2010).

Another important variable that has an effect on cigarette consumption, as shown in previous researches, is the restriction of cigarette smoking on public places. For instance, Keeler et al. (1993) employed monthly time series data from California between 1980 to1990 and concluded that antismoking restrictions have significant negative effect on cigarette consumption.

Lastly, cigarette demand is also affected by the price of the related product and interdependence of cigarette with other goods. To illustrate, if price goes up the smokers may shift to other lower price tobacco goods that they can compensate their nicotine needs. Furthermore, due to recent knowledge of the harmful effects of smoking, the smokers may shift to other less harmful nicotine such as snus in the Swedish case. Hu et al. (1995a) noted

that estimate of the price elasticity might be relatively high given that they did not control for other tobacco control efforts.

3.2 Cigarette demand modeling

Early economic models of addictive goods ignored the addictive behavior of consumers. In contrast, others treated the addiction as irrational behavior and exception from the standard demand model. The standard demand model states that the increase in price of a good reduces the quantity demanded of that good. Researchers such as Elster (1979) Winston (1980) and Schelling (1984) argued that increase in price does not affect the demand for cigarettes because the smokers lack rational behavior in the sense that they cannot control their behavior.

In the past 30 years, economists have extensively researched the behavior of addictive product consumers including the smokers by using both theoretical and empirical models and developed economic models for addictive substances. These addictive economic models differ in their assumptions relating to the extent of consumer rationality. Based on their assumptions of consumer rationality, we can divide these models into three categories;

1. **Imperfectly rational model**: This model assumes that individuals' preferences are not consistent in their life cycle (See Elster (1979), McKenzie (1979), Winston (1980), and Schelling (1978, 1980, 1984)). According to Schelling (1978), the individuals have two opposite personalities; one farsighted personality that wants good health and long life and another short sighted personality that wants tobacco. This is how Schelling (1978) illustrates the smoker behavior in the imperfectly rational model:

   > "Everybody behaves like two people, one who wants clean lungs and long life and another who adores tobacco … . The two are in a continual contest for control; the 'straight' one often in commands most of the time, but the wayward one needing only to get occasional control to spoil the other's best laid plan."

2. **Myopic addiction model**: In this model, it is assumed that past consumption affects the current consumption through *"accumulated stock"* of past consumption and the individuals ignore future consequences of their current choices (Gorman 1967; Pollak 1970, 1976). The individuals in this model maximize their current utility which means that they ignore future disutility such as health problems and other future costs arising

from their current decision. Some theorists of myopic addiction model, namely, Young (1983) and Pekurinen (1989) noticed that the demand for cigarettes is more responsive to price reduction than price increase. In other words, the same absolute amount price change will increase demand more than decrease it. For that reason, Young (1983) and Pekurinen (1989) interpreted as proof for addiction.

According to Mullahy (1985), the myopic addiction model assumes that consumers with more *"accumulated stock"* (i.e., those who consumed more cigarettes in the past) are less price responsive than the consumers with less "accumulated stock" (i.e., those consumed less cigarettes in the past).

3. **Rational addiction model**; several economists have modeled addiction as a rational behavior. In this context, rationality means that individuals in the model include current, past and future consumptions in their utility maximization decision. In contrast to myopic model, this model rejects the concept that smokers behave myopically and that they do not consider the future consequences of their past and current consumptions (Stigler and Becker, 1977; Iannaccone, 1984; Becker and Murphy, 1988).

Some economists preferred rational addiction model over the myopic addiction model. For instance, Chaloupka (1988, 1990) employed data from National Health and Nutrition Examination Survey done in 1970s and found that cigarette consumption is addictive behavior and at the same time smokers do not behave in a myopic way. Becker et al. (1994) found similar findings using aggregate data from USA over the period 1950-1985. Several other researchers used data from different countries and supported the rational addiction model. To illustrate, data from USA (Keeler et al., 1993; Sung et al., 1994) data from Finland (Pekurinen, 1991) and data from Australia (Bardsley and Olekalns, 1998).

Although rational addiction model achieved great popularity among the economists and is the most widely used model for addictive substances in recent times, it is not without critics. Rational addiction is most widely criticized for its assumption of perfect rationality. For example, Akerlof (1991) criticizes rational model because it assumes that individuals are fully aware of the future consequences when making current choices.

3.3 Summary and conclusion of the literature review

The literature review has presented some previous important studies done on price effects on cigarette demand. It has also identified key variables needed to include when constructing cigarette demand model. The literature showed that price has a significant influence on cigarette consumption. The results of price elasticity of demand found by the previous studies fall between - 0.3 to -0.5.

Another important variable shown by the literature is the income variable. It was believed before that cigarette is normal good so that its demand increases as income increases but recent studies found that cigarette is inferior good that its demand decreases as income increases. Furthermore, the literature has shown that cigarette consumption is more common in poor and middle income countries than in rich countries. Most of the researches on cigarette demand use income as a control variable and treat it as an exogenous variable. Restriction regulation such as banning of smoking in public places is another important variable that can negatively affect cigarette consumption.

Lastly, economic models of addiction used by the previous studies in their estimation of cigarette demand have been reviewed. When estimating cigarette demand and other tobacco products, it is always important to consider the addictive nature of tobacco. Rational addiction model developed by Becker and Murphy (1988) seems to be most widely accepted model for tobacco demand estimation. Although the model has critics, several researchers have supported it and many studies have used it employing data from different countries such as USA, Australia, Finland and other countries.

4. Theoretical framework

To analyze the effect of price on cigarette consumption, rational addiction model of Becker et al. (1994) and the myopic model are used in this thesis. The assumptions and the derivation of rational addiction model are based on Becker et al. (1994) p.398. Rational addiction model assumes that the current consumption of addictive good is dependent on the past consumption. The model assumes also that individuals are "*rational*" and it considers the future costs of cigarettes such as the health disadvantages resulting from smoking.

$$U(t) = U(Y_t\,, C_t, C_{t-1}\,, e_t) \qquad (1)$$

Where C_t is the current consumption in period t, C_{t-1} is the past consumption in period *t*-1; Y_t is the consumption of the non-addictive composite goods and e_t represents "*the unmeasured life cycle variable*".

Becker et al. (1994) assumed that the utility function U(t) is concave and quadratic in Y_t , C_t and e_t, they further assumed that the individual maximizes life time utility and has the time preference rate which is equal to the market interest rate. The model assumes individuals to be "*infinite-lived*". Present value of wealth (A^0) is also ignored in this model.

$$max \sum_{t=1}^{\infty} \beta^{t-1} U(\, C_t, C_{t-1}\,, Y_t, e_t) \qquad (2)$$

$$\sum_{t=1}^{\infty} \beta^{t-1} (Y_t + P_t\, C_t) = A^0 \qquad (3)$$

Where $\beta = \frac{1}{1+r}$ with r being the discount rate.

By solving the first order condition with respect to Y_t and substituting the result in to the first order condition of C_t, Becker et al. (1994) derived a linear difference equation where the current cigarette consumption is determined by past consumption, future consumption, current prices and "*shift variables"*.

$$C_t = \emptyset_0 + \emptyset C_{t-1} + \beta \emptyset C_{t+1} + \emptyset_1 P_t + \emptyset_2\, e_t + \emptyset_3\, e_{t+1} \qquad (4)$$

Where C_t is the current consumption of addictive good at period t, C_{t-1} and C_{t+1} are respectively past and future consumption, P_t is the price of addictive good at time t; $\emptyset$ measures the effects of past consumption and future consumption on current consumption of addictive good; that is, the larger the value of $\emptyset$ the greater is the degree of addiction. Lastly, e_t and e_{t+1} are "shift variables" The detailed derivation of equation (3) and more discussions (see Becker et al., 1994, p. 398).

Equation (4) is the theoretical base of our econometric model that is used in the thesis.

If the lag term (C_{t-1}) is significant and the lead term (C_{t+1}) is not significant then the rational model is rejected, thus, myopic model is preferred. If lag and lead terms are both significant, the rational model is accepted.

5. Empirical analysis

5.1 Data description

Aggregate time series data from Sweden are employed in this thesis. The data were collected from "The Statistical Yearbook of Sweden" series produced by *Statistiska centralbyrån* / Swedish Statistics (SCB). As far as reliability is concerned, SCB is a reliable Swedish agency that collects data for further use of research, debates and decision making. Data series for most of the variables used in our model are available only on annual basis; therefore, the data employed in this thesis are arranged on yearly basis from 1970 to 2010.

5.2 Variables

The variables used in our empirical model are based on the basic rational model of Becker et al. (1994) discussed in the theoretical framework section of this thesis with in addition to other key variables shown by the literature review. This section gives definition of the variables.

Consumption: The total quantity of cigarettes (in pieces) taxed and legally sold in Sweden was divided by the total Swedish population older than 15 years of the corresponding year to get per capita cigarette consumption.

Price: Average retail price of cigarette price data is adjusted for inflation using corresponding consumer price index. The price data were deflated to real terms, using the local consumer price index (CPI). The price is measured in Swedish krona (SEK) per piece of cigarette.

Income: A total disposable income is divided by the total Swedish population. The income was then deflated using the CPI to get inflation adjusted. The income variable is measured in SEK/person.

Snus: The total quantity of snus (in grams) taxed and legally sold in Sweden was divided by the total Swedish population older than 15 years.

Regulation: This is dummy variable that takes the value of 1 the years there is regulation and 0 when there is negligible or no regulation.

Past consumption: One period lagged of current cigarette consumption to represent past cigarette consumption.

Future consumption: Is a one period lead of current consumption to represent future consumption.

The variables which are used in this model are summarized in table 2.

Table 2. Variables and expected signs

Variable	Describtion	Expected sign
Consum	Current cigarette consumption	
Pconsum	Past cigarette consumption	+
Fconsum	Future cigarette consumption	+
Price	Price	-
Reg	Regulation: Dummy variable	-
Income	Percapita Income	+
Snus	Snus	-

5.3 Empirical models

Model 1 is a rational addiction model. It is very similar to the basic rational model of Becker et al. (1994). We added shift variables to equation (4) that will be used for the remaining independent variables, namely, income, snus and regulation. Model 2 is the myopic version of equation (5) which means that future consumption variable is dropped.

Model 1:

$$Consum_t = \emptyset_0 + \emptyset_1 Pconsum_t + \emptyset_2 Fconsum_t + \emptyset_3 Price_t + \emptyset_4 Reg_t + \emptyset_5 Income_t + \emptyset_6 Snus_t + \varepsilon_t \quad (5)$$

Model 2:

$$Consum_t = \emptyset_0 + \emptyset_1 Pconsum_t + \emptyset_2 Price_t + \emptyset_3 Reg_t + \emptyset_4 Income_t + \emptyset_5 Snus_t + \varepsilon_t \quad (6)$$

5.4 Stationarity and cointegration tests

5.4.1 Unit root test

Aggregate time series data are in most cases none-stationary; therefore, it is important to do a stationary test or unit root test. The problem with non-stationary data is that a standard OLS regression can lead to spurious results that are most likely characterized by high R^2, highly autocorrelated residuals, low Durbin-Watson statistic and F-test of the regression coefficients may be very misleading (Granger and Newbold,1974). There are several methods to test for time series stationarity; the most popular one is Augmented Dickey-Fuller test (ADF) developed by Dickey and Fuller (1979). In ADF test, the null hypothesis is that the variable contains unit root, or the variable is not stationary, and the alternative is that the variable is stationary or has no unit roots. We first test for unit root at level; if unit root is found on levels then test is applied on first difference and second difference until we find no evidence of unit root.

The ADF test shows that the test statistics of all variables are greater than the critical value at level data therefore we fail to reject the null hypothesis and accept that all variables contain unit root at the level data. At the first difference, all variables have shown to have unit roots. At the second difference, no unit root was found in all variables.

Table 3. Results of Augmented Dickey-fuller unit root test

Variable	Unit root statistics level		First difference		Second difference		Degree of integration
	Test Statistics	Critical value	Test Statistics	Critical value	Test Statistics	Critical value	
Consum	0.248	-2.966	-2.357	-2.969	-5.160	-2.972	I(2)
Snus	-1.896	-2.966	-1.366	-2.969	-3.480	-2.972	I(2)
Price	1.483	-2.966	-2.550	-2.969	-6.040	-2.972	I(2)
Income	3.424	-2.966	-1.423	-2.969	-4.140	-2.972	I(2)
Pconsum	0.299	-2.969	-2.301	-2.972	-5.109	-2.975	I(2)
Fconsum	0.000	-2.969	-2.663	-2.972	-4.878	-2.975	I(2)

All critical values are at 1% significance level

5.4.2 Cointegration test

Augmented Dickey-Fuller test has shown that all variables have unit roots at levels and first differences. Our next step is to do a cointegration test and see whether the variables are cointegrated. If the variables are cointegrated then it is possible that a long-run equilibrium exists between these set of variables and we can avoid spurious regression so it is better to estimate the equation at level data. If the variables are not cointegrated we estimate equation at second difference.

Engle and Granger (1987) suggested a two-step process for cointegration analysis. First to regress OLS and get the residual and then to run unit root test on residuals using Dickey Fuller test. The null hypothesis is that there is no cointegration between the variables and the alternative hypothesis is that there is cointegration between the variables. We got an absolute value of t-statistics equal to 2.549 which is less than the absolute critical value of 2.975 at 5% significance level; therefore, we can reject the null hypothesis that there is no co-integration between the variables and conclude there is cointegration between our variables.

5.5 Results and discussions

This section presents the results of our regression model equation (5). The results are then interpreted and the significance of the regression coefficients is discussed. OLS regression was used to test price elasticity of cigarette demand. Therefore, in order for OLS estimators to be BLUE (best linear unbiased estimators) and meet the classical assumptions, our model is tested of misspecification errors, autocorrelation, multicollinearity and heteroskedasticity. STATA 11.0 program was used for the regression analysis and the model tests. Since we have added lag and lead variables to this model, two of the 41 observations have lost bringing down our observations to 39. The results are presented in Table 4.

The result of our regression gives us adjusted R^2 of 0.95 which means that 95% of the variation is explained by our model. The p-value is equal to 0.00 which suggests that our regression coefficients are jointly different from zero at 99.99% confidence level. In this regression analysis, all of the variables have the expected signs. Past consumption, price and income are significant and all their p-values are less than 0.05, therefore, we can reject the null hypothesis that each of these variables has no effect on cigarette consumption. Future consumption, snus and regulation are insignificant and their p-values are greater than 0.05;

thus, we cannot reject the null hypothesis that these variables have no effect on cigarette consumption.

Table 4. Results of OLS regression equation (5)

Variable	Coefficient	Std. Error	t-value	p-value
Constant	973.000	347.000	2.80	0.009
Pconsum	0.320	0.120	2.51	0.017
Fconsum	0.180	0.150	1.20	0.240
Price	-405.000	147.000	-2.75	0.010
Income	0.002	0.001	2.08	0.045
Snus	-0.240	0.200	-1.10	0.574
Reg	-196.679	125.000	-1.57	0.240

Adjusted R^2=0.95 Prob >F = 0.0000

5.5.1 Specification error test

One of the OLS assumptions is that the model is correctly specified and is free from specification errors such as omitted variables, adding irrelevant variables in to the model and incorrect functional form. To test the presence of these specification errors in our model, we have used Ramsey Regression Specification Error Test (RESET) developed by Ramsey (1969). The null hypothesis of this test is that there is no specification error in the model and alternative hypotheses is that the model has specification errors. The test has resulted a p-value of 0.067 which is greater than 0.05 at 5% significance level, so we cannot reject the null hypotheses and the test suggests that our model has no specification errors; in other words, the model is well specified.

5.5.2 Multicollinearity test

Multicollinearity is a problem that arises when two or more variables in the model are closely correlated to one another. Though multicollinearity does not cause bias to the estimates, it increases the standard errors of the coefficients which makes some variables statistically insignificant and leads to type II error. There are several tests for multicollinearity detection, but we use one of them in this thesis; that is, high variance inflation factors VIF which is the most popular test of multicollinearity test. Results of VIF test are summarized in the table below.

Table 5. Results of VIF test of multicollinearity

Variable	VIF	1/VIF
Price	58.18	0.017188
Snus	5.28	0.189496
Income	53.00	0.018866
Fconsum	17.99	0.055598
Pconsum	11.36	0.088031
Mean VIF	26.03	

The results of Table 5 shows mean VIF of 26.03 which is more than 10 and suggests that the model has multicollinearity problem. Multicollinearity is not a major problem as it does not lead to biased estimates and we can still interpret our estimated coefficients, yet, multicollinearity is somehow problem in our model since it increases standard errors and the inflated standard errors make some variables insignificant.

5.5.3 Serial correlation test

Serial correlation, also called autocorrelation, is when the variable is correlated with its self over various time intervals. In other words, we can say serial correlation exists if the error term is serially correlated. The problem of serial correlation is that the OLS estimates of the model will not be efficient, t-statistics will be overestimated and type I error increases. Time series data have the possibility to be affected by serial correlation problem and therefore must be tested for autocorrelation.

For the detection of serial correlation, Durbin Watson test is often used. However, since we have lagged dependent variable as an independent variable in our model, it is not appropriate to use this test; we instead use Durbin's Alternative test suggested by Durbin (1970) which is appropriate for autocorrelation testing of models with lagged independent variables. The null hypothesis of the test is that the regression has no serial correlation and the alternative hypothesis is that the regression has serial correlation. The test result shows a p-value of 0.0003 which is much less than 5%; therefore, we can reject the null hypothesis that our model has no serial correlation problem and conclude that the model has a serial correlation problem.

5.5.4 Heteroskedasticity test

Heteroskedasticity is when the variance of the error term is not constant and the presence of heteroskedasticity violates the OLS assumption that the variance has a constant error term (homoscedasticity). To test for presence of heteroskedasticity in our model, the Breusch-Pagan test has been used. The null hypothesis is that the error term has constant variance (homoscedasticity) and the alternative hypothesis is that the error term has no constant variance (heteroskedasticity). The test has resulted a p-value of 0.0635 which is more than 5%; therefore, we cannot reject the null hypothesis of homoscedasticity and accept that there is no heteroskedasticity problem in our model.

5.5.5 Regression estimation using Newey-West standard errors

Durbin's Alternative test in section 5.5.3 has detected that our model has an autocorrelation problem; therefore, it is important to correct the autocorrelation problem of our regression model. Autocorrelation may sometimes be due to specification errors and this kind of serial correlation is called impure serial correlation. However, as the RESET test in section 5.5.1 did not show any possibility of specification errors, the autocorrelation we have may be a pure in nature. The most common remedy for autocorrelation is the *Newey-West Standard errors*. We have employed this method and found the results shown in Table 6.

Table 6. OLS Regression results of equation (5) using Newey-West standard errors

Variable	Coefficient	Newey-West Std. Error	t-value	p-value
Constant	973.000	323.800	3.01	0.005
Fconsum	0.180	0.160	1.09	0.283
Pconsum	0.320	0.096	3.34	0.002
Price	-405.500	159.000	-2.55	0.016
Income	0.002	0.001	2.23	0.033
Snus	-0.24	0.180	-1.38	0.177
Reg	-196.000	121.000	-1.61	0.117

Adjusted R^2= 0.78 Prob > F= 0.0000

Since the OLS regression in Table 7 does not show other problems than multicollinearity, we can now interpret the estimated coefficients. Past consumption

positively affects current consumption and is significant while future consumption has positive effect on cigarette consumption and insignificant. Positive and significant past consumption implies that cigarette is addictive good. Additionally, the estimated coefficient of past consumption is greater than the estimated coefficient of future consumption which implies a myopic behavior, and hence rejecting the rational addiction model in favor of myopic model.

Since model 1 (rational model) is rejected, we now run the model 2 (myopic model) and compare the two models. The only difference between model 1 and model 2 is that in the later model Fconsum variable is dropped. See equation (6).

Table 7. OLS results of model 1 and model 2 using Newey-West standard errors

Regressors	**Model 1**		**Model 2**	
Cosntant	973.000 *	(323.8)	1264.000 **	(272)
Pconsum	0.320 **	(0.096)	0.390 **	(0.09)
Fconsum	0.180	(0.16)		
Price	-405.000 *	(159)	-482.000 **	(146)
Income	0.002 *	(0.001)	0.002 **	(0.00)
Snus	-0.240	(0.18)	-0.420 *	(0.2)
Reg	-196.000	(121)	-257.000 **	(89)

Standard errors in parenthesis **p< 0.01 *p<0.05

In both model 1 and model 2, all variables have the expected signs. Snus and regulation variables are not statistically significant in model1 while these two variables and all other variables are statistically significant in model 2. Price is also very significant in model 2. Overall, model 2 seems better than model 1.

5.5.6 Price elasticity estimates

Price elasticity is the measurement of how quantity demanded of good is affected by changes in the price of that good (in this case cigarette). If the good has elasticity of demand greater than 1, we say it has elastic demand, which means that quantity demanded is very responsive to price. Thus, if you increase the price by 1 percent, the quantity demanded decreases by more than 1 percent. If the elasticity is less than 1 in absolute value, we say that

it has inelastic demand and if it has an elasticity of exactly 1 we say that it has unit elastic demand.

Short run and long run price elasticity for cigarettes are estimated using the following formulas.

$$Short\ run\ elasticity = Slope\ of\ the\ price * (\frac{Average\ price}{Average\ quanitiy})$$

$$Long\ run\ elasticity = \left[\frac{Slope\ of\ the\ price}{(1 - Slope\ of\ the\ laged\ quantity) * (\frac{Average\ price}{Average\ quantity})}\right]$$

Using these formulas, the results in table (8) are derived. To illustrate, the short run elasticity coefficient of myopic model is -0.29 and long run elasticity coefficient is -0.47; that means the consumers' response to the change in price is low. Thus, for every 1% change in the price of cigarette, there is only a 0.29% to 0.47% change in quantity demanded in the short run and long run respectively. This result indicates that consumers did not respond much to the increase in price. This may be due to the fact that smoking is a form of addiction and smokers cannot easily withdraw from this habit.

Table 8. Demand elasticities of rational addiction and myopic models

Model	Short run elasticity	Long run elasticity
Rational addiction model	-0.24* (0.088)	-0.36* (0.068)
Myopic model	-0.29* (0.087)	-0.47* (0.084)

Standard errors in Parenthesis *p< 0.01

6. Conclusion and implications

Identifying the effects of increases in price on cigarette consumption is important for future government policies on tobacco use. As discussed in the first section of the thesis, the health problems and the negative externalities associated with the smoking may justify the government intervention of cigarette market. High price elasticity of cigarette demand may justify tax increase on cigarette consumption.

The aim of the analysis presented in this thesis was to investigate whether price increase can reduce cigarette consumption in the context of Sweden using aggregate time series data from 1970 to 2010. Several studies on cigarette demand have already shown that the price-elasticity of demand for cigarettes is negative and therefore, an increase of the cigarette price decreases the consumption of cigarettes. The findings of this study confirmed these results for the case of Sweden. The study shows that the price is statistically significant and has inverse relation to cigarette consumption.

Estimates from this study indicate short-run price-elasticity of -0.29 and the long run price elasticity of -0.47. The fact that demand is more price sensitive in the long-run than in the short run suggests that an increase of price could significantly reduce the cigarette consumption in the long run. Also, this finding is in line with previous empirical findings discussed in section 3.1 of this thesis.

This study has attempted to use rational addiction model to quantify the impact of price on consumption of cigarettes. Nevertheless, our finding rejects the rational model in favor of myopic model. The rational model is accepted when the estimated coefficient of the future consumption is positive, significant and has a reasonable value. However, the future consumption variable in our model is found to be insignificant; thus, myopic addiction was also employed in this study.

The Findings of this thesis clearly demonstrate that even though Swedish smokers show addictive behavior, they are still sensitive to changes in the price of cigarette implying that public policies that rise the full price of a cigarette to a consumer, for example a tax increase that raises prices by 10%, will reduce cigarette smoking by up to 2.9% in the short run and 4.7% in the long run.

Above all, the fact that the price elasticity is less than 1 implies that the percentage increase in prices would always be larger than the consumption response.

However, when governments are considering an increase in cigarette excise tax rates to increase price, they may need to consider that smokers may turn to smuggling and the magnitude of the problem may get worse. For example, as stated in section 2.3 this happened in Sweden when the government increased cigarette price through excise tax in 1997 and 1998 and consequently cigarette smuggling reached in its peak. Therefore, when implementing a tax increase, greater enforcement may need to be in place to prevent border-crossing smuggling of cigarettes so as to use taxation policy in an effective manner for smoking reduction and as well for increasing government revenue.

Government regulation of restricting cigarettes is statistically significant in the second model regression and thus smoking restrictions are likely to reduce smoking prevalence according to this study. Therefore, a government attempting to reduce per capita cigarette consumption in its jurisdiction may use smoking restrictions and regulation to control cigarette consumption.

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