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Faculty of Social Sciences

Institute of Economic Studies

MASTER´S THESIS

Smoking - Impact on the State Budget and its Fair Taxation

Author: **Pavel Hait**

Supervisor: **PhDr. Mgr. Jakub Mikolášek**

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Declaration

1. I hereby declare that I have written this thesis independently. All literature and other sources used for thesis are properly referenced
2. I hereby state that the thesis was not used for obtaining a different academic degree
3. I hereby agree that the thesis is available to the public for study and research purposes

In Prague, 10.5.2011 Pavel Hait

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I want to thank my parents for their endorsement and Bára for her smile and patience.

Bibliographic Annotation

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Abstract

The paper addresses the impact of smoking in the Czech Republic in 2009.

The aim is to describe the current facts and trends of tobacco consumption, assess the mortality attributable to smoking, compute its financial impact on the Czech state budget, evaluate the transmission of tax changes into the retail price of cigarettes, assess consumer price elasticity for cigarettes, and compute a fair excise tax on cigarettes for the Czech Republic as well as the tax which would maximise the benefits of smoking for the state budget. For our purposes, we define "fairness" as a situation in which there is no net redistribution of state budget funds between two groups of citizens: non-smokers and smokers. Smokers create benefits (for example, savings on pensions due to their earlier deaths) and costs (for instance, increased health care costs) for the state budget. We search for a tax rate that would balance smoking-associated costs and benefits. Furthermore, we also compute the tax which would maximise net revenues from smoking to the government.

We realised these findings for the Czech Republic, 2009: we observed that there were 22,013 deaths attributable to smoking. About 2.281 billion cigarettes were sold illegally. The costs to the state budget caused by smoking were estimated to 30,547 million CZK, whereas the benefits to 77,915 million CZK. The consumer price own elasticity, controlled for income, was evaluated to be -0.51. Based on these findings and regarding the size of black market, the specific excise tax rate for a cigarette piece to attain the fair taxation should be -0.54 or 4.31 CZK. The specific excise tax rate for a cigarette piece to attain the maximum revenues for state budget is 1.88 CZK (the current specific excise tax rate per piece is 1.07 CZK).

This work is original in many ways. Among others, it adds the effect of second-hand smoke to the evaluation of mortality caused by smoking. Next, to the best of our knowledge, there has been no prior work evaluating "fair" tax for cigarettes as we define it. Last but not least, the work critically describes the pitfalls of other similar studies previously conducted for the Czech Republic.

Bibliografický záznam

Hait, P., (2011), *Kouření - dopad na státní rozpočet a jeho spravedlivé zdanění.* Praha: Karlova Univerzita v Praze, Fakulta Sociálních Věd, Institut Ekonomických Studií.
Konzultant: Mikolášek, J.

Abstrakt

Tato práce se zabývá kouřením a jeho dopady v České Republice v roce 2009.
Cílem práce je popsat současná fakta a trendy ohledně spotřeby tabáku, spočítat dopad kouření na státní rozpočet, posoudit, jak se změna daní promítne do maloochodní ceny cigaret, zhodnotit spotřebitelovu vlastní cenovou elasticitu cigaret a závěrem spočítat spravedlivou sazbu spotřební daně z cigaret pro Českou Republiku, stejně jako sazbu maximalizující příjem do státní pokladny z kouření. „Spravedlnost“ si definujeme jako situaci kdy nedochází k redistribuci prostředků ze státního rozpočtu mezi dvěmi skupinami občanů – kuřáky a nekuřáky. Kuřáci způsobují státnímu rozpočtu ztráty (např. ve formě zvýšených nákladů na zdravotní péči, co musí stát na kuřáky vydat) i příjmy (například úspory na vyplacených penzích díky předčasným úmrtím kuřáků). Budeme hledat takovou daň, aby příjmy a výdaje byly v rovnováze.
Spočítali jsme, že v ČR v roce 2009 zemřelo na následky kouření 22,013 lidí. Rozsah černého trhu s cigaretami jsme odhadli na 2.281 miliard kusů. Náklady státní pokladny způsobené kuřáky byly 30,547 milionů korun, zatímco příjmy jsme odhadli na 77,915 milionů korun. Vlastní cenová elasticita kuřáků, při kontrolování příjmů, byla v ČR -0.51. Spravedlivá daň, při zanedbání černého trhu, by se rovnala specifické sazby daně z přidané hodnoty za jednu cigaretu ve výši -0.54 nebo 4.31 korun. Specifická sazba daně pro dosažení maximálního příjmu pro státní rozpočet z kuřáků se rovná 1.88 korun za cigaretu (Současná specifická sazba daně je 1.07 korun za cigaretu).
Práce je originální svého druhu ve více směrech: kriticky popisuje chyby a nejasnosti podobných studií dosud v ČR provedených. Dále, zohleďňuje efekt pasivního kouření při výpočtu úmrtnosti způsobené kouřením. V neposlední řadě, zdá se, jedná se o první studii, která by se pokoušela vypočítat „spravedlivou“ daň pro cigarety (tak, jak jsme si ji definovali).

Keywords

Tobacco taxation, Tobacco regulation, Economics of smoking, Cigarettes, Smoking, Mortality and morbidity caused by smoking, Smoking-attributable fractions, Czech Republic

Klíčová slova

Zdanění tabáku, Regulace tabáku, Ekonomika kuřáctví, cigarety, kouření, úmrtnost a nemocnost způsobená kouřením, podíl přiřaditelný kouření, Česká Republika

Abbreviations used

CO	Carbon Monoxide
CPI	Consumer's price index
CZK	Czech crown (currency unit)
CSZV	Czech Association for Branded Products
CZSO	Czech Statistical Office
ETS	Environmental Tobacco Smoke
FCTC	Framework Convention on Tobacco Control
FRS CR	Fire Rescue Service of the Czech Republic
PM	Philip Morris ČR a.s.
PYLL	Potential Years of Life Lost
SAF	Smoking attributable fractions
US	United States
VAT	Value Added Tax
VZP	General Health Insurance Company of the Czech Republic
WHO	World Health Organisation

Conflicts of interest

We declare that we have no conflicts of interest.

Charts & Tables

Content

1 Introduction

Tobacco is a very controversial commodity, mainly because its consumption has an adverse impact on health. No source has provided unbiased and comprehensive analysis about tobacco consumption and its consequences in the Czech Republic so far. This paper should fill the gap. We work with data from the Czech Republic for 2009.

We analyse just cigarettes, and not other tobacco products. There are two reasons for this. First, there is insufficient data available for other tobacco products to conduct. Second, Czech households expend 97.4% of their total tobacco spending[1] just on cigarettes[2]. We see the consumption of other tobacco products is very small compared to cigarettes, so it has been omitted from our analysis.

In the second chapter of the thesis, we introduce the current status of cigarette smoking in the Czech Republic. We discuss current smoking rates, the characteristics of smokers, cigarette consumption and trends, the regulation of smoking in the Czech Republic, and so on. The issue of smuggling is usually omitted in similar analyses. However, disregarding the size of the illegal cigarette market would lead to biased conclusions about the total amount of cigarette consumption, so we cover this topic as well. A significant part of the chapter is devoted to a quantitative analysis of the impact of smoking on mortality in the Czech Republic.

In the third chapter, we evaluate the costs and benefits to the state budget caused by smoking. We compare the current situation to a hypothetical situation in which smoking would be entirely absent from the Czech Republic. This analysis provides us with the answer to the question of the direction of the net flow of state budget funds between smokers and non-smokers. Are smokers beneficial or harmful for the state budget? This question is not as simple as it might seem, because there is no measurement methodology that most researchers would agree on[3]. We analyze previous papers concerning this problem, both national and international, and then conduct our own analysis on the 2009 data.

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[1] We would like to thank Pavel Říha from the Czech Statistical Office (CZSO) for providing this information. The number is from 2005 as this is the most recent data: the CZSO did not evaluate it afterwards. However, we may assume the ratio was the same in the following years.

[2] According to the World Bank (1999, p.13), *"manufactured cigarettes and various types of hand-rolled cigarette now account for up to 85 percent of all tobacco consumed worldwide"*.

[3] As stated by the World Bank (1999), the scope of financial costs incurred by smokers is unclear.

In the fourth chapter, we measure the impact of cigarette taxation changes on the retail price of cigarettes. We test the hypothesis that in the Czech Republic, the current change in cigarette taxation will be fully translated to the retail price and hence fully borne by consumers. To do that, we conduct an analysis on Czech historical monthly data of changes in taxation and the prices of cigarettes.

The fifth chapter analyses the price elasticity of smokers. We thoroughly review existing scientific literature about this topic. Unfortunately, there was not a single study on the elasticity specifically in the Czech Republic. Therefore, we try to estimate price sensitivity in the Czech Republic on the best data available, controlling for income[4].

Finally, using the information from chapters 2, 3, 4, and 5, we compute the rate of excise cigarette taxation that would equalise the costs and benefits of cigarette smoking to the Czech state budget. The excise tax on cigarettes is divided into fixed and variable parts. We describe why we kept the variable part constant and modelled only the fixed part. Our suggestion is valid for 2009. However, we may assume that the costs and benefits of smoking do not change much year to year, and the proposed fair taxation rate should thus be valid also for a few years after 2009. We also computed the excise tax rate maximising the revenue for a state budget from smoking.

During the literature review and consultations with experts from the field, we realised that many researchers are biased in both directions. Two camps have hence formed: one arguing for a total ban on cigarettes and the second for a major decrease in cigarette taxation. In the Czech Republic, the loudest opponent of cigarette regulation is the Liberal Institute; many regulation proponents are joined in the organisation called Stop Smoking. Worldwide, a very strong smoking opponent is the World Bank, which has imposed its recommended tobacco control policy since 1991 (World Bank, 1999).

There is usually much controversy in discussions about the earlier deaths caused by smoking, as the topic of death is very sensitive. However, we have to analyse this fully, because the mortality caused by smoking is a factor in many of the computations done in this thesis. The World Bank (1999, p.36) states that *"even if smokers reduce the net costs imposed on others by dying young, it would be misleading to suggest that society is better off because of these premature deaths. To do so would be to accept the logic that says society is better off without its older adults."* We are not going to judge such a statement, because our aim is not to

[4] We also compare our result with the outcomes of recent, as-yet unpublished research by Frank Chaloupka, a professor at the University of Illinois in Chicago, which will be presented in the IARC Handbook of Cancer Control 2011.

measure the impact of smoking on society, but on the state budget only. Some researchers consider that thinking about the early deaths in terms of saving some state budget funds is immoral. We do not go so far as to state what is "good" or "bad". We state only facts and our findings and we leave the final decision if smoke or not to a consumer.

Throughout the thesis, we show the methodological flaws made by local studies analysing similar issues. Our hope is that this paper will bring rational arguments about the topic to the Czech public debate, replacing the ideological pleas that are currently widely present.

2 Overview, Facts and Figures

2.1 History of Tobacco in the Czech Territory

We find it important to highlight the history of the approach of the government towards tobacco within the area of what is now the Czech Republic (throughout the chapter denoted as "Czech territory").

People living in the Czech territory started consuming tobacco at the beginning of the 16th century (Čapek, 1947). It was endorsed and promoted by the ruler at that time, Emperor Rudolf II. Brought to the country by western traders, tobacco was treated as a medicinal herb with magical properties. After the 30 Years' War (1618-1648), smoking started to flourish. The government felt uncomfortable that there was such a growing market without any control, so it decided in 1657 to prohibit smoking totally[5] (Čapek, 1947). The official reason was the immense number of fires caused by cigarettes smoking[6]. However, Czech peasants did not respect the prohibition, and the government did not have enough power to enforce it, so the rule was abolished in 1664 (Čapek, 1947). Soon afterwards, small Czech entrepreneurs, usually the higher and more educated classes of society, started growing tobacco as they witnessed the increasing demand for it. The production of tobacco by the end of the 17th century in the Czech territory was higher than its consumption.

[5] This decision was in compliance with the overall situation at that time: for example, in Russia and Turkey, any person caught smoking was punished with death. In Japan, the punishment took the form of the confiscation of all property (Kassel, 1974).

[6] In chapter 3 of the thesis, it is calculated that the current cost of fires caused by smoking and its distinguishing are less than 1% of total costs for a state budget attributable to smoking

2.1.1 Tobacco Taxation

In the first half of the 16th century, the import as well as the consumption of tobacco in the Czech territory was so tiny that there were no special taxes put on it. There was just a general 2% tax on all imports (Capek, 1947). The government soon realised that it would be better to allow tobacco smoking and then tax it heavily in order to get an additional source of funding for the treasury. It imposed a flat tax on imported tobacco, amounting to about 30% of its original price. As the tax was imposed just on imported tobacco, this served as an incentive for Czech citizens to grow tobacco. The government did not effectively maintain its borders, so many tobacco smugglers crossed the border without paying taxes[7]. The rate of tax evasion was so high that the government soon agreed to pass the duty of tobacco tax collection into the hands of a private company that would pay a fixed price in return. The company was able to get almost 10 times higher tax payments on tobacco than the government had been.

Domestic production had become an increasingly greater competitor for imported tobacco because there was no tax levied on it. This decreased imports. In 1699, the government therefore decided to tax domestic production as well. In 1723, Charles VI enacted a total monopoly on tobacco retail sales for the central government of the Austro-Hungarian Empire (Cinner, 1924). The government established a couple of factories producing tobacco for the domestic market. People were allowed to grow tobacco, but they had to sell their produce to the government. However, only three years later, the monopoly was sold to a private entrepreneur. Consequently, the monopoly was publicly traded until 1783. That year, Emperor Joseph II enacted the rule that every state in the Austro-Hungarian Empire would administer the tobacco monopoly itself (Cinner, 1924). This secured a proper source of funds for the Czech state. Growing tobacco without state approval was forbidden after 1806 (Čapek, 1947).

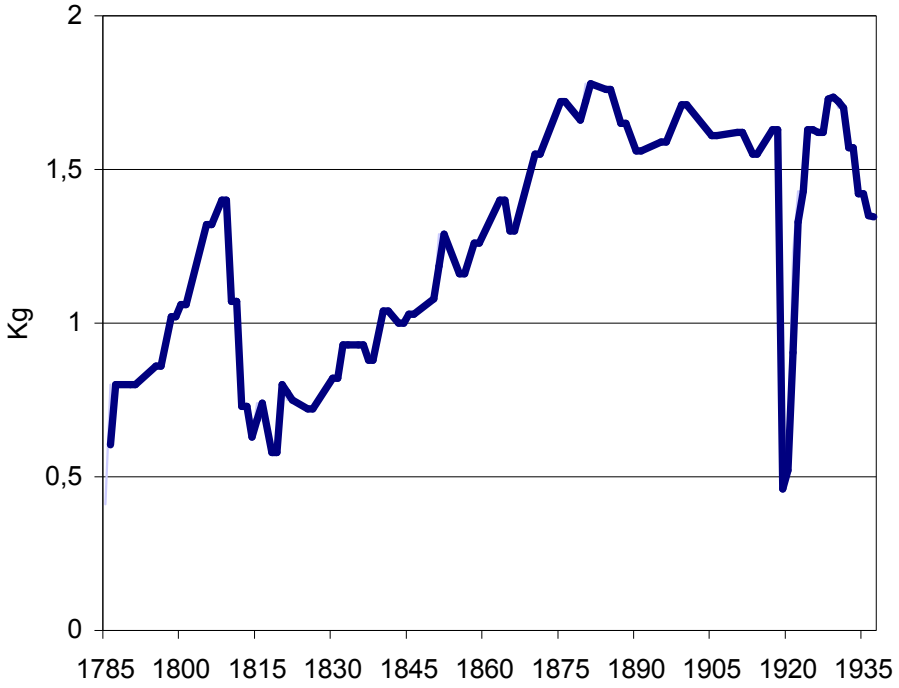
State revenues from tobacco were crucially important during the First Republic (1918-1939). It became the cornerstone of the state budget, bringing the treasury about 1.5 billion CZK per year at the beginning of that period (Čapek, 1947), which was about 13% of the state revenue from all taxes (Vencovský, 1994)[8].

[7] At the beginning of the 18th century, still only about 15% of tobacco was taxed properly; the rest was traded on the black market. Based on our analysis described in the subchapter about the cigarette smuggling, we assume that around 90.5% cigarettes on the Czech market are currently taxed properly.

[8] Unfortunately, Čapek (1947) did not provide the specific year when the 1.5 billion CZK tax revenue from tobacco was collected. The statement that it was 13% of the total tax revenues is valid for the year 1929.

2.1.2 Historical Consumption

Chart 2.1: Annual Tobacco Consumption per Head, Czech Territory



Source: Čapek (1947), our own approximations

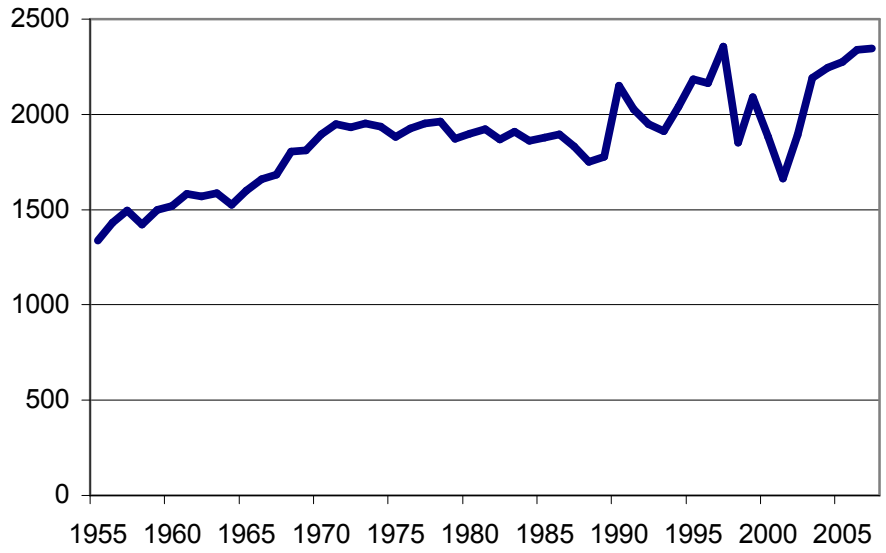
Observing the statistics describing the development of the annual tobacco consumption per head in the Czech territory between 1785 and 1936 in chart 2.1, we can see the main trend is represented by a steady growth in consumption beginning in 1811, when state bankruptcy happened, and continuing to the 1885. The reason was straightforward –smoking tobacco was more and more popular than snuff, and for one regular portion, much greater amount of tobacco is needed for smoking than for snuffing.

From 1664, when tobacco was first taxed, until 1799, the income from tobacco taxes grew 3,000 times in nominal terms (Cinner, 1924). There are four reasons for this. First, the rate of taxation increased. Second, the population grew. But the most important factor was the increase of purchasing power. By the end of 18th century, the living standards in the Czech territory were far better than in the middle of 17th century, so people could afford higher spending on such luxurious items as tobacco.

We may roughly conclude that the impact on health caused by tobacco consumption in the Czech territory in the 18th and 19th century was very low in comparison to the current situation because according to the World Bank (1999, p.13), "*cigarette smoking appears to pose much greater dangers to health than earlier forms of tobacco use.*"

2.1.3 Recent Consumption Trends

Chart 2.2: Annual Cigarettes Consumption per Head, Czech Territory



Source: CZSO (2008, 2010), Sagit

The CZSO measured the annual number of cigarette sold per capita in the Czech territory after 1955[9]. When looking at charts 2.1 and 2.2, we can see that that there is a gap between 1936 and 1955. To the best of our knowledge, there is no consistent source of information about tobacco or cigarette consumption in the Czech territory during these years[10].

A steep increase in consumption occurred between 1955 and 1971, when it went from 1,337 to 1,950 cigarettes per capita per year, implying an average annual consumption growth of 2.4% during that period. Consumption was stable over the next fifteen years, oscillating between 1,887 and 1,961 cigarettes per year per capita. After 1987, there was a very volatile period. The highest consumption of cigarettes per capita (2,354) was reached in 1997.

Based on the information provided in an ERC report (2007), published in Tobacco Atlas, in 2007, the Czech Republic had the fifth highest per capita consumption out of 121 countries for which data were available[11]. In the table 2.1 you can see the 10 countries with the highest per capita consumption.

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[9] Before 1993, i.e. during the existence of the Czechoslovak Republic (until 1960), the Czechoslovak Socialist Republic (1960-1989), and the Czechoslovak Federal Republic (1990-1992), CZSO provided consumption information specifically for the Czech and Slovak part of the Republic.

[10] Furthermore, when comparing charts 2.1 and 2.2, we see that the consumption is measured in different units (once in kilograms and then in cigarette pieces). This does not allow us to compare information from both tables. Unfortunately, we are not able to transform figures from charts to the same unit.

[11] We have to state here that the average per head consumption derived from the Tobacco Atlas (2,368), is a little bit higher than the figure obtained by CZSO (2,345). However, even if we use the lower number and compare it with the Tobacco Atlas results, the Czech Republic would still be in fifth place.

Table 2.1: The highest Per Head Cigarette Consumption by State, 2007

1.Greece	3,017
2.Slovenia	2,537
3.Ukraine	2,526
4.Bulgaria	2,437
5.Czech Republic	**2,368**
6.Macedonia	2,336
7.Russia	2,319
8.Moldova	2,239
9.Spain	2,225
10.Bosnia and Herzegovina	2,145

Source: ERC (2007)

We find it interesting that in Slovakia, the country that formed one state with Czech Republic for most of the last century and thus has much in common with it, there were just 1,430 cigarettes per capita smoked in 2007 which is about 60.4 % of the Czech per head consumption[12]. Even in other neighbouring countries, such as Germany, Austria, and Poland, the consumption per capita in 2007 was just 48%, 71%, and 76%, respectively, of the Czech figure. We may conclude that in recent years, the per capita cigarette consumption in the Czech Republic has been exceptionally high, in the regional as well as worldwide.

Based on CZSO (2010) and our own computations, the total size of official consumption of cigarettes in the Czech Republic in 2009 was 21,727 millions of pieces. Imperial Tobacco, one of the cigarette suppliers in the Czech Republic, estimated the official consumption in 2009 in the Czech Republic was 19,094 millions[13]. We assume the estimation by CZSO to be more accurate[14], so we will use it in the further computations instead of the Imperial Tobacco figure.

2.2 Regulation of Smoking – Standard Methods

In this chapter, we will discuss the standard methods of regulating smoking as well as their usage and application in the Czech Republic to get more acquainted with the current situation. Smoking regulation may be divided into two main groups: non-price policies and price

[12] It may be fruitful to study the reasons for such a huge difference in cigarette consumption between two countries with so much in common. However, such analysis is not in the scope of this thesis.

[13] Based on our computation and the information from the press, available online at http://zpravy.kurzy.cz/261560-spotreba-cigaret-v-cr-nize-o-0-5/, viewed at 2.3.2011

[14] Because CZSO is a state-owned organisation, so its estimations should not be anyhow biased in comparison to the estimations provided by the cigarette supplier

policies in a form of excise taxation. Later in our thesis, we will model the excise taxation of cigarettes; hence it is important to fully understand its structure.

2.2.1 Excise Taxation

"Tobacco, unlike most other goods, imposed social costs (called externalities) when consumed. The existence of these costs justifies government involvement in regulating tobacco consumption and constitutes an economic rationale for the excise tax on tobacco products."

Ross (2004a, p. 76)

Excise taxation is the most common method for regulating the demand for tobacco consumption. In developed countries like the Czech Republic, tobacco has a relatively low price elasticity (Chaloupka et. al, 2000), so its taxation is not likely to distort the market much. If we assume low price elasticity of smokers, we can deduce that a reasonably small tax increase will create higher revenue for the government from excise taxes. This was generally proved for example in a study by Townsend (1998) analysing the UK rate of cigarette taxation and tax revenues between 1971 and 1993.

An increase in tobacco taxation increases the retail prices of cigarettes, which in turn causes the growth of the Consumer Price Index (CPI) and inflation. Therefore, the European Union recommended that its member states exclude tobacco from the CPI. The same approach is advised by Guindon et al (2002). This serves as an incentive for states to increase tax rates, because if they do so, they will not be punished by higher CPI. On the other hand, if tobacco products are a part of CPI, it may serve as an incentive to lower the tobacco taxes. Luxembourg, France, and Belgium have excluded tobacco products from their CPI since 1991, 1992, and 1994, respectively. Guindon (2002) also mentioned the possibility of computing two CPIs, one with the tobacco products and the second without. However, the Czech Republic does not follow this advice. Based on the Czech Statistical Office (CZSO), an institution responsible for adjusting weights in the Czech CPI as well as the calculation of the index, tobacco products are not excluded from the CPI. Their weight in the CPI, according to Pavel Říha from CZSO, is 4.48%. Because the CPI should represent the average household spending, and adding the information (quoted in the introduction) that 97.4% of total tobacco spending is made on cigarettes, we can say that the average household expends 4.36% of its total spending on cigarettes. In the United States (US), the relative weight of tobacco products in the CPI is only about 0.91% (United States Department of Labour, 2011), which may imply

that the relative spending on cigarettes in the Czech Republic is great deal more than in the US.

2.2.2 Non-price Policies

There are also other ways to regulate smoking. In comparison to tax policies, we are not going to model the impact of changes on non-price policies and then suggest the set of non-price policies fulfilling the goals we want (this may be the fruitful extension of our work). However, we find it important to discuss the non-price policies (both generally and then specifically for the Czech Republic) for the sake of completeness of the thesis.

A common method is the restriction of smoking advertisements. A study by Saffer and Chaloupka (2000) suggested that a total ban on smoking advertising in the media could decrease tobacco consumption by 7.9%. Furthermore, they found that a limited set of advertising bans has only a slight effect on smoking consumption, because it simply results in increased advertising in the remaining non-banned media. Nevertheless, based on a study by Joossens et al. (2004, p.140), as most types of advertising are curbed, *"package displays and adverts at the point of sale (POS) have become increasingly important in the marketing strategies of tobacco companies… In Canada, in 2002 the tobacco industry spent 77 million CAN $ on payments to retailers for display."*

In the Czech Republic, information on the marketing expenditures of tobacco companies does not have to be reported to the government (unlike in the abovementioned case of Canada), so we do not know the figures. But in everyday life, we can see that cigarettes are usually prominently displayed in shops and stalls, implying that the payments from tobacco companies are quite large in the Czech Republic as well. In some countries, the visible POS package displays have been banned (for example Iceland in 2001).

Other common measures to reduce smoking include "clean air" laws, which regulate smoking in public places such as workplaces, schools, childcare facilities, restaurants, etc. Yurekli and Zhang (2000) studied the impact of clean indoor-air laws on cigarette consumption on data for 50 states and the District of Columbia in the United States over the 1970-1995 period. They found that by 1995, consumption was reduced by 4.7 packs per capita among the states with anti-smoking laws. Chriqui et al (2001) also conducted research on the US data comparing the development of clean air laws between 1993 and 1999. The results of this research showed that there were states without any clean air laws during the observed period (Alabama, Mississippi, and Wyoming). The results also showed that clean air laws stayed at the same level between 1993 and 1999 in most states. The study concluded that in 1999, the most

common clean air laws across all states were smoking bans in schools and childcare facilities. Bans in private workplaces and restaurants were not common. These results illustrate that the pace of imposing clean air laws is not particularly fast, at least in the US. Fichtenberg and Glantz (2002) systematically reviewed the situation using literature measuring the impact of smoke-free workplaces. They concluded in the chapter results that "*Totally smoke-free workplaces are associated with reductions in prevalence of smoking of 3.8% (95% confidence interval 2.8% to 4.7%) and 3.1 (2.4 to 3.8) fewer cigarettes smoked per day per continuing smoker. Combination of the effects of reduced prevalence and lower consumption per continuing smoker yields a mean reduction of 1.3 cigarettes per day per employee, which corresponds to a relative reduction of 29%."* Chaloupka (2003) states that a total ban on workplaces has an unclear effect on quit rates, whereas the prevalence rate decreases by about 11%.

Media campaigns against smoking proved themselves effective in decreasing prevalence rates (Chaloupka, 2003). On the other hand, there is evidence from a study by Farrelly et al (2002), who studied the impact of anti-smoking campaigns on youths, that the anti-smoking campaigns organised by the tobacco producer itself (Phillip Morris in that case) may have a counterproductive influence[15].

Based on Joossens et al (2004), large and direct health warning labels on packs are an effective way of both informing and discouraging smokers. Laugesen and Meads (1991) came to the same conclusion while analysing a dataset of 22 countries in the 1960-1986 period.

Chaloupka (2003) lists other possible government regulatory interventions in order to prevent people from smoking, including cessation treatment, telephone hotlines, youth access policies, and school education programs.

2.3 Current Regulation of Smoking in the Czech Republic

Membership in the European Union has a significant effect on the regulatory rules in the Czech Republic. There are many EU regulatory smoking policies that must be followed in the Czech Republic. In this subchapter, the range of non-price policies used in the Czech Republic will be presented, and then we analyse the current tax policies in the Czech Republic.

[15] If this conclusion is true, then we consider that the media campaigns against smoking organised by tobacco producers may be quite beneficial for them. They increase the tobacco demand by youth, and on the other hand, they can be perceived positively by society for organising the campaign.

2.3.1 Non-Price Policies

Youth Access Policies

Based on Act 379/2005[16] of the Czech law, sales of tobacco products to customers younger than 18 is prohibited. However, smoking itself is not prohibited for underage consumers. In other words, an underaged individual cannot be fined by the police if caught smoking. Nonetheless, there is an initiative for a change to the law that would make it possible to fine youths aged 15-18 for smoking[17].

Clean Air Laws

Act 379/2005 of the Czech law lists all places where smoking is prohibited. In general, these are places where a high turnover of people is expected (cinemas, theatres, state offices, public transportation and stations, etc.) or where total cleanliness must be maintained (hospitals). The Act was last amended in 2009[18]. Despite public pressure[19], a ban on smoking in restaurants was not enacted in this amendment. Under the current legislation, restaurants can choose freely if they prohibit smoking. Furthermore, they may opt for smoking and non-smoking sections. In such a case, the sections have to be divided[20]. The legislation also states that the character of the establishment (smoking allowed, smoking prohibited, or mixed) has to be visibly indicated by a sticker. After the restrictions imposed by Act 379/2005, consumption of cigarettes in the Czech Republic did not decrease substantively. We can infer that the imposed restrictions were not significant for smokers. At this point, we want to point out that a total ban on smoking in bars and restaurants is in force in a vast majority of the western and northern European countries, so the Czech Republic is a bit anomalous. Analysing the situation in Poland and Slovakia, the east neighbours of the Czech Republic, we can state that the situation there is very similar to the Czech Republic.

According to Czech Labour Code No. 262/2006, smoking is prohibited in the workplace as well as in all other places where non-smoking workers might be exposed to the smoke. However, the employer is allowed to establish a smoking lounge[21]. According to the labour code, the employer must secure that non-smokers do not encounter tobacco smoke during

[16] Valid from 1.1.2006
[17] For example, see www.parlamentnilisty.cz/kraje/zlinsky/185690.aspx, viewed 11.1.2011
[18] The exact date of the amendment was 24.7.2009.
[19] By 10.1.2011, 115,909 people had signed a petition for the total restriction of smoking in all public places including restaurants. http://www.stopkoureni.cz/ , viewed 10.1.2011
[20] Both sections must be in different rooms; however, there is no obligation to have a door between them. We consider the usefulness of such a rule to be questionable.
[21] The smoking lounge must be designed in such a way that the smoke does not leak from the room.

working hours. That means that if there are three colleagues in an office and one of them is a non-smoker, then the employer must prohibit smoking in the office. In a survey provided by Heck et al (2010), 80% of workplaces in the Czech Republic enforce a smoking ban.

Warning Labels

Based on Ministry of Agriculture Notice No. 344/2003, specific information be displayed on a cigarette pack. The warning labels must be placed on the pack. These labels must occupy a specific amount of space on the pack. There must be one general warning covering at least 30% of the biggest side of the pack and one extra warning covering at least 40%. The exact wording of these warnings is specified as well. Furthermore, according to EU Directive 2001/137/EC, Article 5, information on the tar, nicotine, and carbon monoxide yields of the cigarettes has to be printed on the pack[22].

Light Cigarettes

Cigarettes marked as "light" or "low nicotine" may be considered by the public as being better and with a lower concentration of pollutants. However, smokers of light cigarettes inhale the smoke deeper, longer, and more frequently. According to the World Bank (1999, p.24), *"the difference in the risk of premature death for smokers of low-tar or low-nicotine brands compared with smokers of ordinary cigarettes is far less than the difference in risk between nonsmokers and smokers"*. The false belief that "light" cigarettes are safer and healthier led the European Union to prohibit cigarette labelling as "light" or "mild" in 2003. The rule has applied in the Czech Republic as well since its accession to the European Union in 2004.

Quality Standards

According to EU Directive 2001/37/EC, Article 3, the yield of cigarettes marketed or manufactured in the member states cannot be greater (per cigarette) than 10 mg of tar, 1 mg of nicotine and 10 mg of carbon monoxide[23].

[22] All the information must be printed in the official language of the member state.
[23] The health impact of breathing these substances will be briefly discussed in the next chapter.

Media Campaigns

A European Union initiative introduced the HELP programme. This programme is aimed at helping youths to quit smoking. After registration at www.help-eu.com, a person is sent a series of encouraging emails. One of the possible languages is Czech. The webpage also presents the "Helpers" comedy series, which serves the same purpose. To our knowledge, there has not yet been a study measuring the impact of this campaign. Nevertheless, since the individual must actively search in order to find information about the campaign, we assume that its impact is quite limited.

Advertisement Restrictions

According to Act 40/1995, subsequently amended by several regulations [24], tobacco advertisements are strictly regulated under very special conditions. The advertisement must contain a warning label. It must not be targeted at people under the age of 18. Samples of cigarettes cannot be freely distributed as a means of advertising.

Access to Cessation Treatment

In January 2011, there were 32 centres distributed throughout all the regions of the Czech Republic providing treatment for patients with a strong tobacco addiction[25]. These centres are usually set up in bigger hospitals. There are also 50 counselling offices providing consultations in the Czech Republic[26]. Unfortunately, we were unable to collect the size of budgets of these offices, so we will not consider these costs in the next chapter when we evaluate the costs and benefits of smoking on state budget.

Telephone Hotlines

Since 2005, there has been a special hotline for advice on quitting smoking. The hotline is available every working day between 12 and 20. It is free of charge; the customer pays only the regular price for a local call. The hotline is administered by the Czech Coalition against Tobacco. Based on the information provided by the coalition, it administered 5,000 calls between January 2005 and May 2009[27]. Calculating the average number of calls, we get the

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[24] Amended by Acts 258/2000, 231/2001, 256/2001, 138/2002, 320/2002, 217/2004, 326/2004, 132/2003, 480/2004

[25] Available online at http://www.slzt.cz , viewed 1.11.2010

[26] Available online at http://www.dokurte.cz/?stranka=poradny&typ=clanky, viewed 1.11.2010

[27] Taken from the presentation of the organisation, available online at http://www.google.cz/url?sa=t&source=web&cd=4&ved=0CDUQFjAD&url=http%3A%2F%2Fwww.enqonline

figure of about three calls per day. From our point of view, such a rate is quite low, and hence this telephone hotline is not very useful for Czech smokers.

Prevention Conducted by the Fire Rescue Service of the Czech Republic[28]

The Fire Rescue Service of the Czech Republic (FRS CR) is bound by law (Act No. 238, first paragraph) to protect the health, life, and property of the inhabitants from fires. Smoking prevention is understood as an activity that will limit the start and spread of fires. The key laws instructing FRS CR in preventive activities are Acts No. 133 about fire protection and No. 246 about fire prevention. Smoking prevention is included in a wide range of actions on the regional as well as national level as part of fire prevention. Smoking prevention by FRS CR as such is not centrally directed.

Framework Convention on Tobacco Control

The World Health Organisation adopted the "Framework Convention on Tobacco Control" (FCTC) in 2003[29]. It came into force in 2005. There are currently[30] 172 Parties to the FCTC. Its aim is *"to protect present and future generations from the devastating health, social, environmental and economic consequences of tobacco consumption"* (Part II, Article 3 of the FCTC). It establishes price and non-price measures to reduce tobacco consumption. It was ratified by the vast majority of the European countries. To our knowledge, the only European countries not ratifying the FCTC are the Czech Republic and Switzerland. Hence we assume that it will be ratified in the Czech Republic in the near future. The impact of the ratification is difficult to predict because the FCTC sets only general aims. We should emphasize that many Parties to the FCTC have taken a very relaxed approach. For example, they are obliged to send reports describing their implementation of anti-smoking policies; however, of the 180 Parties that were to submit a January 2011 report, 20 did not meet the deadline (FCTC newsletter, 2011).

.org%2Fdownloads%2F10th_Anniversary_Conference%2FDay2%2FThe_Czech_Experience_Mirek_Zmeskal.ppt&rct=j&q=czech%20coalition%20against%20tobacco&ei=-YJ-Ta2TC8fEswaOptnwBg&usg=AFQjCNHcE58v3Bwx_l1ADKV3mHq8EvZjEg&sig2=i4Wij0GqBVlkofMwSV_8-g&cad=rja, viewed 3.3.2011. The exact number quoted was "over 5,000 calls", but we decided to assume the number 5,000 as a total for computing the average. We asked the organisation to provide us with more current figures, but they did not respond.

[28] We would like to express our gratitude to plk. Ing. Rudolf Kaiser, the Director of the Prevention Department for the Fire Rescue Service of the Czech Republic, for providing us the information about the smoking prevention activities of his department.

[29] Information about the FCTC as well as the FCTC itself is available online at: www.who.int/fctc/en, Viewed 25.1.2011

[30] To date: 9.2.2011

2.3.2 Tax Policies

Excise Tax

Tobacco products in the Czech Republic are subject to excise taxation. The excise tax for cigarettes is in the form of the sum of a specific and ad valorem component. The specific component sets a fixed amount which must be paid for a cigarette piece, regardless of its price. The ad valorem tax is calculated as a percentage of the retail cigarette price. Then, there is also a minimal excise tax per cigarette piece which is the minimal amount that must be paid. In case of cigars and tobacco, there is only the specific component. The size of the excise tax on tobacco products in the Czech Republic is determined by EU regulations. The past development of tobacco excise taxation was as follows:

Table 2.2: The Development of Excise Tax Rates on Tobacco, Czech Republic [CZK]

Valid Since	1.7.2005	1.4.2006	1.3.2007	1.1.2008	1.2.2010
Cigarettes-fixed	0.60	0.73	0.88	1.03	1.07
Cigarettes-variable	24%	25%	27%	28%	28%
Cigarettes-minimal	1.13	1.36	1.64	1.92	2.01
Cigars per piece	0.79	0.79	0.9	1.15	1.15
Tobacco/for 1 kg	720	810	905	1280	1340

Source: David (2010)

We see that the excise tax rates for tobacco products have been gradually increasing.

Denote:

retail price of a cigarette	p
variable part of a tax	v
fixed part of a tax (per piece)	f
minimal tax (per piece)	M

Then, the amount of excise tax paid on one cigarette equals $\max(f + vp; M)$. When we plug in the figures for the Czech Republic, we get $\max(1.07 + 0.28p; 2.01)$. Solving the equation 1.07 + 0.28p=2.01, we derive that it would be unreasonable for the cigarette producer to set a price for a sole cigarette in a pack at lower than approximately 3.36 ZK.

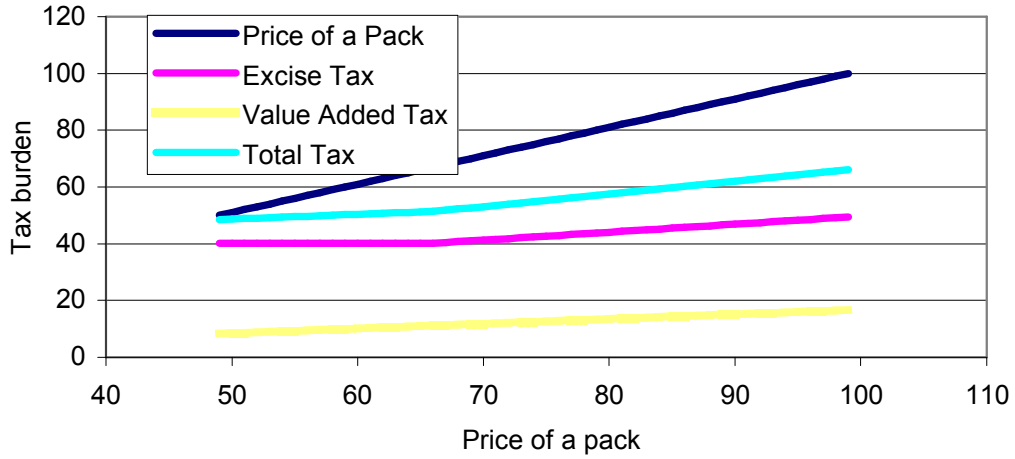
Value-Added Tax

There is also a value-added tax that must be taken into account. It is currently set at the level of 20%. The ad valorem excise tax and VAT are identical in effect. The excise tax enters the tax base for the computation of the VAT. Therefore, the final tax payout of a cigarette's producer for a single cigarette is $\max(1.07 + 0.28p; 2.01) + p\frac{0.2}{1.2}$

For a p=3.36 CZK, approximately 2.57 CZK is spent on taxes.

Taking a look at the pricing of packs of 20 cigarettes as of 1.1.2011, we can see the cheapest ones have retail prices of 61 CZK[31]; the wholesale prices for these low-end packs are about 58 CZK[32]. The tax burden for producers is 50.37 CZK, so the production costs and profit of the producer is squeezed to 7.63 CZK. The chart 2.4 depicts how much is paid on both excise and value-added tax based on the price of a pack (20 cigarettes).

Chart 2.3: Money Paid on Taxes for a Cigarette Pack [CZK]



We see that theoretically, for a cigarette pack with a retail price of 48 CZK under the current tax regime, 100% of its price would be paid on taxes. To fully grasp the impact of taxation on the retail price, we took two popular cigarette packs[33] and computed the burden of all taxes on them separately. The results are provided in the table 2.3:

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[31] Cigarettes RGD (product lines Blue KS, Orange KS, Silver KS, Menthol KS, Blue 100, Orange 100) produced by Phillip Morris; Route 66 (Original, Blue, Menthol, Original 100, Blue 100) produced by Imperial Tobacco; Steels (Red, Blue, Red 100, Blue 100) by British American Tobacco; LD (Red RC, Blue RC, Silver, Menthol, Red 100, Blue 100) and Monte Carlo (Silver, Fine menthol) by Japan Tobacco International; and Denim (Red, Blue, Mint) and Respect (Red, Gold) by Von Eicken/TDR – current (1.1.2011) prices of cigarettes taken from http://www.geco.cz/files/cenik-od-1.1.2011-web.pdf, viewed 5.1.2011 and http://www.mfcr.cz/cps/rde/xbcr/mfcr/CenovyVestnik_15_2010_pdf.pdf, viewed 6.1.2011

[32] Available online at http://www.geco.cz/files/cenik-od-1.1.2011-web.pdf, viewed 5.1.2011

[33] Both these packs were part of the consumer basket for February 2001 constructed by CZSO; the composition of a basket is available online at http://czso.cz/csu/redakce.nsf/i/inflace, viewed 3.3.2011

Table 2.3: Breakdown of Tax Burden on Two Popular Cigarette Packs

All prices in CZK	Petra KS Box	Marlboro KS Box	Difference
Retail price including taxes	69.00	82.00	13.00
Taxes			
1.Specific excise	21.40	21.40	0.00
2.Ad valorem excise	19.32	22.96	3.64
3.VAT	11.50	13.70	2.20
Total tax	52.22	58.06	5.84
Retail price excluding taxes	16.78	23.94	7.16

We see that whereas the difference in retail price for consumers is 13 CZK, 45% of that difference is consumed by the tax burden, so the selling price for producers differs by 7.16 CZK only.

The Council of the European Union has adopted a new directive, Council Directive 2010/12/EU, amending EU Directives on excise taxes of tobacco products. Among other changes, there will be an increase of the minimum excise yield rule to 90 EUR per 1,000 cigarettes by January 1st, 2014[34].

2.4 Cigarette Smuggling

The analysis of cigarette smuggling and its volume in the Czech Republic is twofold. First, we have to evaluate its size, because we need to know the total number of cigarettes smoked in the Czech Republic for further computations. Second, we want to determine if the volume of smuggling is dependent on the price of cigarettes in the country.

There are two general types of cigarette smuggling: bootlegging and wholesale smuggling. Based on Merriman et al (2000, p.1), "*Bootlegging is the legal purchase of cigarettes in one country but consumption or resale in another country without paying applicable taxes or duties"* at the borders. This happens very often on a small scale when tourists travel to countries with low cigarette prices and bring some back to the Czech Republic. Wholesale smuggling occurs when cigarettes are sold without the payment of taxes or duties, even in the country of their origin. This is a situation of illegal cigarette producers. Another example of wholesale smuggling is when an official cigarette exporter claims that the excise tax will be paid in the exported country, but does not actually sell the cigarettes there, thus avoiding the excise taxation.

[34] Based on the Official Journal of the European Union, currently it is 79 EUR (or equivalently 2,010 CZK).

The main incentive for bootlegging is the price differentials among neighbouring countries. In the Czech Republic, these price differentials are becoming smaller and smaller thanks to the EU tax harmonisation. In 1995, the retail price of 20 cigarettes in Germany was as much as ten times higher than the retail price in the Czech Republic (Merriman et al (2000)). Currently, the relative differential is substantively less. We have omitted bootlegging from our further analysis due to a total lack of data on bootlegging in the Czech Republic.

Measuring illegal tobacco trade (=wholesale smuggling) is challenging. First, because of its illegality, traders are unlikely to keep records of their activity. Second, experts serving as data sources may bias the estimate in order to lobby for their own purposes (this will be described later in the example of Czech experts).

The black market for cigarettes may be harmful for cigarette producers, because it decreases their sales. Many current illegal producers of cigarettes are able to create counterfeit cigarettes whose appearance is very similar to the appearance of the well-known brands. Cigarettes are smuggled to the Czech Republic mainly from the countries of the former Soviet Union. Some are sold on the Czech market; some go to the west.

2.4.1 The Amount of Smuggled Cigarettes in the Czech Republic

From our perspective, the only firm evaluation of smuggling is the volume of smuggled cigarettes and tobacco confiscated in the Czech Republic by its Customs Administration. According to the 2009 report, in 2009, it confiscated 7.5 million cigarettes and 30 tons of tobacco; this tax evasion was evaluated to be 18 million CZK and 41 million CZK, respectively. In comparison to the total domestic cigarette market, this is a tiny amount[35]. If the ratio of smuggled tobacco confiscated by the Customs Administration were the same every year, it would be possible to analyse it compared to the average cigarette retail price to determine if there was causality. However, the yearly volume of tobacco confiscated by the Customs Administration has been very unstable over the last 10 years, so the assumption that the Administration confiscates the same ratio of smuggled tobacco in the Czech Market is most probably invalid.

To the best of our knowledge, the most comprehensive study about the volume of smuggling was done by Merriman et al (2000). That study used two methods to evaluate the size of the business. The first method, giving just a general idea about the ratio of smuggling to the total market, is to compare the recorded global exports and imports. In 1996, this ratio was 1:1.57.

[35] However, this is already a non-negligible amount for a state budget

There were 707 billion cigarettes imported and 1,107 billion exported. In that year, about 17.5% of the world cigarette production was exported (Chaloupka and Corbett (1998)). If the difference between import and export was caused only by smuggling, then smuggling accounted for 6.3% of world cigarette consumption. We measured if this conclusion applied to more recent data as well. We derived the data about the total world production and imports and exports for 2000-2004 from the United States Department of Agriculture:

Table 2.4: Total World Production, Cigarette Imports and Exports [millions pieces]

Year	Production	Imports	Exports	Net exports to production
2000	5,609,147	721,971	842,561	2.15%
2001	5,642,831	694,238	820,269	2.23%
2002	5,602,487	646,943	804,337	2.81%
2003	5,662,271	649,525	858,520	3.69%
2004	5,530,474	637,820	761,183	2.23%

Source: United States Department of Agriculture

We can see that the amount was only between 2.15 and 3.69%. Based on Merriman et al (2000), it may be said that this is the worldwide percentage of smuggled cigarettes from the overall consumption.

The second method evaluated by Merriman et al (2000) is country-specific. The authors compiled a dataset of expert opinions about the level of cigarette smuggling in their countries for 1995. In total, 65 countries were analysed. The estimate of the Czech expert for the Czech Republic was that the ratio of smuggled cigarettes to the properly taxed ones sold in the Czech market was 7%. The authors made a unique analysis: they conducted a regression of the expert evaluations on the GDP per capita, transparency index, and price per pack in US dollars in all 65 countries. They realised that only the transparency index, not the GDP per capita nor the price per pack, was significant in determining the ratio of smuggled cigarettes. This may lead to the conclusion that we will not influence the volume of smuggled cigarettes by changing cigarette taxation. We use this conclusion in our further computations. However, we have to keep in mind that a variable describing the difference in the price of cigarettes in a given state and the price in neighbouring states was not included in the regression. We consider that such a variable may partially determine smuggling.

The most recent analysis of the illegal cigarette trade was conducted by Joossens et al (2009) stating that "*11.6% of the global cigarette market was illicit, equivalent to 657 billion cigarettes a year and 40.5 billion in lost revenue."* The authors considered the method of

comparing the export-import difference as not the most accurate. They completed expert estimates from 84 countries representing 85% of the world population (the Czech Republic was not among these countries). Their findings, divided by the income of a country, were as follows:

Table 2.5: Estimation of Illegal Cigarette Market

Country Specification	Average Legal Price ($US)	Average Percent of Illegal Cigarette Consumption
Low Income	1.13	16.8
Middle Income	1.89	11.8
High Income	4.91	9.8

Source: Joossens et al (2009)

The results may lead us to conclude that the size of the illegal cigarette market in the Czech Republic is 9.8%.

We also asked the Customs Administration of the Czech Republic[36] for their estimate. Their evaluation of the size of the illegal cigarette market to the official one for 2009 was 8%. Based on an article by Marek (2009), the Czech Association for Branded Products (CSZV) estimated that in 2008, there were 3.5 billion cigarettes sold on the black market, which accounted for about 13% of the total consumption. However, we believe there is a risk that the CSZV may inflate their estimate in order to push the government to fight more actively against smuggled cigarettes (Phillip Morris Czech Republic – the sole cigarette producer in the Czech Republic – is a member of the association, and the demand for its cigarettes is assumed to be negatively correlated with the amount of smuggled cigarettes on the market; hence the company has an incentive to do its best to diminish the size of smuggled cigarettes business). We assume that the Customs Administration may be biased in the opposite direction. This office is partially responsible for the prevention of smuggled tobacco. Therefore, its aim may be to appear as if it does not allow much smuggled tobacco to enter the Czech market. The table 2.6 provides the discussed estimates. We do not consider the general world estimations by Merriman et al (2000), as there is an evidence for wide variations in the amount of smuggling among countries[37].

[36] The date of enquiry: 15.1.2011

[37] For example, based on Jooseens et al (2009), in Georgia, 49% of the cigarette market was illegal; in Spain, it was just 1%.

Table 2.6: Estimation of the Illegal Cigarette Market, Czech Republic

Author	Year of estimation	Share of smuggling on the market
Merriman	1995	7.0%
Joossens et al	2007	9.8%
Marek	2009	13.0%
Customs Admin	2009	8.0%

We omit the estimation provided by Merriman as it may be already perceived as outdated. We also omit the Joossens et al result as it is not country specific, but only for a group of high-income countries.

The remaining estimates are by Marek and the Customs Administration. We consider them of similar importance, so the most reasonable way to reach a final figure is to weight both estimates equally. As a result, we infer that the percentage of smuggled cigarettes to the taxed ones sold in the Czech Republic is about 10.5%. We see that this result is very similar to the result concluded by Joossens (2009) for high-income countries. The official domestic consumption of cigarettes per capita in 2009 in the Czech Republic as quoted by CZSO was 2,071 (CZSO, 2010), and the total consumption was 21,727 millions pieces. Adjusting that number for our estimation of smuggled cigarettes, we conclude that the consumption of cigarettes per capita in the Czech Republic in 2009 was 2,288, and the total consumption including the illegal market was 24,008 millions pieces.

2.5 Prevalence of Smoking in the Czech Republic

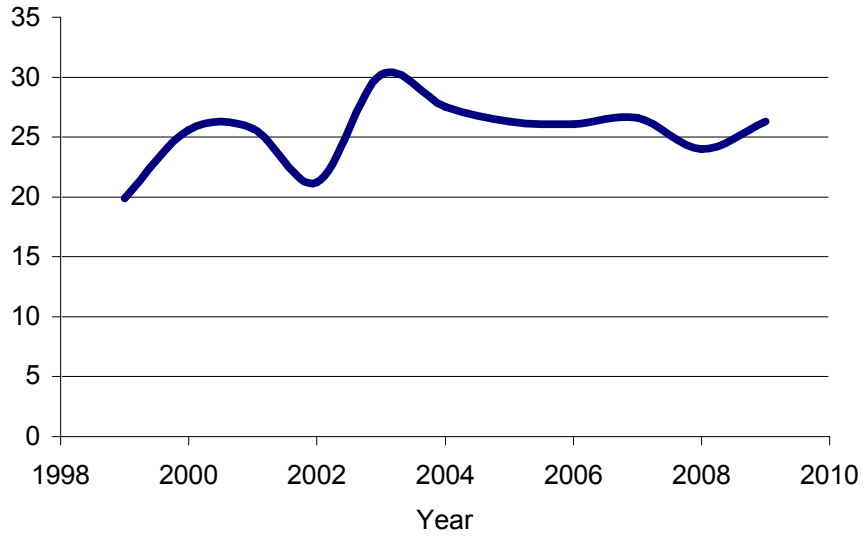
The prevalence of smoking is a vital factor in measuring the smoking-attributable mortality and morbidity caused by smoking. Therefore, it is important to evaluate the most accurate rate of prevalence. The World Bank (1999) estimated the number of smokers worldwide to be 1.1 billion[38], which means the world smoking prevalence was 19% before 2000[39].

To the best of our knowledge, the most comprehensive source for measuring the prevalence of smoking in the Czech Republic is the study conducted by Sovinová et al (2010). It has been conducted annually, using the same methodology, since 1997. In 2009, it used a representative sample of 1,495 respondents between 15 and 64 years of age. According to the study, in recent years about 25% of the population in the Czech Republic[40] between 15 and 64

[38]The year for which this estimation is valid was not stated. We assume it is for 1998.
[39] We took the 1998 world population figure from McDevitt (1999).
[40] An active smoker is defined as a person who smokes on average more than 1 cigarette per day. The study also evaluated the percentage of smokers smoking less than 1 cigarette per day. We treat this group as insignificant.

years of age were active smokers. In chart 2.5 we can see the time series of the prevalence between 1999 and 2009.

Chart 2.4: Percentage of Smokers in the Czech Republic, 15-64 years



Source: Sovinová et al (2010)

The prevalence of smokers peaked in 2003 at 30.2%. In 2009, the prevalence of smokers in the population group 15-64 years was 26.3%. Assuming the wider group 15+, the prevalence was 23.6%[41].

The prevalence of smokers is higher among men than among women. In the Czech Republic in 2009, these figures were 29.7% for the former and 20.4% for the latter[42]. The age group with the highest prevalence is 15-34 years. There are no significant differences among the Czech regions in smoking prevalence and habits. The study by Sovinová et al (2010) states that in the Czech Republic, smoking is not correlated with the salary. Conversely, there is a negative correlation between the prevalence of smoking and the level of attained education[43]. In our opinion, these two statements seem to contradict each other.

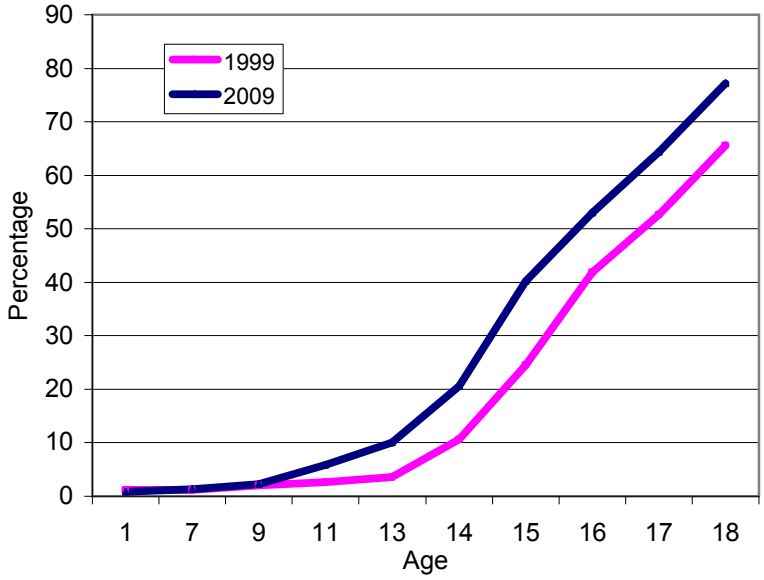
[41] The same figure is quoted by the WHO in their European Health for All Databases. So we assume they use Sovinová's survey as a source

[42] These figures are for the 15+ population; they were obtained from Sadílek, one of the co-authors of the Sovinová et al (2010) study. Throughout the thesis, we decided to use the prevalences that were provided to us by Sadílek, because in order to compute the mortality rate associated with smoking, the prevalence of current smokers, former smokers, and non-smokers for 15+ population is needed. Sovinová (2010) does not provide these figures in the study.

[43] This was proved in many countries worldwide. For example, the survey conducted by the World Bank (1999) in the Indian city Chennai found that the prevalence among illiterate men was 64%, while among men with 12+ years education, it was just 21%.

In the Czech Republic, 76% of smokers began smoking before they were 19 years old. There is an observable trend in the Czech Republic that people start smoking at increasingly younger ages. The chart 2.6 shows the cumulative distribution of the initial smoking age in the Czech Republic for 1999 and 2009.

Chart 2.5: Age of Smoking Initiation, cumulative distributive function, Czech Republic



Source: Sovinová et al (2010)

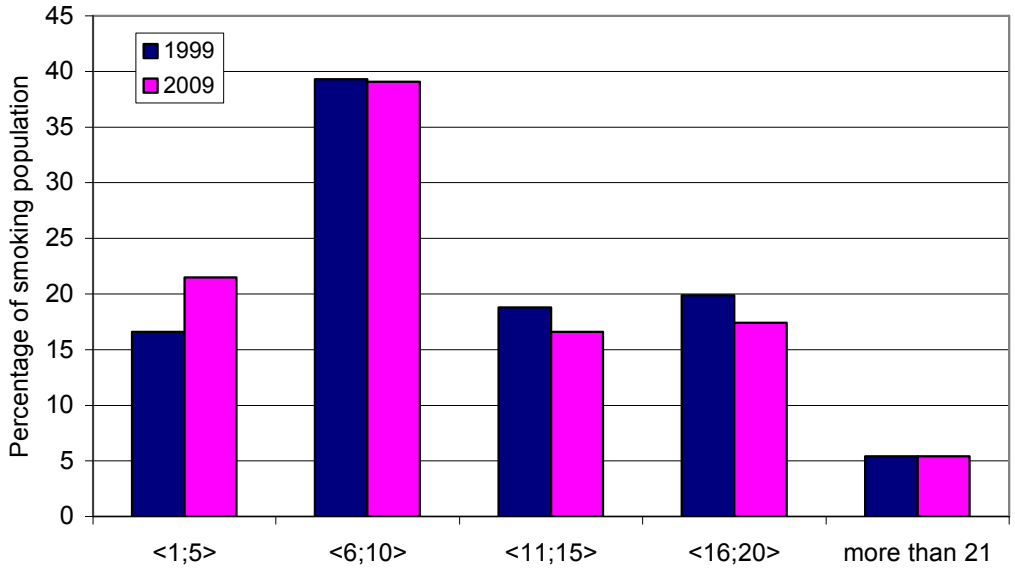
It is clear that the average starting age is decreasing. In 2009, 40% of current smokers stated that they had started smoking at the age of 15 or younger. The percentage in 1999 was only 24.5%[44]. The World Bank (1999) stated that in high-income countries, about 80% of smokers start with their habit before the age of 19. In 1999, the Czech Republic was below that average[45]. However, the World Bank estimation from the 90s correctly describes the 2009 situation in the Czech Republic.

Sovinová et al (2010) also collected data on the average number of cigarettes smoked by smokers in 2009. As above, we compare this with the data for 1999.

[44] This may be alarming information for policymakers, as young smokers do not usually correctly identify the risks associated with cigarette smoking.

[45] We may consider that in 1999, the Czech Republic was not in the group of high-income countries as defined by the World Bank.

Chart 2.6: Number of Cigarettes Smoked Per Day, Czech Smokers



Source: Sovinová et al (2010)

The number of smokers smoking 1-5 cigarettes per day grew by 30%. The percentage of smokers in all other categories decreased. We realised one interesting paradigm connected to this table.

2.5.1 Paradigm- inconsistency of main sources

We know the prevalence of smokers aged 15+ in the Czech Republic was 23.6%. If we assume that 4% of the 14- population are smokers, then we can compute that the prevalence of smokers for the whole population was 20.8% in 2009[46]. CZSO (2010) stated that 21,727 million cigarettes were sold in 2009 in the Czech Republic. Divided this by number of days in a year, by the number of inhabitants in the Czech Republic in 2009 and by computed prevalence in 2009, we get that the consumption of cigarettes per smoker per day is 27. This is not at all in compliance with the information provided by the Sovinová et al study (2010), which states that only 5.4% of smokers consume more than 21 cigarettes daily. We analyzed the possible reasons for such different outcomes.

The survey conducted by Sovinová et al is done annually, following the same format since 1997. Comparing the expressed smoking prevalence with that of previous years, we see there is no striking difference: as in the 2004-2008 period, the prevalence was in the 24-27.5%

[46] Computation based on the Czech demographic yearbook 2009 conducted by CZSO, available online at http://www.czso.cz/csu/2010edicniplan.nsf/p/4019-10, viewed 14.12.2011

range for 15-64 population. We may thus conclude that a prevalence of 26.3% for the 15-64 population in 2009 should not be far from the real value.

The very same argument applies for the distribution of smokers over the number of smoked cigarettes per day. During 2004-2008, it differed very little from the 2009 values. The information provided by CZSO about the number of cigarettes sold should also be correct as it is similar to previous annual values.

There is one more source estimating the number of cigarettes sold in the Czech Republic. This is the 2009 internal report for the European Commission conducted by KPMG. This report would help us to distinguish the correct figures. Unfortunately, the report is not publicly available and despite our best efforts, we were unable to obtain it.

We would like to underline that we did not consider the illegal market in our computation above. Considering the illegal market, the difference in figures provided by CZSO and Sovinova´s survey is even bigger. We spoke with a local researcher, Dr. Petr Sadílek, about this paradigm. He was not able to provide us with a satisfying solution. Finding a solution to this paradigm may be a challenging, potentially very fruitful subject for further research.

2.6 Diseases and Illnesses Caused by Smoking

"Few people now dispute that smoking is damaging human health on a global scale."

World Bank, 1999, p. 1

Tobacco Smoke and Its Composition

Tobacco smoke is created by the imperfect burning of tobacco. This kind of burning is caused by several factors: insufficient inflow of oxygen, fluctuant temperature during smoking (between 835 and 884 degrees Celsius), and imperfectly flammable tobacco leaves. Burning tobacco creates a wide range of chemical substances and compounds.

The air polluted by cigarette smoke contains about 5,000 substances originating from the process of burning. Based on estimates, the true number of substances may be 20 times higher, e.g. about 100,000 substances (Langrová, 2004). From our point of view, this fact may serve to support the hypothesis that smoking causes even more illnesses than is currently known. With such a high number of chemical substances created by smoking, not all causalities between a specific substance and a specific illness have yet been found. Currently, the key and most dangerous known substances in cigarette smoke are carbon monoxide, nicotine, and tar.

Carbon Monoxide

Carbon monoxide (CO) originates from imperfect burning of tobacco and cigarette paper. CO ties with haemoglobin (which transports oxygen in the human body). This decreases the ability of the blood to transport oxygen, which may result in up to 15% oxygen deficiency in an extreme case. The lack of oxygen endangers mainly the functions of the brain and heart. The continual effect of CO influences the nervous system and creates conditions for heart-vessel illnesses, such as stroke.

Nicotine

Nicotine is a highly toxic, colourless substance. The fumes from one cigarette contain about 10 mg of nicotine. Nicotine is an addictive drug. It quickly enters the bloodstream and then attains the nervous system. Nicotine enters the brain about 7 seconds after inhalation. Chronic nicotine poisoning is called nicotinism. Nicotine poisoning usually occurs when a user smokes more than 20 cigarettes per day. This causes a wide range of harsh effects, such as insomnia (the most common effect), lack of appetite, and nausea.

Tar

This dark substance is created during the cooling and condensation of smoke. It is responsible for the specific taste and smell of cigarettes. Tar has carcinogenic effects (it causes cancer). Tar could be eliminated from cigarettes by using special kinds of filtered tobacco, but as a result, a smoker would inhale just the hot smoke without any taste or smell.

Health Effects of Passive Smoking

The smoke produced by cigarettes can be divided into primary smoke, which is inhaled by a smoker and, after filtration in the lungs, exhaled, and secondary smoke, which comes from the freely burning end of the cigarette (the end that is not in a user's mouth).

A passive smoker inhales not only the smoke exhaled by a smoker, but also the smoke escaping from the freely burning end of the cigarette. This secondary source of smoke contains many more dangerous substances. It is more concentrated, due to the temperature of burning. The higher the burning temperature, the lower the amount of poisonous substances. A cigarette has a temperature of 1000 degrees Celsius when actively smoked, but it has just 400 degrees between pulls. The secondary stream of smoke thus contains more cancer-causing substances.

The definition of passive smoking is not totally clear. There is a more general definition stating that it is the *exposure of a non-smoking person to tobacco combustion products from smoking by others* (Jaakkola, 2010; Yao He et al, 2008). There is also a more concrete definition, similar to the first one, but adding that the exposure is non-voluntary (mentioned in Zeise, 1999). Throughout the text, we apply the first, broader definition.

2.6.1 Specific Illnesses Caused by Smoking

The core conclusion of the Centers of Disease Control and Prevention (2004, p. 8) is that *"smoking harms nearly every organ of the body, causing many diseases and reducing the health of smokers in general."* There is no study of comparable size and quality in the Czech Republic, but we assume that the implications of smoking on the health of a person are quite comparable in the U.S. and the Czech Republic. There is a list of diseases proved to be associated with smoking [47]. They are divided into four main categories: neoplasms, cardiovascular diseases, respiratory diseases, and paediatric effects.

Respiratory Diseases

These are the most common and usually the first consequence of the impact of smoking. Smoke damages the structure and functioning of bronchi and then the lungs. As stated by Zindr (2006, p.1), *"Chronic obstructive lung disease is a serious problem because of its prevalence, mortality, and economic burden on society"*. The kinds of respiratory diseases proved to be associated with smoking are:

- respiratory tuberculosis
- pneumonia
- influenza
- bronchitis
- emphysema
- asthma
- chronic airway obstruction

Neoplasms (Cancer)

Cigarette smoke can increase the risk for many types of cancer, including bladder, cervical, oesophageal, and kidney cancer. Over the years, more and more causal relationships have

[47] The list is based on the relative risks table used in the next chapter of this paper, which builds on Shultz, Novotny, & Rice (1991)

been found between smoking and specific kinds of cancer. For example, in the last decade the relationship between smoking and kidney, laryngeal, and stomach cancer was proved (Zindr, 2006). We infer a high probability that this trend (noting more kinds of cancer as being caused by smoking) will continue in the future, meaning that the current estimations of the number of people who have died from cancer because of smoking is underestimated. The following kinds of cancer are definitely caused by smoking:

- lip, oral cavity, pharynx
- oesophagus
- pancreas
- larynx
- trachea
- lung
- bronchus
- cervix uteri
- urinary bladder
- kidney

Cardiovascular Diseases

Nicotine causes temporarily increased blood pressure and heart rate. The heart must pump a greater volume of blood. Nicotine also causes narrowing of the arteries. Nicotine increases the cohesion of blood platelets: they tend to create clusters. This decreases their lifetime. Cardiovascular diseases that may be caused by smoking are:

- rheumatic heart disease
- hypertension
- ischemic heart disease
- pulmonary heart disease
- cardiac arrest
- cerebrovascular disease
- atherosclerosis
- aortic aneurysm

Paediatric Conditions, Disorders in Pregnancy

When a pregnant woman smokes, nicotine enters the brain of the foetus through the placenta. The foetal and infant diseases whose risk increases when the mother smokes are:

- short gestation
- low birth weight
- respiratory distress syndrome
- sudden infant death syndrome

These diseases are usually fatal for newborns. Based on Wald (1996), 4% of the miscarriages of women who smoke are attributable to smoking. There are other nonfatal diseases caused by smoking during pregnancy. For example, maternal smoking doubles the probability that a

child will suffer from congenital limb reduction (failure of part of a limb to develop). A study on a Czech population with a sample of 5,000 couples and their children was conducted by Masaryk University (2010). The study found that the children of Czech women who smoked during pregnancy were on average 107 grams smaller and 1.3 cm shorter than those with a non-smoking mother. The newborns of Czech fathers who smoke have a significantly higher risk of congenital defect. The research also revealed that about half of women who smoked stopped when they realized they were pregnant.

There is a wide list of other diseases, fatal and non-fatal, that are caused by smoking. For instance, dental problems are associated with smoking. Based on Wald (1996), smoking accounts for 40% of the periodontitis leading to tooth loss in communities where about one-third of adults smoke.

2.6.2 Positive Health Impact of Smoking

For the sake of completeness, we also analyze if smoking reduces the risk for any diseases. A table of diseases where such an effect may be significant was published by Wald (1996). The author of the study also quantified the impact. We challenge his results with the findings (mostly more recent) of other researchers.

Table 2.7: Positive Health Impact of Smoking
Incidence (or Deaths) per 100 000/year

Disease	Non-smoker	Current (or former) smoker
Parkinson's (deaths)	8	4
Ulcerative Colitis	16	13
Alzheimer's (aged over 65)	8,286	5,667
Endometrial Cancer (women over 60)	230	110
Preeclampsia (births)	507	331
Down's Syndrome(births)	147	90
Uterine Fibroids (women aged 25-39)	3,473	2,430
Vomiting During Pregnancy (hyperemesis gravidarum)	864	517

Source: Wald (1996)

Marmot (1990) concluded that there is a consistency in the link between smoking and delaying parkinsonism. Kandinov et al (2008) ran a quantitative study measuring the effect of smoking on the age at Parkinson's disease onset. The study population contained 278 patients. He concluded that smoking more than ten packs a year delays the age of onset by 3.2 years.

Recent research by Cataldo et al (2010) showed by meta-analysis study that smoking increases the risks of Alzheimer's disease. A similar result was found by Rusanen et al (2011), who concluded from a sample of 21,123 people that heavy smoking in midlife is associated with a 157% increase in the risk of Alzheimer's disease more than two decades later.

Concerning women over 60 years of age with endometrial cancer, Terry et al (2010) found a negative association with smoking, which diminishes over time if the subject has quit smoking. Terry et al concluded that there is a positive correlation between the reduced risk of disease and the smoking quantity (number of cigarettes smoked per day) and duration.

Based on Wikström et al (2010, Abstract), "*Preeclampsia is a leading cause of maternal and infant mortality and morbidity worldwide*." The authors collected information from the Swedish Birth Register for 1996-2006. There were 499,243 births to non-smoking mothers. The smoking mothers were further divided by consumption to 9 cigarettes or fewer per day and more than 9 cigarettes per day. The results are provided in the table 2.8:

Table 2.8: Impact of Maternal Smoking on Preeclampsia Prevalence

Maternal Characteristics	Total Births	Preeclampsia Rate
Non-smoker	499,243	3.01%
Cigarette smoker		
1-9 cigarettes per day	41,121	2.32%
>9 cigarettes per day	16,806	1.69%

Source: Wilkstöm et al (2010)

The risk of preeclampsia is 23% lower for light smokers and 44% lower for heavy smokers. In comparison, Engel et al (2008) ran similar research on New York City data for 1995-2003. From a sample of 674,250 pregnancies, the authors found that smoking decreases the probability of preeclampsia by only 12%.

We did not find any recent serious analysis of the impact of smoking on the prevalence of uterine fibroids to compare Wald (1996) results with a more recent research.

To the best of our knowledge, the link between maternal smoking and Down's syndrome has not been proven. Chen et al (1998) did not find any clear relation after controlling for maternal age.

There may be other diseases that smokers are less probable to contract. However, there is no such association based on comprehensive long-term research.

It is clear that health benefits of smoking are rather unambiguous. We can only conclude that smoking probably delays Parkinson's disease and endometrial cancer, and also decreases the risk of preeclampsia[48].

The overall trend in smoking benefits research results is clear: whereas in the 20th century, smoking was believed to diminish the risks for a number of diseases, these links have been dissolved by more recent research. Therefore, we will not consider health benefits of smoking in our further analysis. No study has analyzed the positive impact of smoking on diseases using Czech data. Hence we have to assume that the findings from other countries that were summarized in this subchapter and our final conclusion about the insignificancy of the positive health impact of smoking are valid for the Czech Republic as well.

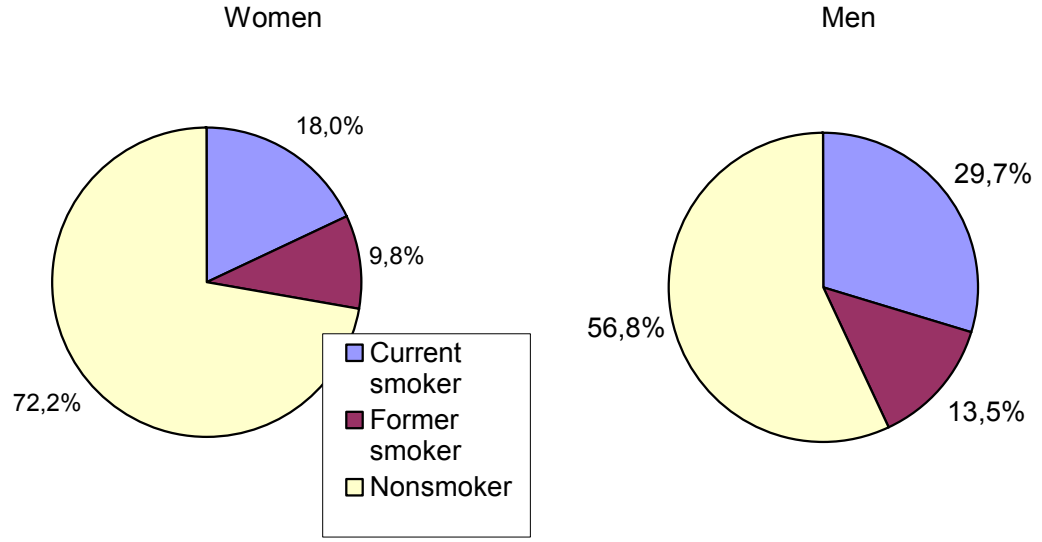
2.7 Smoking-Attributable Mortality

To quantify the estimated impact of smoking on mortality, we used the "direct approach", calculating the fractions of individual mortality diagnoses that are attributable to smoking. These fractions are called Smoking Attributable Fractions (SAF). We believe this is the most appropriate method for calculating smoking-attributable mortality. This method was developed and has been used by the U.S. Centers for Disease Control and Prevention (CDC) (2008). It has also been applied in European countries – for example Banegas et al (2005) for Spain, Walte et al (2000) for Germany. The method evaluates smoking-attributable mortality by applying SAF to the actual population mortality data. To compute SAF requires the current prevalence of smoking in the target adult (15+) population and the values of "relative risks". We collected the smoking prevalence in the Czech Republic for 2009 from Sovinová et al (2010). Separate values of the prevalence for men and women were not published in the study, but they were kindly provided to us by one of the authors, Petr Sadílek[49].

[48] This disease is not directly fatal.

[49] To compute SAF requires the prevalence of non-smokers, former smokers, and current smokers (smoking more than 1 cigarette per day). However, the prevalence measurements obtained from Dr. Sadílek were divided into 5 groups: 1. current smokers, 2. smokers smoking less than 1 cigarette per day, 3. former smokers, 4. former smokers who smoked less than 100 cigarettes total and 5. non-smokers. For the purpose of SAF computation, we added the second and fourth group to the non-smokers.

Chart 2.7: Smoking Prevalence, Czech Republic, 2009



Source: Sadílek, unpublished

The values of the relative risk of illnesses and deaths associated with smoking are unavailable for the Czech population. According to Sovinová et al (2008, p.38), *"the application of relative risks values… (from other countries)… is a common procedure in those countries where these data are not available from domestic epidemiological studies"*. We hence use the relative risks values published in Shultz, Novotny, & Rice (1991). They were later quoted by Thun et al (1997) and served as one of the inputs used by the CDC (2008) for various computations of the impact of smoking. They were also used in the study by Sovinová et al (2006, 2008). We were informed by Dr. Chaloupka that the research of relative risk has not progressed much since the beginning of 1990s so the relative risks by Shultz, Novotny, & Rice (1991) might me the most appropriate available. One of the most recent extensive studies about the costs of smoking by Rehm et al (2006) used updated relative risk values. The values are unpublished; however, they were provided to us by one of the authors[50], Svetlana Popova. The study provides relative risks for fewer diseases than Shultz, Novotny, & Rice (1991). It also does not distinguish between sexes in most cases. Based on these facts, we decided to work with the figures provided by Shultz, Novotny, & Rice (1991). Nevertheless, we have to keep in mind that these figures, even if they are the best ones available, may be outdated[51].

[50] We would like to express our gratitude for the data provision.
[51] New relative risks figures research might be very fruitful.

Table 2.9: Relative Risks of Smoking Values, by Disease

	Males		Females	
	Current	Former	Current	Former
Neoplasms				
Lip, oral cavity, pharynx	27.48	8.80	5.59	2.88
Oesophagus	7.60	5.83	10.25	3.16
Pancreas	2.14	1.12	2.33	1.78
Larynx	10.48	5.24	17.78	11.88
Trachea, lung, bronchus	22.36	9.36	11.94	4.69
Cervix uteri	NA	NA	2.14	1.94
Urinary bladder	2.86	1.90	2.58	1.85
Kidney, other urinary	2.95	1.95	1.41	1.16
Cardiovascular Diseases				
Rheumatic heart disease	1.85	1.32	1.69	1.16
Hypertension	1.85	1.32	1.69	1.16
Ischemic heart disease				
35-64	2.81	1.75	3	1.43
65 and older	1.62	1.29	1.6	1.29
Pulmonary heart disease	1.85	1.32	1.69	1.16
Cardiac arrest, other heart disease	1.85	1.32	1.69	1.16
Cerebrovascular disease				
35-64	3.67	1.38	4.8	1.41
65 and older	1.94	1.27	1.47	1.01
Atherosclerosis	4.06	2.33	3	1.34
Aortic aneurysm	4.06	2.33	3	1.34
Other arterial disease	4.06	2.33	3	1.34
Respiratory Disease				
Respiratory tuberculosis	1.99	1.56	2.18	1.38
Pneumonia, influenza	1.99	1.56	2.18	1.38
Bronchitis, emphysema	9.65	8.75	10.47	7.04
Asthma	1.99	1.56	2.18	1.38
Chronic airway obstruction	9.65	8.75	10.47	7.04
Paediatric Conditions				
Short gestation, low birth weight	1.76		1.76	
Respiratory distress syndrome	1.76		1.76	
Respiratory conditions – newborn	1.76		1.76	
Sudden infant death syndrome	1.50		1.50	

Source: Shultz, Novotny, & Rice (1991)

These values are for firsthand smoking only.

The relation for the computation of SAF is:

$$SAF = \frac{p_0 + p_1(RR_1) + p_2(RR_2) - 1}{p_0 + p_1(RR_1) + p_2(RR_2)}$$; where

p_0 - Percentage of non-smokers in the population; a non-smoker is a person who has smoked less than 100 cigarettes in life

p_1 - Percentage of current smokers in the population; a current smoker is a person smoking more than 1 cigarette per day

p_2 - Percentage of former smokers in the population; a former smoker is a person who smoked more than 100 cigarettes in life but not smokes any more

RR_1 - Value of the relative risk of death of current smokers vs. non-smokers

RR_2 - Value of the relative risk of death of former smokers vs. non-smokers

The total number of deaths from a specific disease caused by smoking is the multiplication of the number of deaths by SAF. For the information about the number of deaths caused by diseases for which the causality between smoking and that disease has been established (and hence RR values evaluated), we used the data provided by the CZSO (2010a). Following the procedure described in Shultz, Novotny, & Rice (1991) as well as by the CDC (2008), we considered only the deaths at the age of 35[52] and over for neoplasms, cardiovascular diseases and respiratory diseases, and the deaths till the ago of 1 in case of paediatric conditions (deaths of infants caused by smoking mothers during pregnancy).

In table 2.10, you can see a table of number of deaths, sorted by disease and sex, for 2000 and 2009. The numbers of total deaths are compared with deaths caused by smoking (computed using SAF).

Table 2.10: Smoking-Attributable Deaths in the Czech Republic in 2000 by Cause of Death and Sex

Disease Category	Males, total number of deaths	Males, smoking-attributable deaths	Females, total number of deaths	Females, smoking-attributable deaths
Neoplasms				
Lip, oral cavity, pharynx	1,162	1,045	112	56
Oesophagus	341	247	64	42
Pancreas	773	202	789	189
Larynx	254	196	23	18
Trachea, lung, bronchus	4,474	3,946	1,243	870
Cervix uteri	0	0	353	81
Urinary bladder	541	218	207	56
Kidney, other urinary	733	304	458	38
Cardiovascular Diseases				
Rheumatic heart disease	124	28	181	22
Hypertension	562	128	649	80
Ischemic heart disease				
35-64	3,158	1,231	836	240
65 and older	8,858	1,617	10,508	1,261

[52] The study does not directly describe why the threshold of 35 years is used. We think authors assumed that the deaths before age 35 cannot be associated with smoking, because people dying so young are unlikely to have smoked long enough that there may be an association between their smoking habits and death.

Pulmonary heart disease	773	176	1,019	125
Cardiac arrest and other heart disease	1,357	310	1,214	149
Cerebrovascular disease				
35-64	953	436	484	203
65 and older	6,016	1,443	9,855	777
Atherosclerosis	4,000	2,085	6,419	1,812
Aortic aneurysm	285	149	109	31
Other arterial disease	50	26	75	21
Respiratory Diseases				
Respiratory tuberculosis	79	21	30	6
Pneumonia, influenza	1,149	310	1,397	279
Bronchitis, emphysema	252	197	152	106
Asthma	63	17	64	13
Chronic airway obstruction	826	647	454	316
Paediatric Conditions				
Short gestation, low birth weight	8	1	4	0
Respiratory distress syndrome	15	1	13	0
Respiratory conditions - newborn	15	1	10	0
Sudden infant death syndrome	7	0	4	0

The biggest threats for male smokers in 2000 were neoplasms of the trachea, lung, and bronchus, causing 3,946 deaths. For female smokers, the biggest risk was atherosclerosis, causing 1,812 deaths.

Table 2.11: Smoking-Attributable Deaths in the Czech Republic on 2009 by Cause of Death and Sex

Disease Category	Males, total number of deaths	Males, smoking-attributable deaths	Females, total number of deaths	Females, smoking-attributable deaths
Neoplasms				
Lip, oral cavity, pharynx	495	445	132	66
Oesophagus	359	260	75	49
Pancreas	958	251	886	213
Larynx	213	164	27	22
Trachea, lung, bronchus	3,974	3,505	1,476	1,033
Cervix uteri	0	0	302	69
Urinary bladder	538	217	219	59
Kidney, other urinary	646	268	407	33
Cardiovascular Diseases				
Rheumatic heart disease	77	18	132	16
Hypertension	812	185	1,145	141
Ischemic heart disease				
35-64	2,626	1,024	674	193
65 and older	9,464	1,727	12,986	1,559
Pulmonary heart disease	926	211	1,316	161
Cardiac arrest and other heart disease	2,249	513	2,415	296
Cerebrovascular disease				
35-64	725	332	352	148

65 and older	4,086	980	7,015	553
Atherosclerosis	2,482	1,294	3,435	970
Aortic aneurysm	313	163	182	51
Other arterial disease	63	33	96	27
Respiratory disease				
Respiratory tuberculosis	35	9	9	2
Pneumonia, influenza	1,667	450	1,595	319
Bronchitis, emphysema	132	103	89	62
Asthma	43	12	51	10
Chronic airway obstruction	1,286	1,007	779	543
Pediatric Conditions				
Short gestation, low birth weight	13	1	8	0
Respiratory distress syndrome	6	0	6	0
Respiratory conditions – newborn	4	0	11	0
Sudden infant death syndrome	10	0	5	0

In comparing 2000 and 2009, the biggest threat to male smokers was still the same: neoplasms of the trachea, lung, and bronchus, killing 3,505 smokers. For female smokers, the biggest threat was no longer atherosclerosis as in 2000, but ischemic heart disease. Summarizing the numbers of deaths from both reference years, we derived their direct comparison:

Chart 2.8: Mortality Caused by First-hand Smoking, Number of Deaths, Czech Republic

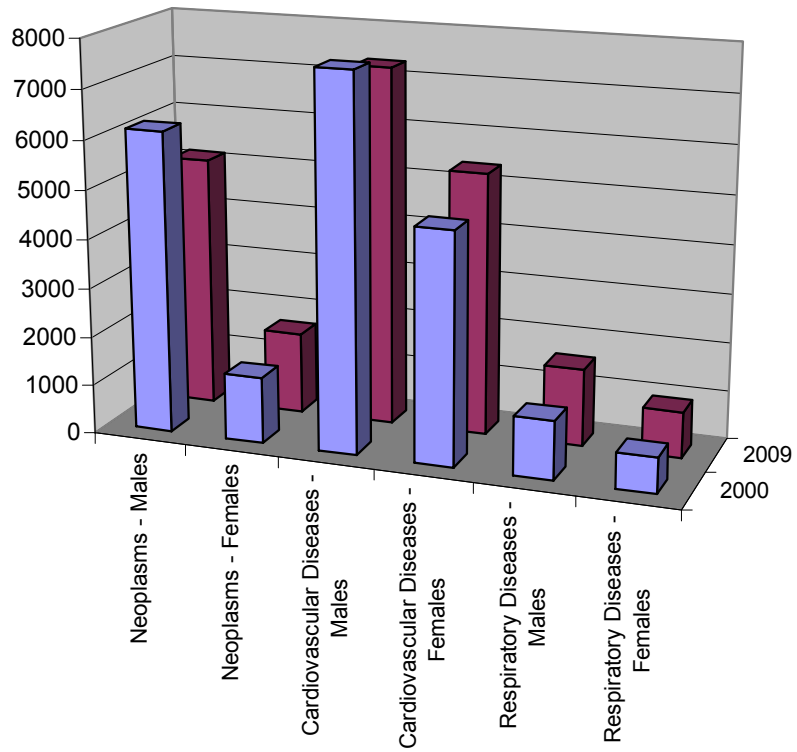


Table 2.12: First-hand Smoking-Attributable Mortality, Czech Republic

Year	Males	Females	Both sexes
2000	14,983	6,792	21,775
2009	13,173	6,597	19,770

Peto et al (2003) estimated that in 2000, the number of deaths in the Czech Republic caused by smoking was 17,746. Sovinová et al (2007) estimated 20,550 deaths in 2002. Based on Ross (2004, p. 185), *„the Minister of Health of the Czech Republic, Bohumil Fiser, reported to the Czech Parliament in summer 2001... that the estimated mortality attributed to smoking is 23,000 persons a year."* We see that the results from Peto, Sovinová as well as Ross are similar to ours. This indicates that our estimate as presented in the table 2.12 is realistic.

Comparing the results in table 2.12 with the total number of deaths, we state that the first-hand deaths caused by smoking accounted for 20% of all deaths in 2000 and 18.4% in 2009[53] in the Czech Republic. Based on our computations, there was a 9% decrease in the number of deaths caused by smoking in the Czech Republic between 2000 and 2009. Looking at the diseases, it is clear that in both observed years, the biggest killer of smokers was respiratory diseases. On the other hand, the impact on infant death of smoking during pregnancy was insignificant. We therefore omit that statistic from our further analysis.

Finally, it may be of interest to compare the ratio of deaths caused by first-hand smoking for most of European Union countries as well as Norway and Island in order to see the relative standing of the Czech Republic. To do so, we use the data from Peto et al (2003) to acquire the estimated number of deaths caused by smoking for countries in 2000[54]. To the best of our knowledge, there has not been a more recent study analyzing European countries. We obtained the number of total deaths for 2000 from the Eurostat Population Database. We got the figures quoted below:

Table 2.13: Death Caused by Smoking, International Comparison, year 2000

	Deaths caused by smoking	Deaths – total	Percentage
Hungary	29,070	135,601	21%
Iceland	390	1,828	21%
Denmark	12,329	57,986	21%
United Kingdom	117,771	608,365	19%

[53] Data for the total number of deaths in 2000 and 2009 taken from CZSO, available online at http://www.czso.cz/csu/2010edicniplan.nsf/kapitola/4017-10-(2000_az_2009)-2009, viewed 1.2.2011

[54] Peto did not make an estimate for Iceland. Therefore, for Iceland we used the estimate of Sigurdsson (2000).

Poland	68,629	368,027	19%
Netherlands	25,725	140,527	18%
Ireland	5,653	31,391	18%
Belgium	18,646	104,903	18%
Czech Republic	17,746	109,101	16%
Slovakia	8,039	52,724	15%
0Luxembourg	570	3,754	15%
Slovenia	2,808	18,588	15%
Estonia	2,751	18,403	15%
Italy	80,061	555,502	14%
Germany	108,835	838,797	13%
Latvia	4,131	32,205	13%
Greece	13,332	105,209	13%
Norway	5,544	44,002	13%
Spain	45,342	360,391	13%
Lithuania	4,671	38,919	12%
Austria	8,903	76,780	12%
France	60,578	540,717	11%
Switzerland	6,978	62,528	11%
Finland	5,102	49,339	10%
Malta	295	2,941	10%
Sweden	8,205	93,461	9%
Portugal	8,405	105,364	8%
Total	**670,509**	**4,557,353**	**15%**

Source: Peto et al (2003), Sigurdsson (2000), Eurostat population database

The table indicates that there is no geographical dependence on the rate of deaths caused by smoking. The highest percentage, 21%, was attained in Hungary, Iceland, and Denmark; the lowest percentages, 9% and 8%, were reached in Sweden and Portugal, respectively. The overall average percentage for all the analysed countries is 15%. In terms of the rate of deaths caused by smoking, the Czech Republic in 2000 was at the European average. We used the estimates from the study by Peto, rather than our own estimate, because all of the percentages except for Iceland were computed using Peto's methodology. If we consider our computed percentage of deaths caused by smoking in the Czech Republic in 2000 – 20% – and compare it with the other countries where Peto's approach was used, the Czech Republic would be significantly above the European average. However, this result would be misleading because of the different methodologies used. The World Bank (1999) estimated that in the 1990s, about 10% of worldwide deaths were caused by smoking, and it also estimates this percentage to increase to 17% by 2030.

We would like to highlight that we did not include death-attributable mortality caused by second-hand (passive) smoking. However, it is widely accepted that second-hand smoke is a

significant source of health problems and deaths[55]. For example, Woodward and Laugesen (2001) estimated that 347 annual deaths in New Zealand are attributable to second-hand smoke. To the best of our knowledge, the most comprehensive and recent study of the impact of second-hand smoke on non-smokers was conducted by Oberg et al (2011). They analysed data for 2004 from 192 countries from all world regions, and then evaluated the data by region. The Czech Republic belonged to the "Europe A" region, covering mainly the western European countries. Based on surveys, the authors concluded that about 51% of children, 35% of non-smoking men, and 31% of non-smoking women are regularly exposed to second-hand smoke. Based on the study and our computations, 0.83% of the deaths in the region were attributable to second-hand smoke[56] in 2004.

We computed our own estimate of the deaths attributable to second-hand smoke for the Czech Republic. Based on Oberg et al (2011), there are six diseases attributable to second-hand smoke. These are childhood diseases (lower respiratory infections, asthma, acute otitis media) and adult diseases (asthma, lung cancer, and ischemic heart disease). The authors stated that in 2004, 72 children died because of second-hand smoke in 26 European countries and Israel. As the number is small, we omit childhood diseases from our analysis. Using the methodology of Oberg et al (2011) and the mortality data from 2009 provided by CZSO (2010a), we obtained the following results for the Czech Republic:

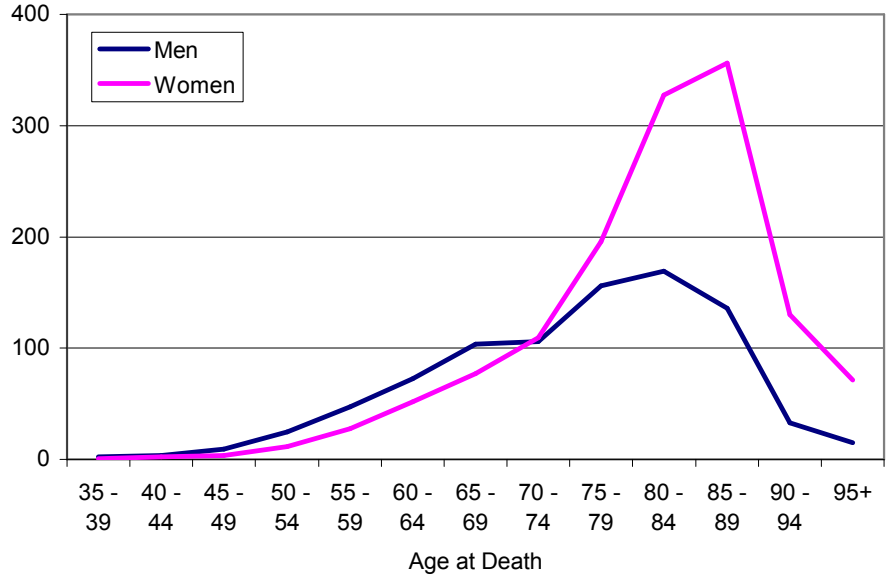
Table 2.14: Second-hand-Smoke Attributable Deaths Differentiated by Disease, Czech Republic, 2009

Disease	Number of Deaths – Men	Number of Deaths - Women	Total
Asthma	4	7	11
Lung cancer	40	118	158
Ischemic heart disease	834	1,260	2,074
TOTAL	878	1,365	2,243

[55] For example: Barnoya et al (2005) stated that the second hand smoke increases the risk of coronary heart disease by 30%. In case of all U.S. workplaces are smoke-free, there would be about 1500 myocardial infarctions of nonsmokers prevented in the year of implementation.

[56] The study concluded 35,500 deaths attributable to secondhand-smoke. The size of the region was about 418 millions inhabitants (based on Eurostat). We assume the number of deaths was 4.230 millions (the ratio of number of annual deaths to total population in the Czech Republic in 2009 was 0.0103, we assume the same ratio to hold for observed region for 2004). Dividing 35,500 by 4,230,000, we are getting the ratio 0.83%

Chart 2.9: Second-hand Smoke Attributable Deaths Differentiated by Age at Death and Sex, Czech Republic, 2009



The number of deaths caused by both firsthand and second-hand smoking in the Czech Republic for 2009 was 22,013, accounting for 20.3% of all deaths.

2.8 Deaths Caused by Smoking, Divided by Age at Death

For computing the benefits and costs of smoking for the state budget, we have to examine the distribution of deaths attributable to smoking over the age at death. We also compute the Potential Years of Life Lost (PYLL), which indicates how many years of life smokers in the Czech Republic lost because of early death. CZSO (2010a) provides the number of deaths according to disease, sex, and age at death[57]. We omitted the deaths of infants caused by smoking, as there were only few such deaths in 2009 based on our analysis in the previous subchapter. Then, we multiplied the number of deaths by the appropriate SAF coefficient (Smoking Attributable Fractions – described above already). We also added the effect of the second-hand smoke that we evaluated. We ran the computation separately for men and women. The results showing the number of deaths associated with smoking in different ages of death are in the table 2.15:

[57] The material states the number of deaths for ages 0-4, 5-10, and so on…

Table 2.15: Men's Deaths Caused by First-hand and Second-hand Smoking, Differentiated by Age at Death, Czech Republic, 2009

	Age at Death												
Disease	**35 - 39**	**40 - 44**	**45 – 49**	**50 - 54**	**55 - 59**	**60 - 64**	**65 - 69**	**70 - 74**	**75 - 79**	**80 - 84**	**85 - 89**	**90 - 94**	**95+**
Neoplasms													
Lip, oral cavity, pharynx	4	13	28	70	95	91	63	29	22	18	10	2	0
Oesophagus	1	0	14	27	54	50	42	24	22	17	6	1	0
Pancreas	2	3	7	14	28	45	46	35	38	23	9	1	1
Larynx	1	2	9	15	37	38	28	19	9	5	3	0	0
Trachea, lung, bronchus	7	14	53	169	411	694	707	578	491	301	105	9	4
Urinary bladder	0	0	2	8	11	18	25	32	48	45	23	4	2
Kidney, other urinary	1	2	4	17	29	44	43	39	44	27	13	2	1
Cardiovascular Diseases													
Rheumatic heart disease	0	0	0	1	1	2	2	3	2	3	3	1	0
Hypertension	0	2	3	5	11	19	23	23	29	35	27	5	3
Ischemic heart disease	15	27	70	184	344	527	334	348	523	577	469	115	53
Pulmonary heart disease	1	2	5	8	16	26	22	24	31	37	31	5	3
Cardiac arrest and other heart disease	5	8	14	24	42	60	60	55	73	80	68	14	9
Cerebrovascular disease	6	10	20	42	93	162	108	129	202	248	215	58	21
Atherosclerosis	1	5	7	30	59	96	142	138	213	260	249	59	37
Aortic aneurysm	3	2	2	6	9	18	24	27	29	25	17	2	0
Other arterial disease	1	1	1	3	2	2	5	3	5	5	4	2	2
Respiratory Disease													
Respiratory tuberculosis	0	1	1	1	1	2	2	1	0	0	1	0	0
Pneumonia, influenza	7	7	10	16	29	35	42	41	72	85	75	21	10
Bronchitis, emphysema	0	1	4	5	9	11	12	16	15	14	14	2	0
Asthma	1	0	0	0	1	1	1	1	3	4	2	0	0
Chronic airways obstruction	2	6	5	22	79	124	138	150	188	154	112	20	9

The number one disease killing male smokers in the Czech Republic varies according to age at death. Most deaths for the age groups 35-54 and 75+ are caused by ischemic heart disease. The biggest threat for active and passive male smokers between 55 and 69 are neoplasms of the trachea, lung, and bronchus.

Table 2.16: Women's Deaths Caused by Firsthand and Second-hand Smoking Differentiated by Age at Death, Czech Republic, 2009

	Age at Death												
Disease	**35 – 39**	**40 - 44**	**45 - 49**	**50 - 54**	**55 - 59**	**60 - 64**	**65 – 69**	**70 – 74**	**75 - 79**	**80 - 84**	**85 - 89**	**90 - 94**	**95+**
Neoplasms													
Lip, oral cavity, pharynx	1	2	2	4	9	15	9	6	7	6	5	2	2
Oesophagus	0	1	0	4	7	6	5	3	6	9	7	1	0
Pancreas	0	2	3	6	17	22	30	27	39	35	26	4	2
Larynx	0	0	2	2	1	2	1	4	4	2	3	0	0
Trachea, lung, bronchus	2	5	19	60	149	199	189	141	169	128	73	14	3
Cervix uteri	2	4	6	7	10	10	8	8	6	6	4	0	0
Urinary bladder	0	0	1	1	1	6	8	6	10	13	9	2	1
Kidney, other urinary	0	0	0	1	2	3	4	5	6	7	4	0	0
Cardiovascular diseases													
Rheumatic heart disease	0	0	0	0	0	1	2	1	3	4	3	1	0
Hypertension	0	0	1	1	4	6	9	12	20	34	35	13	6
Ischemic heart disease	2	6	8	26	65	136	123	206	412	732	813	300	164
Pulmonary heart disease	1	1	2	2	5	8	12	16	26	40	37	8	4
Cardiac arrest and other heart disease	1	1	2	4	7	12	19	26	47	67	74	24	13
Cerebrovascular disease	5	7	10	20	41	66	20	38	90	154	168	55	27
Atherosclerosis	0	1	1	4	6	17	32	54	132	247	296	110	71
Aortic aneurysm	0	0	0	1	2	4	3	8	10	14	7	1	0
Other arterial disease	0	0	0	0	0	1	1	1	3	6	10	3	1
Respiratory disease													
Respiratory tuberculosis	0	0	0	0	0	0	0	0	0	1	0	0	0
Pneumonia, influenza	2	2	4	4	8	10	15	19	46	74	86	30	19
Bronchitis, emphysema	1	1	1	1	1	6	7	5	10	13	13	3	1
Asthma	0	1	0	1	1	2	2	3	3	2	1	0	1
Chronic airway obstruction	0	1	4	8	26	48	48	61	98	109	95	33	11

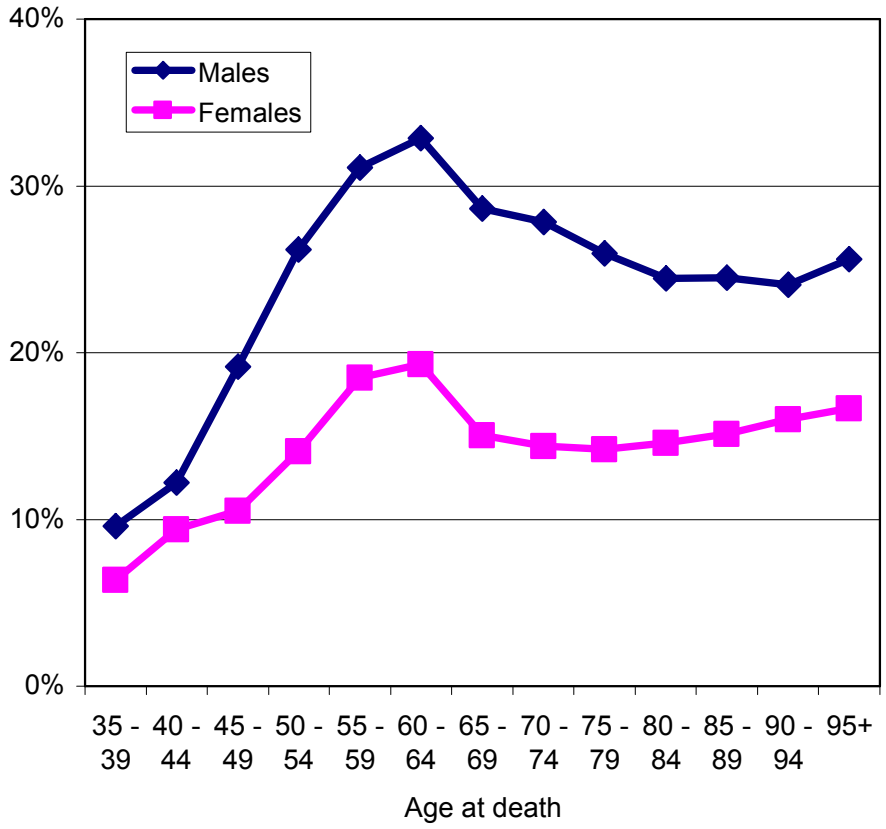
The diseases causing the most deaths among female smokers are: cerebrovascular diseases for ages 35-44 at death; neoplasms of the trachea, lung, and bronchus for ages 45-69 at death, and ischemic heart disease for deaths at ages 70+. Summing the number of deaths at different age intervals, we get the following aggregate figures:

Table 2.17: Number of Deaths Caused by Smoking Divided by Sex and Age at Death, Czech Republic, 2009

Age	35 - 39	40 - 44	45 – 49	50 - 54	55 - 59	60 - 64	65 – 69	70 - 74	75 - 79	80 - 84	85 - 89	90 - 94	95+
Males	58	104	259	669	1363	2064	1867	1715	2058	1961	1456	322	154
Females	16	36	65	158	361	579	547	648	1146	1701	1770	605	327

Based on the figures computed above, we can derive a chart comparing the percentage of deaths caused by smoking to total deaths divided by age and sex:

Chart 2.10: Percentage of Deaths Caused by Smoking, Czech Republic, 2009



We conclude that the relative ratio of deaths caused by smoking divided by age differs greatly by sex. Whereas 33% of male deaths at age 60-64 are attributable to smoking, the percentage for females for the same age is just 19%. The ratio of deaths attributable to smoking to the total number of deaths is the highest in these ages at death for both sexes. Conversely, the

lowest percentage for both sexes is for the 35-39 age at death, only 10% for men and 6% for women.

Habrová & Hrubá (2007), in their study on the economics of smoking habits in the Czech Republic, stated that half of the Czech people who died because of smoking had died at a productive age. Arthur D. Little (2000) assumed the ratio to be 33%. Both studies stated these ratios without any computations which would back up their assumptions. A "productive age" is defined as lower than the age of retirement. This was approximately 62 years for men and 60 for women in 2009. Using the figures we derived, we conclude that the percentage of deaths caused by smoking that occur at productive age is 8% of total deaths caused by smoking for females and 23% for males[58], so we see we derived great deal lower ratios in comparison to other Czech studies.

This information serves as a stepping stone for deriving the figure of Potential Years of Life Lost (PYLL) caused by smoking among citizens in the Czech Republic in 2009. PYLL is defined as the number of years of life lost due to smoking. This figure is not directly needed for our further computations in next chapters, but its magnitude is interesting as one of the by-products of this thesis.

There are two ways to get a PYLL figure: using the average life expectancy at birth and using life expectancy for different ages.

2.8.1 Using Life Expectancy at Birth

Many authors compute the PYLL using only life expectancy at birth. This approach is suggested by the Association of the Public Health Epidemiologists in Ontario[59]. The procedure of computing PYLL is as follows:

First, determine the average life expectancy for men and women at birth in a given population. For the Czech Republic, these figures are provided by CZSO (2010b). The material states the figures as 74 years for men and 80 for women. Next, deduct the age of death (caused by smoking) from the life expectancy[60] .The outcome is the PYLL for the smoker. Using this procedure, the PYLL due to smoking is 41,324 for women and 87,571 for men in the Czech Republic in 2009.

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[58] We assume that the number of deaths is distributed evenly in every age interval of death. So if (for example) there are 2,016 male deaths between 60 and 64 years, the assumed number of deaths at the age of 60 would be 2,016 divided by 5.

[59] Available online at http://www.apheo.ca/index.php?pid=190, viewed 20.2.2011

[60] We assume that the average age at death in every interval is the mean of the lower and upper range of the interval. Furthermore, we assume that no people died because of smoking at an age higher than 100.

This procedure has one serious and obvious flaw. It assumes that if a person dies because of smoking at an age above the life expectancy at birth, that person does not lose any years of life. This is generally not true. Therefore, a more specific approach should be used.

2.8.2 Using Age-Specific Life Expectancies

For this PYLL computation, take the age-specific life expectancy for a given death age, and multiply it by the number of deaths in the given age interval. This approach is described and recommended by the CDC[61]. Summing up the result across all age intervals produces the PYLL for the whole population. The resulting number is the PYLL for a given age interval. Below are the results after applying both procedures:

PYLL 1 – computing PYLL using the life expectancy at birth for all age intervals of death

PYLL 2 – computing PYLL using the specific life expectancies for every age interval

Table 2.18: Total Potential Years of Life Lost Caused by Smoking, Divided by Sex, Czech Republic, 2009

	35 – 39	40 – 44	45 – 49	50 – 54	55 – 59	60 – 64	65 – 69
Men							
PYLL 1	2,107	3,291	6,853	14,387	22,494	23,733	12,134
PYLL 2	2,251	3 552	7,499	16,728	28,629	35,084	26 134
Female							
PYLL 1	694	1,344	2,128	4,341	8,116	10,132	6,842
PYLL 2	718	1,397	2,226	4,736	9,018	12,158	8,179
	70 - 74	**75 - 79**	**80 -84**	**85 – 89**	**90 - 94**	**95+**	***SUM***
Men							
PYLL 1	2,572						***87,571***
PYLL 2	18,862	16,467	11,768	5,823	965	307	***174,070***
Female							
PYLL 1	4,862	2,865					***41,324***
PYLL 2	8,428	10,315	10,204	7,081	1,211	327	***77,125***

We assume that the more realistic estimate is PYLL 2 as it is more methodologically precise. In 2009, smoking resulted in 174,070 PYLL for men and 77,125 for women. Summarising the figures, we conclude that deaths in 2009 caused by smoking resulted in 251,195 PYLL.

[61] Available online at http://apps.nccd.cdc.gov/sammec/methodology.asp#Health, viewed 2.2.2011

3 Costs and Benefits Attributable to Smoking

In this chapter, we compute the benefits and costs of cigarette smoking to the state budget during a one-year period. We compare the current state with a situation in which there is no smoking among citizens. We will use the figures about the smoking-attributable mortality which we derived in previous chapter.

We start with a brief overview of previous foreign analyses of this topic. Then we look a bit more closely at the papers analysing the Czech situation. We compare the selection of costs and benefits factors that authors have included with their studies and our own evaluation. In our analysis, we work with data for 2009, as these are the most recent data available.

The task of analysing the impact of smokers on the state budget has been executed in a range of studies for some foreign countries – Viscusi (1994), Doran et al (1996), Scollo et al (2006) – as well as local ones – Arthur D. Little (2000)[62], Habrová & Hrubá (2007). The studies analysing the situation in foreign countries are of very limited use in our work, as the structure of social and health care (hence the costs and benefits attributable to early deaths caused by smoking) differs largely among countries.

Viscusi (1994), analyzing U.S. data, correctly assumed that the costs of smokers to the government are in the form of medical care provided to smokers. On the benefits side, he calculated the savings from pensions and nursing resulting from the earlier deaths of smokers. He concluded that the revenues to the state budget exceeded the costs. Doran et al (1996) conducted a similar but more profound analysis on Australian data. They listed a wide range of costs caused by smoking, notably health care, antismoking campaigns, foregone earnings due to earlier deaths, absenteeism caused by the higher morbidity of smokers, and the effects of passive smoking. On the revenue side, they put only taxes from cigarettes. We assume their omission of the savings in heath care and pensions expenses accrued through earlier deaths was a mistake, but even so, they concluded that smokers are beneficial for the state budget. The study published by Scollo et al (2006), again analysing the Australian case, is organised in a similar manner and hence it also produced similar results – that smokers are beneficial for the state budget.

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[62] The study was criticised heavily by Ross (2004, p. 183): "*the study considered only the effect of smoking on public finances, not on society as a whole, thus providing a misleading and incomplete picture of costs borne both by individuals and by the society as a whole"*. We disagree with Ross – Arthur D. Little study stated many times thats its aim is to compute the impact of smoking only on the state budget. It did not compute the impact on society as this was not the claimed aim of the study. It was also criticised in a similar manner by Bates (2001).

In the Czech Republic, there have been two thorough studies: one by Arthur D. Little (2000) analysing Czech data from 1999, and one by Habrová & Hrubá (2007) analysing 2003 data. There is also a study by Sadílek (2001), analysing only the healthcare costs incurred by smoking in 1999. A study by Sovinová et al (2007), working with 2002 data, had the same aim.

The study conducted by Arthur D. Little (2000) evaluated following benefits:

- excise tax
- VAT
- Healthcare costs savings due to early mortality
- Corporate income taxes
- Customs duties
- Pension & social expenses savings due to early mortality
- Savings on housing for the elderly

Unlike the Arthur D. Little study, we did not add the VAT revenue to our analysis. We assume that if people did not spend money on cigarettes, they would spend it on other goods taxed at the same VAT rate[63]. Hence, the treasury does not get more or less revenue from VAT when there are no smokers.

The same logic applies for corporate income tax. Does the sole cigarette producer in the Czech Republic – Philip Morris CR a.s.[64] – have higher profitability than comparable firms? If the profitability is standard, then it does not mean any excess revenue for a government. In our analysis, we omit the effect of savings on housing for the elderly (called "Domovy Důchodců" in Czech). We consider this factor as irrelevant due to its small size in comparison to other factors. The study conducted by Arthur D. Little (2000) evaluated following costs:

- Smoking-related (firsthand) healthcare costs
- Absentee-related state budget costs
- Lost income tax due to higher mortality
- ETS-related health care costs
- Fire-induced costs

[63] Generally, this may not be always true. People can for example put the saved money on the savings account, hence the state would not get any VAT revenue.

[64] We would like to thank Šárka Miškovská from the Customs Administration of the Czech Republic for the information that PM is currently (as of 2.3.2011) the sole cigarette producer in the Czech Republic.

The study was very heavily criticized for the list of costs considered to be caused by smoking. Ross (2004) stated that the healthcare costs were heavily underestimated in the Arthur D. Little study. Furthermore, she argued that Arthur D. Little did not add the value of human capital lost due to early deaths caused by second-hand smoke. She also pointed out that the Arthur D. Little study assumed a very minimal loss of life due to smoking. The next objection is the usage of outdated information for smoking-attributable mortality in the Czech Republic. The whole critique leads to the conclusion that Arthur D. Little dramatically underestimated costs and overestimated revenues[65]. The result of Arthur D. Little study was that smokers generate positive financial impact on the government fiscal position[66]. In comparison to the Arthur D. Little study (2000), the study by Habrová & Hrubá (2007) omitted the savings in healthcare costs due to early mortality from the revenue side. On the costs side, the authors added all kinds of pensions paid due to mortality or morbidity caused by smoking (disability pension, widow/widower pension, etc). They also added the loss of the uncollected income tax due to deaths in the productive age. Their result was in opposition to all of the above-reviewed studies: they concluded that smokers cause higher costs than benefits for state budget. However, we think that they committed a serious computational error in the widow and widower pensions paid caused by smoking. After correcting for that, the overall result of the analysis would be the opposite. We will describe this more in the subchapter about the computation of the impact of smoking on paid widow and widower pensions in 2009.

Based on the literature discussed above and our evaluation, we consider the following structure of costs and benefits:

Table 3.1: Costs and Benefits Considered

COSTS:	BENEFITS:
Smoking-related health care	Excise tax
Sickness benefits	Retirement pensions
Disability pensions	Healthcare savings
Widow and widower pensions	Excess corporate tax
Fires	

[65] We have to mention why we think the Arthur D. Little study (2000) may be biased. Arthur D. Little conducted the analysis for Philip Morris CR a.s., the biggest Czech cigarette supplier, so there may have been an incentive for the consultancy company to get a result that would be favourable to its client.

[66] This result was assumed by many as "controversial", hence study gained the international recognition as it was discussed by BBC, Daily Telegraph, Guardian, New York Times and so on (Bates, 2001).

Except for excise tax benefit, excess corporate tax benefit and costs of fires caused by smoking, all the costs and benefits will be evaluated based on smoking-attributable mortality evaluated above.

The benefit of health care costs savings (caused by earlier deaths of smokers) and the cost of smoking-related health care have major impact on budgets of the health insurance companies. For simplification, we will assume that these budgets are fully interconnected with the state budget. Under such assumption, the factors having impact on health insurance companies' budgets have the same impact on the state budget. We are aware that in the Czech Republic, there is some interconnection but definitely not the full one in the reality.

Before analysing these concrete costs and benefits factors, we will briefly discuss the impact of smoking on the Czech labour market. If we conclude that the cigarette market generates a significant amount of employment, this may be regarded as another benefit for state budget. This analysis was not included in any of the previous studies.

3.1 Employment in the Tobacco Industry

Van Liemt (2002, p.25) stated that "*over a million people are employed in the world tobacco industry*.[67]" During the 1990s, employment in the tobacco industry went down in 15 out of 16 measured countries[68]. This serves as empirical proof of a general idea that the tobacco industry has been improving its production procedures, therefore needing less and less labour. The next reason for the downward employment trend is privatization and trade liberalization. In many countries, tobacco companies were state-owned, resulting in high staffing levels and low productivity. When these companies are privatized, the number of employees usually goes down. We agree with van Liemt (2002, p.30) that *"the prospects for further employment growth in the tobacco processing industry look dim"*.

Warner & Fulton (1994) simulated the effects of a situation in the US state of Michigan in which the tobacco products would be eliminated. The spending on tobacco would be redistributed to other goods and services. They found that there would be a rapid increase in employment opportunities.

Warner et al (1996) simulated the same situation on a sample of the US as a whole. They concluded that the elimination of tobacco expenditures at the beginning of 1993 would neither

[67] Most of the workers are employed in China, India, and Indonesia. The author also noted a wide productivity gap between China and the US: the US produced three times more cigarettes per worker.

[68] The only exception was Poland, where the tobacco industry employed 11,000 people in 1990 and 12,400 in 1997.

increase nor decrease the number of jobs at the end of the year. However, by the end of 2000, the number of jobs would grow by 133,000.

A similar simulation has not been run on the Czech market. However, we show that the impact on the Czech labour market of absolute smoking cessation would be negligible.

3.1.1 Employment in the Tobacco Industry – Czech Republic

The Czech Republic is a net importer of raw tobacco. According to van Liemt (2002), there were 1000 workers employed in the tobacco industry in the Czech Republic in the 1990s[69]. We analyze what would happen on the Czech labour market if there had been zero Czech demand for cigarettes in 2009[70].

The sole cigarette producer in the Czech Republic is Philip Morris CR a.s. (PM). Headquartered in Prague, PM has a key manufacturing plant in Kutna Hora and a smaller one in Strážnice. In 2009, PM had 1197 employees in total. These employees produced cigarettes for the Czech market, and for export to other countries as well.

The company does not provide the number of employees specifically producing cigarettes for the Czech market, so this figure must be estimated. The volumes of shipments to the Czech market as well as for export are available. The Czech Republic (10.9 billion units) accounts for 38% of PM's total production (28.6 billion units). The number of employees producing cigarettes for the Czech market may thus be 1197 * 0.38 = 455 employees (assuming linear relationship).

The Czech market annual size was 21.7 billion cigarettes in the 2009. By comparing the production of PM CR and the size of the Czech market, we see that the Czech Republic is a net exporter of cigarettes.

Other companies providing cigarettes for the Czech market – Imperial Tobacco, British American Tobacco, Japan Tobacco International, and Von Eicken/TDR – are each registered in the Czech Republic as a Limited Liability Company (s.r.o.). This means that they are not obliged to publish information about their situation, so we were not able to collect the data about the number of people employed in the Czech Republic. Since they actually just import and distribute the goods, we assume the number of people employed by these companies in the Czech Republic is negligible. We may state that Czech cigarette consumption generates employment in some foreign countries where the factories of these companies are located.

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[69] Just for comparison: the figure for Slovakia was 1,000; 12,000 for Germany; and 1,200 for Austria.

[70] All the numerical data in this paragraph are derived from the Philip Morris Annual Reports and the survey by AC Nielsen that is quoted in this report. All figures depicted the situation in 2009.

However, we do not consider this fact in our analysis because we are interested in only the Czech labour market.

We conclude that any possible influence of decreased demand for cigarettes in the Czech Republic (caused by changes in taxation) on employment is negligible[71] as the Czech employment opportunities created by the cigarette market are just in terms of hundreds. In the short term, a few hundred Czech positions would be closed. But the money that consumers would spend on something other than tobacco would create new jobs, however, not necessarily in the Czech Republic. In the long term, the effect may even be positive, such as the effect computed in the US market simulations.

Based on this brief analysis, we conclude that the effect of smoking cigarettes on Czech employment may be omitted due to its very small size.

3.2 Costs

3.2.1 Cost of Fires Caused by Smoking

"Reducing smoking can substantially reduce fire and disaster tolls"

Leistikow (2000, p.1)

In the chapter about the history of smoking and its regulation, we mentioned that the first attempts to regulate smoking in lands of the current Czech Republic in the medieval ages were made due to many fires that were initiated by smoking. Now, we try to estimate the current impact of smoking on fires and its cost.

Worldwide, Leistikow et al (2000) concluded that smoking caused US and global fire costs of 6.95 and 27.2 billion USD, respectively. Leistikow also stated that smoking is the cause of 30% of US and 10% of global fire deaths[72]. We consider that the data available in the Leistikow study for the US cannot be extrapolated and applied to the Czech Republic because there are too many differences between the Czech Republic and the US[73]. A Surgeon General's Report (2004) on the US data mentioned smoking as one of the factors contributing to residential fires. In the majority of analyses of the total costs of smoking, the factor of fires

[71] Basically, the only two countries whose labour market is significantly dependent on the production and export of tobacco are Malawi and Zimbabwe, where tobacco constitutes 61% and 23%, respectively, of the total profit from export (Habrová & Hrubá, 2007).

[72] One of the biggest disasters ever most probably caused by smoking was the fire in the Mont Blanc Tunnel in 1999, with 39 deaths and economic losses worth almost 1 billion USD

[73] Firefighters are organized differently, the climates are different, the costs of fires are calculated differently (because of different price levels), etc.

caused by smoking is not included. This leads to the conclusion that this factor is regarded as irrelevant.

Nevertheless, because of the very high number of cigarettes smoked per head in the Czech Republic, we find it important to determine whether the costs of fires caused by smoking (mainly by carelessly discarded stubs) is a significant figure in the evaluation of total costs of smoking. A study by Arthur D. Little (2000) included fire-induced costs as a factor in the analysis of the Czech Republic. We compare these results with our own at the end of the chapter.

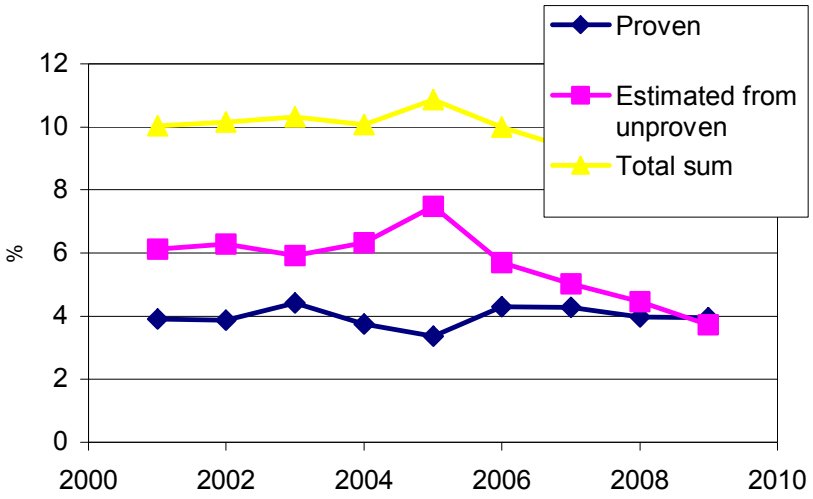
The Fire Rescue Service of the Czech Republic is quite centralised, and was therefore able to provide various structured time-series data about fires at the national level for the last ten years in their statistical yearbooks 2001-2009. They evaluate the direct costs of fires that were demonstrably caused by smoking. Other figures needed for our evaluation are not presented in the statistics. We interviewed two top representatives of the Fire Rescue Service: Captain Radek Kislinger, official spokesperson of the General Directorate of Fire Rescue Service of the Czech Republic, and Commander Jiří Hošek, directing investigator of the causes of fires in the Prague region (12/2010 and 1/2011). We asked for their qualified estimations of the missing figures needed for evaluation.

Approximately 4% of all fires were proved to be directly caused by smoking, with direct damage amounting to about 40 million CZK per year. The impact of smoking on healthcare expenses is estimated to be in billions of CZK. We could conclude that researching the costs of fires caused by smoking is not necessary because it is not relevant.

However, many fires (about 7%) in the Czech Republic are not classified with any official reason for the fire, because it was not possible to determine the cause. These fires are responsible for about 20% of the direct damage caused by fires in the Czech Republic. Based on our interviewees' estimations, about 80% of these fires were caused by smoking. If this is so, it dramatically increases the damage caused by smoking, hence serving as a motivation for deeper analysis.

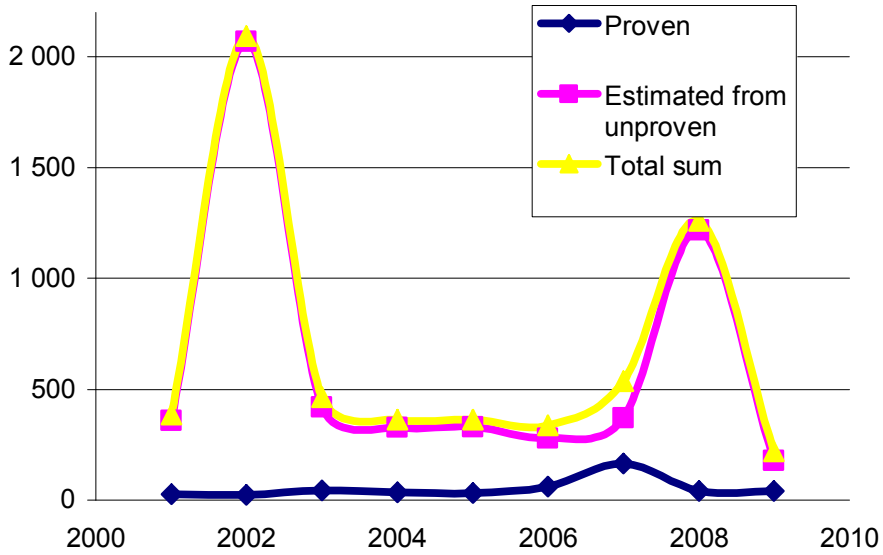
The chart 3.1 shows the annual percentage of all fires caused by smoking. It has been declining over recent years.

Chart 3.1: Estimated Percentage of All Fires Caused by Smoking



The cost of the direct damage of fires that were caused by smoking is of greater importance. The chart 3.2 shows that the level of these damages has been fluctuating widely, peaking at 2 billion CZK in 2002, and plummeting in 2009 to 218 millions CZK, the lowest value over the last decade.

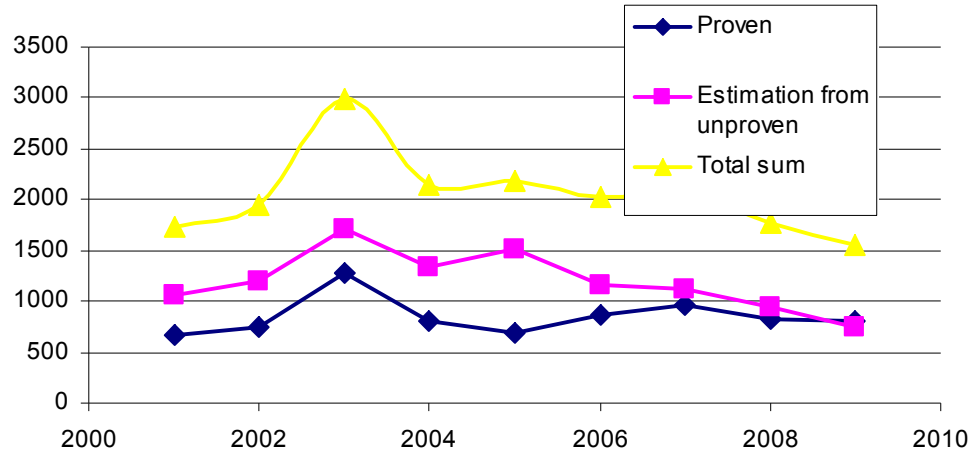
Chart 3.2: Estimated Costs of Direct Damage from Fires Caused by Smoking [millions CZK]



These figures only cover damages to property and land caused by fire. They may already be relevant to our analysis. However, we also have to add the indirect costs, particularly the cost of firefighters' work and the depreciation of their equipment when extinguishing the fire.

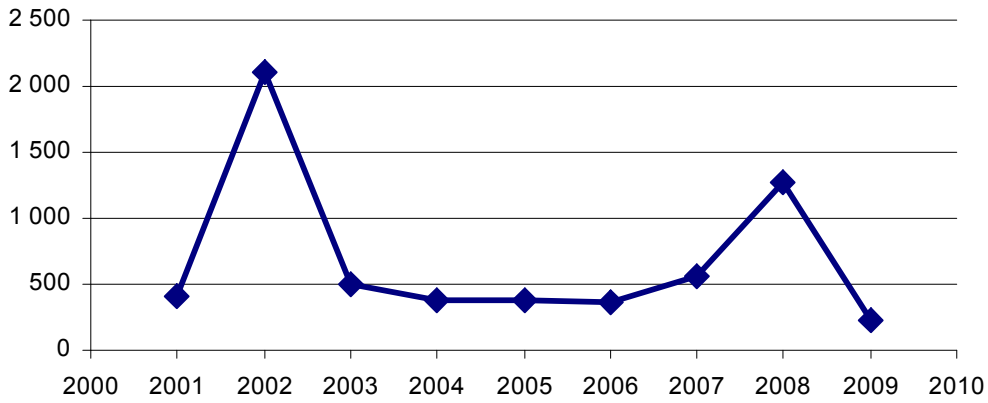
These costs are very difficult to evaluate for a single fire. They are determined by the number of firefighters needed, the equipment used, the size, type, and location of the fire, and so on. According to Captain Kislinger, the indirect costs associated with one event can be averaged to 10,000 CZK. The chart 3.3 depicts the expected number of fires caused by smoking.

Chart 3.3: Estimated Number of Fires Caused by Smoking



Multiplying the number of fires caused by smoking by 10,000 CZK and adding this to the evaluated direct damages of smoking, we get results depicted in chart 3.4:

Chart 3.4: Direct and Indirect Costs (in millions CZK) of Fires Caused by Smoking



Therefore, after adding the direct and indirect costs of fires as shown on the chart, the total figure for 2009 is 234 million CZK. The cost for 2009 was a marked exception, as the figure had been a great deal higher in previous years.

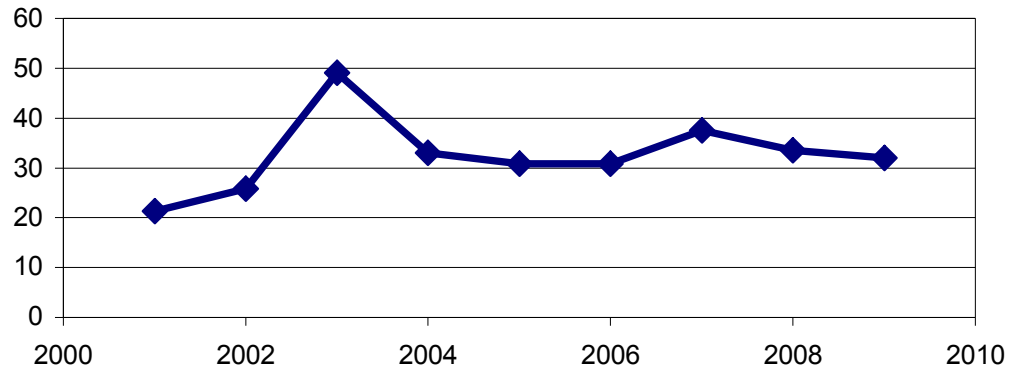
At this point, we should emphasize that there is an additional source of indirect costs that has to be added. The number of fires without any direct costs is also covered in the Czech fire brigade statistics. This includes fires that burn only grass and fires in landfills. However, these

fires still have indirect costs in the form of the work of firefighters who have to go to the fire site and check it. The cost of such an event may be evaluated as 5,000 CZK[74].

Captain Kislinger estimated that 55% of the non-damaging fires were caused by smoking; Commander Jiří Hošek estimated the figure at 65%. These figures were obtained independently, because the interviews were separate. The final estimate was established as an arithmetic average.

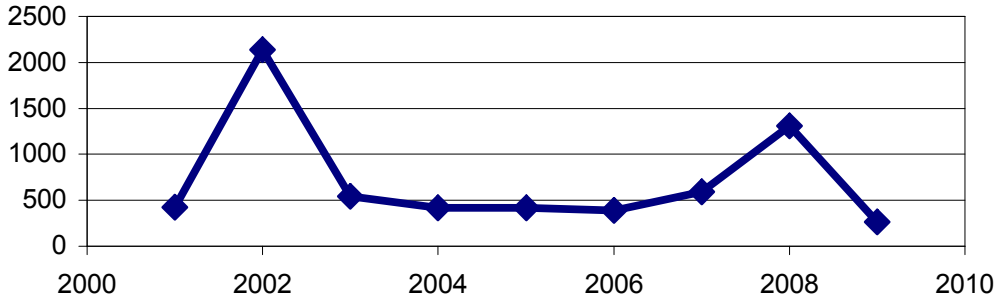
If we estimate that 60% of these fires were caused by smoking, multiplying this estimation by 5,000 CZK reveals the additional indirect costs caused by non-damaging fires, depicted in chart 3.5:

Chart 3.5: Indirect Costs of Non-Damaging Fires Caused by Smoking [millions CZK]



If we add this estimation to the sum of direct and indirect costs of damaging fires, we finally obtain the total costs depicted in the chart 3.6:

Chart 3.6: Total Costs [millions CZK]



[74] If an individual in the Czech Republic calls the fire brigade without cause, that individual has to pay the cost of their work. Every Czech region (kraj) charges a different price, but it is approximately 5,000 CZK. We can thus estimate that the cost for calling firefighters without reason is equal to the cost of verifying a non-damaging fire, because it requires a similar amount of time.

For the 2001-2009 period, the final evaluation is around 0.5 billion CZK, with two outliers far above (2002 – costs 2.1 billion and 2008 – 1.3 billion). In 2009, the total costs were 266 million CZK. There are additional costs not included in the analysis. We omitted the administrative and operational costs of fire brigades, including only the costs of reaching the location and extinguishing the fire, and equipment amortisation. Furthermore, we omitted the treatment costs for any people injured during these fires. We did not add deaths caused by smoking-associated fires. Leistikow et al. (2000) concluded that this factor is a major component when calculating fire costs. We did not add legal and administrative costs or the costs due to lost productivity of the injured.

One of the main causes of fires, besides smoking, is children playing with matches and lighters. In 2009 in the Czech Republic, based on the Fire Rescue statistics, this resulted in direct costs of 35 million CZK. It is a reasonable assumption that matches and lighters are more likely to be found in a smoker's home than in a non-smoker's home, so smoking indirectly contributes to the fires caused by children. Both interviewees said that it was not possible to evaluate the percentage of fires caused by children that may be associated with parental smoking. Therefore, this factor is not added to the analysis. Generally, based on the list of mentioned factors that were omitted, the final evaluation is probably lower than an evaluation that considered all factors together.

The methodology compares to that of the study by Arthur D. Little (2000). Arthur D. Little's analysis begins with the costs of fires caused by smoking. Then it continues in the same procedure we followed, considering the percentage of fires without an assigned cause attributable to smoking. Little estimated that figure by *"taking share of costs of unassigned cases based on same incidence ratio of smoking related fires among all assigned cases of fires"*. However, this approach is not the most efficient, as the interviewees informed us. Most fires without assigned cause were initiated by smoking. Based on Radek Kislinger, proving that the cause of a fire was smoking is very difficult in comparison to proving other reasons. Furthermore, Arthur D. Little did not add any indirect costs caused by fires. Therefore, we conclude that the result of the study stating that *"the fire costs attributable to smoking range from 28 mil. CZK to 70 mil. CZK"* is still very conservative. This is in compliance with many domestic as well as international complaints about the report, leading to the apology from Philip Morris admitting the inaccuracy of the report.

3.2.2 Loss Induced by Paid Sickness Benefits Caused by Smoking

Raynauld & Vidal (1992) argue that the time lost on the job due to smoking as well as the absenteeism without loss of pay are negligible, because *"in a majority of cases, the alleged external cost is very much a private cost; people are not paid when they do not work or they lose either money or leisure from taking 'sick days', which are interchangeable with additional wages or days off."*

Raynauld & Vidal (1992) convey one very logical statement that we agree with: *"if smoking had been significantly related to costs for the employer, or to productivity, then smokers' wage rates would certainly have reflected it"*. The authors cited the research by Bonilla (1989) stating that in a sample of 33,032 individuals, no significant effect of smoking on absenteeism had been found. A similar conclusion was derived by Leigh (1991). He used a smoking dummy as one of many variables describing work absenteeism. He emphasised that he sorted smokers and non-smokers without further division of smokers according to how much they smoked or what they smoked. Therefore, his results may not be correct.

On the other hand, Beemsterboer et al (2009) conducted a vast literature review about the topic and concluded that smoking leads to higher frequency and duration of absenteeism. However, these statements were not quantified.

The highest estimate found was made by MacKenzie (1994) – *"Cigarette smokers are absent from work approximately 6.5 days more per year than non-smokers."* Baliunas et al (2007) estimated that in Canada in 2002, 10.3% of acute care hospital days were attributable to smoking.

According to Neubauer et al (2006), the mortality rate often serves as a proxy for the morbidity rate. We will assume that this simplification is valid. The rate for Germany in 1993 was 13%, and 13.4% in 2003. In the Czech Republic, we calculated that the mortality rate, and hence the morbidity rate, was approximately 20.3% in 2009. Habrová & Hrubá (2007) estimated the morbidity rate for 2003 to be 15%. In most cases, the estimates of the morbidity rate may be treated as conservative, because the study covers just the most serious illnesses. Chaloupka & Warner (2000) state that less serious or less common illnesses caused by smoking, or illnesses where the link with smoking has not been established, are usually not covered by analysis.

Jan Škorpík stated that 18,215 million CZK were paid in sickness benefits in 2009. Multiplying that figure with the evaluated morbidity rate, we compute that the sickness benefits paid that were caused by smoking-attributable morbidity amounted to 3,698 million CZK.

3.2.3 Healthcare Costs Incurred by Smoking

The organisation, structure, and financing of healthcare systems differ widely among countries. Therefore, there is not a general standardized procedure for estimating the healthcare costs incurred by smoking. Hence, a country-specific approach must be used. Following the approach taken by Sovinová (2007), we divide the costs of health care into three subgroups: hospital care, ambulatory care, and medicine.

There have been four studies estimating the healthcare costs incurred by smoking in the Czech Republic. Two studies analysing the data for 1999 were published, by Sadílek (2001)[75] and Arthur D. Little (2000). Sovinová et al (2007) computed the healthcare costs incurred by smoking for 2002. Furthermore, there was a study by Habrová & Hrubá (2007) analyzing the 2003 costs. The study by Sadílek is not generally available. The same holds for the study by Sovinová (2007). We interviewed the authors and they provided us with their studies. The table below summarises their results:

Table 3.2: Estimations of Healthcare Costs Incurred by Smoking, Czech Republic

Author	Analysed year	Estimate [in millions, CZK]
Sadílek	1999	22,989
Arthur D. Little	1999	11,422
Sovinová et al	2002	11,277
Habrová & Hrubá	2003	18,148

There is great disparity among the estimates. The estimates of Sadílek and Arthur D. Little differ so much when they both analysed the same year Because Arthur D. Little used different SAFs. Sadílek stated that his SAF values were derived from expert opinion. He added that if there was ambiguity concerning which SAF rate to use, he always used the lower one. Sadílek provided the cost breakdown for every disease for which a fraction of the prevalence is attributable to smoking. Arthur D. Little did not provide a cost breakdown by specific diseases, but provided the aggregated costs for four main disease categories: neoplasms, cardiovascular diseases, respiratory diseases, and infant diseases. The results of Arthur D. Little and Sadílek are compared in the table 3.3:

[75] Sadílek's estimate covers the costs of hospital care only.

Table 3.3: Healthcare Costs, Breakdown [millions CZK]

Type of disease	Sadílek	Arthur D. Little	Difference
Neoplasm	2,350	1,060	1 : 2.22
Ischemic heart disease	13,650	5,030	1 : 2.71
Respiratory diseases	5,480	2,430	1 : 2.26
Infant diseases (before 1 year of age)	1,510	80	1 : 18.88

The most apparent difference is in the costs attributable to smoking in infant diseases. Here the Arthur D. Little study estimated just 5% of the value estimated by Sadílek. One of the reasons for such big differences between the two studies could be that based on Ross (2004), Arthur D. Little made its estimates for VZP clients only, so the expenses of other health insurance companies were neglected.

Sadílek used information published by VZP[76] about the costs of treating specific illnesses (covering both hospitalization and medication). Then, he derived the smoking-attributable fractions in applicable diseases[77]. By multiplying SAF by the total costs of a specific illness, and combining all illnesses with the allocated SAF, he derived an estimate for the VZP data. Then, he multiplied the number by 1.25 to reflect the whole population, because he considered that in 1999, VZP served about 75-80% of the population.

Sadílek made a slight error. According to the VZP 2000 Annual Report, the health insurance company served 73.6% of the Czech population. Therefore, the VZP costs computed by Sadílek should be multiplied by 1.359 in order to accurately reflect the whole population. Based on this argument, the costs for 1999 were 24,994 million CZK. We have to emphasize that the outpatient treatments due to smoking were not included. Therefore, the real number would have been even higher. Habrová & Hrubá got 18,148 CZK for 2003, but their estimation was based on very simple assumptions.

The studies by Sadílek and Arthur D. Little stated that they used the data from the VZP Annual Report for the annual total costs of treatment of specific diseases. VZP does not publish these specific data any more. It did not responded to our request for these data. We also asked the author of the latest study, Daniela Habrová, for a brief description of the methodology used in her estimation of the total treatment costs, but she did not respond to our request.

[76] the largest health insurance company in the Czech Republic

[77] Sadílek does not provide the source for the SAFs used in his study. We do not know if he used information from a foreign study or if he made specific adjustments for the Czech population.

The study by Sovinová et al (2007) is the most advanced in comparison to other mentioned local studies. It uses the same SAFs as we did in Chapter 2. As with the study by Sadílek, we were able to obtain Sovinová's unpublished data about the costs of VZP spent on treatment of specific diseases. After evaluating the VZP costs attributable to smoking, they were aggregated for the whole population. The results are provided in the table 3.4:

Table 3.4: Healthcare Costs Attributable to Smoking [millions CZK], Czech Republic 2002

	Costs
Hospital Care	6,145
Ambulatory Care	2,181
Medicals	2,951
Total	11,277

Source: Sovinová (2007)

The total healthcare expenses that year (2002) were 154,066 million CZK. We computed that smoking-attributable expenses were 7.3% of the total health care expenses[78]. The percentage of the ambulatory care to the hospital care and medicals attributable to smoking was 24%. Neubauer et al (2006) analysed 2003 data for Germany, stating that the ambulatory care cost 1,769 million EUR; hospital care (covering rehabilitation) and prescribed drugs cost 5,711 million EUR. So the percentage was 31%. His result was roughly similar to the one of Sovinová. Assuming that the health care in the Czech Republic has a similar structure to that of Germany, we may take that as empirical evidence that the Sovinová's result is correct.

The ratio of smoking-attributable costs of ambulatory care to hospital care was revealed by Sovinová to be 35%. Zhang et al (1993) estimated that in the US the ratio was 49%. Yang et al (2005) estimated the ratio in Taiwan at 79% based on the 2001 data. We are unsure if we can derive an accurate ratio for the Czech Republic from these studies. The dispersion when comparing countries from different continents could be due to different health care systems.

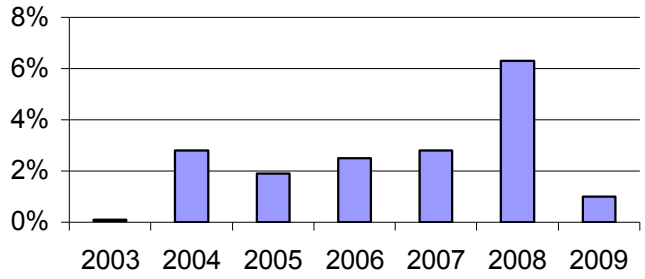
As stated, the study by Sovinová is the most comprehensive. We were unable to obtain data from VZP about the costs of treatment according to illnesses. Therefore, we use Sovinová's results to obtain an estimate of the total healthcare costs for the Czech public state budget in 2009. We see two fundamental potential approaches. We can assume that the real costs of treatment attributable to smoking are the same. In this case, we would adjust Sovinová's results to inflation to get the value for 2009. Or, we may assume that the share of smoking-

[78] By total healthcare expenses, we mean the estimated total expenses of the health insurance companies.

attributable expenses from the total expenses is the same. Therefore, we would take the same share from the 2009 total expenses. We computed the results using both approaches.

For the first approach, we measure inflation according to the Consumer Price Index changes. The average annual rate of inflation for 2000-2009 is presented in the chart 3.7:

Chart 3.7: Annual Inflation, Czech Republic, 2003-2009



Source: CZSO (2011)

We obtain a nominal estimate for 2009 using the following formula:

$$E_{2009} = E_{2002} \prod_{k=2003}^{2009} (1 + i_k)$$

E_{2009} - the estimate for 2009

E_{2002} - the estimate from Sovinová's study

i_k - the average annual inflation rate in a year

According to this computation, the total healthcare costs incurred by smoking in 2009 would be 13,578 million CZK.

The second approach requires the amount of total healthcare expenses paid by the health insurance companies. In 2009, based on the VZP Annual Report, the total healthcare expenses were 133,788 million CZK. VZP covered 60.3% of Czech policyholders[79]. Therefore, we may assume that the total healthcare expenses of all health insurance companies in the Czech Republic were 221,871 million CZK. Multiplying that by the percentage of the smoking-attributable expenses derived by Sovinová (7.3%) provides the result of the second estimation approach: 16,197 million CZK.

The results of the two approaches differ; the second estimate is 19.3% more than the first. After consideration, we selected the second estimate as more accurate as we assume that the costs to health care system attributable to smoking may change widely with the changes of the

[79] By the end of 2009, VZP served 6,262,809 policyholders; the size of the market was 10,381,397.

health care system itself, whereas the ratio of the total healthcare expenses attributable to smoking should stay almost constant even with changes of the health care system.

3.2.3.1 Second-hand Smoking

There is not much literature on the impact of second-hand smoking on healthcare costs. Collins & Lapsley (1992) as well as Doran & Sanson-Fisher (1996) roughly estimated that second-hand smoke causes 10% of direct smoking costs.

One recent comprehensive study was conducted by Behan et al (2005). The authors predicted the yearly US healthcare costs attributable to second-hand smoke to be 4,982 million USD, while the CDC (2008)[80] stated that the healthcare costs attributable to direct smoking were 96,000 million USD. Based on this information, we see that the ratio of second-hand smoking healthcare expenditures to direct smoking healthcare expenditures was 1:19. We would assume the same ratio holds in the Czech Republic. Therefore, the total healthcare cost of second-hand smoking in 2009 was 842 million CZK.

Combining the healthcare costs of direct and second-hand smoking, we obtained the sum result of 17,039 million CZK.

3.2.4 Other, Unquantified Costs

Costs of Cleaning

Smoking opponents often argue that cleaning up cigarette litter is costly. On the other hand, it may be said that streets and sidewalks have to be cleaned anyway, as cigarettes are not the only litter. Furthermore, the cleaning of sidewalks near private houses is the obligation of the house owners; it is therefore not an expense for the state. There is not a single study quantifying the additional cleaning costs incurred by smoking.

Transport Accidents Caused by Smoking

A driver who is smoking has one hand occupied with a cigarette; this has a negative impact on the driver's responsiveness. On the other hand, it may be argued that nicotine consumption results in higher concentration. In many countries, smoking while driving is prohibited. In the Czech Republic, this restriction holds for drivers of public transportation only. Based on a study conducted by the US Department of Transportation (2006), both lighting and smoking a cigarette have a negligible effect on car accidents. The AAA Foundation for Traffic Safety

[80] Available online at http://www.cdc.gov/tobacco/data_statistics/fact_sheets/fast_facts/index.htm, viewed 31.1.2011

(2001) concluded that smoking accounted for 0.9% of tow-away crashes during the 1995-1999 period[81]. As the consumption of cigarettes per head is higher in the Czech Republic, we may assume that the percentage of car accidents attributable to smoking would be higher. However, if such accidents occur, the cost is borne by the driver responsible for the accident and/or the insurance company. The costs to the state budget are rather indirect in terms of the expenses for police and/or fire-fighters dealing with the accident, as well as losses caused by lower productivity of people due to possible traffic delays initiated by the accident. There is no method for precisely measuring these factors.

For sake of completeness, we would like to state that based on the information provided to us by the director of the Rolling Stocks Department of Czech Railways, train drivers are allowed to smoke in their driving cabins. Again, we are not able to state what ratio of train accidents may be associated with the smoking of a driver.

Furthermore, we learned from interviews with pilots for Czech Airlines, the major operator of domestic flights, that pilots are technically not prohibited from smoking in their cabins[82]. No Czech Airlines plane has been involved in any major domestic flight accident.

Anti-Smoking Campaigns

We do not know the size of the financial burden on the Czech state incurred by initiating and running anti-smoking campaigns. The cost is in a form of subsidies to various organisations helping smokers to quit. Some European countries run big campaigns against smoking, such as Scotland's campaign launched in 1992. By 1997, it had cost the government 1.4 million pounds (Ratcliffe et al, 1997). We may use such information about the costs of similar campaigns in foreign countries to evaluate the costs of campaigns against smoking in the Czech Republic. However, there was not any particular big campaign run by the Czech government against smoking in 2009.

Emotional Losses

Generally, death creates strong emotions in surviving relatives. These feelings may manifest in days missed from work and lower productivity. There is no method for quantifying these losses in the literature so far.

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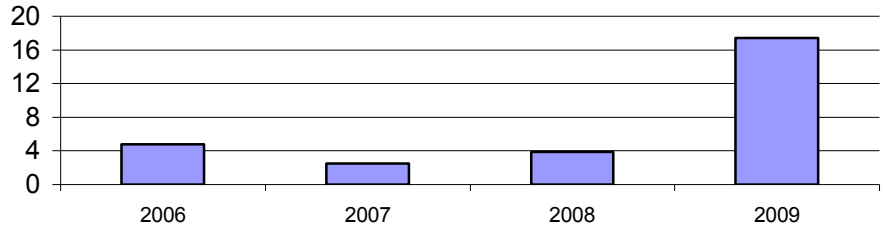
[81] It varies widely over the years: the percentage was 1.6, 0.5, 1.6, 0.01 and 1.2 for specific years in the period 1995-1999. In a breakdown by age, 1.1% of accidents attributable to smoking appeared among drivers ages 20-29, while 0% were at age 65+. Concerning the breakdown by sex, there is no difference as the amount is 0.9% for both sexes.

[82] There is usually no smoke detector.

Income Tax, Social Insurance, Health Insurance Losses

Habrová & Hrubá (2007) assumed that if a person dies at a productive age, that person's employment will virtually disappear. Hence, the state would not get funds from the income tax of the person. However, we find it more reasonable to assume that if a person dies, that person is immediately replaced by another who was previous unemployed. This may be true especially for 2009, as there were on average more than sixteen unemployed people per one job offering, so we may consider that any newly available positions were quickly filled.

Chart 3.8: Number of Unemployed per One Job Offering, Czech Republic



Source: CZSO

Assuming that both persons get the same salary for the work, there is no loss in income tax for the state when somebody dies at productive age because of smoking. Under this assumption, the government would even save some money because there would be fewer unemployed people, hence less unemployment wages would be paid from the state budget. We are aware of the limitations of our assumptions. Both our approach and that of Habrová & Hrubá (2007) are extreme. However, we consider that our assumptions are closer to reality. The very same logic applies for the obligatory payments of social and health insurance from the salary.
The fruitful extension of the thesis might be the estimation of the length of the procedure of searching for new employee when the present one died and then compute the losses for a state budget caused by these gaps.

Lower Productivity

Ross (2004, p.185) states that *"The internal costs borne by private employers result from lower productivity among smoking employees, since they spend a certain percentage of their working hours pursuing their habit. In addition, smokers have more sick days, which represent additional losses to a company."* We do not consider that smoking employees

spend significantly less hours working because of pauses for a cigarette in comparison to their non-smoking colleague. On the other hand, we think there is a loss for a company in terms of a smoking employee's lower productivity due to absenteeism from work caused by higher morbidity. Unfortunately, we do not see any way to accurately estimate this factor, so we omitted this from our analysis.

3.3 Benefits

3.3.1 Pensions

Based on the information we received from Jan Škorpík, the head of the actuarial department of the Czech Ministry of Labour and Social Affairs, the breakdown of expenses on various kinds of pensions in 2009 is presented in the table 3.5:

Table 3.5: Social Security Expenses, 2009 [thousands CZK]

Pension	2009
Retirement	243,636,373
Full disability	44,379,732
Partial disability	16,608,816
Widow	21,576,411
Widower	2,249,225
Orphans	3,254,125

The Czech Social Security Administration is the biggest organisation of its kind (in terms of the amount of funds that the organisation operates with) among Czech state administrative organisations. It provides the distribution of all kinds of pensions. In the next subchapters, we will model the impact of early deaths attributable to smoking on the size of pensions paid by the state. The impact of smokers on the volume of paid retirement pensions would be computed based on the structure of deaths caused by smoking divided by age that we already evaluated. The disability pensions paid for smokers are based on the morbidity caused by smoking. Widow, widower, and orphan pensions attributable to smoking will be computed based on the mortality caused by smoking.

It is interesting to mention that smoking creates savings for the state on retirement pensions, but costs for disability, widow, widower, and orphans pensions. We strongly assume that the net effect on pensions (= whether the impact of smoking on pensions generates savings or losses for the state budget) would be positive because of the magnitude of saved retirement pensions caused by earlier deaths caused by smoking, hence we include pensions in the subchapter on benefits for the state budget.

3.3.1.1 Retirement Pensions

Based on the 2009 Annual Report of the Ministry of Labour and Social Affairs[83], the average monthly retirement pension was 11,536 CZK for men and 9,482 CZK for women. We assume that these figures represent the average monthly retirement pension for 2009. Therefore, the average annual retirement pension for 2009 was 138,432 CZK for men and 113,784 for women.

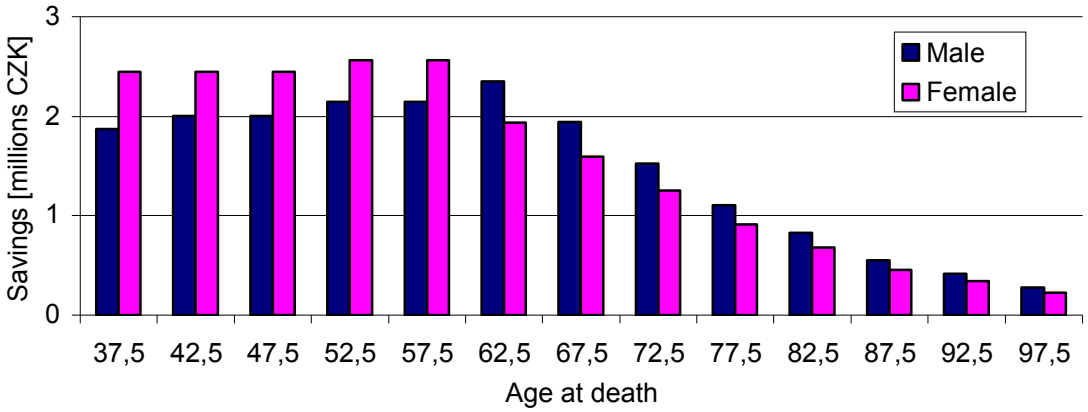
Based on the Eurostat database[84], the average pension age in 2009 in the Czech Republic was 60 years for women and 62 years for men. In our computation, we assume that the smokers who die early would otherwise reach pension at the average age and would receive the average retirement pensions.

We will use the data on smoker mortality that we derived in a previous chapter. Smokers dying before 60 (women) or 62 (men) years lose their retirement pension fully. For example, a female smoker dying at the age of 35-39 loses a retirement pension of 2,446,356 CZK (computation described below).

We assume she died at the age of 37.5. The female life expectancy for age 37 is 44 years, hence we assume that she would have lived to 81.5 years. Subtracting the average pension age, she would receive the retirement pension for 21.5 years. Multiplying that by the annual average retirement pension, we get 2,446,356 CZK.

In the chart 3.9 we can see the state savings for a single death divided by sex and age at death.

Chart 3.9: Retirement Pensions State Savings Caused by Single Death, 2009



[83] Available online at http://www.mpsv.cz/files/clanky/9854/statisticka_rocenka_z_oblasti_prace_a_socialnich_veci_2009.pdf, viewed 15.2.2011

[84] Available online at http://apl.czso.cz/ode/tab/tsdde420.htm, viewed 10.2.2011

The reason the state saves on average more on a person dying at the age of 42 than on a person dying at the age of 37 is the different life expectancies. In 2009, the state saves the most on retirement pensions for an average man dying at the age of 62, or a woman dying at the age 52 or 57.

By multiplying the results for a single death with the number of deaths caused by smoking divided by sex and age at death (previously computed), we find that female deaths caused by smoking saved 7,710 million and male deaths 21,174 million. Combining these two figures, we conclude that deaths associated with smoking saved 28,884 million on retirement pensions.

3.3.1.1.1 Widow(er) Pensions

The payment of these pensions is based on the death of the partner. Habrová & Hrubá (2007) assumed that the widow and widower pensions paid because of smoking attributable deaths were 17,694 million CZK. They multiplied the estimated amount of pensions paid in 2003 with the smoking-attributable morbidity, which was expected to be 15%. Based on the information from Jan Škorpík, the amount of paid widow and widower pensions in 2003 was 18,830 million CZK. Multiplying that by the 15% morbidity expected by the authors is 2,825 million CZK. We think that the authors made a serious mistake (their result should be 2,825 million instead of 17,694 million CZK) [85].

In 2009, the government spent 23,825 million CZK on pensions. Multiplying that with our own 20.3% estimate of smoking-attributable deaths, we got a cost of 4,836 million CZK.

It may be argued that it is not possible to model the impact of widow and widower pensions caused by smoking. If a male smoker dies earlier, his partner gets a widow's pension if she is still alive (= this is a cost for the government). However, the early death of a smoker also means that he will not get the widower's pension that he might otherwise get (if his partner dies sooner) (=this means revenue for the government). We will leave such complicated scenarios aside.

There may be a possible impact on the orphan pensions[86]. We may assume that smokers dying at an age under 55 years leave children younger than 26, and thus create a cost for the

[85] The work containing this mistake was defended as a Ph.D. thesis and published in a local journal. Neither of the opponents found the mistake. According to the work, smokers incurred net costs of 14.6 billion CZK for the 2003 state budget. Adjusting the work for the mistake analysed above, the result would be the opposite: smokers generated net revenues for the budget amounting to 230 million CZK. We tried to verify this with Habrová, the main author, but she did not respond to our inquiry.

[86] Financial assistance provided to people before their 26th birthdays who lost one of their parents.

government. However, only 6% of all deaths due to smoking occur before age 55, and the orphan pensions make up just 1% of pensions, so we will not consider this in our analysis.

3.3.1.2 Disability Pensions

Based on the broad definition of the Czech Ministry of Labour and Social Affairs, a person is disabled if his working ability is diminished because of health or mental disability. There are three degrees of disability based on percentages describing the decline in working ability in comparison to a healthy person. The procedure for computing the impact of smoking on the amount of disability pensions paid by the state is unclear. Habrová & Hrubá (2007) computed it simply by multiplying the total amount of disability pensions paid by the state and the relative morbidity ratio attributable to smoking. We consider this approach to be inefficient.

In its Statistical Annual Report, the Czech Social Security Administration (CSSA) provides a breakdown of newly paid disability pensions for a given year for given ICD health classifications. It does not provide the breakdown for specific diseases. Knowing the figures for specific diseases would make it possible to precisely construct the amount of disability pensions paid due to smoking, as the morbidity rate caused by smoking for a group of diseases is already known.

We assume that the volume of newly paid disability pensions divided by health classification represent the overall distribution of disability pensions by health classification. The illnesses to which we computed SAF belong to the classifications I. (certain infectious and parasitic diseases) II. (neoplasms), IX. (diseases of the circulatory system), X.[87] (diseases of the respiratory system), XIV. (conditions originating in the prenatal period) and XVIII. (symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified).

We omit types I., XIV., and XVIII. from our analysis, because based on the SAF table used in a previous chapter the effect of smoking on the development of these classifications is negligible.

Now we compute the relative morbidity rate caused by smoking for each of these groups by dividing the number of deaths caused by smoking that we computed already and the total number of deaths (again assuming that mortality rate = morbidity rate) which is provided by the CZSO (2010a).

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[87] In the chapter on the computation of mortality caused by smoking, one of the diseases in the group of respiratory diseases was respiratory tuberculosis. However, by ICD 10 measures, this disease belongs to group I. Therefore, we will not consider this disease as a respiratory disease. Respiratory tuberculosis caused only a tiny number of deaths attributable to smoking, so its omission does not influence our analysis.

Table 3.6: Ratio of Deaths Attributable to Smoking for Selected Diagnoses, 2009

Diagnosis	Deaths – smoking	Deaths - total	Ratio
	Men		
II.Neoplasms	5,149	15,673	33%
IX. Cardiovascular diseases	7,314	24,051	30%
X. Respiratory diseases	1,577	3,505	45%
	Women		
II. Neoplasms	1,662	12,391	13%
IX. Cardiovascular diseases	5,356	30,049	18%
X. Respiratory diseases	940	2,888	33%

The number of people newly awarded full disability pensions in 2009 according to the Statistical Annual Report of the Czech Social Security Administration is presented in the table 3.7:

Table 3.7: Number of Newly Disabled

Full disability		
Diagnosis	Male	Female
II.	2,255	2,278
IX.	1,733	387
X.	306	119
All	12,461	8,531
Partial disability		
II.	805	1,459
IX.	1,865	653
X.	251	247
All	13,425	12,766

Multiplying the ratio of deaths attributable to smoking in a given diagnosis by the ratio of newly disabled people with a given diagnosis to the all newly disabled people, and then distributing the sum by sex and by diagnoses II., IX., and X, we find that 8.7% of new full disability is caused by smoking, and 5.1% of partial disability is caused by smoking. Again, we want to emphasize the assumption that the distribution of newly disabled people over the health classifications is the same as the distribution of all disabled people. Habrová & Hrubá (2007) take the 15% general morbidity rate as given. However, even if our computed general morbidity rate is far higher, the breakdown into the specific different health classifications provides far lower values for analysing the ratio of disability caused by smoking.

The expense paid by the state for full disability in 2009 was 44,380 million CZK. Multiplying that by 8.7%, we get 3,861 million CZK. The expense paid by the state for partial disability in

2009 was 16,609 million CZK. Multiplying that by 5.1%, we get 847 million CZK. The sum of both figures shows the burden for the state budget of disability pensions caused by smoking-attributable diseases is 4,708 million CZK.
Calculating the joint effect of smoking on all analysed pensions, there is a net benefit for the state budget amounting to 19,340 million CZK.

3.3.2 Healthcare Savings

In the Czech Republic, much health treatment is provided free of charge by one of the health insurance companies to which the citizen is assigned. There is a legal constraint that a citizen must be assigned to one and only one health insurance company. If a person dies earlier from smoking, the company gets an excess benefit in forms of savings from the health care that must otherwise be provided. VZP provides the average healthcare costs for a patient based on age and sex in its annual report. The information for 2009 is given in the table 3.8:

Table 3.8: Average Annual Costs for Health Care for 1 person in 2009 [CZK]

Age	Male	Female	Total
0-4	16,453	14,855	15,673
5-9	9,014	7,565	8,313
10-14	9,347	9,374	9,360
15-19	8,474	9,828	9,124
20-24	7,105	9,849	8,403
25-29	7,817	13,059	10,253
30-34	9,212	14,298	11,549
35-39	10,072	13,578	11,707
40-44	12,000	14,307	13,073
45-49	14,342	17,181	15,676
50-54	19,930	21,239	20,560
55-59	27,872	24,133	26,026
60-64	35,170	28,983	31,972
65-69	42,954	35,451	38,858
70-74	50,672	40,602	44,739
75-79	56,751	46,275	50,258
80-84	55,727	47,920	50,479
85+	54,711	50,806	51,840
Average	20,031	22,287	21,167

Source: VZP

Analysing the figures for males, we see that the costs generally fall with age till 20-24 years, and then increase with age. It is interesting to see the healthcare costs for men over 85 years are slightly lower than for their counterparts aged 80-84. We are not aware of anything to explain that fact. It might not be an anomaly, as according to the VZP 2007 and 2008 Annual

Reports, it occurred in these years as well. Figures for females are characterised by the same trend as males.

Using the number of deaths due to smoking that we already calculated, we can find the savings on health care due to those deaths. The computation can be done as follows (example):

The number of deaths of females aged 35-39 is 16. We assumed that the age at death for all of them is 37.5. The life expectancy at the age of 37 is another 44 years of life. One of these deaths thus results in the following savings for the healthcare system:

2.5*13,578+5*14,307+5*17,181+5*21,239+5*24,133+….+1.5*47,920

We run the same computation for every sex and age interval. We obtain the benefits presented in the table below:

Table 3.9: Healthcare Savings Due to Early Deaths Attributable to Smoking [thousands CZK]

Age at death	Males	Females
37.5	64,941	20,356
42.5	111,767	42,170
47.5	259,624	71,913
52.5	652,440	165,763
57.5	1,243,717	337,872
62.5	1,674,605	493,178
67.5	1,359,152	404,320
72.5	1,038,237	387,610
77.5	921,892	494,564
82.5	648,824	506,173
87.5	242,833	284,031
92.5	19,325	26,982
97.5	6,152	7,277
Sum	8,243,508	3,242,211

The total savings due to the early deaths of firsthand and second-hand smoking for 2009 were 11,486 million CZK. We are fully aware of the limitations of our approach. First, VZP covered just 60.3% of patients. We assume here that the sample of patients covered by VZP is representative for the whole population. However, according to Ladislav Csémy, this is inaccurate. Based on VZP annual report, the sample of VZP clients is not representative in terms of the age distribution or regional distribution. For example, in 2009, VZP covered 86% of men over 85 years old, and only 50% of the population under 5 years old. Concerning regional disparities, it covers 75% of the population in the Vysocina region and only 37% of the population in the Olomouc region.

As already stated, there are other health insurance companies operating in the Czech Republic. Some are aimed at specific population subgroups, such as the Health Insurance Company of the Ministry of Interior. These specific subgroups may be characterised by non-standard healthcare requirements. To the best of our knowledge, other health insurance companies do not provide information about the healthcare costs of their average policyholder.
We also assumed in our analysis that the real value of the average annual healthcare costs in the future would be the same.

3.3.3 Net Tax Revenues

The mechanism of tobacco taxation in the Czech Republic, as well as recent tax rate developments, was described already in the chapter about tobacco regulation. This subchapter is devoted to the evaluation of the revenues for the state budget from tobacco taxation.

Excise Tax

The table 3.10 depicts the revenues from the excise taxes on tobacco for 2005-2009:

Table 3.10: Government Revenues from Excise Taxes on Tobacco, Czech Republic

Year	Revenue [millions CZK]	Share of government revenue from excise taxes	Share of government revenue from all taxes	Share of total government revenue
2005	25,430	24.5%	5.5%	2.9%
2006	32,241	28.6%	6.9%	3.5%
2007	46,998	35.7%	8.8%	4.6%
2008	37,507	29.9%	6.9%	3.5%
2009	37,704	30.4%	6.9%	3.9%

Source: Customs Administration of the Czech Republic, Ministry of Finance of the Czech Republic

In nominal terms, the revenues grew nominally by 48% between 2005 and 2009[88]. This was due to the rapid growth of taxation, not to increased consumption, because the consumption between these two years actually decreased. The share of the excise tobacco taxes in the revenue from all taxes seems to be very stable at 6.9%. The simple arithmetic average share of the total government revenue throughout the 2005-2009 period was 3.7%.

[88] The Customs Administration of the Czech Republic assumed that the revenue from the excise tax on tobacco would be 50 billion CZK for 2009. We see that the actual revenue was 25% less than the estimate. Source: Presentation of the Customs Administration of the Czech Republic, available online [in Czech]: http://www.celnisprava.cz/cz/statistiky/Vsledky%20celnho%20a%20daovho%20zen/2009.pdf, viewed 1.1.2011

This percentage is far lower in the US: in 2008, it was just 0.7%[89]. This is due to a lower excise tax burden on cigarettes in the US. In Australia, we computed that the percentage in 2009 was 1.9% of the state budget revenues. Nearer to the Czech Republic, in Germany, the share of tobacco tax was 2.6% of all taxes[90] in 2009, whereas the share on the total state budget revenues was just 1.3%[91]. Based on the information provided by the Slovak Ministry of Finance, the percentage for Slovakia was 4.8%[92] in 2009.

Table 3.11: Percentage of the Total Government Revenue from Excise Tax on Tobacco, 2009[93]

Slovakia	4.8
Czech Republic	3.9
Australia	1.9
Germany	1.3
United States	0.7

Based on our own findings, we may assume that the Czech government relies more heavily on the revenues from the excise tax on tobacco than the Austria, Germany and United States and less than Slovakia.

There is no robust database on the breakdown of the total tax revenue by the different kinds of tobacco products (cigarettes, cigars, and other tobacco). The Customs Administration does not collect such data. However, as mentioned already, the percentage of the total expenses on tobacco that customers spend on cigarettes was 97.4%[94]. We do not know the average price of cigars and packaged tobacco that creates the residual 2.6%. However, the excise taxation and hence the state revenues for these products is really low in comparison with cigarettes. Therefore, we assume that the revenues from excise taxes on tobacco equal the revenues from

[89] Information about the tax revenue taken from the Urban Institute and the Brookings Institution, available online at http://www.taxpolicycenter.org/taxfacts/displayafact.cfm?Docid=403, viewed 1.1.2011. Information about the total government revenue taken from http://www.usgovernmentrevenue.com/yearrev2009_0.html#usgs302, viewed 1.1.2011

[90] Statistics on tax revenue 2007-2009, Federal Statistical Office available online at http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Content/Statistics/FinanzenSteuern/Steuern/Steueraufkommen/Tabellen/Content75/KassenmaessigeSteuereinnahmen.psml, viewed at 3.1.2011

[91] Development of Public Finance, Federal Statistical Office, available online at http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Navigation/Statistics/FinanzenSteuern/OeffentlicheHaushalte/OeffentlicheFinanzen.psml, viewed 3.1.2011

[92] The final report about the public finance budget for 2009 available online (in Slovak): http://www.finance.gov.sk/Components/CategoryDocuments/s_LoadDocument.aspx?categoryId=7803&documentId=5358, viewed 1.3.2011

[93] Data for the United States are from the year 2008

[94] Throughout the EU and the US, cigarettes accounted for over 90% of tobacco consumption (Cnossen, Smart, 2005)

excise taxes on cigarettes[95]. We may thus state that the revenue from the excise taxation for the state budget in 2009 was 37,704 million CZK.

Value Added Tax, Corporate Tax

Some authors include value added tax and corporate tax to the revenues from cigarettes (Habrová & Hrubá, 2007; Arthur D. Little, 2000). We do not agree with that approach. Our aim is to show the costs and revenues generated by tobacco consumption in comparison to no tobacco consumption. As already stated in the introduction of the third chapter, we assume if people did not spend their money on cigarettes, they would spend it on another good taxed at the same VAT rate[96]. We conclude that the revenues from value added tax will not be considered in our analysis.

Concerning the corporate tax, we have to consider if the tobacco industry generates higher profits than the average. In 2009, Philip Morris, the only cigarette producer in the Czech Republic, paid 676 million CZK in corporate taxes. In 2009, its total assets were worth 13,706 million CZK and its net profit was 2,506 million CZK. Therefore, the Return on Asset (ROA) percentage defined as the net profit divided by total asset was 18%. Based on the data provided by CZSO (2009) and our computations, the arithmetic average ROA in Czech industry in 2004-2007 was 7.09%[97]. We may presume the same rate for 2009. This leads to the conclusion that Philip Morris brings the state budget roughly 413 million CZK more than another firm of the same size (in terms of value of assets) with an average ROA. As a result, we can state that the government has corporate tax revenues of 413 million CZK more than if no cigarettes were produced[98] in the Czech Republic. Combining the revenues from the excise tax and the corporate tax, we conclude that the benefit of taxes for the state budget for 2009 was 38,117 million CZK.

Cost of Tax Collection

It should be mentioned that collecting taxes is costly. OECD (2008) estimated the ratio of the administrative costs of collecting taxes to the net tax revenue. The same ratio is also evaluated

[95] We have to keep in mind that under such an assumption, the state revenues from the cigarette excise tax is overvalued.

[96] In the Czech Republic, there are (as of 1.1.2011) two rates for value added taxation: a standard 20% and a lower 10%. The vast majority of goods are taxed at the standard rate; the lower rate is used mainly for food and medicine. Tobacco products are taxed under the standard rate.

[97] the information for the year 2008 and onward were not available

[98] Here we assume that once there is no cigarette consumption in the Czech Republic, there would be also no cigarette production

by the Customs Administration of the Czech Republic and presented in its annual report. The percentages for the Czech Republic for 2005-2009 (numbers for 2005-2007 are from the OECD, 2008-2009 from the Czech Customs Administration) are presented below:

Table 3.12: Aggregate Administrative Costs to Net Revenue Collections (in %)

2005	1.29
2006	1.38
2007	1.25
2008	1.30
2009	1.50

Except for 2007, the ratio grew every year for the 2005-2009 period. If we take the 2009 tax revenues – 38,117 million – and deduct the estimated costs of collecting the taxes in 2009, we get a net taxation revenue reaching 37,545 million CZK in 2009 (37,138 million CZK for excise tax plus 407 million CZK for excess corporate tax)

3.3.4 Other Potential Benefits

Common Agricultural Policy

The growing of tobacco in Europe was heavily subsidised by the Common Agricultural Policy (Antonanzas & Rodriguez, 2007). The authors stated that the EU subsidies for tobacco production would cease by 2010. While analysing the database of all subsidies to the Czech Republic from the Common Agricultural Policy[99], we concluded that no financial funds for tobacco production were received in the Czech Republic in 2009. Hence we may state that the Czech Republic did not have any benefit from that policy as there was no individual recipient.

The table 3.13 below summarises the evaluated costs and benefits for the Czech state budget in 2009 caused by smoking:

Table 3.13: Costs and Benefits for the State Budget Caused by Smoking in 2009, [millions CZK]

COSTS		**BENEFITS**	
Health care	17,039	Excise tax	37,138
Widow(er) pensions	4,836	Retirement pensions	28,884
Disability pensions	4,708	Health care	11,486
Sickness benefits	3,698	Excess corporate tax	407
Fires	266		
Total	***30,547***		***77,915***

[99] Available online at http://www.farmsubsidy.org/CZ/, viewed 19.1.2011

Based on our analysis, smoking generated a net benefit of 47,368 million CZK for the state budget in 2009.

4 Transmission of Tax Change to Retail Price

The aim of this chapter is to evaluate the impact of a possible tax change on the retail cigarette price.

Delipalla & O'Donnell (2001, p.11) studied the effects of changes of both kinds of excise taxes (specific and *ad valorem*) on retail cigarette prices "*by regressing price data from twelve European countries over sixteen years on corresponding tax data and controls for other determinants of prices*." Data was taken from the 1982-1997 period. The study concluded that taxes are not always fully projected into consumer prices. In northern European countries, changes of both rates were less than fully projected into prices, whereas the result in southern European countries was the exact opposite.

Keeler et al (1996) concluded that *ceteris paribus*, a 1 cent tax increase on a cigarette pack pushed up the retail price by 1.11 cents. Therefore, the increased tax burden is more than passed on the consumers.

David (2010) analysed the impact of the cigarette taxation changes in the Czech Republic between 2001 and 2009. There were only tax increases (no decreases) during that period. His analysis provided straightforward results: the date of the taxation change is strongly correlated with the significance of its impact on the retail price, in the sense that more recent tax changes have more significant impacts on the retail price. Whereas the taxation change on 1.1.2004 caused no significant impact on the retail price, the change on 1.1.2008 caused a relevant growth in price. David did not discuss the validity of the assumptions of the econometric model he used. Therefore, we are not sure if the results may be taken as relevant.

The most recent study of the issue was done by Chaloupka et al (2010, p.20). They analysed data from 21 EU countries in the 1998-2007 period. They concluded that "*the average price of a pack of 20 cigarettes would increase for about 0.015-0.02 Euros if the real specific excise tax per 20 cigarettes increased by 0.02 Euro and the real ad valorem fell by 0.02 Euro*[100]*."*

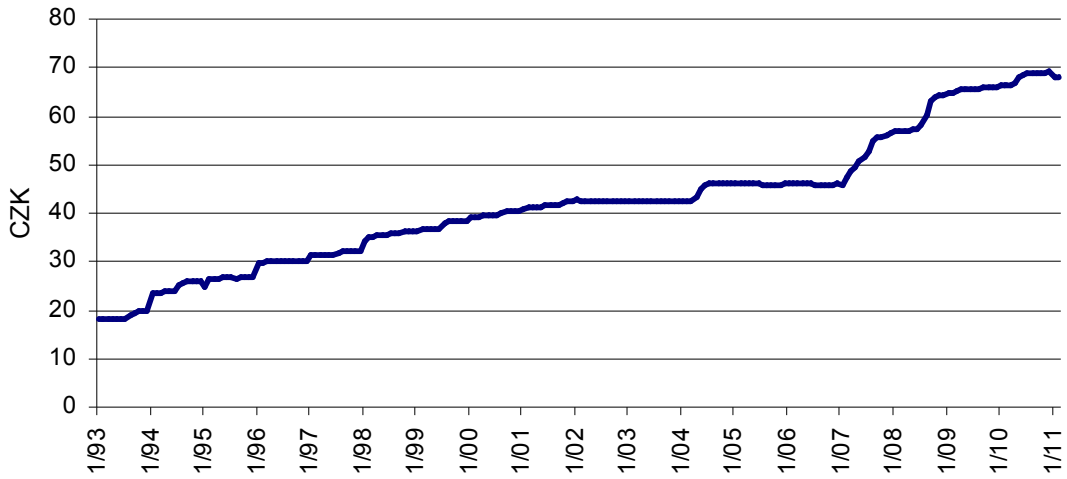
[100] We changed the measurement units, the original quotation is as follows: "*the average price of a pack of 20 cigarettes would increase for about 0.015-0.02 Euros if the real specific excise tax per 1000 cigarettes increased by 1 Euro and the real ad valorem fell by 1 Euro."*

They also proved that the higher reliance on *ad valorem* taxes creates a wider gap between premium and low-end cigarettes: "*a 10 percent raise in the share of ad valorem tax leads to about a 4 to 5 percents increase in the price gap, on average.*"

4.1 Estimation of the Transmission Effect

We collected data about the average cigarette price for the period January 1993-February 2011 (218 time observations). The development of the average nominal price of cigarettes over time is shown below. The procedure for derivation of this figure is described in the next chapter about the price elasticity of smokers.

Chart 4.1: Average Nominal Retail Price



Source: Pavel Říha, CZSO, our own estimation

Based on Sagit and David (2010), there were 14 increases in excise cigarette tax during that period[101]. They are listed in the table below:

[101] David (2010), in his list of tax changes since 1993, covers one change less. The tax increase of 1.1.1996 is not mentioned in his list. Furthermore, he stated that the change in 1994 happened in January, whereas Sagit stated July. For this paper, we assume that the correct information is provided by Sagit.

Table 4.1: Cigarette Excise Taxation (per piece)[102], CZK

Date	Fixed rate	Specific rate (%)	Minimum tax
1.1.1993	0.37	0	0
1.7.1993	0.36	0	0
1.7.1994	0.40	0	0
1.1.1995	0.41	0	0
1.1.1996	0.55	0	0
1.1.1998	0.64	0	0
1.1.1999	0.67	0	0
1.8.2001	0.36	22	0.67
1.1.2004	0.48	23	0.90
1.5.2004	0.48	23	0.94
1.1.2006	0.60	24	1.13
1.4.2006	0.73	25	1.36
1.3.2007	0.88	27	1.64
1.1.2008	1.03	28	1.92
1.1.2010	1.07	28	2.01

Source: Sagit, David (2010)

One of these changes, on 1.5.2004, was only to adjust the minimum excise rate. The change on 1.7.1993 was negligible: it decreased the specific rate just by 0.01 CZK. We omitted these two changes from our analysis. We used 12 dummies as exogenous variables. They were constructed in order to be equal 0 before the specific tax change and 1 after the tax change. Such a regression may help us to identify the influence of taxation changes on the retail price. The next exogenous variable is a simple time trend (defined as a number of months since January 1993), which would serve in our case as a proxy of the growth of cigarettes prices[103] not caused by taxation. The dependent variable is average nominal retail price of cigarettes. This analysis is an expansion of the similar analysis run by David (2010), who analysed six tax changes during the 2001-2009 period, without including the time trend. We assumed the following regression:

$$P_t = \alpha + t + \sum_{a=1}^{12} A_a \beta_a + \varepsilon_t \qquad \text{t=1…218}$$

Based on the Durbin Watson test, there is a strong autocorrelation present in the OLS residuals. Using Newey-West estimators, we got the following outcome:

[102] The rates quoted are valid for cigarettes shorter than 70 mm; there were different rates for cigarettes longer than 70 mm. The taxation changes for cigarettes longer than 70 mm always happened at the same time as changes in short cigarette rates. After 1.7.2001, the fixed and specific rates for both "long" and "short" cigarettes were unified.

[103] The inputs influencing the final retail price are salaries, prices of inputs (tobacco), prices of electricity, prices of fuel, and so on. We do not have these figures available in an appropriate form, so we use the simple linear time trend as a proxy

Regression with Newey-West standard errors
maximum lag: 12

Number of obs = 218
F(13, 204) = 21548.00
Prob > F = 0.0000

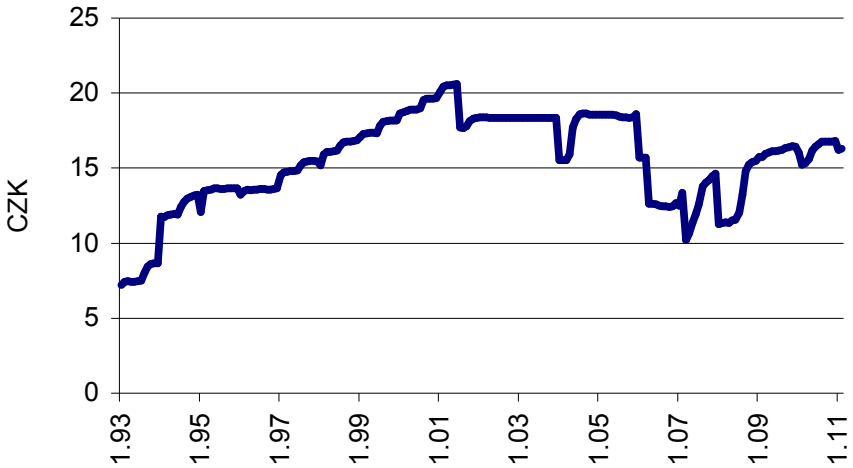
priceNominal	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
change1	3.781615	.4800492	7.88	0.000	2.835121	4.728109
change2	.3326411	1.002151	0.33	0.740	-1.643261	2.308543
change3	1.638042	1.018918	1.61	0.109	-.3709183	3.647002
change4	.0694226	.8174045	0.08	0.932	-1.542222	1.681067
change5	-2.181491	1.251468	-1.74	0.083	-4.648962	.2859803
change6	-2.803074	1.009227	-2.78	0.006	-4.792928	-.8132202
change7	1.032573	.7307127	1.41	0.159	-.4081443	2.473291
change8	-1.923612	.6973412	-2.76	0.006	-3.298532	-.5486918
change9	-1.319573	.3490292	-3.78	0.000	-2.00774	-.6314059
change10	5.268388	.7766825	6.78	0.000	3.737034	6.799743
change11	6.382981	2.160648	2.95	0.004	2.122916	10.64305
change12	1.853467	1.25661	1.47	0.142	-.6241411	4.331075
time	.181046	.0378111	4.79	0.000	.1064954	.2555966
_cons	17.59278	.2505953	70.20	0.000	17.0987	18.08687

The model returned very ambiguous results indicating that the last three tax increases caused a substantial nominal price growth of cigarettes, whereas some tax increases before 2006 caused a drop in price[104]. This ambiguity may be caused by the lack of exogenous variables, which are hence proxied by a time trend. We also have to emphasize that producers do not usually increase cigarette prices only at a time of tax increase. Some producers raise the price in several steps beginning far before the taxation increase[105]; others try to gain a bigger market share and delay the price increase for several months after the tax increase[106].

There is another way to estimate the impact of the tax change on the price change. This involves subtracting the tax burden from the average cigarette price. Subtracting the value-added tax and excise tax reveals the net price. Its development is depicted in the chart below:

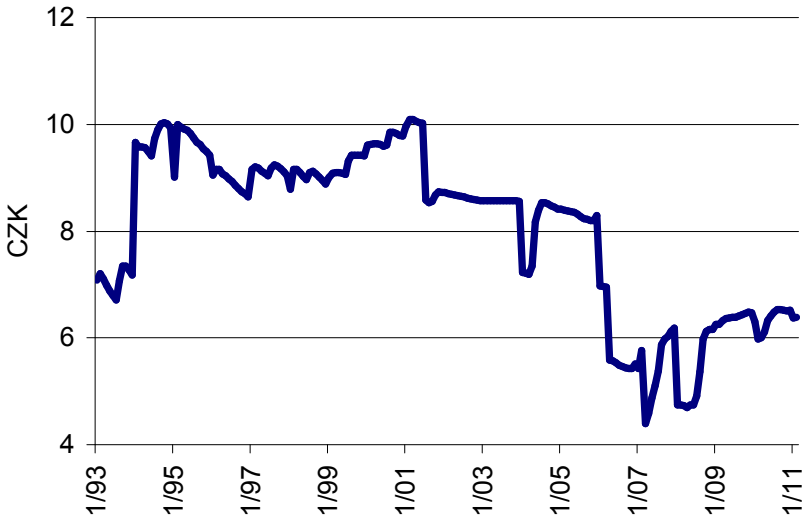
[104] We ran a similar model with the difference that we allowed a different monthly time trend for every year. However, the results were much similar.
[105] Example: The price of Marlboro cigarettes went up before as well as after the tax increase in January 2008; the same happened with Petra cigarettes and the tax increase in March 2007.
[106] Example: The price of Winston Classic Red stayed constant during the tax increase in January 2008; it went up several months later.

Chart 4.2: Tax Free Nominal Price of Cigarette Pack



The depicted price is in nominal terms. However, we would like to have it in real terms because the growth of nominal price may be caused by inflation. We adjusted the price for inflation[107] to get the real net price of cigarette pack.

Chart 4.3: Tax Free Real Price of Cigarette Pack



Analysing verbally the development of the tax-free real price of a cigarette pack over time, we may evaluate the impact of the taxation changes on this variable.

[107] We consider the definition of *inflation* as *changes in the consumer price index* (CPI). Data about CPI changes during 1995-2011 are available at the web pages of CZSO: http://www.czso.cz/csu/redakce.nsf/i/mira_inflace, viewed 3.3.2011. Data about CPI changes during 1993-1995 were taken from Mika (1998). We took the year 1993 as a base period for our inflation adjustment computation.

A strong growth in the real price happened in January 1994. No tax change occurred, so the reason for such growth remains unexplained from this point of view. Then, between January 1994 and June 2001, real price steadily fluctuated between 8.7 and 10 CZK. In July 2001, a dramatic growth in excise taxation occurred. There was a switch between the specific rate and the double rate system (i.e. usage of both specific and *ad valorem* rate). The specific rate dropped by 0.31 CZK per cigarette; however, a 22% *ad valorem* tax caused an overall growth of the tax burden for virtually all cigarette brands. After this taxation change, real price did not go up again. We may assume that the market was already very competitive at that time, and hence the cigarette suppliers preferred to internalize the increased tax burden rather than decrease their market share.

The real price was virtually constant until January 2004, when the next big taxation growth occurred. The specific rate grew by 2.4 CZK per pack, and *ad valorem* by 1%. The real price went down for a couple of months, and in June 2004, it was back to the same figure as in previous years. From our point of the view, this shows that at that stage, suppliers simply decided to transmit the taxation growth into the retail price a few months after the taxation change. There are two possible reasons for that: either the suppliers wanted to keep the real price instead of fighting for a bigger market share, or they had to increase the price in order to avoid bankruptcy.

A huge drop in real prices occurred between January and April 2006, because during that period, the specific and *ad valorem* rates were increased twice. Suppliers did not increase the retail prices to maintain the real price of pack at the same level. After May 2006, the real price floated around 6 CZK. The impacts of taxation in March 2007, January 2008, and February 2010 are clear: shortly after the introduction of the tax, the net real price went up again to its value before the taxation increase.

In other words, we may say that after the last three taxation increases, the tax burden increase was fully transmitted to consumers in order to maintain the real price of cigarettes. Based on that conclusion, in our computation of an optimal tax we will consider that the taxation change would be fully transmitted into the retail price. We have to be aware that throughout our reasoning, we assumed that change of taxation is the only significant variable in explaining the changes in the tax free real price. However, this may not be true in the reality.

Next explanatory variables might be the demand for cigarettes, the price of raw tobacco- the key input in the cigarettes production, and so on[108].

This is an evident pattern of suppliers when the excise tax increases. However, what would happen to the real price if the excise tax decreased? Such a situation has not happened in the Czech Republic since 1993[109], so we cannot derive the answer from any empirical analysis of the past data. It has not happened in any country similar to Czech Republic either. Therefore, we can only assume that path-dependency holds in such a way that the behaviour of the cigarette suppliers would be fundamentally the same for a tax decrease as for a tax increase: the change in the tax burden would be fully transmitted into the retail price. In the years shortly before 2009, suppliers tried to maintain the tax-free real price. We may assume they would have the same approach to tax decreases. We understand the strength of this assumption; however, to the best of our knowledge, there is not a sole study analysing this issue[110] that would help us to derive a more precise solution.

5 Price Elasticity of Cigarette Consumer Demand

We evaluated costs and benefits to the state budget caused by smoking. To derive a fair taxation that would balance both parameters as well as the taxation maximising the net revenue for a state budget from the cigarette consumption, it is necessary to know the average price elasticity of cigarettes consumption in the Czech Republic.

Evaluating the price elasticity coefficients for cigarettes has been studied since 1933 (Schoenberg, 1933). According to Chaloupka & Warner (1999), there is "*support for the inverse relationship between price sensitivity and age*." We consider that one of the reasons for such a relationship is the inverse correlation between income and price sensitivity. The authors quoted several studies supporting the statement. Gallet & List (2003) did a meta-analysis of price elasticity for cigarettes, controlling for income. They covered 86 studies between 1955 and 2001. Such a large sample size may imply robust analysis results. Taking into account only publications from 36 top journals, the median estimate of the price elasticity was -0.47. They also found that studies taking into account the effects of smuggling report lower price elasticity (-0.36). Studies analysing the demand responses to price changes show

[108] We were unable to collect the monthly values for the last several years of these variables. Obtaining these data and putting these variables into the regression might be a valuable extension of our analysis

[109] With the exception of 1.7.1993, but at that time, the specific rate decrease was minor: only 0.01 CZK.

[110] There is a lack of data for this situation. Empirical analysis is almost impossible.

lower elasticity (-0.4) in the short term than in the long term (-0.44). This is probably in relation to the fact that cigarettes are addictive. Hence, consumers cannot react to the price changes immediately, even if they decide to stop smoking because of the financial burden of such a habit; they need some time to overcome the addiction.

Lance et al (2003) estimated the price elasticity's in China and Russia to be in a range from 0 to -0.15. The authors stated that the reason might be the very high smoking intensity in both samples caused by strongly addicted consumers. This may be caused by a lack of regulation on tobacco quality. Therefore, cigarettes have higher nicotine content and hence are more addictive. Furthermore, the authors state that in developed countries, a tax increase is accompanied by a public health effort to decrease smoking and support measures for quitters. Such help for people trying to quit is far weaker in China and Russia, resulting in lower price responsiveness.

We may assume that the price sensitivity to smoking in the Czech Republic may be similar to that of neighbouring countries. Using the German annual per capita tobacco consumption data from 1991 to 2004, Hanewinkel (2006) estimated the price sensitivity to be -0.84. Based on Gardes (2004), the aggregate price elasticity in Poland is -0.62[111].

5.1 Estimating the Elasticity on Czech Data

There has been no study to evaluate price elasticity in the Czech Republic. In our communications with Dr. Frank Chaloupka, he provided us with the most recent result of his team's research for the 2011 IACR Handbook of Cancer Control. He informed us that "*the -0.4 estimate would be reasonable to use for the Czech Republic*[112]*."* We ran our own analysis on the most recent Czech data available to estimate the price elasticity of smoking for the Czech Republic.

Model

We ran the following regression, which is most commonly used in the above-quoted studies measuring the price elasticity of cigarettes:

$$Consumption_t = \beta_0 + \beta_1 \Pr ice_t + \beta_2 Income_t + \varepsilon_t$$

[111] Worgotter & Kunze (1986) reported the price elasticity in Austria to be -0.54. However, their analysed data set from 1955-1983 is already outdated, so we may consider that this estimate may no longer be valid. To the best of our knowledge, an estimate for Slovakia has not yet been made.

[112] The same conclusion was mentioned in the study by the World Bank (1999), which Chaloupka coordinated.

Where *consumption* is the per head consumption of cigarettes, *price* is the average price of cigarette pack, and *income* is the average income during selected period.

Data

The source of data for per capita consumption of cigarettes and the average annual nominal gross salary is the CZSO (2008, 2010, 2011a). It would be more reasonable to use the average net salary, because this measure better represents the disposable income. However, according to Ondřej Košata from the CZSO, the average net salaries have not been evaluated since 2001. Constructing an index approximating the average price of cigarette packs is challenging, because the information about the volumes of different brands of cigarettes sold is not publicly available. The Czech Customs Administration provides information about changes in cigarette prices and about the prices of new cigarettes entering the market in the "Price Bulletin" publication, published by the Ministry of Finance. It has being issued monthly since July 1st, 2001. The retail cigarette price must be the same as quoted is this bulletin. Before July 1st, 2001, cigarette prices floated freely[113].

The only attempt to construct a monthly index of average cigarette prices was conducted by David (2010). He constructed the monthly price cigarette index by taking the arithmetic average of all cigarette pack prices based on the prices quoted in the "Price Bulletin"[114]. The Administration does not withdraw licences from cigarettes that are not sold anymore. Therefore, the index constructed by David (2010) is probably biased downwards: cigarettes sold now and cigarettes no longer sold but still on the list are equally weighted. Furthermore, as the prices have only been listed in the bulletin since 2001, his methodology did not allow him to obtain an estimate of the average cigarette price before that date.

We decided to adopt our own approach. As a measure of the average price of cigarette pack, we use the arithmetic average of the cigarette packs in the consumer's consumption basket as defined by the CZSO. We obtained the monthly prices of cigarettes in the consumer basket since 1991 from Pavel Říha, CZSO. The information on annual cigarette consumption per head has been provided since 1955, the average annual nominal gross income has been available since 1993. This restricts our dataset: it begins in 1993. We do not consider that restriction as being detrimental, as we think that the observed 1993-2009 period is long

[113] The reason for the change between free and fixed retail prices lies in the change of taxation – before 1.7.2001, there was only a specific excise rate on cigarettes. However, on 1.7.2001, the *ad valorem* rate was introduced. It is computed as a ratio from the retail price, so in order to fairly compute the *ad valorem* rate, the retail price must be fixed.

[114] We would like to thank the author for providing us with his datasets, results, and methodology.

enough. There were deep structural changes in the Czech Republic in 1989-1993; therefore, data from this period may be highly influenced by these changes and hence not very reliable.
We do not have the monthly data of consumption and income, so we can only run time series regression for years. This is a crucial disadvantage of our dataset. We converted all variables to natural logarithms as we are interested in the value of elasticity, so the regression looks as follows:

$$\ln(Consumption_t) = \beta_0 + \beta_1 \ln(\mathrm{Pr}ice_t) + \beta_2 \ln(Income_t) + \varepsilon_t$$

After running OLS estimation, we see all the OLS conditions are fulfilled except for the condition of no autocorrelation. The value of Durbin-Watson statistics is 1.15. We are unsure about the specific form of the autocorrelation; hence we use the Newey-West estimator. We got the following outcome:

```
Regression with Newey-West standard errors          Number of obs  =        17
maximum lag: 1                                      F(  2,    14)  =      2.74
                                                    Prob > F       =    0.0992
```

consumption	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
income	.4525259	.2008024	2.25	0.041	.0218476	.8832043
price	-.5058261	.2458146	-2.06	0.059	-1.033046	.0213938
_cons	5.177865	1.061713	4.88	0.000	2.900716	7.455013

The whole model is significant at the 10% rejection rate. The observed estimation of the price elasticity is -0.51 (and the elasticity of the salary is 0.45, both significant at a 10% rejection rate[115]). This is not far from Chaloupka's suggestion as well as the outcome of literature review, so we may consider our result to be reliable.
We have to be aware as there might be a risk of the spurious regression. However, we would need more observations to analyse that.

[115] We did the same regression, allowing the maximum lag (a parameter of the Newey West estimator) to be 2, 3 and 4, and in all cases, the coefficient of the price elasticity was significant at 10% rejection rate.

6 Excise Taxation Evaluation

6.1 Which Rate to Adjust?

Before we propose the methodology for computing various excise tax rates for cigarettes in the Czech Republic, we have to answer a crucial question: which excise tax rate are we going to model – specific, *ad valorem*, or both?

Based on Chaloupka (2010), of the 187 countries for which the data about the taxation of cigarettes are available, 60 used just specific taxation, 60 used only *ad valorem*, 48 used both types (mostly European), and 19 did not impose any excise tax on cigarettes. Within Europe, the southern countries seem to favour *ad valorem* taxation, while the northern countries prefer specific taxation.

We would assume that in our excise tax suggestions, we would change just one rate (the *ad valorem* or specific tax one) and the second would be kept constant to the current state.

Generally, we could model the situation when we terminate both the *ad valorem* and specific tax and replace it with just one rate. Such an analysis may be interesting scientifically, but its practical impact would be very limited, because the system of using both rates is very deeply rooted in the EU regulations. The probability of being allowed to switch to just one kind of tax rate in the Czech Republic (either through withdrawal from the EU, or through a change in the regulation for all EU states) is negligible. Therefore, for the sake of realism, we assume that modelling a situation when both rates are used and just one is changed better describes the policy-makers' future possible moves.

6.1.1 Specific versus Ad Valorem Taxation

In this subchapter, we discuss which of two excise rates to model.

Based on Cnossen (2005), under a perfectly competitive market for a homogenous product, a specific tax may be replaced by its percentage equivalent with no effect whatsoever. The choice between specific or *ad valorem* tax is irrelevant in such a scenario. However, cigarettes available on the Czech market are not homogenous. There are huge differences among brands in price and quality. In a competitive market with a heterogeneous product, *ad valorem* taxation does not disturb the relative prices between different brands, so consumers continue to choose their brand based on cost rather than tax difference (Cnossen, 2005). This is an advantage of *ad valorem* taxation. The problem with *ad valorem* taxation is that it creates an incentive for downgrading quality, whereas specific taxation should increase the average quality, according to Sobel & Garrett (1997). They proved empirically that an increase of the

specific tax raises the quality of cigarettes. One of the reasons for that is introduced by the Alchian-Allen theorem, stating that the introduction of a fixed fee implies an increase in the relative price of the cheaper, lower quality product.

Assuming that every cigarette, regardless of the brand, causes the same damage, that externalities can be corrected by introducing a specific tax that would equalize the net damage of a cigarette. Delipalla and O'Donnell (2001) revealed that specific tax has a greater impact on retail prices. From our point of view, this is a reasonable result as the size of the specific tax paid by a producer cannot be decreased by decreasing the retail cigarette price.

Another very practical factor influencing the considerations between adjusting both kinds of taxes is the cost of tax collection. A specific tax is easy to collect; it may be imposed at any stage in production or distribution. An *ad valorem* tax would be very difficult to collect at free market prices. Therefore, in the Czech Republic, the retail prices of cigarettes are fixed and may be changed just in monthly intervals[116].

A specific excise tax is also more predictable in terms of government revenue. This has been proven by the recent situation in Spain. Spain depended heavily on *ad valorem* taxation. In 2006, it raised the *ad valorem* rate, causing a drop in excise revenues for the treasury. The situation was caused by producers who decreased cigarette prices in order to minimise the tax burden on themselves (Antonanzas & Rodriguez, 2007).

The disadvantage of a specific tax is its non-adaptability to inflation. However, as the excise tax from cigarettes is an important source for the state budget, we consider that policy-makers try to maintain the real revenue from this source by adjusting the specific tax[117]. Australia adopted a policy of adjusting cigarette prices to the consumer price index twice a year (Guindon et al, 2002).

Based on the analysis above, we decided to model the specific tax, mainly because its change would be easier to impose than *ad valorem* tax and also its income may be more precisely predicted.

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[116] We see here that without *ad valorem* taxation, it would be unnecessary to regulate the prices of cigarettes.

[117] Guindon et al (2002) measured the annual price change in real terms between 1990 and 2000 using the example of one pack of Marlboro cigarettes in 69 countries. During the selected period, the Czech Republic was in the top 10 countries regarding the size of the drop in real price. According to the authors, the real price fell annually by 6.45%. This may prove that during the observed period, policy-makers in the Czech Republic were not able to maintain the real price of cigarettes.

6.2 Optimal Tax Computation

In previous chapters, we computed the costs and benefits caused by smokers to the state budget. We also evaluated their price elasticity to cigarettes as well as the transmission of the change of tax into the tax-free price of cigarettes. We concluded that the change of the tax burden would be fully borne by consumers. We discussed which excise tax rate to adjust, and chose the specific rate.

Now we propose a model incorporating all this information, providing a fair excise tax rate as well as a tax rate maximising the government revenue from cigarettes as an output. The variables used in our modelling are summarised in the table below.

Table 6.1: Variables, Their Notation and Values Used in Computations

Notation	Variable	Value
C_0	Total costs to the budget caused by smoking before the tax change	30,547 millions CZK
C_1	Total costs to budget caused by smoking after the tax change	*Unknown*
B_0	Total benefits to the budget caused by smoking before the tax change	77,915 millions CZK
B_1	Total benefits to the budget caused by smoking after the tax change	*Unknown*
c	Relative own price elasticity of cigarettes	-0.51
T_0	Total excise tax revenue from cigarettes before the tax change	77,915 millions CZK
r_0	Ad valorem tax rate (in % of retail price)	28%
t_0	Specific tax rate of one cigarette before the tax change	1.07 CZK
t_1	Specific tax rate of one cigarette after the tax change	*Unknown*
v	Value added tax (in %)	20%
P_0	Average retail price of one cigarette before the tax change	3.28
P_1	Average retail price of one cigarette after the tax change	*Unknown*
N_0	Number of cigarettes sold on the Czech Market before the tax change	21,727 millions
N_1	Number of cigarettes sold on the Czech Market after the tax change	*Unknown*
I	Number of cigarettes sold on the Czech illegal Market	2,281 millions

We divide our analysis into two parts. In the first one, the illegal market with cigarettes is not considered. In the second one, it is added into the model.

Case A) Omitting the Illegal Market:

By our definition of a fair tax, we would like to attain a situation where

$$C_1 = B_1$$

The own-price elasticity is defined as follows:

$$c = \frac{\frac{\Delta N}{N}}{\frac{\Delta P}{P}} = \frac{\frac{N_1 - N_0}{N_0}}{\frac{(t_1 - t_0)}{\left(\frac{1}{1+v} - r_0\right)P_0}} \tag{1}$$

In the equation (1), there are two unknowns – N_1 and t_1. We derived the relationship

$$\Delta P = P_1 - P_2 = \frac{t_1 - t_0}{\frac{1}{1+v} - r_0} \tag{2}$$

[118]

used in (1) from the fact that total tax burden plus tax-free price equals the retail price including taxes. Denoting the tax-free price as *k*, the equation could be written in a following way:

$t_0 + r_0 P_0 - \frac{P_0}{1+v} + k = 0$ for the situation before the tax change

$t_1 + r_0 P_1 - \frac{P_1}{1+v} + k = 0$ for the situation after the tax change

From the equations above, we can simply derive (2).

We assume that costs depend linearly on the number of smoked cigarettes[119]. Therefore, the costs after the tax change would be:

$$C_1 = \frac{C_0}{N_0} N_1 \tag{3}$$

whereas benefits would be:

$$B_1 = \frac{B_0 - T_0}{N_0} N_1 + t_1 N_1 + r_0 P_1 N_1 \tag{4}$$

Substituting (2) into (4) and balancing (3) and (4) results in:

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[118] Based on the assumption that the change of the specific tax rate is fully transmitted into a change of price, and assuming further that the *ad valorem* excise tax and VAT stays the same.

[119] This is a simplified assumption. Analysing the elasticities of concrete benefit and cost factors to the number of cigarettes smoked may be a possible extension of this paper. This would lead to a more precise evaluation of the optimal taxation question.

$$\frac{C_0}{N_0}N_1 = \frac{B_0 - T_0}{N_0}N_1 + t_1 N_1 + r_0\left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0}\right)N_1 \tag{5}$$

We see that we can divide the whole equation by N_1 (under the reasonable assumption that the number of consumed cigarettes after taxation would not be zero):

$$\frac{C_0}{N_0} = \frac{B_0 - T_0}{N_0} + t_1 + r_0\left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0}\right) \tag{6}$$

There is only one unknown parameter - t_1. From (6), it is clear that:

$$t_1 = \frac{\frac{C_0 - B_0 + T_0}{N_0} + r_0\left(\frac{t_0}{\frac{1}{1+v} - r_0} - P_0\right)}{1 + \frac{r_0}{\frac{1}{1+v} - r_0}} \tag{7}$$

The second fair taxation solution is a case when N_1 equals zero (shown in (5)). Under such an assumption, from (1), we derive that:

$$t_1 = \frac{N_0 c t_0 - N_0 P_0}{c N_0}$$

It is also possible to compute a tax rate that would maximise the revenue for the state budget. We are looking for a specific tax rate to maximise the difference between benefits and costs. The setting of our optimisation problem is as follows:

$$\max_{t_1}\left\{\left[\frac{N_0 c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + N_0\right]\left[\frac{B_0 - T_0}{N_0} + t_1 + r_0\left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0} - \frac{C_0}{N_0}\right)\right]\right\}$$

When disregarding illegal market, the specific tax rate equalising costs and benefits for the state budget is -0.55 CZK or 4.63 CZK. The second case implies the zero consumption of

cigarettes. The specific tax rate maximising the revenue for the government would be 2.04 CZK, and the net revenue under this scenario would be 61,660 million CZK.

Case B) Including the Illegal Market:

Based on our evaluation, the illegal market constitutes 10.5% of the official market. Cigarettes sold on the black market incur the same costs as cigarettes sold legally. They produce the same benefits, except for the tax revenue. We also concluded that the size of illegal market is constant, regardless of the retail price of cigarettes[120]. So, denoting the size of illegal market as I, the cost after the tax change would be:

$$C_1 = \frac{C_0}{N_0 + I}(N_1 + I) \tag{8}$$

Whereas the benefits after tax change would be:

$$B_1 = \left(\frac{B_0 - T_0}{N_0 + I}\right)(N_1 + I) + t_1 N_1 + r_0 P_1 N_1 \tag{9}$$

Incorporating (2), (8), and (9) into one equation (again, searching for the balance of benefits and costs) results in:

$$\frac{C_0}{N_0 + I}(N_1 + I) = \left(\frac{B_0 - T_0}{N_0 + I}\right)(N_1 + I) + t_1 N_1 + r_0 \left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0}\right) N_1 \tag{10}$$

which can be transformed into:

$$\left(\frac{C_0 - B_0 + T_0}{N_0 + I}\right)(N_1 + I) = \left[t_1 + r_0 \left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0}\right)\right] N_1 \tag{11}$$

The own-price elasticity is now defined as follows:

[120] This was discussed in the chapter about the illegal market. We admit that it is simplified. However, we do not have any data to measure the impact of the cigarette price changes on the volume of the illegal cigarette market.

$$c = \frac{\frac{\Delta N}{N}}{\frac{\Delta P}{P}} = \frac{\frac{N_1 - N_0}{N_0 + I}}{\frac{(t_1 - t_0)}{\left(\frac{1}{1+v} - r_0\right)P_0}} \tag{12}$$

Basically, it is different from the price elasticity defined in case a) in only one respect: the basis for the total consumption is now extended by adding the size of illegal market. From (12), it is clear that:

$$N_1 = \frac{(N_0 + I)c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + N_0 \tag{13}$$

Inserting (13) into (11):

$$\left(\frac{C_0 - B_0 + T_0}{N_0 + I}\right)\left[\frac{(N_0 + I)c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + N_0 + I\right] = \left[t_1 + r_0\left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0}\right)\right]\left[\frac{(N_0 + I)c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + N_0\right]$$

After a simple transformation:

$$(C_0 - B_0 + T_0)\left[\frac{c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + 1\right] = \left[t_1 + r_0\left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0}\right)\right]\left[\frac{(N_0 + I)c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + N_0\right] \tag{14}$$

The only unknown variable in equation (14) is t_1. This is a quadratic equation. By denoting

$$At_1^2 + Bt_1 + C = 0$$

after the transformation of (14), it is shown that:

$$A = (N_0 + I)c\left(1 - \frac{r_0}{\frac{1}{1+v} - r_0}\right)$$

$$B = -(C_0 - B_0 + T_0)c - t_0(N_0 + I)c + N_0P_0\left(\frac{1}{1+v} - r_0\right) + r_0P_0(N_0 + I)c + \frac{2t_0r_0(N_0 + I)}{\frac{1}{1+v} - r_0}c + r_0N_0P_0$$

$$C = (C_0 - B_0 + T_0)ct_0 - (C_0 - B_0 + T_0)P_0\left(\frac{1}{1+v} - r_0\right) - \frac{r_0 {t_0}^2 (N_0+I)c}{\frac{1}{1+v} - r_0} + r_0 P_0 N_0 P_0\left(\frac{1}{1+v} - r_0\right) - r_0 t_0 N_0 P_0$$

The solutions of the equation are in the form $t_1 = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$, so the term $B^2 - 4AC$ must be nonnegative for a solution to exist.

Now it is possible to incorporate the value that we derived in our previous analysis: Executing the computation reveals that with an illegal market, there are two results for a fair excise fixed tax rate per cigarette piece: the first is -0.54 CZK and the second one 4.31 CZK. Under the first result, the average retail price for a cigarette would be 0.35 CZK. For the second result, it would be 9.71 CZK. The second solution is "trivial" in the sense that under such a high taxation, the cigarette consumption would be zero. From that, it can be implied that the costs and benefits attributable to smoking would be zero.

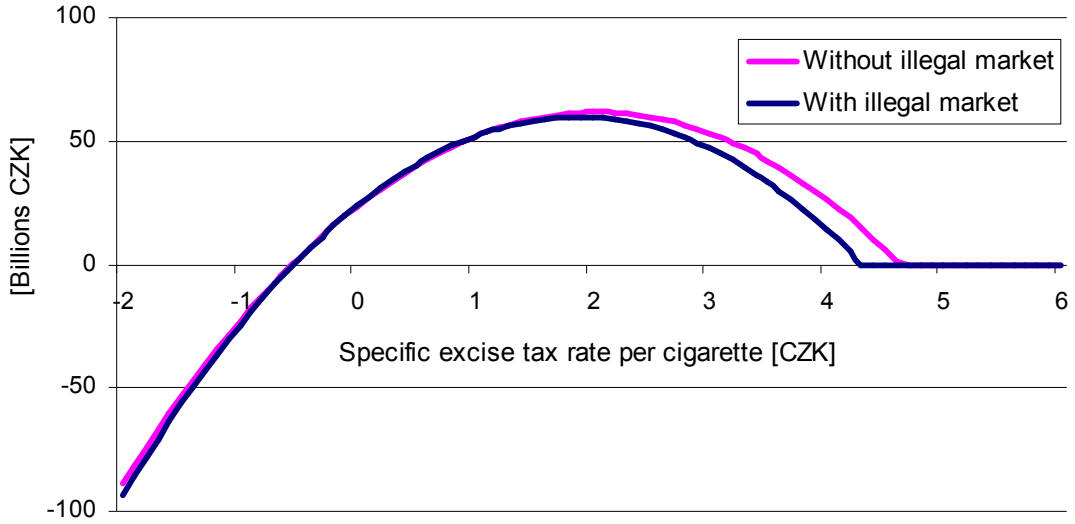
In case of revenue maximisation, we are solving the following problem:

$$\max_{t_1}\left\{\left[t_1 + r_0\left(P_0 + \frac{t_1 - t_0}{\frac{1}{1+v} - r_0}\right)\right]\left[\frac{(N_0 + I)c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + N_0\right] - (C_0 - B_0 + T_0)\left[\frac{c(t_1 - t_0)}{P_0\left(\frac{1}{1+v} - r_0\right)} + 1\right]\right\}$$

This reveals that the specific rate maximising the net revenue for the government would be 1.88 CZK. The net revenue under this scenario would be 59,762 million CZK.

With and without the illegal market, the results are almost identical. A chart depicting the development of a net revenue based on a specific excise tax rate is shown below.

Chart 6.1: Net Revenue from Cigarette Taxation



The assumption that the consumption of cigarettes cannot be negative is incorporated.

Table 6.2: Tax Rates Suggestions

Tax rates and prices in CZK	**Specific tax rate**	**Taxed cigarette consumption (N_1)**	**Retail price per cigarette (P_1)**
Omitting the illegal market			
Fair taxation (1)	-0.55	28,261,005,583	0.35
Fair taxation (2)	4.63	0	9.71
State budget revenue maximisation	2.04	15,805,555,686	5.03
Including the illegal market			
Fair taxation (1)	-0.54	32,590,190,264	0.37
Fair taxation (2)	4.31	0	9.14
State budget revenue maximisation	1.88	16,263,171,358	4.74

In our model, we assume that the change in retail price as well as the change in demand initiated by the change in taxation would take place immediately. However, we are aware that in reality, these transitions take time. There are many possible extensions of our basic model. For example, some studies conclude that the size of the illegal cigarette market is negatively dependent on the retail price of cigarettes (World Bank, 1999).

7 Conclusion

The aim of the thesis is to evaluate the impact of cigarette smoking on the Czech state budget and to suggest both the excise taxation rate that would balance the state budget costs and benefits attributable to smoking and the excise taxation rate that would maximise the difference between benefits and costs for state budget. All figures and findings quoted below are valid for the Czech Republic in 2009.

We calculated the distribution of deaths attributable to smoking over the ages at deaths. Not only first-hand smoking, but also second-hand smoking was considered in our analysis. We concluded that there were 22,013 deaths caused by smoking, which accounted for 20.3% of all deaths. After thorough analysis of the positive health effects of smoking, we concluded that they are negligible. Our calculations showed that there were about 251,195 potential years of life lost caused by deaths attributable to smoking.

Next, we evaluated various factors caused by smoking cigarettes which have an impact on the state budget. On the benefit side, the revenues from taxes and from the savings in retirement pensions and health care caused by earlier deaths associated with smoking were considered. On the cost side, we considered the healthcare costs, disability pensions, and sickness benefits as factors associated with the higher morbidity of smokers. Next, we evaluated the size of widow and widower pensions paid that are attributable to deaths caused by smoking and also the cost of fires caused by smoking. The results of our evaluations are in the table below:

COSTS		**BENEFITS**	
health care	17,039	excise tax	37,138
widow(er) pensions	4,836	retirement pensions	28,884
disability pensions	4,708	health care	11,486
sickness benefits	3,698	excess corporate tax	413
Fires	266		
Total	***30,547***		***77,915***

The current cigarette excise taxation is such that smokers are beneficial for the state budget. If Czech citizens are divided into smokers and non-smokers, there is a clear net redistribution of funds from the smokers to non-smokers. We computed the price elasticity of smoking, controlling for income, to be -0.51. In short-term, a 10% increase in the retail price of cigarettes would cause an approximate 5% drop in consumption. We determined that in recent years, taxation changes were fully projected into the retail cigarette price. .

A fair specific excise tax rate that would neutralise the impact of smokers on the state budget should be either -0.54 CZK or 4.31 CZK. The latter case is trivial, because the excise specific taxes of 4.31 CZK or higher would (in theory) cause cigarette consumption to be zero.

The rate maximising the revenue for state budget would be 1.88 CZK, bringing a net contribution amounting to 59,762 million CZK.

In our computations of the various tax rates, we also considered the illegal cigarette market, which we evaluated as 10.5% of the legal market.

We fully understand that the idea of modelling a situation in which there is no smoking in the society and computing its impact on the state budget is a very comprehensive task. The biggest limitation that we see in throughout our paper is the simplified assumption that every productive worker who dies (because of smoking) is immediately replaced by a different worker who was unemployed. This is not generally true in reality; there is always some time before the new worker is found and hired. Furthermore, with very demanding positions, the position can really "close" because nobody with sufficiently specific skills to fit the position is available.

The main outcomes of the paper are not only interesting, but also useful for both smokers and non-smokers in the Czech society. Our results are country specific; they will most probably be incorrect if used for a country other than the Czech Republic, even if similar. The prevalence of smoking, the size of the illegal market, the own-price elasticity of smokers – all these variables may be quite different in a different country.

We have to underline that we assumed that the costs and savings caused by smoking on budgets of health insurance companies are regarded as the costs and savings on the state budget. However, in the reality, budgets of the health insurance companies are only loosely linked to the state budget. Disregarding the impact on smoking on the health insurance companies, we can state that the costs for the state budget in 2009 caused by smoking were 13,508 millions, whereas benefits were 66,435 millions. The possible extension of the thesis may be the computation of various tax rates for this scenario when the impact on the budgets on health insurance companies is omitted.

Based on our conclusions, can it be stated that cigarette consumption is beneficial for the Czech society? Not at all. The only result that can be stated is that it is beneficial for the state budget. The thesis could be further extended to explore the evaluation of a socially optimal taxation. From our perspective, the key thing to evaluate while estimating socially optimal taxation is following: people (at least most of them) value their lives. As this paper shows, smoking decreases the length of life substantively. The question is: do people internalise the

loss of life caused by smoking when they decide whether to smoke? We may assume that people are not fully rational in this case. To reveal the size of their irrationality, we have to realise how they evaluate the loss of life caused by their smoking habits. Then we compare their thoughts with the actual value, computed by SAF. The difference from the actual computed value and their expectation is the cost of smoking that they do not internalise. Therefore, taxation has to be adjusted to cover this cost. The fact that cigarette consumption is addictive further complicates the situation – with addiction, the decision maker loses rationality. Knowing the irrationality of smokers in their opinions about the loss of life caused by smoking, and knowing the subjective assessment of the monetary value of one year of life of a smoker, we would be able to begin to answer many interesting questions concerning smoking. For example, how much should the staff in pubs is compensated for the fact that they work in smoke-heavy environments?

The thesis specifically discusses cigarettes within the wide list of tobacco products. In the Czech Republic, cigarettes hold the strong majority on the tobacco market. However, it may be seen that the amount of tobacco smoked through a water pipe is increasing in the Czech Republic, particularly among youths (Sovinová, 2010a). The usage of water pipes can be dangerous as its detrimental impact on health is greater than usually expected among the population. Therefore, it may be highly relevant in the future to analyse the tobacco used in water pipes as we analysed cigarettes.

We hope that this paper will stir both academic and public debate about cigarette consumption and the impact on the state budget.

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Email communication:

Chaloupka Frank J. – Professor, University of Illinois at Chicago

David Petr – Associate Professor, Department of Accounting and Taxes , Mendel University in Brno

Kaiser Rudolf - Director of the Prevention Department for the Fire Rescue Service of the Czech Republic

Košata Ondřej, Říha Pavel, Kalnická Vladimira – Czech Statistical Office

Miškovská Šárka – PR, custom and tax advisory department, Custom Administration of the Czech Republic

Popova Svetlana - Public Health and Regulatory Policies, Centre for Addiction and Mental Health, Canada

Srb Tomas – Institute of Health Information and Statistics of the Czech Republic

Škorpík Jan - Head of the actuary department of the Ministry of Labour and Social Affairs