THE IMPACT OF TOBACCO TAXATION ON CIGARETTE CONSUMPTION:

A CASE STUDY OF FRANCE

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# THE IMPACT OF TOBACCO TAXATION ON CIGARETTE CONSUMPTION: A CASE STUDY OF FRANCE

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# VITA

Cédric Evenor Dupont de Rivaltz, son of Philippe and Geneviève Dupont de Rivaltz was born December 12, 1982, in Réduit, Mauritius. He graduated from Labourdonnais High School in June, 2001 and went studying in France in September 2000. After participating on a student exchange program at San Francisco State University, he graduated in June, 2005, from the University of Paris-Dauphine with the equivalent of a Bachelor of Science in Business Administration (Applied Economics). He entered the Graduate School of Auburn University in August, 2005.

THESIS ABSTRACT

# THE IMPACT OF TOBACCO TAXATION ON CIGARETTE CONSUMPTION: A CASE STUDY OF FRANCE

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This thesis investigates the relationship between tobacco taxes and the consumption of cigarettes in France. The goal of this thesis is to determine the impact of the recent successive increases in tobacco taxes on the demand for cigarettes. The basic model of "rational addiction" of Becker et al (1994) is used and modified to construct and test a new empirical model. The study is a time series analysis employing monthly data from February 2000 to December 2005. Results show that the price of cigarettes and therefore, the tobacco taxes have a significant impact on cigarette sales. The price-elasticity of demand for cigarettes in France is found to be elastic and negative, suggesting that the French government can discriminate the consumption of cigarette through an increase of tobacco taxes.

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# CHAPTER I

# INTRODUCTION

Cigarettes and tobacco products are the biggest preventable cause of disease and premature death in the World and are thus the largest solvable public health problem (World Health Organization). Questioned in the past, the negative consequences of tobacco consumption are now undeniable. According to the most recent studies, chronic consumption of 10 cigarettes per day doubles the risk of having a heart attack and this risk triples when consuming 20 cigarettes per day. The risk of sudden death for an adult is multiplied by 10 and those of an arterial vascular disease of the limb by 3. The potential effects of smoking cigarettes on health are frightening. One out of two lifetime smokers will die from their habit and half of these deaths will occur in middle age. In France, around 66,000 people die every year from smoking cigarettes and, in addition, figures show that second hand smoking leads to 3,000 deaths per year (Euromonitor, 2005). Unfortunately, the public have often underestimated the negative consequences of smoking and also the fact that cigarettes are addictive. Dependence on tobacco is both physical and psychological. If the average smoker is deprived of cigarette consumption he will be tense, nervous, irritable, anxious and perhaps depressed. He may even shake and sweat. It is then hard for him to end his addiction to smoking. Psychological dependency is a behavioral dependency linked to the fact that smokers

attach the action of smoking to some activities or to some pleasant or unpleasant circumstances. This dependency is even more important if the smoker is young.

Nicotine is the main addictive component in cigarettes. It is a stimulant that has an effect on the nervous system and can be the main cause of physical dependency on tobacco. More than four thousand organic components can be counted in a cigarette and fifty of them can cause cancer. Consequently, one of the main effects of tobacco smoke on health is its contribution to a number of cancers. Tobacco is responsible for more than 30% of all cancers (la ligue contre le cancer: the league against cancer). It causes respiratory diseases and increases the risk of malformation or illness of the child of a smoking mother. In France, half of the deaths caused by tobacco are due to cancer. The other half is mainly represented by respiratory and circulatory diseases. At the current rate of increase, in 2025, the number of deaths may reach 160,000 people per year, of which 50,000 are women. The French government, concerned by this issue, adopted in 1976 the Veil law and in 1991, the Evin law in order to reduce the licit consumption of cigarettes by prohibiting the advertising of tobacco. On March 2003, the French president, Jacques Chirac, launched the "cancer plan" to inform the French about the negative effects of smoking tobacco. Additionally, the government has regularly raised the price of cigarette packs by increasing the percentage tax on cigarettes. From 1999 to 2003, the tax on cigarettes increased from 75.99 % to 79.00%. (CDIT, 2003)
By 2003, the consumption of cigarettes decreased 12% as compared to 1999. Assuming that this decrease in consumption came exclusively from quitters, it represents 1.8 million smokers. (INPES, 2003)

It appears that this increase in price can be a major key to prevent smoking. However, there are several factors to take into account when studying the demand for cigarettes and the goal of this thesis is to assess, using the French example, the impact of tax increases on cigarette consumption and its diverse consequences.

The following chapter provides an overview of the French tobacco control policies starting from the Veil law in 1976 until the recent increases in cigarette taxes. It shows how the French government has fought to decrease the prevalence of smoking by forbidding the advertising for tobacco products, by informing the French population of the bad consequences of smoking, and by raising the price of cigarettes. Since these increases in prices have recently been done through consequent increases in the tax rate on cigarettes, the next chapter will also focus on the French taxation system for tobacco products.

Chapter III presents a generalization of different techniques developed to obtain an appropriate taxation rate. One of these techniques consists of measuring the external costs generated by smokers while another is based on the misperception of the harmful effects of cigarette consumption. This chapter also discusses the potential consequences of an excessively high taxation such as smuggling and inequalities among the population.

Chapter IV is a literature review of many studies on cigarette consumption. Very few studies have addressed the analysis of cigarette demand in France; however, in other countries, mostly in the United-States, the literature on tobacco consumption is abundant and provides many models and important results. This literature review will focus on the impact of prices, and therefore taxes on the demand for cigarette consumption. It will expose the different techniques and data used as well as problems in the data. The goal

of this chapter is to use the literature to obtain different econometric tools that will be used in the modeling of the analysis of the tobacco tax impact on cigarette consumption in France.

In chapter V, the basic "rational addiction" model of Becker et al (1994) will be used to construct a proposed model that includes different variables affecting the demand for cigarettes in France. The "rational addiction" model is discussed as well as innovations brought by this analysis. The inclusion of the variables used is explained as well as their expected signs.

The data and the construction of the variables employed in the model is explained in chapter VI. The analysis uses monthly observations for the period of January 2000 through to January 2006. However, to be able to employ as many observations as possible, some of the observations are predicted and some others are transformed from quarterly and semi-annual data to monthly data. This chapter exposes the different techniques used to obtain all the important variables for the desired period of study. A preliminary model is then specified; it uses 9 independent variables which are regressed on the amount of cigarette sales per capita in France.

Chapter VII presents the results of the regression. To make sure that the estimates of the coefficients are the best linear unbiased estimates, the model is tested for misspecification bias, heteroskedasticity and autocorrelation of the residuals. The variables are then interpreted. A new model is then specified to better interpret the impact of cigarette prices on cigarette sales.

Finally, chapter VIII summarizes all the results found in the econometric analysis. It provides a conclusion and implications of the interpreted results as well as suggestions for improvement in this research.

In this thesis, the term “tobacco” is used very broadly, often as a synonym for “cigarette”.

## CHAPTER II

## OVERVIEW OF TOBACCO CONTROL IN FRANCE

Around one person in four is a smoker in France. This is a much higher percentage than in other European countries (In Sweden, around one person in six is a smoker). Concerned by the potential impact of cigarette smoking on the French public health, the French government has adopted diverse policies to fight against this relatively high smoking prevalence. Until 1995 the production, import, and distribution of tobacco was monopolized by the French-based tobacco company, SEITA (Société d'Exploitation Industrielle des Tabacs et Allumettes: Industrial Exploitation Society of Tobacco and Matches). In 1998, SEITA merged with its Spanish counterpart, Tabacalera to form Altadis, and is now owned by the government that controls all the sales of tobacco through the tobacconists. (Euromonitor, 2005)

The French government adopted two laws to discourage people from smoking cigarettes. These laws have primarily been focused on creating controls over where people can smoke, and what information they receive about cigarettes in advertising, branding and health literature. In 1976, the Veil law was passed and focused on forbidding direct advertising of tobacco based products (Journal officiel de la république française: Official newspaper of the French republic, August 2003). In 1991, the Evin law was adopted to complement the Veil law and further control the information about tobacco and alcohol based products available to consumers.

Concerning tobacco based products, the Evin law includes several regulations. For example, it requires cigarette packets to include the component percentages of nicotine and tar as well as the quantity of toxics in mg/cigarette. Moreover, every packet must contain a warning message such as, “Smoking kills”, “Smoking severely harms your health and the health of those around you”, “Smokers die younger" (Journal officiel de la république française, January 1991). Since September 2003, these warning signs cover 30 percent of the front packaging surface and 40 percent of the back. Words like “light,” or “ultra light” are forbidden in the displayed product name as well as any other indications that may suggest that cigarettes are a minor drug with low impact.

By adding new regulations about broader information regarding tobacco products, it is thought that the Evin Law has been more effective than the Veil Law of 1976 which focused only on direct advertising. All propaganda or advertising, direct or indirect in favor of cigarettes or tobacco products is strictly forbidden in public places. The Evin Law goes further by placing controls around where people can smoke and how they are protected from smoke. For example, it prohibits smoking at school and in the playground: anyone who smokes in a “non smoking” area is levied a fee of €450; if restaurants or coffee shops do not have any signs for “smoking” and “non-smoking” areas or if the ventilation system does not conform to the standards set in law, the fee can reach €1500. (Journal officiel de la république française, January 1991)

More recently, the government has also taken other measures. On March 23, 2003, the “National Strategy against Cancer” also known as the “Cancer Plan” was detailed and sets out to inform the French about the consequences of smoking cigarettes. In fact, according to the Observatoire regional d’Ile de France (Scientific Observatory of

Ile de France), the French population are poorly informed about the effects of tobacco[1]; they often associate the harmful effects of cigarettes with pulmonary diseases but practically never with other forms of disease like cardiovascular and respiratory disease. Additionally a large percentage of the population thinks that cigarettes are only dangerous from a certain amount of consumption, while others think they can cancel out the bad effects of smoking by exercising. Therefore, to redress the apparent information asymmetry among the population, the "Cancer Plan" launched "an aggressive media campaign […] to "de-normalise" the consumption of tobacco in French society. The campaigns consist of posters, radio messages and TV films informing the public about the toxic components present in tobacco smoke. Other radio campaigns targeting young people try to show that the feeling of freedom associated with smoking is an illusion". (Euromonitor, May 2005, p. 4)

On July 24, 2003, the French government continued its fight to reduce the prevalence of smoking by signing a new law that forbids the sale of cigarettes to minors under 16 years old. If the law is broken, a fee of €150 will be imposed (Journal officiel de la république française, August 2003). In addition, since January 1, 2004, the quantity of tar contained in a cigarette must be reduced from 12 to 10 mg/cigarette and the amount of nicotine and carbon monoxide should not be larger than 1 mg and 10 mg respectively per cigarette.

Moreover, with the passing of the Evin Law, the price of tobacco is no longer part of the consumer price index calculus. This gives the government a free hand to control the price of cigarettes without impacting inflation and therefore, keeping it independent

[1] This shows an important contrast between the French and American population. In fact, Viscusi, in 1992, showed that, in the United-States, smokers overestimate the harmful effect of cigarettes.

from other key variables in the economic growth equation. Since 1991, the price of cigarettes has increased eleven times. From September 1991 to January 2000, the nominal price jumped from FFr10.80 (French Francs, the pre-euro currency of France) for the best-selling packet of mild cigarettes in France, to FFr21.00. (CDIT, 2000)

According to data from INSEE: Institut national des statistiques et des études économiques (National Institute for Statistics and Economic Studies), the consumption of cigarettes has decrease from 5.8 cigarettes per person per day in September 1991 to 5 cigarettes in December 1996 (person of 15 years old or older), (Anguis & Dubeaux, INSEE Première, 1997). Although it is necessary to take into account other factors, it is legitimate to suggest that the strong and repeated increases in price have discouraged people from smoking. Consequently, the French government has continued to drive up the price of cigarette packs. In 2003, the French government revealed its objective of doubling the price of cigarettes in 5 years through consequent increases in tobacco taxes (Euromonitor, 2005). Thus, from 2003 to now, the tax rate has increase from 75.99% to 80.39% of the retail price of cigarette packs.

Now that the historical aspect of tobacco consumption in France and the different French control policies have been exposed, the rest of this thesis focuses on the impact of an increase in tobacco taxes. An econometric analysis will model the recent tax increases in France as well as other factors that affect the cigarette consumption from 2000 to 2006.

To begin, it is important to understand the French tobacco tax system. In France, the retail price of cigarette packs is divided into three elements: the manufacturer and wholesale distributor share, the licensed seller share, and taxes.

According to the CDIT, from all the sales of tobacco products made in 2000, around 17% went to manufacturers and wholesale distributors, 8% to licensed sellers, and around 75% to the State in the form of taxes. This represents nearly FFr65 billion (€10 billion) that the State acquired in 2000. (CDIT, 2001)

The French tax system on tobacco products is particularly complex. Three different taxes are applied:

- VAT: Value added tax
- BAPSA: Budget annexe des prestations sociales agricoles (Supplementary budget for agricultural social security benefits)
- Tax on usage rights

However, to make sure that an increase in taxes will not shift the demand of cigarette to mild-price and economy brands, the French government has broken the usage rights into two parts: a specific part and a proportional part of retail sale price. Using the bestselling cigarette pack as the base reference, the government can tax the cheapest cigarettes proportionally more than the other cigarettes through the specific tax. The tax percentage of the cheapest cigarette packs varies with the price of the bestselling cigarette brand. The following table summarizes the breakdown of the retail price of the bestselling cigarette packs (Malboro) on January 8, 2001. According to this table, 75.99% of the price of the best-selling cigarettes packet (Marlboro) corresponds to taxes. Because of the varying tax on the usage rights, this proportion becomes 76.3% on average, when we take into account all the brands of cigarettes sold in France. (CDIT, 2001)

**Table 1**

**Breakdown of sale price of a cigarette packet of Marlboro on January 8, 2001**

| | | In Francs | As % of retail sale price |
|---|---|---|---|
| Tobacconist and Industry's share | Licensed seller | 1.76 | 8 |
| | Producer and distributor | 3.52 | 16.01 |
| State Tax | VAT | 3.6 | 16.39 |
| | BAPSA | 0.14 | 0.61 |
| | usage rights | 12.98 | 58.99 |
| | Total State tax revenue | 16.72 | 75.99 |
| Total | | 22 | 100 |

***Source: CDIT***

To better illustrate the calculation of taxes on cigarette packs, table 2 shows a comparison of the breakdown of the retail price of Marlboro against the retail price of Gauloise brune, one of the lowest price brands.

**Table 2**

**Marlboro versus Gauloise brune on January 4, 1999**

| | Marlboro | Gauloise brune |
|---|---|---|
| Retail price | FFr20.00 | FFr15.00 |
| VAT (17.08%) | FFr3.41 | FFr2.56 |
| BAPSA (0.61%) | FFr0.12 | FFr0.09 |
| Usage rights (58.3%) including: | FFr11.66 | FFr8.93 |
| - proportional part (54.3%) | FFr10.90 | FFr8.17 |
| - specific part (5%) | **FFr0.76** [2] | **FFr0.76** |
| total tax revenue | FFr15.20 | FFr11.59 |
| Tax in % of the retail price | 75.99 | 77.25 |

***Source: CDIT***

[2] Specific part = % of specific part * % of total tax on Marlboro * retail price of Marlboro = 0.05*0.7599*20.00 = 0.76

Starting with the Veil law in 1976, this chapter has presented the different policies used by the French government to reduce the consumption of cigarettes. It has shown the different restrictions imposed on smoking as well as the new policies that consist in increasing the price of cigarettes and in informing the population about the harmful effect of cigarettes in order to discourage people from smoking and reduce the initiation of tobacco use.

# CHAPTER III

## TAXATION OF CIGARETTES AND TOBACCO PRODUCTS

Many studies have shown that taxation of cigarettes and tobacco products is an effective way to diminish the consumption of these products. Cigarette taxation is also a way to increase governments' revenues at least in the short term. However, this taxation policy is facing several problems. This section will discuss these problems and analyze the different techniques and hypotheses used to determine the optimal rate of taxation.

According to Ramsey, in term of tax revenue, the optimal tax on commodities is one that can not be easily avoided by the consumer (Ramsey, 1927). The tax should distort the consumer's behavior as little as possible. In that sense, if the price-elasticity of demand for tobacco products is low, their taxation can be justified in the contribution of governments' revenues.

However, the use of tobacco taxation as a fiscal policy can face several constraints. If the tax is too high, it will encourage smuggling and criminality and therefore generate losses in governments' revenues. To reduce the risk of smuggling, it is important that the different governments in frontier countries harmonize their politics in terms of tobacco taxation. However, this harmonization has been very challenging, often due to different beliefs.

The optimal taxation rate of cigarette and tobacco products is very difficult to determine. One potential technique is to use the external costs. In fact, it is evident that smokers generate external costs by smoking in public places. Arthur Cecil Pigou was the fist economist to make the distinction between the social and private costs. The social costs include both, the private costs and the external costs which are characteristics of a "market failure". In 1920, Pigou stated that it would be theoretically possible for the government to use taxes in order to correct the economy from these externalities. Although it has been very hard to apply, this theory has inspired a large number of studies that have tried to value external costs generated by cigarette smoking to help governments charge smokers, through appropriate taxation, for the externalities they generate. However, measuring the external costs of smoking faces a couple of difficulties. First, it is important to compare a group of smokers to an identical group of non-smokers. Both groups should contain individuals with the same characteristics in terms of age, sex, personal income, education and other factors. The next difficulty is the quantitative evaluation of the external costs caused by smokers that is generally made through a cost-benefit analysis.

In addition to the external costs, another method can be used in the determination of the cigarette taxation rate. Some economists have hypothesized that smokers are imperfectly informed on the potential risks caused by cigarette consumption. In that sense, it is important for the government to intervene and try to correct the smokers' misperception of the risks. This hypothesis has been largely criticized, because for several years information regarding the harm of cigarette consumption has been revealed to the public and recent surveys have shown that smokers, even the youngest ones, have

been informed of the diverse risks caused by cigarette smoking. However, even if people are aware of those risks, it does not mean that they evaluate correctly the probability that those risks occurs when consuming cigarettes. This mis-evaluation is mainly due to the fact that cigarettes are addictive which makes it hard for people to stop smoking. Another reason is that the damage of smoking is cumulative and its consequences on health occur in the long run rather than in the short term. In the case of addiction to cigarettes, there is a non-financial cost associate with the change from the status of smoker to non-smoker which can discourage cigarette consumers from stopping smoking at the moment they are aware of the exact harm cigarettes can cause. This aspect of dependency to cigarette use is particularly important for the case of youths since the consumption of cigarettes is a behavior that appears very early, at the beginning of adolescence.

In order to correct for this misevaluation of risk, a government possesses at least two policy options:

- The first involves increasing taxation of cigarettes and tobacco products to discourage their consumption and, at the same time, redressing the mis-pricing of the risks of smoking cigarettes. To do this, a government can impose a tax that will provide smokers with the economic equivalence of the correct perception of the probabilities of health damages caused by cigarette consumption. However, this procedure can be discriminatory because every individual is different and therefore has a different utility function. It is then possible that, for some people, the satisfaction of smoking overcomes the harmful effects of cigarettes.

- The second policy option is to provide smokers with these probabilities directly. However, this process requires the collection of precise information, its transmission to the public and a common level of comprehension of the information. Unfortunately, this process is laborious, expensive and relatively slow. In fact, it takes several years for this policy to see changes compared to a very short interval of time for a policy based on taxation. However, these two policies are not, in any sense, exclusive and, it could therefore be judicious to apply them simultaneously.

Although the tobacco taxation policy appears to be useful in reducing the consumption of cigarettes, it might also cause several problems that need to be taken into account. Many studies have shown that tobacco taxes are regressive. It seems that low income smokers consume as many cigarettes as the wealthy smokers. Thus, tobacco taxes impose a selective and unfair burden on the poorest because they pay a greater percentage of their income to cover the tax. Consequently, the increase of tobacco taxes as a policy to reduce cigarette consumption has been criticized from an "equity" perspective. This notion of equity suggests that the amount of taxes paid by every individual should represent the same percentage share of their income. There is an important distinction between what economists call "Horizontal equity" and "Vertical equity". Horizontal equity concerns individuals that have specific similar characteristics while vertical equity concerns individuals that differ by those characteristics where income is generally the main characteristic used. A way to correct for inequity caused by tobacco taxes is to impose a different tax rates to individuals that belong to the "vertical equity" group, so that wealthier cigarette consumers pay a higher tax rate than poorer cigarette consumers. So far, there is no evidence of such a policy being applied on

tobacco products. However, the fact that taxes are regressive does not mitigate their efficacy in reducing consumption and therefore promoting public health goals. It is important to notice that taxes are regressive because of the inequalities among the population. Therefore, it can be argued that the government should focus on trying to reduce the source of the underlying inequalities through social allowance regulations or fiscal policies. On the other hand, it can be argued that taxes are progressive if they are successful in forcing the poor to quit smoking. In that sense, only the wealthier will smoke and pay tobacco taxes. Consequently, taxes are progressive because they reduce the inequalities.

Another problem that can occur when raising the tobacco taxes is the increase of cross-border traffic and smuggling of cigarettes. The cross-border traffic is legal if it does not exceed the amount authorized by law. Above this amount, an import tax is required to be paid. If there is a small difference in the price of cigarettes between two countries, only individuals who cross the border frequently will change their habits of consumption. However, if the difference in price is very large, more people will go abroad just to buy cigarettes. It is also common that non-smokers that travel bring back some cheaper cigarettes for friends and/or family.

While cross-border traffic of cigarettes is legal, smuggling is completely forbidden. By definition, tobacco smuggling is when any amount of cigarettes is illegally imported into a country. Imported through this channel, taxes are avoided and cigarettes are sold to consumers via black markets. Many ways are used to avoid the border check: such as transport by private airplanes, small ships and through overland smuggling routes. Smuggling is likely to occur when the tobacco tax is very high. Thus, the more the

difference between the costs of production and price of cigarettes, the more smuggling will occur.

This chapter has presented the different techniques used to try to determine an optimal taxation rate for tobacco products as well as some of the consequences of an increase in tobacco taxes including the smuggling issues and the potential regressivity of taxes. It has been shown that taxes should either, redress the mis-pricing of the risks of cigarette smoking or cover the external costs generated by smokers. However, it is important to note that, beside the external costs caused by second-hand smoking, the remaining costs depend on the regulation of a country. These costs are caused by smokers but exist only because of political decisions such as the provision of medical care partially covers by the social security for the case of France.

# CHAPTER IV

# LITERATURE REVIEW

Because of its contribution to a large number of diseases and premature deaths, cigarette consumption is a major focus of the field of Health Economics. Many fiscal policies have been devised to reach the governments' objectives of public health. These policies rely on a large number of econometric analyses that estimate the determinants of demand for cigarettes. The literature on cigarette consumption is broad, and because of the numerous works published, the factors determining the demand for tobacco products and, more precisely, for cigarettes, are well-known.

Most economists focus on two distinct outcomes of changes in prices (and thus taxes) on cigarette consumption. As the price of cigarettes increases, smokers can either stop smoking and join the group of non-smokers, or decrease their consumption. Studies in this field have estimated price-elasticities of the demand for cigarettes, and observed differences are due to the differences in econometric modeling and different data used.

Initially, many economists considered the consumption of addictive substances, such as cigarettes, to be an irrational behavior that is not appropriate for conventional economic analyses (Winston, 1980 ; Schelling, 1984). They believed that the demand for cigarettes does not respect the law of demand characterized by the negative slope of the demand curve. However, many researchers have since proven that demand for cigarettes

is sensitive to changes in their price, even after taking into account the addiction phenomenon. This chapter seeks to explore the key findings of this later literature.

This literature review contains three parts. The first part presents the different analysis made on cigarette consumption and the occurring problems of the estimations. The second part discusses the studies made on the taxation of cigarettes and other tobacco products and their importance in the determination of an optimal taxation system. Finally, the last part is a brief summary of the important information and results exposed in the subsequent sections.

***THE ESTIMATION OF DEMAND FOR CIGARETTES:***

Numerous econometric models on cigarette consumption have examined how price affects the demand for cigarettes. According to the Surgeon General's Report on reducing tobacco use, in the United-States, whatever the data used, the price-elasticity values for the aggregate demand for cigarettes was found to be between -0.14 and -1.12 and most of the time between – 0.3 and – 0.5. Therefore, for every 1% increase in the price of cigarettes, there is between 0.3% and 0.5% decrease in the quantity of cigarettes demanded. However, price is not the only determinant factor in the demand for cigarettes. Another important variable is income. The income-elasticity of demand for cigarettes is often calculated along with the price-elasticity. Some of the first studies on the demand for cigarettes concluded that cigarettes are normal goods because their consumption increases with an increase in income. In fact, Fujii (1980) estimated the demand for cigarettes in the United-States with annual time series data from 1929 to 1973. Using a double log specification, he found an income-elasticity of demand of 0.339. Therefore,

for every 1% increase in the income, there is a 0.339% increase in their consumption of cigarettes. However, more recent studies have also shown that cigarettes should be considered as an inferior good because the consumption of cigarettes is a decreasing function of the income. For example, Townsend et al (1994), using data from the British general household survey, found that the average cigarette consumption per adult decreases by 40% for all men and by 24% for all women when the real income per capita increases by 55%. Consequently, it seems that results on income-elasticity differ significantly depending on the data employed. The next section will focus on these differences and show that results might depend on the population studied.

Many studies on the effects of price changes on cigarette consumption use time series data to construct their econometric model. In addition to price of cigarettes and income, the literature suggests that time series analyses incorporate a number of other variables in the models to examine the demand for cigarettes and other tobacco products. An important variable is the information of the negative effects of cigarette consumption. In fact, studies have shown that people that have been informed of the bad consequences of smoking cigarettes on health have decreased their consumption significantly. Shneider, Klein and Murphy (1981) studied the impact of two published reports on cigarette consumption: a 1953 report by the American Cancer Society and the British Medical Research Council, which claimed that "death rates were significantly higher for cigarette smokers than nonsmokers" and the 1964 U.S. Surgeon General's report which showed that cigarette smoking was causally related to lung cancer. Their study has shown that the cumulative effects of those two health reports have reduced the consumption of tobacco per capita by 25%.

A second important variable to consider is the effect of advertising. It is believed that advertising for tobacco products increases the global demand for them (Keeler et al., 2004). However, some controversial results have shown that the global demand for cigarettes can remain the same even when the quantity of advertising increases. One potential explanation is that advertising does not change the global demand, by encouraging new smokers or existing ones to smoke more, but only modifies the market shares of cigarette manufacturers and distributors.

The literature shows that time series analysis of cigarette consumption should also include the different restrictions on cigarette smoking. Keeler, et al. (1993) have analyzed the effects of antismoking regulations on the consumption of cigarettes in California using monthly time-series data for 1980 through 1990 and found that antismoking regulations do reduce cigarette consumption.

A last and very important factor should be taken into account when using time series data: addiction. A lot of economists have, in the past, ignored the addictive nature of goods like cigarettes in the estimation of the demand for them. More recently, however, most studies focus on the addictive characteristic of these goods. Economic models of dependency can be divided into three groups: Imperfectly rational addiction models, Myopic-addiction models and Rational-addiction models.

The first group assumes that people have different preferences over time. Smoking is one of the preferences and since people can change their decisions on their smoking habits across their lifetime, this model of addiction is said to be "imperfectly rational". For example, a woman that smokes with the intention of quitting when she gets pregnant can change her mind later in life. So far, though, imperfectly rational

addiction models have not been used in empirical studies of cigarette smoking or other addictions.

The second group of models assumes that "people know that their current smoking is based on their past smoking (i.e. that smoking is addictive), but do not take account of the future consequences of their addiction when making current choices." (Chaloupka, Tauras and Grossman; 2000; p. 107-108). Houthakker and Taylor (1966) projected the composition of private-consumption expenditure for eighty-three commodities (including cigarettes) to the year 1970. They were the first to show that current consumption does not only depend on income and prices, but also a "stock of habits". Many econometric analyses are based on the myopic-addiction model of Houthakker and Taylor and have shown that past consumption of cigarettes has an increasing effect on current consumption.

The last group of models considers addiction as a fully rational behavior. This theory of "rational addiction" has first been suggested by Becker and Murphy (1988). They claimed that the consumption of cigarettes not only depends on past consumption but also on future consumption. Smokers know their dependence on cigarettes and as a result they take into account the future implications of their dependence to smoking when making current consumption decisions: "in our model, present and future consumption are complements, and a person becomes more addicted at present when he expects events to raise his future consumption. That is, in our model, both present and future behaviors are part of a consistent maximising plan." (Becker and Murphy, 1988, p. 691-692). Therefore, in order to estimate the price elasticity of demand for cigarettes without bias, it is important to include the lagged and lead consumption of cigarettes in the model.

Using the fully rational behavior model of Becker and Murphy (1988), Chaloupka in 1991 found that smoking cigarettes was an addictive behavior and that smokers did not react in a myopic way. He estimated the demand for cigarettes using the Second National Health and Nutrition Examination Survey and found a price-elasticity included between -0.27 and -0.38. His estimates are based on age and education and the results show that younger and less educated people behave in a more myopic way and are more sensitive to changes in price than their counterparts. By dividing his study by gender, Chaloupka also showed that men's behavior is more myopic than women's and that they are also more sensitive to change in prices.

By using the same framework, Becker, Grossman and Murphy (1994) found similar results by employing annual per capita cigarette sales data for every state in the United-States from 1955 through 1985. Other studies have been made using U.S. data but also data from other countries and the results confirm the hypothesis of "rational addiction". In fact, Bardsley and Olekalns (1998) applied Becker and Murphy's model of rational addiction augmented by data on advertising, demographic factors and regulatory intervention in Australia. They found that price, income and demographic factors affect cigarette consumption significantly and, at the same time, they showed that addiction is a non-myopic behavior. However, the evidence is mixed when it comes to the rationality of cigarette smoking. In fact, the model of "rational addiction" has been widely criticized. Becker and Murphy based their model on a perfect foresight hypothesis stating that smokers know perfectly well their dependence to cigarettes and can therefore plan their future consumption. However, Orphonides and Zeros (1995) contested the "rational addiction" model by introducing the notion of uncertainty. They stated that

inexperienced smokers are not fully informed of the potential harmful effects of tobacco. Knowledge of the addictive effects comes from the observations of other smokers but also by personal experimentation which in itself takes time and implies little foresight. Furthermore, the harmful effects of smoking are different from one individual to another. In that sense, inexperienced smokers are not fully aware of their dependence to tobacco and their future consumption is not automatically taken into account in their present consumption choices.

Although a lot of studies on cigarette consumption use time-series data, many economists have recently employed cross-sectional and panel data in order to implement in their model other determinants of cigarette smoking. In fact, numerous other factors have been studied such as advertising, gender, education level, social class, professional status, age group, religion, and race. In the United States, most of these studies focus on individual states and their different tax levels on cigarettes. The price-elasticity values found were generally between – 0.15 and – 0.60. (Baltagi and Goel, 1987)

Results concerning cigarette consumption by age are particularly important. In fact, empirical studies have shown that there is a high negative correlation between the age people start to smoke and the following factors: number of cigarettes consumed, difficulty of stopping smoking, and the harmful effect on health. Lewit, Coate and Grossman (1981) were the first to study the cigarette consumption of teenagers. They used data from the "Cycle III of the Health Examination Survey" from March 1966 to March 1970 to analyze the price, socio-economic and demographic effects on cigarette consumption of 12 to 17 years old youths. They found that a "youth is more likely to smoke and to smoke larger amounts if he is not a student, if he works during the school

year, if he works during school vacations, if his mother works full-time, and if his father is absent from the household. Boys smoke more than girls, whites smoke more than blacks; and older youths smoke more than younger youths" (Lewit, Coate and Grossman , 1981, p.42). Concerning the price effects, they showed that price has a big impact on the decision of smoking (price-elasticity of -1.20) and that overall youth price-elasticity for cigarette demand is -1.4. Lewit, Coate and Grossman have also shown the importance of information about the harmful effects of tobacco on the decision of whether or not to smoke among young people.

Wasserman et al (1991) used several of the "Health Interview Surveys" from the 1970's and 1980's in order to examine the change across time of the price-elasticity of demand for cigarettes. They employed data on 12 to 17 years old youths from the "National Health and Nutrition Examination II" to analyze the effects of price and regulations restricting smoking in public places. They obtained a statistically insignificant estimate of the price effect on cigarette consumption among youths. Furthermore, they found that the price-elasticity of demand does not differ from a teenager to an adult. However, regulations restricting smoking in public places do have a negative impact on the cigarette consumption for both teenagers and adults. These results led Chaloupka and Grossman (1996) to focus on the effect of different smoking restrictions, and particularly, control policies discouraging youths from consuming cigarettes. They used data from the University of Michigan's Institute that has constructed surveys of eighth, tenth, and twelfth grade students for the years 1992, 1993 and 1994. Chaloupka and Grossman estimated the equation of the participation of young smokers to the consumption of cigarettes and found that an increase in cigarette excise taxes

significantly decreases the consumption of cigarettes. In fact, their estimate of the price-elasticity of youth cigarette demand is -1.313 which is much more than the estimate of the adult "price elasticity centered on -0.4" (Chaloupka and Grossman; 1996; p. 24). This estimate is consistent with the result found by the previous study on youth of Lewit, Coate and Grossman (1981), though it diverges from the findings of Wassermann et al (1991). Chaloupka and Grossman also find that restrictions on smoking in public places and smoking limits at school have a significant impact in decreasing the consumption of cigarettes among youths. However, limits on youth access to tobacco products do not appear to be a powerful tool for tobacco control policies.

However, Gilpin and Pierce (1997) have contradicted the conclusions of Chaloupka and Grossman (1996) through their study of smoking initiation by adolescents. Gilpin and Pierce employed data from three population surveys (September 1992, January 1993 and May 1993) conducted by the US census bureau for labor force monitoring. They analyzed the tendencies of initiation rates to cigarette smoking during the decades 1979-1989 for demographic subgroups of 14-17 years old adolescents. Their results show that the initiation rate of cigarette smoking is higher for those who have dropped out of High school and lower for those who went to college. At the beginning of the 80's, the initiation rate was decreasing for both, the adolescent (14-17 years old) and the young adults (18 to 21 years old). However, changes occurred from the mid-80's. The number of adolescents who started smoking cigarettes has increased suggesting that external factors have influenced the decision of smoking among this population. Those potential external factors are numerous and sometimes hard "to measure, such as enforcement of laws regarding sales of cigarettes to minors, changes in the social image

of smoking derived from peers, or changes in community norms regarding smoking, including preventive education." (Gilpin and Pierce, 1997, p. 125)

Gilpin and Pierce (1997) emphasize the fact that if adolescents, with a high price-elasticity of demand, were more sensitive to changes in price than adults (as several studies have shown including Chaloupka and Grossman in 1996), cigarette prices should have decreased during the second part of the 80's. However, it was observed that prices have increased, which renders the stability of the effect of prices on demand questionable. Gilpin and Pierce (1997) explained those adolescents have increased their consumption because the tobacco industry has increased its advertising budget and has radically changed its marketing campaigns. In fact, from 1979 to 1989, the percentage increase in total advertising budgets for tobacco firms was 95%, a yearly average of 9.5% (arithmetically).

On the other hand, the conclusions of Gilpin and Pierce (1997) do not constitute a definitive refutation of the results found by Chaloupka and Grossman (1996). In fact, their study does not use econometric methods that allow them to take into account simultaneously the external factors that could have influenced the cigarette consumption of adolescents. Many other studies have faced this problem. In fact prices, sales, and consumption of cigarettes occur simultaneously and if this simultaneity is not taken into account, the estimation of the price elasticity of demand for cigarettes may be biased.

It is also important to note that there is generally a high correlation between several key variables and the price of cigarettes. As a result, the estimation of the impact of price on the demand for cigarettes can be very sensitive to the inclusion or exclusion of some key variables. The inclusion of highly correlated variables or the exclusion of

potentially important variables generates instability in the models. For example, if the smuggling of cigarettes is not taken into account, the estimates obtained may be biased. Therefore, many studies have integrated in their models the possibility of smuggling. For instance, Keeler et al (1996) have included "an index of export attractiveness" (Keeler et al, 1996, p. 506) as a proxy variable for smuggling.

However, even if some of these problems have not been corrected, most of the studies on cigarette consumption have found similar estimates of price-elasticity for demand, ranging between -0.3 and -0.5 (U.S. Department of Health and Human Services, 2000)

***FURTHER RESULTS ON TOBACCO TAXATION:***

Chapter III has presented the different theories and implications of the taxation of cigarettes and tobacco products. While searching for the optimal tobacco taxation system, many economists have used these theories to analyze the effects of an increase of cigarette taxes on cigarette consumption, but also on many other factors that will be presented in this section.

Some economists have tried to value the external costs generated by smokers in order to make them bear the full cost of their consumption of cigarettes through appropriate taxes. Manning et al (1989) have estimated these external costs in the U.S. through "lifetime costs by tracking expenditures for two hypothetical cohorts of men and women from age 20 years to death. One cohort smokes, the other does not" (Manning et al, 1989, p. 1604). They found an external cost of smoking of 0.15 cents per pack which was, at the time, less than half the value of the excise tax. However,

Manning et al (1989) and other economists have under-estimated the external costs caused by smokers because they could not take into account the additional costs associated to second-hand smoking. The finding of an optimal taxation rate for cigarettes is very complex and many economists have studied the diverse consequences of an increase in tobacco tax instead.

Concerning the retail price of cigarette packs, it is generally observed that an increase in the tax rate of cigarettes results in a more than proportional increase of the retail price. For example, Harris (1987), studied the impact of the increase of the U.S. federal excise tax on cigarettes in 1983 and showed that an 8 cent increase of taxes results in a 16 cent increase of cigarette prices that is not explained by the production costs. A potential explanation for this non-proportional increase is that producers and manufacturers raise prices to increase their profits obtained from the present smokers. Theses profits will help to offset the future loss of new potential smokers that, due to a raise in taxes, might be discouraged to smoke.

Conversely, Keeler et al (1996) observed that in the United-States, it is possible that price increases were less than proportional to the increases in taxes because cigarette sellers are using price-discrimination in order to offsets some of the anti-smoking laws. Therefore, sellers lower the net price of cigarettes in States were anti-smoking laws are abundant. However, Keeler et al (1996) stated that this price-discrimination had little effect on the retail price of cigarettes. They employed annual state-level data from 1960 to 1990 and found that on average, an increase of tobacco taxes by 1 cent leads to an increase of 1.11 cents of the cigarette prices.

One of the biggest potential problems caused by an increase of tobacco taxes is the development of black markets for smuggled cigarettes. In fact, taxes on cigarettes vary significantly from one country to another leading to strong variation in prices that can encourage contraband. While the main goals of an increase in cigarette taxes are to reduce cigarette smoking and to increase state revenues, some countries have failed to achieve these goals because of a high smuggling issue. In Canada for example, between 1991 and 1992, the government has significantly increased the price of cigarette packs through tax increases. The average price of a Canadian cigarette pack was more than twice the U.S. average price. Consequently, an impressive smuggling network has been developed and in 1993, smuggled cigarettes from the United-States reached nearly 30% of the market share in Canada. To stop this big contraband issue, the Canadian government has decided to bring down the cigarette pack price to that of the United-States. (Alain, 1997)

Sweden had a similar experience following two important tax increases in 1996 and 1997 that led to the development of a black market for cigarettes. However, even with the presence of smuggling, these increases in taxes have been successful in decreasing the prevalence of smoking and increasing state revenues. According to "the personal communication" by Nordgren (1998), between 1996 and 1997, the smoking prevalence in Sweden has decreased by 4% among men and by 1% among women and the tax revenue rose by 9%. However, these tax increases were very unpopular among the Swedish population and the government, afraid to see smuggling becoming a real problem, repealed the tax increases in 1998.

Joossens et al (1998) reported that the existence of smuggling is not only caused by high taxes on cigarettes. There are other important factors to take into account such as informal distribution networks and the weakness of policies against tobacco contraband. In fact, with the exception of Canada and Sweden, it seems that an increase in tax has been a good policy for many countries. In France, the numerous increases in taxes and prices from September 1991 to December 1996 has reduced smoking prevalence by 15% and increased tobacco tax revenue by nearly 80%. Simultaneously, the presence of smuggling appears to be very low. (Baudier, 1997)

In the United-States, because of the cigarette tax differences across States, many economists took an interest in studying the bootlegging effects which is a particular aspect of smuggling. In fact, bootlegging consists of buying large amounts of cigarettes in low-tax jurisdictions and then reselling them in high-tax jurisdictions. Studies in this area have shown that smuggled cigarettes from States with low-tax jurisdictions represent a large percentage share of their total sales of cigarettes. (Saba et al, 1995; Manchester, 1976)

In addition to smuggling, the notion of "vertical equity" has been previously developed in Chapter III to show that taxes on tobacco are regressive if low-income smokers consume as many cigarettes as middle or high-income smokers. However, empirical analyses in this field have brought controversial results depending on the population studied. For some low-income and middle-income countries, smoking prevalence is more important for the wealthiest. (Strebel et al, 1989; Taylor et al, 1996)

On the other hand, some studies on high-income countries have shown the opposite result. For example, in the United-Kingdom, low-income individuals smoke three fold more than the wealthiest. (UK Department of Health, 1998)

We can thus conclude that the regressivity of tobacco taxes is less important in low-income and middle-income countries. Furthermore, recent studies on the relationship between price-elasticity of demand for cigarettes and socio-economic status have shown that the level of regressivity associated with tobacco taxes has been largely over-estimated. Chaloupka (1991) stated that less educated people are more sensitive to changes in price. Similarly, Townsend et al (1994) found a negative relationship between the absolute value of the price-elasticity for demand and the social status in the United-Kingdom. In that sense, for the case of high-income countries, even if tobacco taxes are heavy on the income of the poorest smokers, higher taxes on cigarettes may be progressive because it significantly reduces the difference in smoking prevalence between smokers from different socio-economic backgrounds.

Even if an increase of tobacco taxes can have bad effects as mentioned above, this literature review has shown its efficiency in terms of reducing the cigarette consumption and the initiation to tobacco use. Knowing the harmful effects of tobacco consumption on health, an increase of tobacco taxes significantly reduces the number of diseases and premature deaths caused by cigarette smoking. In fact, Moore (1996) analyzed the relationship between cigarette taxes and smoking-related deaths in the United-States. He employed state level data from 1954 to 1988 and found that a 10% increase in tobacco taxes reduces the number of premature deaths caused by cigarette smoking by 6000 people a year.

***SUMMARY AND CONCLUSIONS:***

This literature review has presented numerous econometrics studies on the demand for cigarette consumption and the effects and benefits of an increase of tobacco taxes. It has explored most of the variables that need to be taken into account when constructing a model on cigarette demand. When using time series data, it is necessary to correct for the addictive aspect of tobacco. Although it has been largely criticized, the "rational addiction" framework of Becker and Murphy (1988) has brought significant results confirming the necessity of adding the lagged and lead consumption of cigarettes to control for addiction. With the use of cross-sectional and pooled data, many economists have explored different socio-economic and demographic group's propensity to smoke. Results have shown that the price-elasticity for cigarette demand usually ranges between -0.3 and -0.5. Thus, an increase of 1% of cigarette prices leads to a decrease of 0.3% to 0.5% of cigarette consumption. In that case, an increase of cigarette prices through taxes will lead to an increase of state tax revenue and to a decrease of cigarette consumption. Additionally, it seems that youths are much more sensitive to changes in prices. In fact, studies have shown that their price-elasticity for the demand of cigarettes is around 3 times larger than that of an adult (Chaloupka and Grossman, 1996; Lewit, Coate and Grossman 1981).

An increase of cigarette taxes is therefore a good way to reduce initiation to cigarette use and to reduce the consumption of tobacco among young smokers. Studies on socio-economic groups have shown that, in high income countries, the prevalence of smoking is more important among the poorest. However, it seems that they are more

sensitive to changes in prices than the wealthiest. Consequently, an increase in taxes is a way to reduce significantly the consumption of tobacco among low-income smokers and to redistribute equally the propensity to smoke among the different socio-backgrounds. (Townsend et al, 1994; Chaloupka, 1991)

In conclusion, if problems such as cigarette smuggling are well controlled by governments, the literature has shown that an increase in tobacco taxes is a great policy to reduce cigarette consumption and initiation to cigarette use. It is a way to prevent diseases and premature death among smokers and victims of second-hand smoke. Additionally, because the demand for cigarette has generally been found to be inelastic (the absolute value of the price-elasticity for demand is included between 0 and 1), an increase in taxes is a great way to raise tax revenues that will not be fully offset by the decrease in cigarette sales and thus, will generate benefits to the government. These benefits are often used to finance the health care provided to the public. However, there is a possibility that this provision of medical care can discourage individuals from quitting smoking because nowadays, some of the consequences of cigarette use on health can be cured.

# CHAPTER V

# THEORETICAL MODEL AND VARIABLES

For the past three years, the price of cigarettes in France has significantly increased through important increases in tobacco taxes. To analyze the effects of these recent increases in taxes on cigarette consumption, the base model of rational addiction on cigarette demand from Becker, Grossman and Murphy (1994) is used. As it has been shown in the literature review, it is important to take into consideration several factors when studying the demand for cigarettes. When dealing with time series data, an important factor to consider is the addictive aspect of cigarettes. Based on the "rational addiction" framework of Becker and Murphy (1988), Becker et al (1994) have constructed a model that illustrate the effects of cigarette addiction and other "shift" variables on cigarette consumption. In their paper "An Empirical Analysis Of Cigarette Addiction", Becker et al (1994) based their analysis on the assumption that individuals make perfect predictions and take into account their future consumption when making current choices. Subject to their lifetime budget constraints, individuals maximize their lifetime utility by choosing time paths for addictive goods (cigarettes) and composite of non-addictive goods consumption levels.

At the period t, the lifetime utility U(t) can be expressed as follows:

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

The addictiveness of cigarettes is represented by $C_t$, the current consumption of cigarettes and $C_{t-1}$, the consumption of cigarettes in period t-1. The other components $Y_t$ and $e_t$ represent respectively the consumption of the composite of non-addictive commodities and "unmeasured life-cycle variables".

Becker et al (1994) assumed that the utility function *U(t)* is concave and quadratic in $C_t$, $C_{t-1}$, $Y_t$ and $e_t$. They solved for the first order condition for $Y_t$ and obtained the following linear difference equation:

$$(2) \qquad C_t = \alpha_0 + \alpha_1 C_{t-1} + \alpha_2 P_t + \alpha_3 C_{t+1} + \alpha_4 A_t$$

Where Ct is the consumption of cigarettes in period t, Ct-1 and Ct+1 are respectively the lagged and future consumption and Pt is the real price of cigarette in period t. The term At represents some "shift variables" (other variables that affect the consumption of cigarettes).

The model used in this thesis is very similar to the basic rational model of Becker et al (1994). The per capita cigarette sale is used as a proxy of cigarette consumption per capita for the dependant variable. The lagged and future per capita cigarette sales are employed to characterize the addictive rational behavior of cigarette consumption. Since the addiction to cigarettes is defined as a devotion to the habit of smoking, a positive relationship is expected between those two variables and the dependant variable.

Five shift variables are used for the remaining independent variables: the real tax price, the real GDP per capita, the real advertising expenses per capita against tobacco, the number of tobacco substitutes per capita and a dummy variable to correct for seasonality. Since the main goal in this analysis is to determine the impact of a change in

taxes on cigarette consumption, the real tobacco tax price is employed. Theoretically, an increase in taxes should decrease consumption.

A positive relationship between the real GDP per capita and the per capita cigarette sales is expected. In fact, if the real GDP per capita increases, the disposable income increases and generally leads to higher consumption.

The sign of advertising expenses per capita is unknown. Theoretically, the warning on health about the harmful effects of cigarettes should discourage people from smoking. However, economists have argued that advertising against tobacco products are ineffective communication devices (Krugman et al., 1999)

Many empirical papers have analyzed the cigarette consumption by taking into account the addictive behavior of smoking. However, if addiction is important, the desire to stop smoking should also be considered. Therefore, the amount of tobacco substitutes per capita is included in the model. The expected sign of this variable is negative.

Finally, a dummy variable is used to control for seasonality. This dummy takes the value 1 for the months April though September which are considered to be the warmest months in France and 0 otherwise. This dummy is expected to have a positive relationship with the consumption of cigarettes. In fact, it is believed that people smoke more when it is warm. One argument is that people generally smoke more during holidays and therefore, during the summer. Another explanation is that many people do not smoke in closed areas. Therefore, if it is very cold, they might be discouraged to go outside to smoke. One last thing differs from the basic rational model of Becker, Grossman and

Murphy (1994). If the tobacco tax is a percentage of the retail price and then it is not possible to use both, the tobacco tax and the cigarette price in the model because of colinearity problems. However, if the data on the net price presents some variation, it can be used in the model as an additionally regressor. The sign of the net price is expected to be negative because an increase in the net price should decrease the consumption of cigarettes.

Now that the different variables used in the model have been presented, the next section introduces the sources of the data employed and the different transformations applied to construct the variables of the model.

## CHAPTER VI

## DATA AND METHODOLOGY

The data used in this thesis is, or has been transformed into monthly observations and the period studied ranges from January 2003 to January 2006.

Cigarette consumption data is obtained from Altadis, the key player in tobacco distribution in France. Altadis, previously called Seita, distributes most of the cigarettes consumed in France to a network of 36,000 tobacconists. The data is represented on the basis of monthly sales and the population is used as the denominator to adjust for the effect of population growth on cigarette sales. Therefore, the dependant variable is represented by the amount of cigarette sales per capita represented in the model by **C**. However, the data on population is yearly data and interpolation has been used to construct monthly data. Even if this method leads to a loss of precision, the monthly data should be very close to reality since the annual population growth rate in France is stable around 0.62%

The data on cigarette taxation is the tax percentage of the price of Marlboro cigarette packs. Data were obtained from the CDIT (Centre de documentation et d'information sur le tabac: Center for tobacco information and documentation).
As it has been mentioned in Chapter II, tax on cigarettes in France depends partly on the price of the bestselling cigarette, which varies with the tax. From January 2000 to January 2006, the best-selling cigarettes pack in France was Marlboro. Therefore, the price of

Marlboro packs is used as the base reference to construct the percentage of taxation. The data has been transformed into the Tax price in euros by multiplying the tax percentage by the price of cigarette packs. The tax price is then weighted by the French consumer price index to obtain the real tax price per cigarette pack represented by the notation **TAX**.

The retail cigarette pack price data is also obtained form Altadis. Data represents the price of Marlboro cigarette packs. To obtain the net price, the retail price has been multiplied by (1- Tax percentage). The net price has then been weighted by the French consumer price index to obtain the real net price of a cigarette pack, **NP**.

The data on the French GDP was obtained from INSEE (Institut National de la Statistique et des Études Économiques: National Institute for Statistics and Economic Studies). Since the data on the GDP are not monthly but quarterly data, the method of interpolation has once again been used to transform the observations into monthly data. The GDP is in euro and has been weighted by the French population and the consumer price index in order to obtain the real GDP per capita, **GDP**.

The expenses on advertising against cigarette consumption data were obtained from the OFDT (Observatoire français des drogues et des toxicomanies: French monitoring center for drugs and drug addiction). These advertisings were directed by INPES (Institut national de prévention et d'éducation pour la santé: French Institute for Prevention and Health Education) through several media campaigns (T.V., radio, posters, newspapers, interactive media). Since some other organizations advertise on the harmful effects of tobacco products, the data does not represent the integrality of the advertisings in France. Nevertheless, INPES is the main advertiser against cigarette consumption in

France and the data used represents the majority of the advertising expenses. However, by looking at the data, we can notice a considerable amount of zeros suggesting that INPES does not advertise during some months. According to the CDIT, advertising in France is a seasonal procedure and the presence of zeros is not surprising. In fact, the data shows that the highest advertising expenses are in May and June which correspond to the period around the World Smokefree Day, the 31st of May. In addition, the data obtained on advertising expenses are limited to the period January 2003 to January 2005 while the other variables of the model use data from January 2000 to January 2006. In order to employ in the model as many observations as possible, the missing observations of advertising expenses have been predicted through an OLS regression. The advertising has been regressed on the time trend and eleven dummies taking the value 1 for their respective month. The base dummy is the month of June, which is, by looking at the data, the month where France advertises the most. The regressed equation is shown as followed:

$$(3) \quad ADVERTISING_t = \alpha_0 + \alpha_1 TIME + \alpha_2 D2 + \alpha_3 D3 + \alpha_4 D4 + \alpha_5 D5 + \alpha_6 D6 + \alpha_7 D7 + \alpha_8 D8 + \alpha_9 D9 + \alpha_{10} D10 + \alpha_{11} D11 + \alpha_{12} D12 + \varepsilon_t$$

The OLS regression has brought an adjusted $R^2$ of 0.544 and F value of 4.59 suggesting that the coefficient of the variables are jointly significant at the 5% level.

By using the coefficient of the variables obtained through the regression, it has been possible to predict the missing observations of the advertising variable. The data on advertising expenses has then been weighted by the population and the consumer price index in order to obtain the real advertising expenses per capita represented by the

notation **ADV**. However, in comparison to the observed data, the prediction results look suspicious. In fact, the results indicate that France advertises relatively regularly each month which is controversial with the several zeros observed previously. To control for any potential anomaly in the predicted values, an additional dummy **DUMADV** has been added in the model. This dummy takes the value 1 for the predicted observations and zero otherwise.

Finally, the data on cigarette substitutes represents the total sale of nicotine products (patches, oral pills and gum) and was obtained from the OFDT. The data has been weighted by the population to obtain the per capita sale of cigarette substitutes, **SUB**. Based on the selection criteria of the time-series model, the following Model is specified through this econometric equation:

$$\underline{\text{Model 1}}: \quad (4) \quad C_t = \alpha_0 + \alpha_1 Clag_t + \alpha_2 Clead_t + \alpha_3 NP_t + \alpha_4 TAX_t + \alpha_5 GDP_t + \alpha_6 ADV_t + \alpha_7 SUB_t + \alpha_8 WARM_t + \alpha_9 DUMADV_t + \varepsilon_t$$

The variables employed are summarized in the following table:

**Table 3**

**Variables description**

| | |
|---|---|
| C | Amount of cigarette sold per capita[3] |
| Clag | Lagged cigarette sold per capita |
| Clead | Future cigarette sold per capita |
| NP | Real net price of cigarette |
| TAX | Real tax price of cigarette |
| GDP | Real GDP per capita |
| ADV | Real tobacco advertising expenses per capita |
| SUB | Amount of tobacco substitutes per capita |
| WARM | =1 for warm months |
| DUMADV | =1 for predicted advertising values |

[3] See Table 8 of the appendix for descriptive statistics

# CHAPTER VII

# RESULTS

This chapter focuses on the results of the OLS regression of the equation *(4).* The statistical significance of the coefficient estimates as well as their interpretation are discussed. To ensure that the estimators are the best linear unbiased estimators, the model is tested for misspecification errors, autocorrelation, heteroskedasticity and multicolinearity. The results are then reported and analyzed.

It has been specified in the previous chapter that the observations were obtained from January 2003 to January 2006. However, since the lagged and future consumption are employed in the model, two observations are lost bringing down the model to 71 observations.

Using the 71 observations and degrees of freedom of 61, the regression results of the estimation of equation *(4)* gave us a F-statistic of 75.72. Therefore, the coefficients of the variables are jointly different from zero at the 5% level. The adjusted $R^2$ is equal to 0.906 suggesting that 90.6% of the variation in the data is explained by the model.

Equation *(4)* was estimated using limdep 8.0 and the results are summarized in table 4 on the following page.

**Table 4**

**OLS regression – Equation *(4)***

| Variable | Coefficient | Standard Error | t-value | P-value |
|---|---|---|---|---|
| **Constant**** | 12.200 | 5.381 | 2.267 | 0.027 |
| **CLAG***** | -0.197 | 0.105 | -1.878 | 0.065 |
| **CLEAD*** | -0.304 | 0.112 | -2.712 | 0.009 |
| **NP** | -1.426 | 1.881 | -0.758 | 0.451 |
| **TAX*** | -2.335 | 0.311 | -7.503 | 0.000 |
| **SUB***** | -86.539 | 48.455 | -1.786 | 0.079 |
| **ADV*** | 7.035 | 2.124 | 3.312 | 0.002 |
| **GDP** | 0.001 | 0.003 | 0.505 | 0.616 |
| **DUMADV** | 0.052 | 0.185 | 0.282 | 0.779 |
| **WARM*** | 0.490 | 0.109 | 4.485 | 0.000 |

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

All the variables have the right signs except for the real GDP per capita (**GDP),** the lagged cigarette sale per capita (**Clag)**, and the future cigarette sale per capita (**Clead)**. While the variable **GDP** is not significant, **Clag** and **Clead** are respectively significant at the 10% and 1% significance level and their negative sign is contradictory to the "rational addiction" model theory. However, since the analysis uses monthly data, it is possible that the model did not capture addiction. In addition, although the net price is positive and thus wears the expected sign, it is not significant. The per capita substitute for cigarettes, **SUB** also wears the expected sign but is only significant at the 10% level. It is plausible that the model presents a loss of efficiency due to a misspecification of the model. It is therefore important to test for a misspecification bias. Consequently, the Ramsey RESET test was employed and brought a F-value of 2.01. This value is inferior

to the critical F-statistic (2.76) and thus, fails to reject, at the 5% significance level, the null hypothesis stating that the model is correctly specified. However, the value of 2.01 is not far from the critical value of 2.76 suggesting that a better functional form can be found.

One of the most common modes of transformation used is the natural log. In fact, the double log form is very useful because the estimates of the coefficients can be interpreted as elasticities. Equation *(4)* is therefore transformed into a double log form and the Box-Cox test is used to verify whether this functional form is better than the linear specification.

The double log regression is specified as followed:

$$(5) \quad logC_t = \beta_0 + \beta_1 logClag + \beta_2 logClead + \beta_3 logNP_t + \beta_4 logTAX_t + \beta_5 logGDP_t + \beta_6 log^4 ADV_t + \beta_7 logSUB_t + \beta_8 WARM_t + \beta_9 DUMADV_t + \varepsilon_t$$

The l* value of the Box-Cox test is found by using the exponential of the mean of **LOGC** (calculated at 23.388) as well as the residuals sum of squares of the linear model (5.823) and the residuals sum of squares of the double log model (0.265). The l* value [5] is found to be inferior to the Chi-Square critical value of 3.84. Therefore, we fail to reject the null hypothesis at the 5% significance level and conclude that the two regressions are observationally equivalent. However, after running the Ramsey RESET test on regression *(5)*, the new F-statistic is equal to 1.409. This value is inferior to the one found with the linear form, suggesting that the double log is a better functional form.

[4] The zeros contained in the observations of the advertising expenses have been replaced by a value very closed to 0 in order to transform the variable ADV into the log form

[5] l* = 71/2*abs{ln[(5.823÷23.388)/ 0.265)]} = 1.890

The OLS regression results of equation *(5)* obtained by limdep 8.0 are represented in the following table:

**Table 5**

**OLS regression – Equation *(5)***

| Variable | Coefficient | Standard Error | t-value | P-value |
|---|---|---|---|---|
| **Constant** | -2.353 | 9.299 | -0.253 | 0.801 |
| **LOGCLAG**** | -0.256 | 0.106 | -2.406 | 0.019 |
| **LOGCLEAD*** | -0.356 | 0.114 | -3.118 | 0.003 |
| **LOGNP** | 0.227 | 0.329 | 0.691 | 0.492 |
| **LOGTAX*** | -1.809 | 0.230 | -7.865 | 0.000 |
| **LOGSUB***** | -0.048 | 0.025 | -1.901 | 0.062 |
| **LOGADV**** | 0.004 | 0.002 | 2.291 | 0.025 |
| **LOGGDP** | 0.857 | 1.232 | 0.695 | 0.489 |
| **DUMADV** | 0.001 | 0.040 | 0.031 | 0.975 |
| **WARM*** | 0.108 | 0.024 | 4.558 | 0.000 |

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

The differences between the linear regression *(4)* and the double log regression *(5)* are very slim. The results of the OLS regression of equation *(5)* show that the constant term is no longer significant and that the real advertising expenses per capita is no longer significant at the 1% level but only at the 10% level. However, while the real net price variable and the dummy DUMADV are still not significant, the significance of all the remaining variables has slightly increased through bigger t-statistics (in absolute value). Therefore, it seems that the double log form has brought the model a gain in efficiency.

The adjusted $R^2$ is now equal to 0.904 suggesting that 90.4% of the variation in the data is explained by the model.

To verify that the OLS assumptions have not been violated, regression *(5)* needs to be checked for heterosckedasticity, multicolinearity and autocorrelation.

The presence of heterosckedasticity can be presumed by plotting the estimated squared residual versus the independent variables. By looking at the plots, it seems that only the log of real advertising expenses per capita, **LOGADV** potentially shows a pattern. It implies that heterosckedasticity might be caused by this variable. To test whether this presumption is true or not, the Goldfelt-Quandt test has been used. Data has been arranged according to ascending value of **LOGADV** and ten central observations have been omitted. The F-statistic of the Goldfelt-Quandt test is equal to 1.049 which is inferior to the critical F value of 2.12 at the 5% level. Therefore, we fail to reject the null hypothesis of homosckedasticity.

To make sure that heterosckedasticity is not a problem in regression *(5)*, the Breush-Pagan test has also been run and brought a chi-squared value of 15.705. Since the critical value at the 5% significance level is 16.92, we fail to reject the null hypothesis and therefore, there is no heterosckedasticity in the model.

However, since the model is a time series analysis, autocorrelation of residuals also needs to be tested for. The model employed a lag of the dependant variable in the regression so the Durbin-h test is used instead of the Durbin-Watson-d test.

The Durbin-h statistic is computed through the following formula:

$h = (1-0.5*d)*[N/(1-N*VARc)]^{\wedge 0.5}$

with N, the number of observations and VARc, the estimated variance of the least squares regression coefficient on **Clag.** With 71 observations, a variance VARc equal to 0.011and a Durbin-Watson-d value equal to 2.17, the Durbin-h value is calculated at -1.615. The Durbin-h test shows thus that there is no autocorrelation at the 5% significance level. In fact, the absolute value of the Durbin-h value is inferior to the critical value and fails to reject the null hypothesis stating that there is no autocorrelation.

In addition, it is important to note that the model might present a problem of simultaneity lead by potential endogeneity of the cigarette price that can cause biased estimates. Therefore, a test of exogeneity presented by D. N. Gujarati has been used. As a result, the estimate coefficient of the fitted real net price is inferior to the critical value. The null hypothesis is thus rejected suggesting that the real net price is exogenous. Simultaneity is not a problem in the model. This result is support by the RESET test that has detected no form of misspecification.

Finally, the model is tested for multicollinearity. As a rule of thumb, if the pair-wise or zero-order correlation coefficient between two regressors is high, then the model has a serious problem of multicollinearity. By looking at the correlation matrix in table 7 of the appendix, we can notice that some of the pair-wise correlations are high suggesting multicollinearity. For example, the correlation between **LOGClead** and **LOGTAX** is equal to -0.923, suggesting that there is a strong negative relationship between these two variables.

The auxiliary regression of each independent variable confirms the presence of multicollinearity. In fact, except for the dummy **WARM** and the two variables **LOGSUB** and **LOGADV**, all the auxiliary regressions result in a high $R^2$. In addition, all the F-

values were superior to the critical value. However, Multicollinearity is not a major problem because it does not lead to biased estimates but simply to larger standard errors and wider confidence intervals that can lead to type II errors.

Since the regression *(5)* does not present other problems than Mullticolinearity, the estimated coefficients can now be interpreted. Since the model is specified in the double log form, the coefficients represent the elasticities (except for the dummy variables). The most significant variable is the real tax price of cigarette packs. According to the results, an increase of 1% of the real tax price reduces the amount of cigarette sales per capita by 1.809%. The increase in tobacco taxes appears therefore to be very effective in diminishing the sales of cigarettes in France.

The real net price is affected by the double log elasticity of 0.227. An increase of the real net price increases thus the cigarette sale per capita. This elasticity is obtained by holding all the other variables constant. However, the net price generally increases due to an increase in taxes suggesting that the real tax price can not be held constant and that this elasticity is wrong. Although the real net price is not significant, a better model will be to combine the real net price and the real tax price into one variable. It also might be a way to reduce the multicollinearity problem. In fact, multicollinearity occurs because two (or more) variables are related and that they measure essentially the same thing. Since the net price and the tax price are components of the cigarette price, these two variables have been added and replaced by the real retail price of cigarette, **P**. The new model is thus specified as followed:

$$\underline{\text{Model 2}}: \quad (6) \quad C_t = \alpha_0 + \alpha_1 Clag + \alpha_2 Clead + \alpha_3 P_t + \alpha_4 GDP_t + \alpha_5 ADV_t + \alpha_6 SUB_t + \alpha_7 WARM_t + \alpha_8 DUMADV_t + \varepsilon_t$$

By combining the real net price and the real tax price, the degrees of freedom is now equal to 62. The OLS regression results of equation *(6)* shows a F-statistic of 86.22 leading to the conclusion that the coefficients of the variables are jointly different from zero at the 5% level. The adjusted $R^2$ is equal to 0.907 suggesting that 90.7% of the variation in the data is explained by the model.

The OLS regression results of equation *(6)* are represented in the following table:

**Table 6**

**OLS regression – Equation *(6)***

| Variable | Coefficient | Standard Error | t-value | P-value |
|---|---|---|---|---|
| **Constant**** | 11.656 | 5.224 | 2.231 | 0.029 |
| **CLAG***** | -0.197 | 0.104 | -1.890 | 0.063 |
| **CLEAD*** | -0.297 | 0.110 | -2.692 | 0.009 |
| **P*** | -2.305 | 0.303 | -7.617 | 0.000 |
| **SUB***** | -77.146 | 43.921 | -1.756 | 0.084 |
| **ADV*** | 6.898 | 2.091 | 3.299 | 0.002 |
| **GDP** | 0.002 | 0.003 | 0.769 | 0.445 |
| **DUMADV** | 0.027 | 0.177 | 0.156 | 0.877 |
| **WARM*** | 0.494 | 0.108 | 4.555 | 0.000 |

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

To check whether a double log or a linear form should be employed, Model 2 is submitted to the Box-Cox test. The l* value [6] of the Box-Cox test is superior to the Chi-

[6] l* = 71/2*abs{ln[(5.844÷23.388)/ 0.284)]} = 4.545

Square critical value of 3.84 rejecting the null hypothesis at the 5% significance level. The test concludes thus that the two regressions are observationally different and that the linear form fits the data better than the double log form. Regression *(6)* is then retained and submitted to the Ramsey RESET test to check for misspecification. The test has resulted in a low F-value (1.654) showing that the model is well-specified.
Regression (6) is then tested for heteroskedasticity and autocorrelation of the residuals. The Breush-Pagan test with a Chi squared of 6.735 has detected no form of heterosckedasticity and Durbin-h test has shown that there is no autocorrelation at the 5% significance level (h* = -1.691). In fact, the absolute value of the t-statistic of the lagged residual is equal to 0.972 and is inferior to the critical value 2.00. Therefore, we fail to reject the null hypothesis stating that there is no autocorrelation.
Since model 2 does not present any problems, the results of the OLS regression of equation *(6)* can be interpreted.

With 7 significant variables, the results are very satisfying. Only the real GDP per capita and the dummy **DUMADV** are not significant. In addition, all the variables except **Clag** and **Clead** wear the expected sign.

With a t-statistic of 7.617 (in absolute value), the most significant variable is the real retail price of cigarette packs, **P**. To be able to analyze the effect of an increase in **P** on the per capita cigarette sales, **C,** the price-elasticity is calculated. By using the mean of **P** and **C** shown in the summary statistic table 8 of the appendices as well as the coefficient of **P** obtained through the regression, we obtain a price-elasticity of -1.753[7]. Therefore, an increase of 1% in the real price reduces the amount of cigarette sales per

[7] Price-elasticity = -2.305*(3.75920240÷4.94260932)=-1.753

capita by 1.753%. The absolute value of this price-elasticity is considerably higher than those found in the United-States. In fact, “almost all of the estimates obtained from time series methods based on alternative economic theories and applied to various data produced estimates of the price elasticity of demand in a relatively narrow range, which was centered on -0.4”. (U.S. Department of Health and Human Services, 2000; p.326) This implies that the French government can largely discriminate the consumption of cigarette in France.

The coefficient of the per capita sales of cigarettes substitutes, **SUB,** is equal to -77.146 and its mean to 0.0022 leading to an elasticity of -0.0357. Therefore, an increase of 1% of the variable **SUB** decreases the per capita cigarette sales by 0.0357%. Although this elasticity is very low, the variable **SUB** is significant at the 10% level suggesting that its inclusion in the model has been a good choice. It seems that the desire of quitting smoking needs to be part of the addictive rational model.

The real per capita advertising expenses, **ADV** has a positive sign suggesting that an increase of advertising expenses increase the amount of cigarette sales per capita. This positive relationship is very surprising knowing that the main goal of these advertising expenses is to discourage people from smoking. However, the variable **ADV** is affected by the coefficient 6.898 leading to an elasticity of 0.0314. Consequently, its effect on cigarette consumption is negligible.

The OLS results also show that an increase of the real GDP per capita, **GDP,** increases the per capita cigarette sales suggesting that cigarettes are normal goods. With a coefficient of 0.002, the income elasticity is calculated to be equal to 0.827. Therefore, an increase of **GDP** by 1% will increase the per capita cigarette sales by 0.827%. However,

the variable is not significant suggesting that cigarettes in France might actually be neither, a normal good or an inferior good. Consequently, an increase in real GDP will not affect the consumption of cigarettes.

The dummy variable **WARM** holds an expected positive sign. The dummy is statistically significant at the 1% level showing that cigarette consumption consistently increases when it is warm. This strengthens the hypothesis that people smoke more during holidays.

The dummy variable **DUMADV** is not significant suggesting that the predicted observations of the advertising expenses are adequate.

Finally, the OLS results show that the lagged and future per capita cigarette sales variables are statistically significant but both have the wrong sign. In fact, these variables represent the addictive behavior of smokers to cigarettes and should have a positive sign. However, it is possible that these variables did not capture the "rational addiction" to cigarettes due to the monthly data. Another explanation is that the model capture a "rational non-addiction" that shows that the French are not addicted to cigarettes and therefore can take effective decision against cigarette consumption.

# CHAPTER VIII

# CONCLUSION

The goal of this analysis was to identify the factors that affect the consumption of cigarettes and to determine the impact of an increase of cigarette taxes on cigarette consumption in France. This thesis began by a brief historical aspect of the smoking prevalence in France as well as the different measures used by the government to reduce the cigarette consumption. Through the large literature on the demand for cigarette, it has been shown that an increase of tobacco taxes has often been used as the main policy to fight against cigarette smoking. In fact, several studies on cigarette consumption from different countries but mostly form the United-States have shown that the price-elasticity of the demand for cigarettes is negative and therefore, an increase of the cigarette price through an increase in tobacco taxes, decreases the consumption of cigarettes.

The econometric analysis of this thesis has confirmed these results for the case of France. Using the basic "rational addiction" model of Becker et al (1994), two models have been constructed and the model 2 specified at the end of chapter VII has been retained. The OLS regression has shown that most of the variables used in the model are significant. In addition to the addictive aspect of cigarettes, the significance of the per capita sales of substitutes for cigarette has proven that the willingness of people to stop smoking also needs to be considered. The dummy **WARM** was used to control for seasonality. However, its strong significance has shown that smokers in France consume

considerably more cigarettes during the months of April trough September. In France, most of the people take vacations in July-August leading to the conclusion that people smoke more during holidays. This is mainly due to the fact that they have more free time and are not submitted to some of the job's restrictions on smoking.

Results have shown that an increase of real advertising expenses per capita against cigarettes slightly increases the per capita sales of cigarettes. However, this effect is practically null leading to the conclusion that the current advertising against cigarette consumption is ineffective in France. While the advertising for tobacco products is forbidden since the Evin law in 1991, it seems that the government needs to revise its advertising policies against the tobacco products and better inform the population about the harmful effect of cigarette consumption if they want to discourage people from smoking. However, the particularities on the data obtained on the advertising expenses might have falsified its estimate. In fact, some of the observations have been predicted and therefore did not account for some zero values that are present among the observed observations. It is certainly possible that INPES has not advertised during some of the predicted months. Thus, a definite conclusion on the effects of advertising against tobacco products can not be made.

The results on the real GDP per capita, which is a proxy variable for the real income have shown that cigarettes are a normal good in France. Consequently, an increase in real income increases the demand for cigarettes. However, because of the insignificance of the real GDP per capita, its effects on the per capita cigarette sales are questionable. Cigarettes in France might be neither, a normal good or an inferior good.

Finally and most importantly, the results on the real price have shown that an increase of tobacco taxes decreases significantly the sales of cigarettes per capita in France. In fact, a price-elasticity of -1.753 has been calculated suggesting that an increase of the real price by 1% reduces the per capita cigarette sales by 1.753%. This price-elasticity is much higher than that calculated for the United-States which is centered on -0.4. It seems therefore that the French population does not have a strong addiction to cigarettes. As a result, although the advertising against tobacco products are ineffective, the policy on tobacco taxes is a great tool for the French government. By increasing the taxes, the government can significantly discriminate the sales of cigarette. In fact, according to Altadis, the sale of cigarettes in France in volume has dropped by 22.4% on the first trimester of 2004 in comparison with the last trimester of 2003. Altadis stated that the consequence of the drop of the official market of tobacco is due to the tax increase in January 2004. The increase of the price of cigarette by 20% in October 2002, and the increase of 9% in January 2004 have strongly affected the sales of cigarettes. (MILDT, 2006)

However, as it has been discussed in Chapter III, the increase of taxes is not without consequences. In France, from 1999 to 2004, the number of cigarettes sold has decreased by 34% (OFDT, 2005). In the same time, the prevalence of smokers has only decreased by 10% (Guilbert, 2005). The difference between the sale of cigarettes and the prevalence of smoking can be explained by a decrease in cigarette consumption. However, another explanation is the possibility that smokers are buying cigarettes from other countries with lower taxes or on illegal markets.

The increase of tobacco taxation has also increased the inequalities among the French population. In fact, Le Coeur stated in 2003 that the consumption of cigarettes has exclusively decreased among the wealthier households. For 10% of the poorest families, the average consumption of cigarettes has stabilized around 8 cigarettes per day per adult which is much more than the overall average of 3.6 cigarettes per day per adult. As a consequence to the increase in tobacco taxes, the income share of the less wealthy households spent on tobacco consumption has largely increased violating the principle of "vertical equity".

In addition, the slow down of the cigarette sales has caused a drop of the distribution of cigarettes to the tobacconists by 40% in November and by 29% in December leading to a decrease of the tobacconists' income (CDIT, 2004).

To conclude, the elastic price-elasticity of demand for cigarettes in France implies a decrease of the tobacco tax revenue that is used to finance the social security budget. This shows a big contrast with the United-States where the price-elasticity of demand is inelastic and were an increase in tobacco taxes increase the tax revenue. However, this shows that the French government goal is to reduce cigarette consumption exclusively.

Unfortunately, the data used in the econometric model of this thesis does not allow analyzing some of the consequences of the increases of tobacco taxes in France. For future analyzes, it will be interesting if possible, to employ cross-sectional data of individual surveys or panel data in order to implement in the model other determinants of cigarette smoking such as education level, social class, professional status and the age. However, econometric analysis of this thesis has brought good preliminary results. The increase in tobacco taxes is a powerful tool for the French government to reduce cigarette

consumption in France. In addition, advertising policies against tobacco products might need to be reviewed and ameliorated. In concern to the potential smuggling problem, a proposed solution should be to maintain high taxation, and fight strongly against contraband, with effective measures such as: postage-due-stamp, serial numbers, inscription in the language of the country, on danger of smoking for health, and improved detector methods.

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# APPENDIX

## Table 7
## Model 1 – Correlation Matrix

| | LOGCLAG | LOGCLEAD | LOGNP | LOGTAX | LOGSUB | LOGADV | LOGGDP | DUMADV | WARM |
|---|---|---|---|---|---|---|---|---|---|
| **LOGCLAG** | 1 | 0.83545 | -0.77488 | -0.90799 | -0.36976 | 0.52991 | -0.7557 | 0.79469 | 0.2378 |
| **LOGCLEAD** | 0.83545 | 1 | -0.81842 | -0.92332 | -0.45216 | 0.49936 | -0.81974 | 0.82396 | 0.2371 |
| **LOGNP** | -0.77488 | -0.81842 | 1 | 0.88356 | 0.44309 | -0.4821 | 0.85113 | -0.85209 | -0.0566 |
| **LOGTAX** | -0.90799 | -0.92332 | 0.88356 | 1 | 0.35719 | -0.55376 | 0.86647 | -0.89272 | -0.0701 |
| **LOGSUB** | -0.36976 | -0.45216 | 0.44309 | 0.35719 | 1 | -0.0527 | 0.26781 | -0.32093 | -0.454 |
| **LOGADV** | 0.52991 | 0.49936 | -0.4821 | -0.55376 | -0.0527 | 1 | -0.50782 | 0.57269 | -0.1169 |
| **LOGGDP** | -0.7557 | -0.81974 | 0.85113 | 0.86647 | 0.26781 | -0.50782 | 1 | -0.77543 | -0.1074 |
| **DUMADV** | 0.79469 | 0.82396 | -0.85209 | -0.89272 | -0.32093 | 0.57269 | -0.77543 | 1 | -0.0716 |
| **WARM** | 0.2378 | 0.2371 | -0.0566 | -0.07008 | -0.45402 | -0.1169 | -0.1074 | -0.0716 | 1 |

## Table 8
## Model 2 – Descriptive Statistics

| Variable | Mean | Standard deviation | Min | Max | Cases |
|---|---|---|---|---|---|
| **C** | 4.943 | 1.006 | 3.107 | 6.729 | 71 |
| **CLAG** | 4.962 | 0.996 | 3.107 | 6.729 | 71 |
| **CLEAD** | 4.919 | 1.016 | 3.107 | 6.729 | 71 |
| **P** | 3.759 | 0.573 | 3.108 | 4.587 | 71 |
| **SUB** | 0.002 | 0.001 | 0.001 | 0.007 | 71 |
| **ADV** | 0.022 | 0.021 | 0 | 0.083 | 71 |
| **GDP** | 2045.196 | 30.622 | 1975.804 | 2104.825 | 71 |
| **DUMADV** | 0.535 | 0.502 | 0 | 1 | 71 |
| **WARM** | 0.507 | 0.504 | 0 | 1 | 71 |