

# **The effect of tobacco prices on tobacco sales:**

## **How much will increased prices decrease sales?**

A time series data analysis for Norway over the period 1996 - 2015

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# Abstract

The national aim of Norway is to achieve a totally tobacco free future. Tobacco is available to the consumers for a price. Increasing tobacco prices (through tax) is one of the most important strategies to reduce tobacco consumption as well as sales. This research analyze the effect of tobacco prices on tobacco sales with special focus on cigarettes covering the period 1996- 2015. The most popular and common way to explore the relationship between cigarettes prices and cigarettes sales is to compute the price elasticity. The study used an annual data series of a number of key variables including border trade and sales in tax-free shops to pursue an Ordinary Least Square (OLS) method. The results reveals that a 10% increase in domestic prices leads to a reduction in sales of about 9.6%. After including border trade and tax-free sales in the analysis the effect becomes 5.8%, which reflects the smaller effect of raising domestic prices. However, the effect of increasing domestic prices are still important.

## Keywords

Price elasticity, Cigarettes, Border Trade, Norway

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Jobaida Yeasmin Mili

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# List of Acronyms

CI	Confidence Intervals
CPI	Consumer Price Index
DOLS	Dinamic Ordinary Least Squares
FCTC	Framework Convention on Tobacco Control
GDP	Gross Domestic Product
OLS	Ordinary Least Square
S. error	Standard Error
SSB	Statistics Norway
WHO	World Health Organization



# Chapter 1: Introduction

Tobacco use and its negative impact on health, economy and society is one of the major global health challenges. More than five million people across the world die each year due to tobacco consumption. If this trend persists, it is estimated that tobacco will kill more than eight million world people each year by 2030 (Tobacco Control Program, World Bank, 2017). Smoking is well documented as being the single largest preventable cause of premature death. Therefore, from a health perspective, it is necessary to intervene and reduce the “anti-health” behavior of tobacco consumption to decrease the number of current and future tobacco-related global health challenge and death.

Like many other countries tobacco control program has always been remained a very important issue for Norway since 1965. Twenty eight per cent of its population is still smoking and seventeen per cent on a daily basis. More than 5000 Norwegian men and women die each year from smoking caused diseases (A tobacco-free future. National strategy for tobacco control, 2013-2016; regjeringen.no, 2013). To deal with this serious issue the Ministry of Health and Care Services launched its strategy in 2013 with a vision of a tobacco free future under the motto,

“Our vision is a tobacco-free future – a future in which individuals and communities are no longer affected by tobacco's many harmful effects on health and where children and adults live healthier and longer lives.”

Tobacco control strategy is the most important way of reducing tobacco use. The tobacco Act contains some policies such as a ban on smoking in public transport, public indoor environment (a complete ban on smoking in bars and restaurants since 2004 and designated smoking rooms were banned in 2014), a total ban on advertising, tobacco display ban, health warning on packages, prohibits the sales of tobacco products to minors under 18 years to decrease the tobacco consumption, to take forward the tobacco control strategy and to come closer to the vision (a tobacco-free future).

To support these health policies price increases and higher tobacco taxes work as instruments. The smoking restrictions and tax increases becomes even more comprehensive to fulfill the national strategy for tobacco control. It is only not in Norway, many other countries increase tax on tobacco to increase its price, presumably, to make tobacco so costly in order to reduce the tobacco use. The WHO (2010) stressed that “a significant increase in tobacco product taxes

and prices has been demonstrated to be the single most effective and cost-effective intervention for reducing tobacco use, particularly among the young and the poor”. Economic research clearly demonstrates that the demand for cigarettes and other tobacco products (for example snus-smokeless tobacco, hand rolled cigarettes etc.) is responsive to changes in prices and other factors (Chaloupka 1998).

For years Researchers/ Economists are interested to see how the economic factors affect tobacco consumption because the success in reducing tobacco consumption as well as sales can be contributed to the government’s tobacco control effort. Most of the studies are based on the relationship between cigarette price and cigarette demand. They have estimated cigarette demand equations by using diverse data, theoretical modeling, and empirical strategies. Majority of the economists found clear inverse relationship between the price of cigarettes and consumption of cigarettes (Tauras et. al 2016).

### **Objectives and Research Questions of the study:**

The objective of my study is to analyze the effect of tobacco prices on tobacco sales with special focus on cigarettes over, 1996- 2015.

The Research questions of this study is: What is the influence of cigarette prices on the sale of cigarettes?

Before explaining the procedure how I will answer my research question I am going to give some background and discuss why it is important to analyze the price elasticity of cigarettes.

### **Why is this an important question? And how to answer the question?**

The state’s aim is to achieve a totally tobacco free future. Tobacco is available to the consumers for a price. Increasing tobacco prices (through tax) is one of the most important strategies to reduce tobacco consumption and sale. It is necessary to understand the mechanism and the contributions of this procedure. Price elasticities of cigarette demand varies depending on the different price level. The price elasticities are monotonically increasing with the price in different states in the US (Tauras et al. 2016). Numerous studies have been performed on this issue both in developed and developing countries. Warner (1990) confirmed that cigarettes demand is more price responsive in developing countries than in developed countries given the low incomes and low cigarette consumption in developing countries. Price elasticities of tobacco among high income countries differ depending on their own purchasing power and

other factors. Therefore, it is best to have Norway's own elasticity estimates (Melberg 2007). Knowing this it is possible to influence the tobacco demand, more appropriately can reduce the demand. The findings of this study may be valuable to the policymakers who expecting cigarette taxes could reduce the cigarette sale. It could help them to figure out how big the price effect could be.

There are several possible ways to calculate the responsiveness of a product with price change. The fundamental base of economic theory is that if price increase (or decrease) of a product it will decrease (or increase) the consumption of that product. The most popular and common way to explore the relationship between price and consumption of a product is computing the price elasticity of demand (which explains how much demand will decrease if one increases price by 1%). To answer my research question I used an econometric estimation with 20 years annual data where cigarettes sales is explained by a number of key variables. The final results of this study come through the Ordinary Least Square (OLS) method.

### **Organizations of the study**

The rest of this study is organized as follows. In chapter two I explain the background information of the tobacco sales. A literature review on previous research done on this field highlights in chapter three. Fourth, I present the data construction process and data sources of my dataset. I go through the methodology (statistical analysis) in chapter five. I provide the results and discussion of my analysis in chapter six. In chapter seven I include some special cases. Finally, my thesis ended with the conclusion in chapter eight.

## Chapter 2: Background

Tobacco consumption is an epidemic that kills a lots of present and future life (A tobacco-free future, National strategy for tobacco control, 2013-2016; regjeringen.no, 2013). Every country has its own unique and distinct tobacco epidemic. So it is better to know the tobacco situation within the country. For example, some countries may have border trade facilities or it is possible for the people to substitute one tobacco product with others (Wilkins et al. 2003). Norway has the border trade facilities with Sweden and Finland and it is also possible to buy cigarettes from tax free shop. It is specified that in 2005 every fourth cigarettes which is smoked in Norway was bought in abroad (Melberg 2007). Since the early 1990s the unregistered cigarettes and tobacco consumption has been increased, especially in the years 1997-2001 the amount is accounted for about a quarter of total consumption. It is revealed that 11% was purchased in Sweden, 5% in Denmark, and 9% in other foreign countries and 1% was smuggled into the country (Lund 2004). A recent study by KPMG (2016) confirmed that a 12% of total cigarettes consumption in Norway comes from Sweden.

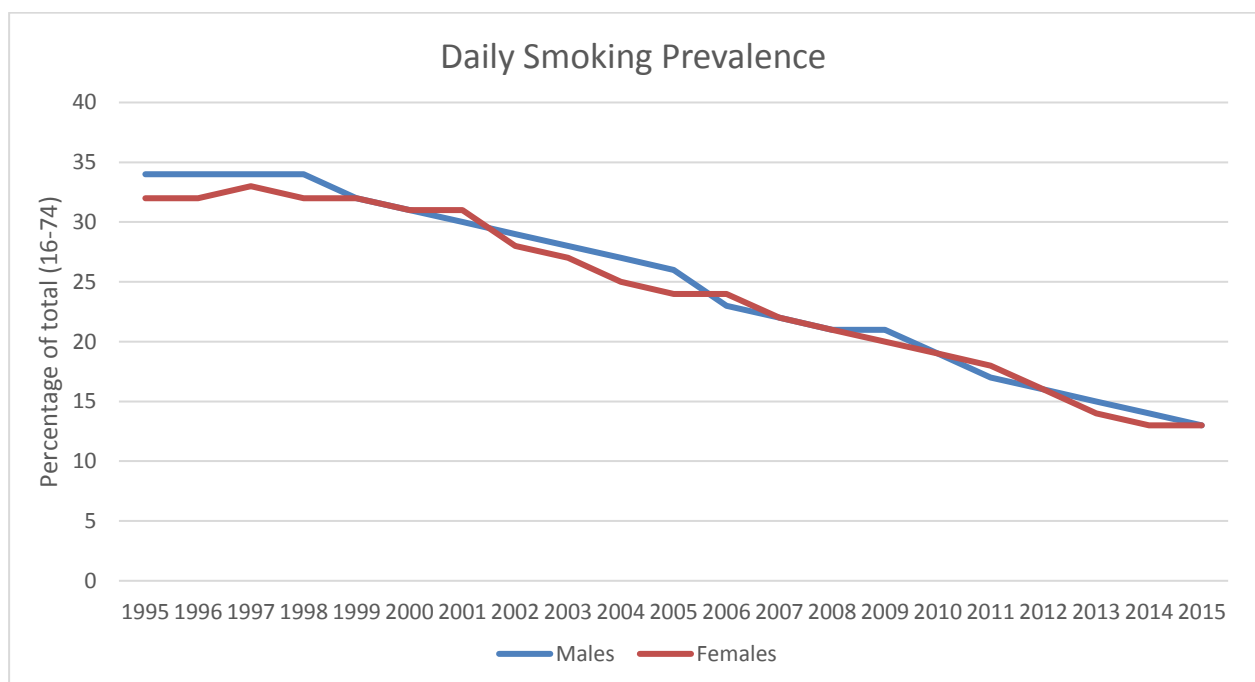
On the other hand snus has become a popular alternative of cigarettes because of its user-friendly nature, e.g. it can be used in smoke free places and it is comparatively cheaper than cigarettes. Moreover, it comes in a variety of flavors such as mint and eucalyptus and packed in small pouches (like a tea bag) which is presented in graceful and colorful tin boxes. People also believe that snus has less harmful nicotine than cigarettes. The increasing use of snus (especially among young adults) has recently become a headache for the Norwegian health authorities. To ensure a tobacco-free future the central goal is to eliminate of tobacco use in all its forms, whatever it is cigarettes or snus or hand rolled cigarettes. A large number of studies have examined the effect of cigarettes prices on cigarettes consumption and these studies consistently find that higher cigarettes prices (which can be raised by increasing tax) is associated with lower cigarettes consumption (Conner 2014, Levy et al. 2000, Chaloupka and Wechsler 1997) . Findings suggests that price increase on cigarettes is an effective policy to quit or reduce smoking and may stops others from starting. However, it has also been argued that in some countries the price level is so high that further price increases will not have a large effect. Because of this it is important and interesting to investigate the price elasticity in Norway since it has a high price level already.



## 2.1 A brief history on tobacco use in Norway:

Tobacco harms the health, economy, and moreover the spirit of Norway. According to the Directorate of Health, the socio- economic costs of smoking is 8 or 80 billion Norwegian kroner per year, whether one estimates only the costs of health care or costs for the society as a whole. Smoking kills more than 5000 of its population in each year and approximately 350-550 persons die from passive smoking every year. The daily smoking prevalence has declined sharply from 1995 to 2015 (figure 2.1). About 13% of the population smoked daily and 9% smoked occasionally (16-74 years old) in 2015 while it was 33% for daily smokers and 13% for occasional smokers for the same age group in 1995. In 2015, there was virtually no difference between men and women when it was accounted for daily smoking but the rate was 10% for men and 8% for women in the case of occasional smoking.

**Figure 2.1 Daily smoking prevalence among men and women, aged 16-74, 1995-2015**

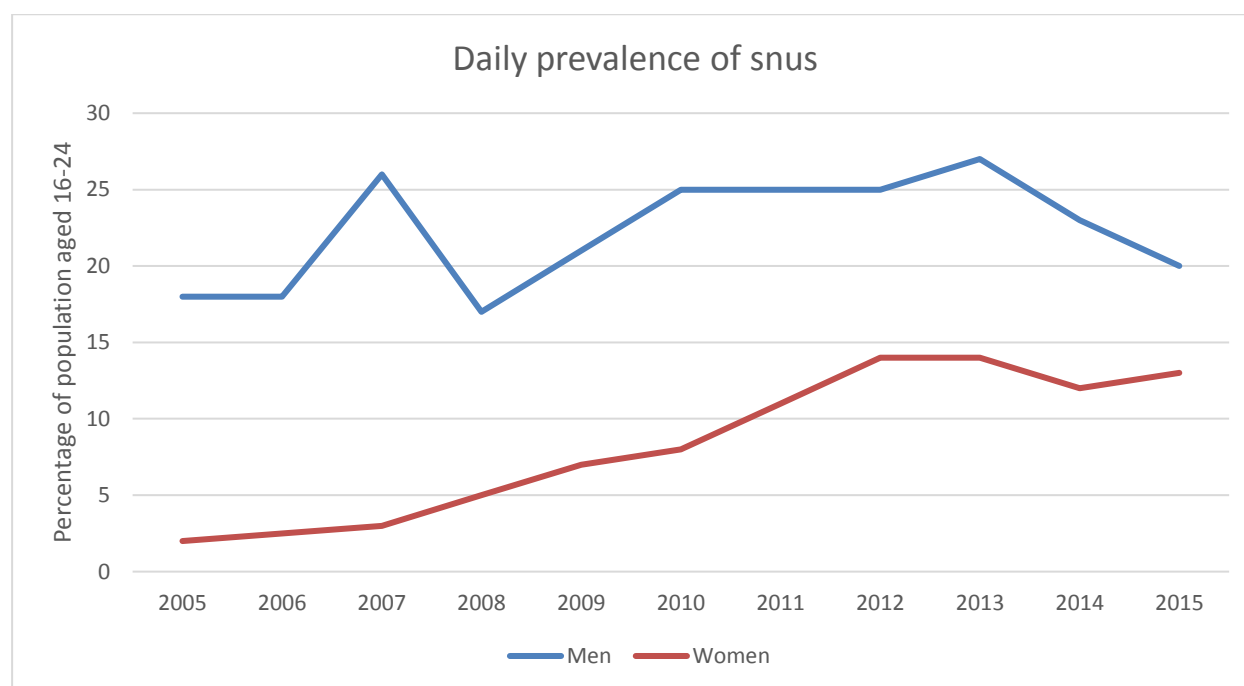


Source: Statistics Norway, Table: 05307

Recently the Norwegian health authorities become concerned about the increasing trend of snus use (especially among the young). In 2015, 17% of the population (aged 16-24) used snus in a daily basis while the rate was 10% of the population in 2005 for the same age group. In 2015, 20% of men used snus daily and 11% occasionally, which gives a total of 31% snus users (16-24 years). Women aged 16-24, daily users were 13% and occasional snus users were 5% at the

same year. Among men aged 16-24, 18% used snus daily in 2005 compared to 2% of women for same age group. In addition, 17 % of men and 7 % of women used snus occasionally. However, the fact is that snus use has an increasing trend in the case of women in recent years (figure 2.2).

**Figure 2.2 Prevalence of daily snus use among men and women, aged 16-24, 2005-2015**



Source: Statistics Norway, Table 07664 and 07692

## 2.2 Tobacco control status in Norway

With a long history (since 1960s) of tobacco control, Norway has become a leading example of many other countries. Norway was the first country to ratify the WHO Framework Convention on Tobacco Control (FCTC) on 16 June 2003. According to the WHO (2010) “Norway was one of the first countries to enact a comprehensive tobacco control act that consequently led to a decline in smoking prevalence.” The country ranked third (among 31 European countries) based on a scale for tobacco control measures suggested by the World Bank (Association of European Cancer Leagues' Tobacco Control Scale 2010) in 2010 (<<A tobacco-free future. National strategy for tobacco control, 2013–2016>> regjeringen.no). Sweden and the United Kingdom has lower smoking prevalence than in Norway. The Norwegian government wants to be best in the world in the case of tobacco control. In 2010, the Norwegian Ministry of Health

and Care Services requested the WHO experts in order to do an assessment of the tobacco control efforts of the country. The evaluation had both positive and negative results. Keeping in mind the challenges and the key recommendations by the WHO experts the Norwegian government set the following goals for the year 2016,

- Prevent young people from taking up smoking and snus use
- Motivate and provide assistance for snus and smoking cessation
- Protecting the population and society against the harmful effects of tobacco

## **2.3 Norwegian Tobacco Control Policy**

The use of regulatory measure and economic policy instrument has been proven as a measure of limiting and preventing tobacco damage and consumption. The objectives of the Norwegian tobacco control policy is:

- To prevent the onset of tobacco use by young people,
- To provide tobacco users with help and motivation to quit, and
- To protect third parties from exposure to tobacco smoke and tobacco use.

(<https://helsedirektoratet.no/english/tobacco-control#norway's-tobacco-control-strategy>).

To achieve these objectives the authorities follows the following policies:

Restrictive measures – legislation, Tobacco cessation, Mass media campaigns, Prevention programs and Tax/price policies. Through the restrictions, it is possible to restrict the access to and demand of tobacco products. In addition to tax policy and restrictions, mass media campaign has always been a strong a measure to prevent more people to quit or taking up smoking and snus use. I introduced some of the legislative measure in chapter one. Here I am presenting the economic policy instrument-tax.

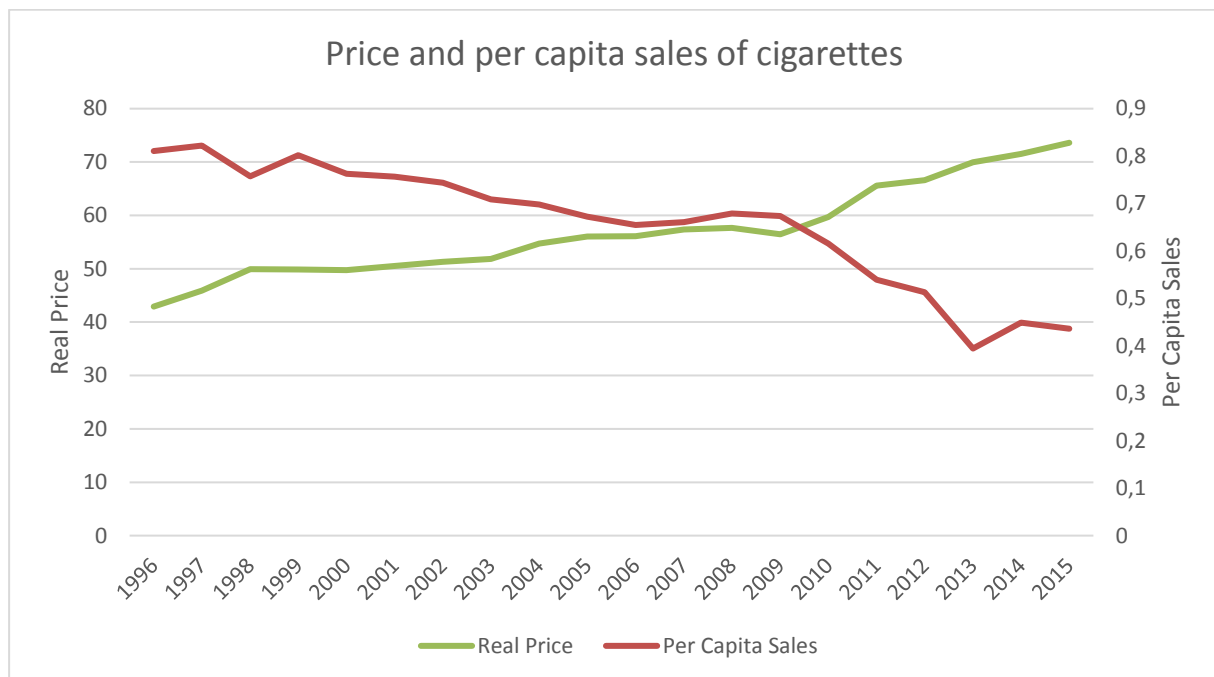
### **2.3.1 Economic Policy Instruments**

Many countries of the world impose different kinds of tax on different kinds of tobacco products, while the size and magnitude of tax are changing over time. Norway has a long tradition of using taxation as a tobacco control policy. Since 1915 there has been a special tax (specific excise tax) on tobacco. The rationale of tax policy is to reduce tobacco consumption because when price rises demand fall despite of its addictive nature. In 2012, tobacco tax and VAT rate was 73% of the retail price of the tobacco product (<<A tobacco-free future. National strategy for tobacco control, 2013–2016>> regjeringen.no). People with little education and low income is highly responsive to tax. Evidence from the international studies show that the young are quite sensitive to the cigarettes price increase. For example, Chaloupka (1997), found the price elasticity of cigarettes smoking participation of the US young -0.66. This is also true for Norway. The Norwegian young are two to three times more price sensitive than the adults. The SIRUS (2007) confirmed that an increase of 10 per cent in retail price of tobacco will lead to a reduction of overall consumption by 5% and young consumption by around 15%.

## **2.4 A brief overview of tobacco price and sales relationship**

In Norway, the price of cigarettes has gradually been increasing over time. As shown in figure (2.3a) the real price (adjusted for inflation, base year 1998) of cigarettes increased significantly between 1996 and 2015. Over the whole period price increased by 71.51%, so it is expected to be a fall in sales in cigarettes. From the figure we can see that cigarettes sale decreased overtime and the overall cigarettes sale reduced by 46.2%. The trend declined sharply since 2010. This could happened because of the higher price increase at the same time. To see this one may think that price does not have a strong effect on cigarettes sales. But the fact is that may be the effect of some other factors could offset the price effect at the same period, e.g. income and price and demand of a substitute product of cigarettes and the addictive nature of human. Generally higher income influences the demand of a product so as for cigarettes.

**Figure 2.3a: Trend of Real Price and Per capita sales of Cigarettes, 1996-2015**



As I stated before that snus (smokeless tobacco) has become a popular alternative of cigarettes in Norway. From the figure 2.3b we can see that over the whole period (1996-2015) snus had an increasing trend of sales even if price also increased at the same period. In this period price increased by 83% and sales increased by 201%. The dashing elegant design of snus box and the user friendly appearances make snus comfortable to young adult. Consequently snus sales increased at a high rate. Both income and addictive nature also influence the snus sales. Before concluding the fact that increase price will decrease the sales, one must take into account other factors too.

**Figure 2.3b Trend of Real Price and Per capita Sales of Snus, 1996-2015**

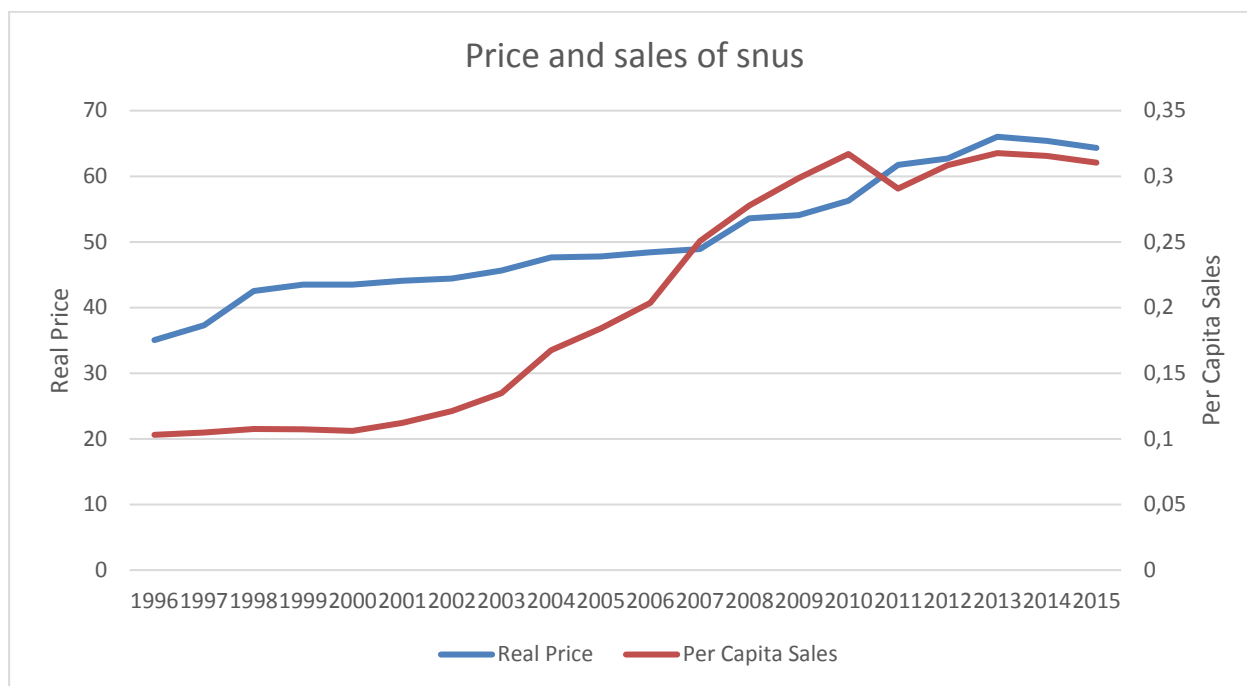


Figure 2.4 displays an overall picture of cigarettes and snus sale from 1996 to 2015. Over the whole period we see that cigarettes sale has steadily been decreasing since 1996, while snus sale has an increasing trend at the same path. The confirmation of the increasing trend of snus has become the burning issue for the government currently to achieve the tobacco free future.

**Figure 2.4 Trend of annual Cigarettes and Snus sales in kilo, 1996-2015**

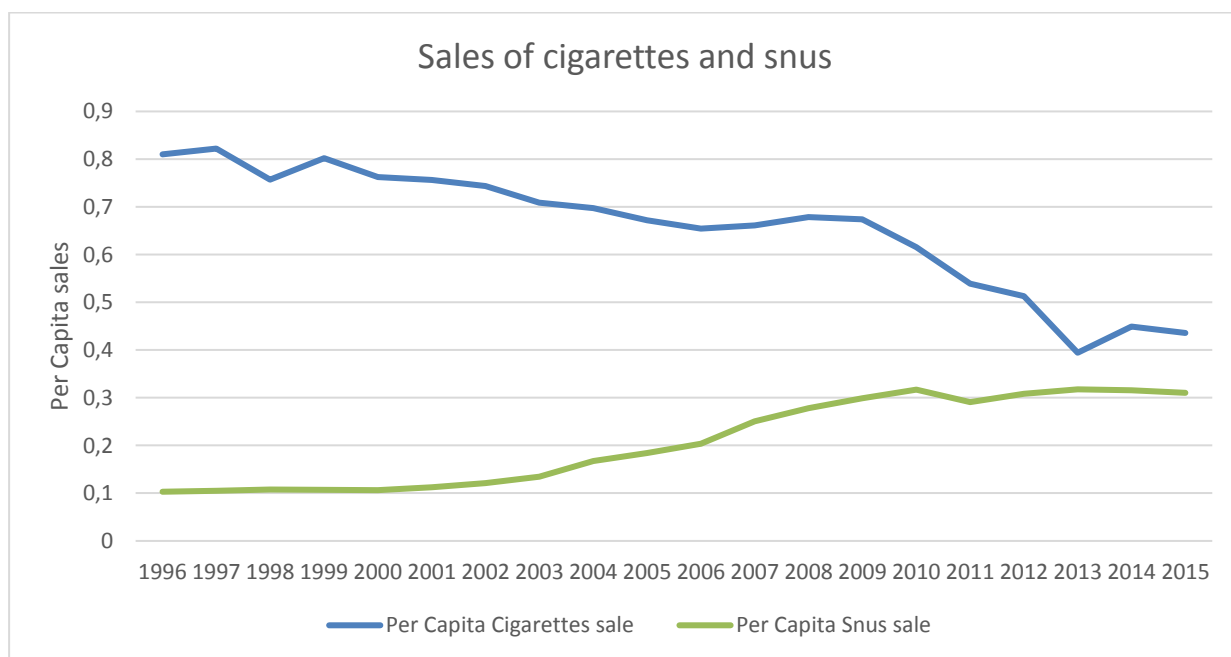
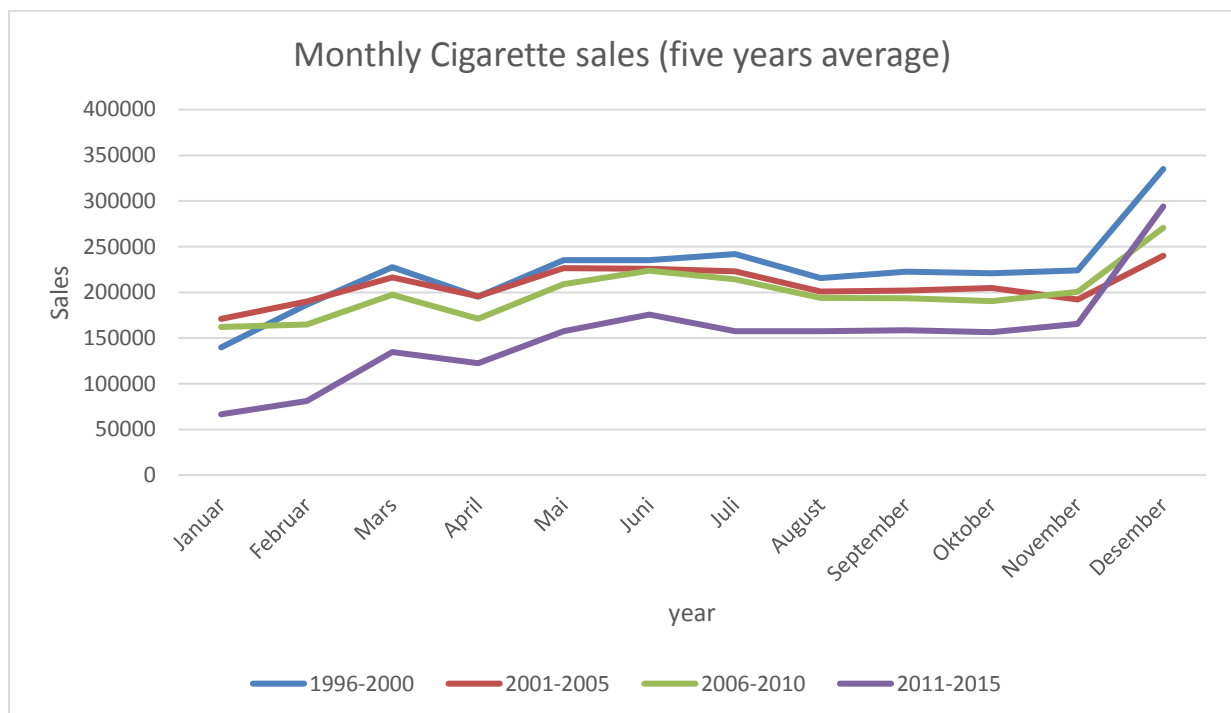


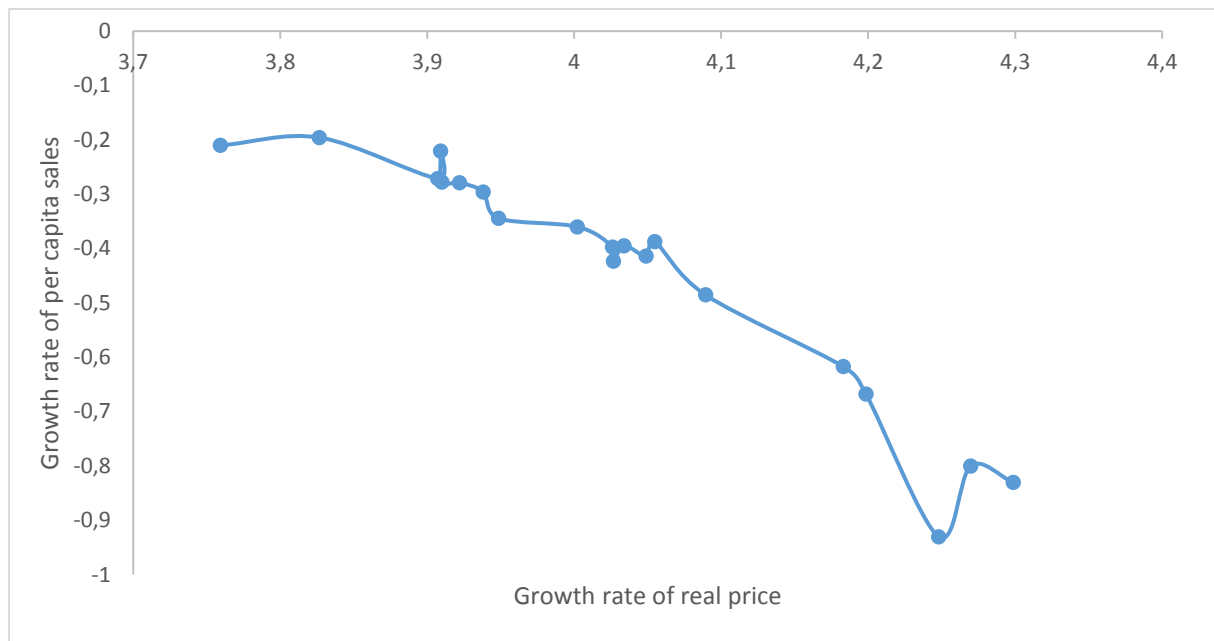
Figure 2.5 presents the monthly trend of cigarettes sales covering the period from 1996 to 2015 with a five years average. The sales in January were quite small in each and every year, while the sales increased sharply in November to December. This is the effect of tax because everybody wants to avoid the tax effect (which lead to price increase), so that they buy extra many cigarettes in order to build up a stock of cigarettes for future use before a price increase comes.

**Figure 2.5 Monthly trend of Cigarettes sales, 1996-2015**



The following figure (2.6) shows the relationship between the growth rate of real price and growth rate of per capita sales of cigarettes. The figure depicts an inverse relationship between price and sales. The downward sloping curve confirm that the more the growth rate of price increase the more the growth rate of per capita sales decrease.

**Figure 2.6 Relationship between growth rate of real price of cigarettes and growth rate of per capita sales, 1996-2015**



Chapter 2 is an orientation of the tobacco history of Norway and the background information of the price and tobacco sales relationship. In this section I present a brief history on tobacco use in Norway, Tobacco control status in Norway, Norwegian Tobacco control policy, and a brief overview of tobacco price and sales relationship. I will go on with the literature review in the following chapter.



## Chapter 3: Literature Review

In this section I conducted a literature review focusing on the theoretical frameworks and the empirical findings of other researchers on this topic. The simple cigarettes demand model will be presented in the first part and then I will provide the empirical studies. Since the objective of the study is to analyse the effect of tobacco prices on tobacco sales, investigating results found by other researchers provided the fundament to compare my results with the previous research work.

### 3.1 Theory

Regarding the theoretical basis of modeling tobacco demand, it gets a special attention because of its addictive nature. The standard / traditional demand model for many goods says that if price goes up then its demand fall. Researchers such as Winston (1980) and Schelling (1984) argued that smokers do not behave rationally because they could not control themselves from the addictive nature. As a result tax or price increase on tobacco consumption has less impact in comparison to other consumption good. In contrast, a large number of recent studies confirms that cigarettes demand indeed has a negative relationship with price.

The traditional model does not include the habit or addiction, saying that consumption is affected by the same year price. The functional form of this model is,

$$Q_t = b_0 + b_1P_t + b_2Y_t + b_3T_t + b_4SR_t + b_5D_m + \varepsilon_t \dots \dots (1)$$

Where:  $Q_t$  = per capita consumption of cigarettes per adult in year  $t$

$P_t$  = weighted average real retail price per cigarette in year  $t$

$Y_t$  = real personal disposable income per adult in year  $t$

$T_t$  = time trend variable in year  $t$

$SR_t$  = index of smoking restrictions in year  $t$

$D_m$  = an intercept dummy for the introduction of an intensive “smoking or health” information campaign in year  $m$ ; 0 prior to year  $m$ , 1 from year  $m$  onwards

$\varepsilon_t$  = error term

(Source: Wilkins et al. 2003)

But for the case of cigarettes, if the price is lower and consumption is higher in a particular year, it will make many addicted. Consequently the consumption could be high in the following year even if increase price. So it is necessary to capture the addictive nature during tobacco demand modeling. One can do this by adding last year price or consumption. Now the addictive economic models treated as myopic (e.g. Pollack 1970) and rational addiction (Becker and Murphy, 1988). The myopic (meaning short-sighted) addiction model based on short-sighted addictive behavior. The model says that current addictive consumption decisions depend not only on current but also last year's consumption or last year's prices. The model can be represented as the following equation,

$$Q_t = b_0 + b_1P_t + b_2Y_t + b_3T_t + b_4SR_t + b_5D_m + b_6P_{t-1} + \epsilon_t \dots\dots\dots (2)$$

Where:  $P_{t-1}$  = weighted average real retail price per cigarette in year  $t-1$

All other variables the same as for Equation (1).

Where myopic model ignored future implications when making current decisions, the rational model goes further with a contrasting assumption. The model argues that anticipated future price change affect the current consumption decision, meaning that people look forward. If they expect a future price change they will adjust their consumption depending on the price change (permanent or temporary). If the price change is temporary it will make an increase in the demand because they will build a stock of cigarettes for future consumption to avoid the price increase. On the other hand if the price change is permanent it will lead to reduce the consumption because rational consumers want to get rid of a habit that will become even more expensive in future (Melberg 2007). Both situation shows the importance of including future expected price while modeling current cigarettes demand. The functional form of the model,

$$Q_t = b_0 + b_1P_t + b_2Y_t + b_3T_t + b_4SR_t + b_5D_n + b_6P_{t-1} + b_7P_{t+1} + \epsilon_t \dots\dots\dots (3)$$

Where:  $P_{t-1}$  = weighted average real retail price per cigarette in year  $t-1$

$P_{t+1}$  = weighted average real retail price per cigarette in year year  $t+1$

All other variables the same as for Equation (1).

In short, we have three theatrical model for cigarettes demand modeling,

- The traditional model: current year price is important for the current quantity demanded.
- The myopic model: both current year and previous years price is important for current consumption/ demand.
- The rational addiction model: last year, this year and expected future price is important for demand.

These three models will be the theoretical basis of my thesis to explore the research question.

### **3.2 Review of empirical studies**

Using a multiple regression analysis methods, Melberg (2007) summarize the econometric findings on the relationship between the price and sales of tobacco in Norway. The study used time series data from 1985 to 2005 and included previously ignored variables e.g. border trade and sales in tax-free shops. The author confirmed that working with such data are easy and understandable. The author used three different kinds of models: traditional, habit formation (vanedanningsmodell) and rational addiction model to make the results more specific and precise as all of these model has its own assumptions. The logarithmic model was being used in this study. The results of this study confirmed that a 10% increase in domestic prices leads to a 4.6% reduction in consumption after accounting for border trade. The effect was about 10% when the variable was ignored. The study finally conclude that domestic prices still are important but the effect becomes smaller when it considered border trade and sales in tax-free shops in the analysis. Melberg (2007) also reported that he could not clearly see which age group of population were more affected by the interventions as the study used time series data not individual level data.

Fernaández et al. (2004) analyzed the effect of price of cigarettes on tobacco consumption (The price elasticity of demand for cigarettes) in Spain using data from 1965 to 2000. The study used a multiple regression analysis to examine how the cigarette consumption is influenced by price (average price of 20 cigarettes - blond, black, and the average of these two) and income. They used a single log-linear equation in order to estimate the price elasticity of demand for cigarettes:

$$\log Q_t = \beta_0 + \beta_1 \log P_t + \beta_2 \log Y_t + E_t \quad [t=1965-2000]$$

Where,  $q_t$  measures average cigarette consumption per adult per day,  $P_t$  denotes real price of cigarettes,  $Y_t$  is for annual per capita GDP and  $E_t$  is the random error. The coefficient  $\beta_1$  and  $\beta_2$  depicts the price and income elasticity respectively.

Their investigation results revealed that a 1% increase in price leads to a 0.19% decrease of consumption (price elasticity of  $-0.19$ ;  $P < 0.01$ ) when it was accounted for total consumption. The price elasticity for blond cigarettes was  $-1.25$  and  $-0.61$  for black and both were significant.

A Mexican studies by Chávez et al. (2010) found that if cigarette prices increase 10% it could reduce consumption in 2.5% ( $p < 0.05$ ). The study used a Quarterly time series of consumption, price and income between 1994 and 2005. Both Ordinary Least Squares (OLS) (for long-run demand model) and Dinamic Ordinary Least Squares (DOLS) (to correct for potential endogeneity of independent variables and autocorrelation of the residuals) were performed in this analysis. The study ended with the conclusion that an increase in taxes could increase cigarette prices which could reduce cigarettes consumption.

Chaloupka and Wechsler (1997) estimated the effect of cigarette prices and other tobacco control policies on cigarette smoking among the US youth and young adults. The investigated result of this study specified a negative and statistically significant impact on smoking. The US College students are quite price sensitive. The study confirmed that higher cigarette excise taxes would increase the cigarettes prices and which would result in the reduction of cigarette consumption.

Conner (2014) estimated the effect of price on smoking by using a large panel dataset which includes low/middle income countries. The ultimate goal of this study was to estimate the price elasticity of tobacco demand between and within countries. To do so the study used a within-between estimator and a first difference model. Final result came with an elasticity of  $-0.19$  across countries, meaning that a 10% increase in price reduced consumption by  $-1.9\%$ . The study did not find a within country effect.

A recently published US studies by Tauras et al. (2016) examined the price elasticity of cigarette demand at different price levels. The study used aggregate state-level data from the year 1991 to 2012. By using GLM (generalized linear models) with log link and gamma distribution (to estimate cigarette demand equations) they found that the absolute value of the price elasticity of demand monotonically increased with the price. They used four different types of models by

adding some new variables in each model. The average price elasticity of demand in Models 1, 2, 3, and 4 are -0.77, -0.66, -0.65, and -0.73.

Jha and Chaloupka (2000) reviewed a numbers of studies from high income countries and from low income and middle income countries and they found that higher tobacco prices significantly and consistently reduce tobacco consumption. A 10% increase in prices would reduce smoking of about 4% in high income countries and by about 8% is accounted for low income and middle income countries.

Gallet and List (2003) performed a meta-analysis of elasticities of cigarettes demand. They reviewed 86 studies on price elasticity of cigarettes demand over the period 1960 to 2001 and concluded that the mean price elasticity across these studies was -0.48, meaning that a 10% increase in price followed by a 4.8% decrease in cigarettes consumption.

Chaloupka et al. (2010) reported the price elasticity of cigarettes demand was in the range from -0.25 to -0.5 after revising more than 100 studies from industrialized countries. The magnitude implied that a 10% increase in the price of cigarettes leads to a reduction of cigarette consumption by between 2.5% and 5.0%. They also confirmed that the consumption reduction was even larger in the low and middle income countries by the same price increase.

**Table 1. Price elasticities of cigarettes demand found by previous studies**

<b>Researcher</b>	<b>Elasticity</b>	<b>Country</b>
Chaloupka (1998)	from -0.3 to -0.5.	Meta-analysis
Ahmed and Vaziri (2014)	Short-run price-elasticity - 0.29 and the long run price elasticity -0.47.	Sweden
Shin and Seo (2013)	-0.38 ~ -0.49	Korea
Chaloupka et al(2010)	from -0.25 to -0.50	Meta-analysis; from industrialized countries
Melberg (2007)	-0.46	Norway
Conner (2014)	-0.19	Low/middle income countries
Tauras et al. (2016)	-0.77, -0.66, -0.65, and -0.73 in different models	USA
Chávez R et al. (2010)	-0.25	Mexico
Fernández et al. (2004)	-0.19	Spain
Gallet and List (2003)	-0.48	Meta-analysis
Jha and Chaloupka (2000)	-0.40 in high income countries and -0.80 in low and middle income countries	Meta-analysis
Czubek and Johal (2010)	elasticity estimates ranging between -1.17 and -0.92	UK
IARC ( 2011)	-0.6 and -0.2	USA
Kennedy et al. (2015)	-1.8	Ireland

The estimated price elasticities of cigarettes demand found in previous literature varied depending on the time period examined, the inclusion/exclusion of different explanatory variables, data and finally the estimation methods.

## Chapter 4: Data description

The traditional demand model depicts that the quantity demanded of a product basically depends on its own price, price of a substitute good, income and some other factors. The main focus of this research is the price elasticity of cigarettes. It is difficult to include all possible variables in a demand analysis. I tried to include the most important variables here. For this purpose the data used in this paper are the annual observations of sales and price of tobacco (cigarettes and snus) and some other key variables. I used aggregate time series data of 20 years for Norway covering the period 1996- 2015 in my analysis.

### 4.1 Dependent Variable

The dependent variable chosen here is the per-capita cigarette sales. The sales data has been obtained from the Norwegian Directorate of Customs and Excise, which is converted to per-capita sales using the annual population estimates (over the age of 17) from the Statistics Norway (ssb.no). In order to get per capita cigarette sales the total quantity of cigarettes (in kilo) is divided by the total population older than 17 years of the corresponding year.

### 4.2 Independent Variables

**Real prices of cigarettes:** The price data is collected from the Statistics Norway. The data is adjusted for inflation using the corresponding CPI (Consumer Price Index: base year 1998, source: ssb.no). The price data deflated to real terms by dividing nominal cigarette price index by CPI.

**Real individual income:** Income is one of the most important variable for influencing demand. So that I include this variable in my analysis. GDP per capita is collected from the Statistics Norway (ssb.no). The income then deflated by the CPI to get real income.

**Real prices of snus:** the price of substitute good is also important for demand of a product. For example, if snus price increase is relatively lower than cigarettes then people may switched to snus. Consequently price effect of cigarettes will become less. Keeping this in mind I include the real price of snus in my model. The price data deflated to real terms by dividing nominal snus price index by CPI. Snus price data is originally obtained from the Norwegian shop Rimi. I choose Rimi as a representative of the shops because it covers my study period. I did not get snus price data before 1996 anywhere. Besides this some of the other shops started after 1996

and some of the shops had missing price data for some years. As a result Rimi become the most reliable data source.

**Past Price:** is the one period lagged of current cigarette price.

**Future Price:** is a one period lead of current price.

**Table 2. Summary of the variables**

Variable	Description	Source
Cigarettes sale	Total sales ÷ people over 17 years	Norwegian Directorate of Customs and Excise, Statistics Norway
Real prices of cigarettes	Nominal cigarettes price ÷ CPI (1998 =100)	Statistics Norway
Real income	GDP per capita ÷ CPI (1998= 100)	Statistics Norway
Real prices of snus	Nominal snus Prices ÷ CPI (1998= 100)	Statistics Norway
Past price	One period lagged of current cigarette price	
Future price	One period lead of current price.	



# Chapter 5: Methodology

## 5.1 Empirical Model

It is difficult to capture all possible important variable in the case of demand specification. If an important variable is omitted it may affect the analysis by giving biased regression estimates. To avoid the omitted trend several statistical method can be used. One of the easiest way is to analyze the changes from year to year. In a time series analysis, most of the cases the data also become stationary after using changes from year to year. However, it is not possible to see price- sales connection every year while the possibility is to see the correlation between price changes and sales changes from year to year. A log- log model is also useful to do such analysis, where both the dependent and independent variables are log transformed. The interpretation of such model is, an expected percentage change in dependent variable when independent variable increases by some percentage. Such relationships, where both variables are log-transformed, commonly known as elastic in econometrics, and the coefficient of the log independent variable is referred to as an elasticity (Benoit 2011). However, one drawback of using such (double log) model is that it carries the concept of constant price elasticities, which may not be a valid assumption for time series data (Wilkins et al. 2003). I would not expect this drawback in my analysis (the case of Norwegian cigarette consumption) because of the variables – income, price of substitute product of cigarettes (snus) all have an impact on consumers' responsiveness to price changes. I would rather expect the price elasticities will vary over time.

In this research I used three different models (such as, traditional model, myopic model and rational addiction model) to analyze the effect of prices on cigarette sales. Model 1 is a traditional model which is very similar to the model of Wilkins et al. (2003) with some modification. Per capita cigarettes sales is my dependent variable and I used real price of cigarettes, real price of snus and real income as independent variables. Model 2 is the myopic version of model 1 where I included lag price as an independent variable. In model 3 I additionally included future price as an independent variable, the rest of the variables are same as model 2. The model is known as rational addiction model. By investigating the previous literature on price elasticity of tobacco I found that some of the researchers used last and next year's price (e.g. Melberg 2007) to capture the addiction and expectation effect, while the others used last year's and next year's consumption (e.g. Ahmed and Vaziri 2014). The originally developed model take account of consumption not price but there were some statistical problem

using consumption as a variable. To avoid this problem past and future price variables can be used as an indicator for past and future consumption, since both of the prices directly affect consumption respectively (Becker et al. 1990). Finally I used Ordinary Least Square (OLS) Method to estimate the models.

## 5.2 The Choice of Functional Form

The specification of the models are straightforward where cigarettes sales is a function of own price, price of substitute goods and income. The functional form is expressed as follows:

**Cigarettes sales = f (Price of cigarettes, snus price, income, lag price of cigarettes, lead price of cigarettes).**

To determine the functional form of the models I have taken logarithms of both dependent and independent variables which is known as Double-log or log-log functional form.

### Model 1:

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 \ln \text{Snus } P_t + \varepsilon_t \dots \dots \dots (4)$$

Where,  $Q_t$  = per capita sales of cigarettes in time period  $t$

$P_t$  = real price of cigarettes in time period  $t$

$Y_t$  = real income in time period  $t$

$\text{Snus } P_t$  = real price of snus in time period  $t$

$\varepsilon_t$  = error term.

### Model 2:

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 \ln \text{Snus } P_t + b_4 \ln P_{t-1} + \varepsilon_t \dots \dots \dots (5)$$

$P_{t-1}$  = real price of cigarettes in time period  $t-1$

### Model 3:

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 \ln \text{Snus } P_t + b_4 \ln P_{t-1} + b_5 P_{t+1} + \varepsilon_t \dots \dots \dots (6)$$

The coefficients  $b_1$ ,  $b_2$ ,  $b_3$ ,  $b_4$  and  $b_5$  are the respective regression parameters.

**Table 3. Coefficients of the variables and expected signs**

Coefficients	Expected sign
$b_1$ : coefficient of cigarettes price	-
$b_2$ : coefficient of income	+
$b_3$ : coefficient of snus price	+
$b_4$ : coefficient of previous price	-
$b_5$ : coefficient of future price	-

The co-efficient of  $\ln P_t$  is expected to be negative while the coefficients of  $\ln Y_t$  and  $\ln \text{Snus } P_t$  are expected to be positive. This is in line with the traditional demand theory, the quantity demand decreases if price increase and the quantity demand increase if income increases. On the other hand, if the price of substitute good increases the quantity demand will also increase.

## Chapter 6: Results and Discussion

As I described before there are several models (traditional model, myopic model and rational addiction model) can be used to calculate the impact of price changes on cigarettes sales. Finally the study used OLS estimation method to explore how the numbers are different depending on the models (to see a clear picture of the models). I estimated both level models and change models to explore the results. In the level model my data were non stationary based on the unit root test (unit root test result will be presented in appendix). The data become stationary after doing a difference. After this the OLS estimation proceeds. The test results are shown in tables 4 and 5.

The explanatory power ( $R^2$ ) of these models are reported as 92%, 95% and 95% respectively in table 4. It is a statistical measure which has a fairly straightforward meaning; how much of the variability of a factor/ model can be explained by other factors. The higher the value the better the fit of the model indicates a better regression (Newbold et al. 2013). In my models  $R^2$  shows the amount of how much of the change in cigarettes sales can be explained by the variables used in the models and according to the value, the models are fitted well. The Durbin-Watson Test (d is the test statistic) is conducted to test the residuals from a linear regression are independent. The value of d is approximately 2 (Newbold et al. 2013). The test indicated that my models do not have any significant autocorrelation problem. The traditional model has a d-value of 1.51 which is significant at 1% level. The other two models have the d value of 2.02 and 2.51 respectively which is significant both 1% and 5% level. P-value shows the significance of the test results. The significance indicates that how uncertain one is about a factor affecting the cigarettes sales. Higher value indicates considerable uncertainty while the lower value confirms very little risk that the relationship between the variables would be caused by random associations. Results from the table shows that cigarettes sales falls by between 18.0% and 19.3% when prices rise by 10%. Considering the results from these three model one can see that the price effect is quite similar in the traditional model (19.1%) and in the myopic model (19.3%). The effect is less in the rational addiction model (18.0%). But the difference is not that much major compare to the others two. The estimates of the cigarettes price coefficient are both economically and statistically significant in all of these models at different significance level (1% and 5%). The estimated co-efficient of snus price and income indicate positive relationship with cigarettes sales. That means if snus price increases, it will put upward pressure

on the cigarettes demand. On the other hand increasing income will also increase cigarettes sales.

**Table 4: Regression Results (from log-log model), Dependent Variable: Cigarettes sales (price elasticity is highlighted)**

	Model 1 Traditional Model		Model 2 Myopic Model		Model 3 Rational Addiction Model	
	Coefficient	S. error	Coefficient	S. error	Coefficient	S. error
Price of Cigarettes	-1.91	0.5206***	-1.93	0.5722***	-1.8	0.7358**
Price of Snus	0.16	0.4546	0.01	0.3895	0.35	0.4502
Income	0.26	0.1773	0.24	0.1616	0.32	0.1722*
Last year cigarettes price			0.11	0.4655	-0.15	0.4949
Next year cigarettes price					-0.44	0.4603
R <sup>2</sup> (Explanation power)	0.92		0.95		0.95	
Durbin-Watson (d)	1.51		2.02		2.51	
Number of Observations	20		19		18	

Level of significance: \*10%, \*\*5%, \*\*\*1%

Conclusion from the results is that price has a significant effect on cigarettes sales when we control for income and price of snus in the regression analysis.

**Table 5: Regression Results (taking “d” (change) in the models), Dependent Variable: Cigarette sales (price elasticity is highlighted)**

	Model 1 Traditional Model		Model 2 Myopic Model		Model 3 Rational Addiction Model	
	Coefficient	S. error	Coefficient	S. error	Coefficient	S. error
Price of Cigarettes	-0.97	0.7994	-1.22	0.8073	-0.96	0.9606
Price of Snus	-0.22	0.6340	-0.30	0.6293	-0.57	0.8066
Income	0.05	0.3397	-0.01	0.3346	-0.13	0.4047
Last year cigarettes price			0.58	0.5980	0.44	0.6580
Next year cigarettes price					-0.70	0.8930
R <sup>2</sup> (Explanation power)	0.21		0.32		0.36	
Durbin-Watson (d)	2.44		2.41		2.32	
Number of Observations	19		18		17	

Level of significance: \*10%, \*\*5%, \*\*\*1%

From table 5 we can see that the sign of the co-efficient of cigarettes price is negative in all of these three models: traditional, myopic and rational addiction, meaning an inverse relationship between cigarettes sales and cigarettes price. The results confirm that cigarettes sales reduced by between 9.6% and 12.2% with a 10% increase in price. The result is expected and economically important, but there is some uncertainty since not all the results are statistically significant. According to the result the value of the co-efficient of cigarettes price is high enough to say that cigarettes sales is highly dependent on domestic prices. This is also confirmed from the table 4. Another Norwegian study by Melberg (2007) also reported that domestic prices are important to reduce tobacco consumption or sales but the effect becomes smaller when he accounted for border trade and sales in tax-free shops in his analysis.

## **Chapter 7: Some Special Cases**

### **7.1 What about buying Cigarettes from duty free shop and abroad?**

Calculating the price elasticity of cigarettes sales in Norway does only not depend on registered sales in Norway. Investigations have shown that since early 1990s, tax-free shopping, border trade or smuggling of tobacco has been on the rise (Lund 2004). It is also specified that in 2005 every fourth cigarettes which is smoked here in Norway was bought in abroad. The Norwegian people can bring up to 200 cigarettes or 200 grams of other tobacco product (snus or rolled cigarettes) from abroad without paying a toll. In 1980s the Norwegians' purchases of tobacco in Sweden was small because price difference were small at that time. According to the Norwegian Institute of Public Health (Folkehelseinstituttet) (2016) tobacco products were 51% cheaper in Sweden in 2011. Every year a high number of Norwegian travel especially to Sweden to take advantage of cheaper goods. The increased amount of cigarettes inflows from Sweden is a reflection of wide average price gap between Norway and Sweden and the gap is about €5.16 for a packet of 20 cigarettes (KPMG 2016). In 2015, 12% of total cigarettes consumption in Norway was being Swedish (KPMG 2016). During the period 2011-2015 the Norwegian smokers reported in a survey that 20% of their cigarettes consumption comes from Sweden or Denmark (Folkehelseinstituttet, 2016). The smokers also reported that 19% of their cigarettes were being free travel import for the same period of time. The amount is approximately more than double compared to early 1990s (Folkehelseinstituttet, 2016). This is because of the increased foreign trips by the Norwegian. SIRUS (become Folkehelseinstitutte from 2016) calculated that the average duty free sale of tobacco in 2010 and 2011 at Norwegian airports were approximately 16% of domestic sales and additional 4% were traded free of charge from ferries in foreign voyages. According to KPMG (2016) 28% of non-domestic cigarettes in Norway come from Duty Free sources in 2015. There are no detailed data on how much cigarettes smuggled into Norway rather than the seizure amount captured by the customs and excise authorities. The amount varies year to year, but the average amount for the period 2012-2015 were 10 ton (Folkehelseinstituttet, 2016).

The effect of domestic price change can only shows the reduction of domestic sales, it does not mean that consumption will also reduce by the same amount. The price elasticity of cigarettes consumption will be less than price elasticity in respect to sales because people can buy cigarettes from tax-free shop, border and from smuggling. It is therefore important to take into

account the unregistered consumption of cigarettes before saying something about the importance of the price effect to reduce the total cigarettes sales. In order to get a better picture of price effect on cigarettes sales it is wise to add tax free sales along with border trade and domestic sales. I have not include the unregistered consumption in table 4 and 5.

One of the problem of considering border trade is that it is difficult to figure out how much tobacco actually the Norwegian people bought from unregistered sources. However it is possible to get a piece of solution from the annual smoking surveys of Statistics Norway. In this survey (included from 1990 to 2014) they asked the daily smokers about the country of origin of the latest (for last-night) cigarette consumption. By 2015 they conducted another survey by questioning about the sources of supply. The study has taken into account the percentage of cigarettes smoked in last- night bought in Norway, Sweden, Denmark, tax-free shop, elsewhere abroad, internet or other. The survey confirmed that an even smaller proportion of cigarettes bought in Norway. The amount has become just under 60% in 2015 while it was 90% in 1990.

Table 6 and 7 shows that the effect of domestic prices falls when unregistered consumption is included in the model. Here I used the percentage of border purchase come into Norway as an independent variable. For example, according to the annual smoking surveys of Statistics Norway in 1997 the amount was 15%, meaning that this amount came from Sweden, Denmark, tax-free shop, and elsewhere abroad.



**Table 6: Regression results, dependent variable: Cigarettes sales (price elasticity is highlighted from level model), including border trade and tax-free sales in the analysis.**

	Model 1 Traditional Model		Model 2 Myopic Model		Model 3 Rational Addiction Model	
	Coefficient	S. error	Coefficient	S. error	Coefficient	S. error
Price of Cigarettes	-1.76	0.42***	-1.75	0.57***	-1.74	0.74**
Price of Snus	-0.07	0.37	-0.07	0.38	0.23	0.47
Income	0.17	0.15	0.17	0.17	0.26	0.19
Border trade and tax-free sales	0.09	0.07	0.09	0.07	0.07	0.08
Last year cigarettes price			-0.01	0.46	-0.19	0.50
Next year cigarettes price					-0.32	0.48
R <sup>2</sup> (Explanation power)	0.96		0.96		0.95	
Durbin-Watson (d)	2.28		2.41		2.67	
Number of Observations	19		19		18	

Level of significance: \*10%, \*\*5%, \*\*\*1%

Results from the above table (6) shows that cigarettes sales falls by between 17.4% and 17.6% when domestic prices rise by 10% while it was between 18.0% and 19.3% in table (4).

**Table 7: Regression results, dependent variable: Cigarettes Sales (price elasticity is highlighted from “d” models), including border trade and tax-free sales in the analysis.**

	Model 1 Traditional Model		Model 2 Myopic Model		Model 3 Rational Addiction Model	
	Coefficient	S. error	Coefficient	S. error	Coefficient	S. error
Price of Cigarettes	-1.09	0.84	-1.09	0.84	-0.58	1.02
Price of Snus	-0.48	0.73	-0.59	0.74	-1.18	0.99
Income	0.0007	0.34	-0.02	0.34	-0.24	0.42
Border trade and tax-free sales	0.06	0.08	0.06	0.08	0.10	0.09
Last year cigarettes price			0.59	0.61	0.41	0.66
Next year cigarettes price					-0.96	0.93
R <sup>2</sup> (Explanation power)	0.31		0.36		0.42	
Durbin-Watson (d)	2.70		2.40		2.18	
Number of Observations	18		18		17	

Level of significance: \*10%, \*\*5%, \*\*\*1%

At the same time findings from table (7) confirms that a 10% increase in domestic prices would reduce cigarettes sale by about 5.8% while it was 9.6% in table (5). The results indicate that the importance of domestic price rise in Norway (in order to reduce cigarettes sale) somehow become limited when border purchase is accounted. However, findings from these tables (4, 5, 6 and 7) denotes that domestic price increase is still important to reduce sales of cigarettes.

## **7.2 What about considering smoking restrictions in Norway**

To prevent the harmful effect of tobacco and to regulate the sale and consumption of tobacco the country has adopted tobacco control act since 1973. Two of the regulations got more attention – one is the smoking bans in bars and restaurants which is implemented since 2004 and have had a major impact on declining the number of smokers. The second one is a visible display ban on tobacco products which is in power since 2010 (<<A tobacco-free future. National strategy for tobacco control, 2013–2016>> regjeringen.no). The display ban played an important role to reduce the amount of smokers. It is expected that ban could be inversely related with cigarettes consumption and sale. Keeping this in mind I included these two legislative variables in my analysis in a way that variables go from 0 to 2. “1” is for the law came in 2004 and “2” is for the law came in 2010. The findings of the analysis indicate that the price elasticity of cigarettes sale fall by between 5.5% and 8.8% after including legislative variables along with border trade in the cigarettes sales equation. It removes some of the price effect from the analysis.

## **7.3 Summary and Evaluation of the results**

The estimated results (price elasticities) for cigarettes sales in different analysis of this study are presented in table 8. The results confirm that it is very important to pay attention to the border trade and tax-free sales. Firstly, the results depict that price effect reduced significantly in almost all of the models when considering border trade and tax-free sales.

**Table 8: Summary of price elasticities found in the analysis**

	Traditional Model	Myopic Model	Rational Addiction Model
Price elasticity of cigarettes (level model); only Norway	-1.91	-1.93	-1.8
Price elasticity of cigarettes; considering Norway, tax-free shop and border trade (level model)	-1.76	-1.75	-1.74
Price elasticity of cigarettes (change model); only Norway	-0.97	-1.22	-0.96
Price elasticity of cigarettes; considering Norway, tax-free shop and border trade (change model)	-1.09	-1.09	-0.58

Based on my data and analysis I found the price elasticities of cigarettes (considering level model and only Norwegian sales) -1.91, -1.93, -1.8 and -0.97, -1.22, -0.96 (considering change model and only Norwegian sales) respectively in traditional, myopic and rational addiction model. At first glance these figures seem to be bigger but not surprising because another Norwegian study by Wangen and Biørn (2001) estimated that if prices for cigarettes increases 1% , consumption will decrease by 1.7% by using a different data set and method than my study. Melberg (2007) found tobacco (cigarettes + rolled tobacco) price elasticity of about 10% without considering unregistered sales. He also found that cigarettes sales reduced by between 6.0% and 7.7% with a 10% increase in price without border shopping. His study period (from 1985 to 2005) and data are different than mine. My results presented in the above table also confirmed that cigarettes price elasticities reduced after accounting for border trade. However, Cigarettes prices in Norway have increased over time. That is why price elasticities varies among the studies. According to Tauras et al. 2016, “the absolute value of the price elasticity of demand monotonically increases with price”.

A review of the results confirm the expected sign of the last year's and next year's price in the rational addiction model (in the case of level model) whenever border purchase has included or excluded. However, I am not concentrating in level models result because my data was non-stationary here as I discussed before. According to the results in Rational Addiction model

(when taking “d”) next year's price seem to be important to explain changes in demand. The explanation could be like if anyone expect a permanent price increase in coming years the demand will decline. Because a rational consumer wants to avoid the product which is expected to be expensive in future. Based on the results I could say current year's and next year's price changes give a negative impact on sales in the same year and next year.

There may be reason to prefer the results in the Rational Addiction model in Table 7. The reason behind putting most emphasis on the results are, it shows the importance of future price effect on explaining changes in sales, and they take into account both domestic sales and border trade. The other two models also do the same but the net price effect is better in Rational Addiction model.

#### **7.4 How certain are we about the estimates?**

Every statistical analysis deals with some uncertainty. That's why it is just not enough to report only the estimated result found in the analysis (price elasticity analysis). One should say something about how much certainty this results have. Besides this, reporting limitations are also important. So that may be a small change would make the results even better.

However, one way is to measure the uncertainty associated with the estimated price elasticities are to create confidence intervals (CI) for them. Confidence intervals likely to have an upper limit and lower limit of price effect on cigarettes sales or consumption. One could only be safe calculating such a limit if he has many observations or if the data has little variations.

The following figures (7.1) and (7.2) presents the confidence intervals for the price effect for all of the models analyzed in this study.

**Figure 7.1: Confidence intervals (95%) for the price elasticities of the different models (level)**

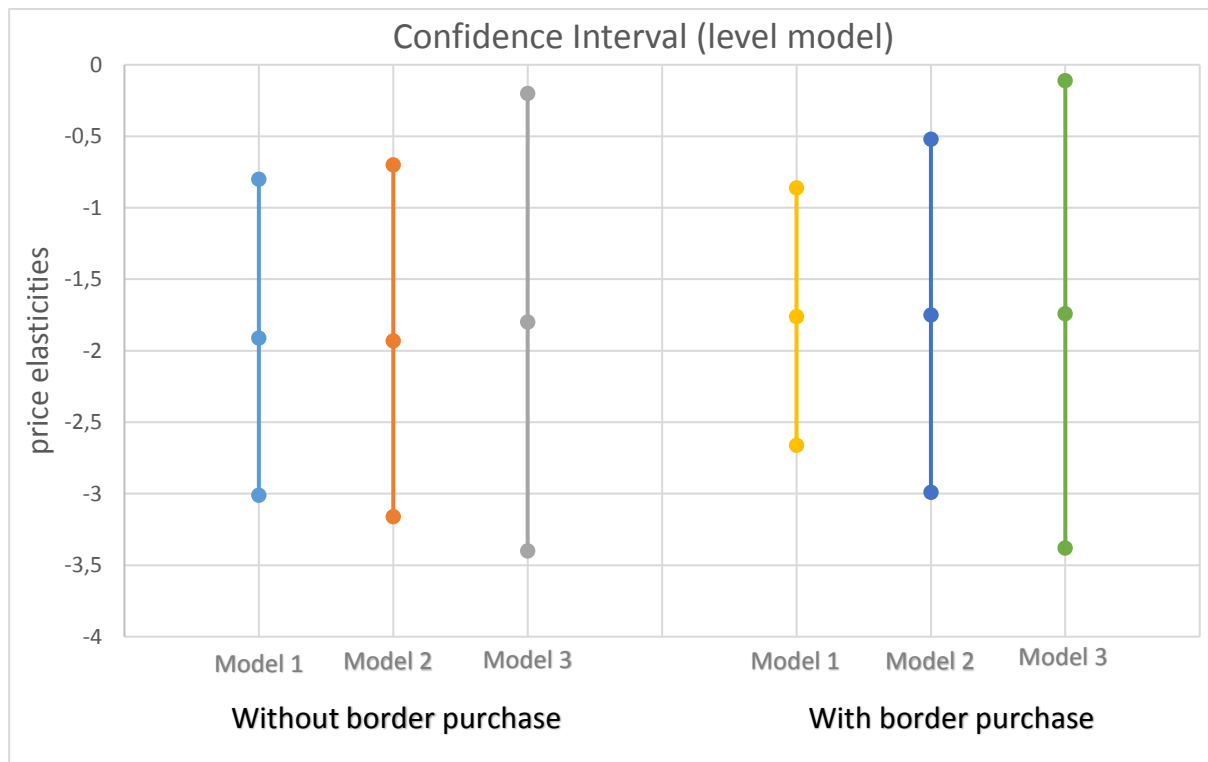
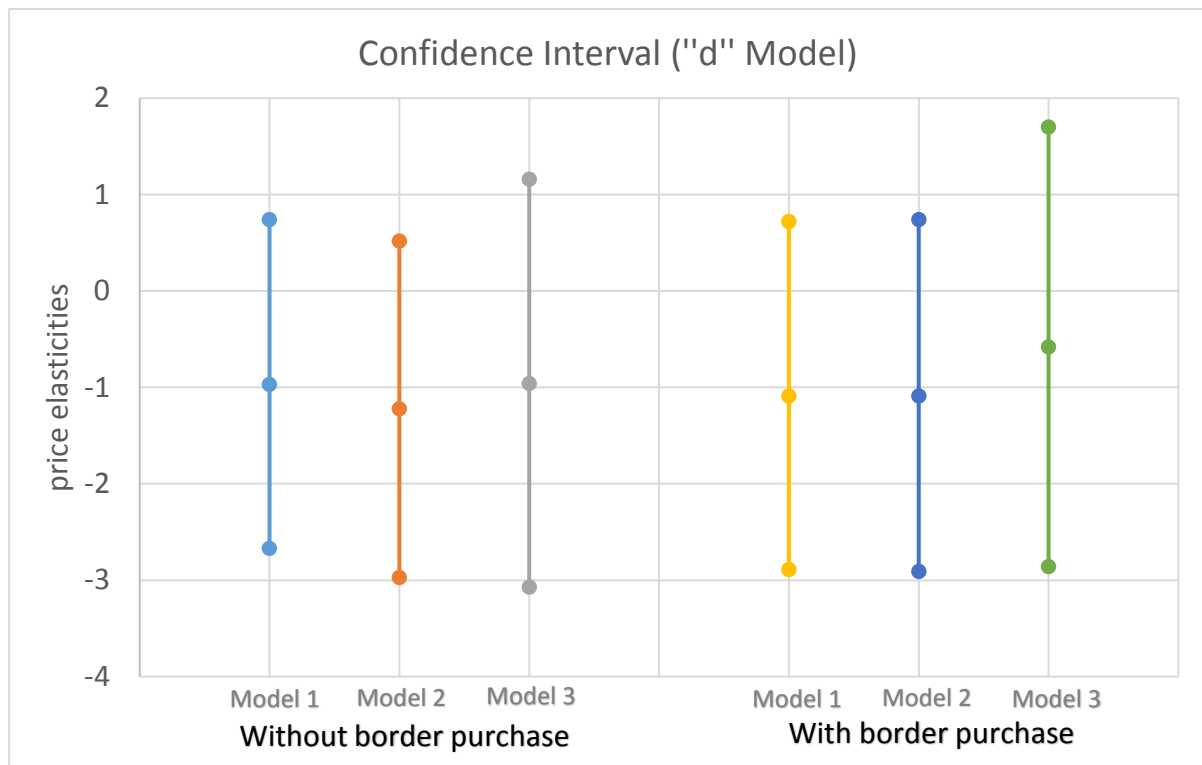


Figure (7.1) and figure (7.2) show the price elasticities of cigarettes for the three different models: traditional model, myopic model, and rational addiction model which is represented by the parallel lines. The length of these lines denote the confidence interval around the price elasticities, where the middle point shows the elasticity. The first three lines depicts the price elasticities without considering border trade while the last three lines consider border trade. The length of the lines show the uncertainty of these price elasticities. For example, to see the first line from figure (7.1) one can certainly say that the price elasticity of cigarettes somehow in between -0.8 and -3.0. The price elasticities for the rest of the models could be explain in the same way from this figure.

Finally, the conclusion from the above figure is that an increase in prices will decrease the cigarettes sales.

**Figure 7.2: Confidence intervals (95%) for the price elasticities of the different models (change)**



The confidence intervals in figure (7.2) has positive upper value based on the analysis results. One possibility of having positive value is taking change in the models. Because as we know that if we take change in the model we miss some of the observations. One should be careful before explain the results in such case. If the range has both negative value one can be quite certainly say that price increase will reduce the sale. However, in my case it is still reasonable because we can see from the lines that the positive values are not so big. It is still potential to say an increase in price will reduce the sales.

## 7.5 Some limitations of my study

Although the study reached its goal, it has some limitations. This research could not cover all the important factors to capture the price effect on tobacco sales because of limited time and resources. By using the aggregated time series data I have not been able to identify which populations (according to sex, age or socio-economic position) are affected mostly due to price changes. To detect the price sensitivity in different age group, individual level data over a long period (panel data) is needed. Early studies confirmed that the youth who does not start smoking yet are quite price sensitive. A US study by Ross and Chaloupka (2003) over 17,287 students in 200 schools all over the US found that the probability of youth cigarette smoking is reduced due to price increase and they also found a negative price effects on youth smoking intensity. Another US study by Tauras, Markowitz, and Cawley (2005) found that price rises of about 10% leads to a reduction of cigarettes consumption by about 8% among young people.

Price sensitivity depending on sex were varied in former studies. For example, in Britain women (in the late 1980s and early 1990s) were more sensitive than men to increases in tobacco prices. On the other hand Chaloupka and Pacula (1999) found that the prevalence elasticity (the proportion of people who smoke at all) of young American men were double compare to young women. Studies also shows that the poorer are tends to be more price sensitive (Jha and Chaloupka 2000).

I could not able to show either the number of smoker reduced or the amount of smoking reduced due to the price effect, i.e. what is the impact of higher prices on smoking participation (whether people smoke at all) and smoking intensity (how much people smoke). The people who are already smoking cigarettes, it is difficult for them to quit even if price increases (Melberg 2007). The study could not clearly say anything about smuggled tobacco into Norway because as I said before there are no detailed data on this.

The nicotine content of cigarettes can also effect the cigarettes sales which has not been considered in this analysis. Conditions (Climatic conditions, higher tax increased the cost of product) on supply side can affect the market, e.g, a bad crop may affect the price (Melberg 2007). These have not been taken into account in this research.

The number of observations is relatively limited in my analysis. Limited observations give less significant result. One should be careful interpreting the estimated results in the case of less observations because it does not fulfill the statistical assumptions behind the analysis.



There is room for future research with more data and new advanced models and to see if the price elasticity changes. It is also possible to see how the Norwegian young adult response with respect to higher cigarettes prices.

## **Chapter 8: Conclusion**

The aim of the analysis presented in this research was to investigate “What is the influence of cigarette prices on the sales of cigarettes?” in the context of Norway using an aggregate time series data covering the period 1996-2015. For calculating the own price elasticity of cigarettes an Ordinary Least Square (OLS) method was adopted.

A fundamental base of economic theory is that there is an inverse relationship between the price and demand of a good. Economic researches also proved that the price-elasticity of cigarettes demand is negative, meaning that an increase in cigarettes prices will decrease the cigarettes consumption as well as sales. The results of this research also confirmed this for the case of Norway. The findings of this study demonstrate that,

- A 10% increase in domestic prices leads to a reduction in sales of about 9.6%.
- The effect becomes 5.8% after including border trade and tax-free sales in the analysis.

According to the results, the increasing domestic price effect on cigarettes sales decline due to the border trade. The reduction makes the domestic price effect smaller but still it has important effect on cigarettes sales reduction.

## LITERATURE CITED:

A tobacco-free future: National strategy for tobacco control, 2013–2016. [www.regjeringen.no](http://www.regjeringen.no)

Ahmed, S. M., and K. Vaziri. 2014. Price elasticity of demand for cigarettes: The Case of Sweden. Master degree project, Högskolan Dalarna.

Becker, G. S., and K. M. Murphy. 1988. A Theory of Rational Addiction. *Journal of Political Economy* 96 (4): 675-700.

Becker, G. S., M. Grossman, and K. M. Murphy. 1990. An Empirical-Analysis of Cigarette Addiction. NBER Working Paper No. 3322.

Becker, G. S., M. Grossman, and K. M. Murphy. 1994. An Empirical-Analysis of Cigarette Addiction. *American Economic Review* 84 (3):396-418.

Benoit, Kenneth. 2011. Linear Regression Models with Logarithmic Transformations. Methodology Institute, London School of Economics.

Chaloupka, F. J. 1999. How effective are Taxes in Reducing Tobacco Consumption? Valuing the Cost of Smoking, *Studies in Risk and Uncertainty* 13: 205-218.

Chaloupka, F. J., and H. Wechsler. 1997. Price, tobacco control policies and smoking among young adults. *Journal of Health Economics* 16 (3): 359-373.

Chaloupka, F.J., and K. E. Warner. 2000. The Economics of Smoking. In *Handbook of Health Economics*. Amsterdam: Elsevier Science Publisher.

Chaloupka, F. J., and R. L. Pacula. 1999. Sex and race difference in young people's responsiveness to price and tobacco control policies. *Tobacco Control* 1999, 8: 373-77.

Chaloupka, F. J., R. Peck, J. A. Tauras, X. Xu, and A. Yurekli. 2010. Cigarette excise taxation: the impact of tax structure on prices, revenues, and cigarette smoking. National bureau of economic research (NBER) working paper number 16287. <http://www.nber.org/papers/w16287>

Conner, R. 2014. The relationship between price of tobacco and smoking. Master thesis, University of Washington.

Czubek, M., and S. Johal. 2010. Econometric Analysis of Cigarette Consumption in the UK. HMRC Working Paper Number 9.

Fernández, E., S. Gallus, A. Schiaffino, A. López-Nicola's, C. La Vecchia, H. Barros and J. Townsend. 2004. Price and consumption of tobacco in Spain over the period 1965–2000. *European Journal of Cancer Prevention* 13:207–211.

Folkehelseinstituttet. 2016. Rusmidler i Norge 2016. Alkohol, tobakk, vanedannende legemidler, narkotika, sniffing, doping og tjenestetilbudet.

Gallet, C. A., and J. A. List. 2003. Cigarette demand: a meta-analysis of elasticities. *Health Economics* 12 (10):821-835.

- Holm, L-E., J. Fisker, B-I. Larsen, P. Puska, and M. Halldórrsson. 2009. Snus does not save lives: quitting smoking does! Tobacco Control 2009, *BMJ Journals* 18(4): 250-251.
- IARC Handbooks of Cancer Prevention. 2011. Effectiveness of Tax and Price Policies for Tobacco Control. Tobacco Control, Vol. 14.
- Jha, P., and F. J. Chaloupka. 2000. The economics of global tobacco control. *BMJ* 321:358-361
- Kennedy, S., V. Pigott, and K. Walsh. 2015. Economics of Tobacco: An Analysis of Cigarette Demand in Ireland. Statistics & Economic Research Branch, Irish tax and customs.
- KPMG Project SUN. 2016. A study of the illicit cigarette market in the European Union, Norway and Switzerland. 2015 Results.  
<https://assets.kpmg.com/content/dam/kpmg/pdf/2016/06/project-sun-report.pdf>
- Levy, D. T., K. M. Cummings, and A. Hyland. 2000. Increasing Taxes as a Strategy to Reduce Cigarette Use and Deaths: Results of a Simulation Model. *Preventive Medicine* 31(3): 279-286.
- Lund, Karl Erik. 2004. Omfanget av grensehandel, taxfreeimport og smugling av tobakk til Norge. Tidsskr Nor Legeforen nr. 1, 124: 35–8.
- Melberg, H. O. 2007. Hvor mye betyr tobakksprisen for endringer i tobakksforbruket Utviklingen i pris og forbruk i Norge mellom 1985 og 2005. Statens Institutt for Rusmiddelforskning (SIRUS). Rapport 1/2007.
- Newbold, P., W. Carlson, and B. Thorne. 2012. Statistics for Business and Economics. Eighth Edition. Pearson Education.
- Olivera-Chávez, R. I., R. Cermeño-Bazán, B. S. de Miera-Juárez, J. A. Jiménez-Ruiz, and L. M. Reynales-Shigematsu. 2010. The effect of tobacco prices on consumption: a time series data analysis for Mexico. *Salud Publica Mex* 52(2): 197-205.
- Park, Sang-Won and Myung-Jae Sung. (2013). A Study on the Optimal Index for Specific Tobacco Excise Tax in Korea. *Korean Association of Public Finance* 6(2):1-40.
- Pedersen, W. and T. V. Soest. 2014. Tobacco use among Norwegian adolescents: from cigarettes to snus. *Addiction* 109: 1154-1162.
- Pollack, R. A. 1970. Habit Formation and Dynamic Demand Functions. *Journal of Political Economy* 78 (4): 745-763.
- Ross, H., and F. J. Chaloupka. 2003. The effect of cigarette prices on youth smoking. *Health Economics* 12 (3): 217-230.
- Schelling, T. C. 1984. Self-Command in Practice, in Policy, and in a Theory of Rational Choice. *American Economic Review* 74(2): 1-11.
- Statistics Norway. [www.ssb.no](http://www.ssb.no)

Tauras, J. A., S. Markowitz, and J. Cawley. 2005. Tobacco control policies and youth smoking: Evidence from a new era. I Substance use: Individual behaviour, social interactions, markets and politics, edited by B. Lindgren and M. Grossman. Oxford: Elsevier.

Tauras, J. A., M. F. Pesko, J. Huang, F. J. Chaloupka, and M. C. Farrelly. 2016. The effect of cigarette prices on cigarette sales: exploring heterogeneity in price elasticities at high and low prices. National bureau of economic research (NBER) working paper series.

The Norwegian Directorate of Customs and Excise. <http://www.toll.no>

The Norwegian Directorate of Health. <https://helsedirektoratet.no>

The World Bank. 2017. Tobacco Control Program.  
<http://www.worldbank.org/en/topic/health/brief/tobacco>

Warner, K. E. 1990. Tobacco Taxation as Health Policy in the Third World. *American Journal of Public Health* 80 (5): 529-531.

WHO technical Manual on Tobacco Tax Administration. 2010. World Health Organization.

Wilkins, N., A. Yurekli, and Teh-wei Hu. Economic Analysis of Tobacco Demand. World Bank 2003. <http://www1.worldbank.org/tobacco/toolkit.asp>.

Winston, G. C. 1980. Addiction and Backsliding: A Theory of Compulsive Consumption. *Journal of Economic Behavior and Organization* 1(4): 295-324.

World Health Organization (WHO). 2010. Joint national capacity assessment on the implementation of effective tobacco control policies in Norway.

# Annex

Unit root results:

	lsales	lrealprice	lrealpricesnus	lrealincome	lbordertrade
P-value	0.6084	0.5815	0.3317	0.9248	0.0000

	dlsales	dlrealprice	dlrealpricesnus	dlrealincome	dlbordertrade
P-value	0.0000	0.0327	0.028	0.0381	0.0000