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MASTER'S THESIS

Optimal Tax Modeling – The Case of Alcohol

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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 agree that my work is available to the public for study and research purposes.

In Prague, 1.5.2009 Jakub Mikolášek

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Bibliographic Annotation

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Abstract

This project focuses on modeling the optimal alcohol tax for the Czech Republic, based on microeconomic findings on consumer's behavior. After stating the key statistical facts on alcohol consumption in the Czech Republic, problems of abusive alcohol consumption are identified and an estimate of costs arising from its consumption is calculated. From these costs we identify that part, which is external to the alcohol abuser (e.g. which affects the other members of society). Using the methodology by Anderson and Baumberg (2006), together with macroeconomic data on local alcohol production, we estimate the net external costs of alcohol consumption. The next step focuses on theoretical modeling of optimal alcohol tax for various alcoholic beverages, using an analogy to a method developed by Pogue and Sgotz (1989) and Saffer and Chaplupka (1994). Analyzing several scenarios, we get an insight view to the problem and we state the requirements on empirical data necessary for numerical calculation of optimal tax. Therefore in the next part, we analyze microeconomic behavior of alcohol consumers in the Czech Republic and estimate demand elasticities using AIDS (Almost Ideal Demand System) estimate on data from Household Budget Statistics by Czech Statistical Office. Then, using the results of microeconomic analysis we compare tax induced reduction in external abuse costs to the dead weigh loss to the consumer's surplus. Taking various assumptions on "social optimality" and consumer behavior and given the elasticities of demand for alcohol, we will create various scenarios for modeling socially optimal taxation.

Bibliografický záznam

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Abstrakt

Tento projekt se zabývá modelováním optimálního zdanění alkoholu v ČR na základě mikroekonomických poznatků o chování soptřebitele. Po úvodním vyjmenování základních statistických údajůo jednotlivých skupinách alkoholických nápojoů se zaměří na identifikaci a odhadnutí nákladů vzniklých společnosti jejich konzumací. Tyto náklady budou dále rozděleny na ty, jež jsou konzumentovy vlastní a na tu část, kterou přenáší na ostatní členy společnosti. Užívaje metodologi publikovanou autorskou dvojicí Anderson a Baumberg (2006), spolu s makroekomonickými údaji o českém alkoholovém průmyslu, vyčíslíme odhad vnejších nákladů spotřeby alkoholu. V dalším kroku se projekt zaměřuje na teoretické modelování společensky optimální míry zdanění jednotlivých tipů alkoholu, za použití metod analogických k postupu autorských dvojic T. F. Pogue a L. G. Sgotz (1989) a H. Saffer, a F. Chaplupka, (1994). Prozkoumání několika alternativních modelů nám umožňuje blíže nahlédnout do problematiky optimálního zdanění komodity a stanovit nároky na empirická data, která budou potřeba pro numerický výpočet optimální daně. Následující fáze se zaměřuje na mikroekonomickou analýzu chování konzumentů alkoholu v České Republice a na odhad jejich poptávkových elasticit po hlavních druzích alkoholu, za využití metody AIDS (Almost Ideal Demand System). Jako zdroj dat pro tuto ekonometrickou studii slouží Statistika rodinných účtů publikována Českým statistickým úřadem. Za použití výsledků mikroekonomické analýzy pak porovnáme ušetřené náklady, vzniklé dodatečným zdaněním, se ztrátou spotřebitelského přebytku, kterou zdanění přinese též. Za použití různých předpokladů o tzv. „společenské optimálnosti“ spotřebitelském chování konzumentů alkoholu pak budeme schopni vytvořit několik scénářů pro modelování společensky optimálního zdanění.

Keywords

Abuse, Almost Ideal Demand System, Alcohol, Beer, Brewing Industry, Consumption, The Czech Republic, Elasticity, Externality, External Costs, Price, Social Costs, Spirits, Tax, Wine.

Klíčová slova

Abúzus, AIDS poptávkový systém, Alkohol, Celospolečenské náklady, Cena, Česká republika, Elasticita, Destiláty, Externalita, Pivo, Spotřeba, Víno, Vnější náklady.

Abbreviation used

BHS	Czech Budget Household Survey
CBMA	Czech Beer and Malt Association
CSO	Czech Statistical Office
CZK	Czech Crown (currency unit)
DALY	Disability-adjusted Life Years
€	Euro (currency unit)
EUROSTAT	European Statistical Office
ha	hectare (area unit: 10 000m^2)
hl	hectoliter (volume unit: 100 liters)
RIBM	Research Institute of Brewing and Malting, Plc.
$	U. S. Dollar (currency unit)
WHO	World Health Organization

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1 Introduction

1.1 Overview

In many countries, alcohol has always had a privileged position among other consumer goods. Its popularity and ability to influence human behavior, has earned alcohol much attention of not only the consumers but also of the governing authorities and of course the scientific community. In the Czech Republic alcohol taxes have recently been the subject of political discussion. In the beginning of 2009 the Czech Ministry of Healthcare proposed adoption of increased excise tax on alcohol in order to compensate budget deficit from easing health-service fees. However, the Ministry of Finance has blocked this initiative stating that effect of increased excise taxes on budget revenues is dubious due to decline in spirit consumption, threat of black market reemergence and possibility of substitution between the beverages to those not taxed (such as non-sparkling wine). Further, we should not neglect the negotiation and political power of the industry. This situation is a more than eloquent illustration of the fact that alcohol related policies are still regarded to be current affairs.

Research studies on alcohol include a large scale of disciplines, ranging from statistical and demographical surveys, through studies examining the impact of alcohol consumption on individual (psychological and medical surveys) or on society as a whole (sociological approach). Last but not least, extensive economic research has been undertaken, examining relationships between alcohol and many economic variables such as domestic product, productivity of labor, employment and tax revenues.

Economic impact of alcohol consumption on society has been given much research attention especially in the United States and Canada. We should name at least long-term periodical statistical surveys done by the National Institute of Alcohol Abuse and Alcoholism (NIAAA). Among the studies devoted to analysis of demand for alcohol and consumer behavior let us mention an influential paper by Ornstein and Levy (1983), which concerns price elasticity estimates for the US alcohol market. Their results are then being elaborated by many other researchers, such as Pogue and Sgotz (1989) developing a theoretical platform for modeling the optimal tax upon alcohol. This branch of alcohol-focused economic research is then extended by Chalupka (1994),

who enriches the scope of analysis by distinguishing various types of alcohol and discusses the problem of tax harmonization across different alcohol beverages.

In Europe, recent research in this field is mostly connected with initiatives of European Committee related to common plans for regulation of adverse impact of alcohol consumption on the community. Current results of this effort include, among others, the report by the Institute of Alcohol Studies – conducted by Anderson and Baumberg (2006), which maps the problem on a pan-European scale based on data from the Committee and WHO. This report does not yet introduce any policy suggestions (as for example often discussed tax measures). However, it introduces numerous statistical facts showing the problems of alcohol abuse as a current topic which needs to be handled in a pan-European context.

In reaction to these regulatory initiatives, there has been a notable effort to analyze also the benefits from alcohol production in Europe. Let us mention the study by Ernst & Young (2006), initiated by the Brewers of Europe, an organization uniting European beer producers. This study analyzes the spin-off effects on employment, the industry' s productivity and value added, and last but not least, the Tax and excise revenues for 30 European countries (including all 27 EU members).

Czech literature is primarily concerned with medicinal and psychological aspects of alcohol consumption, with special focus on impact on youth population group. An extensive research on this field has been done by the National Health Institute – see Sovinová a Csémy (2003). Among others let us name at least psychiatric studies by Karel Nešpor (see e.g. Nešpor 2003). Excessive alcohol consumption in the Czech Republic is generally perceived as an important phenomenon with a direct and adverse impact on a significant proportion of the population. This also implies a negative indirect impact on the rest of society. Most of the studies also concur that alcohol consumption trends have been deteriorating recently, meaning increasing rate of alcohol abuse and especially the shifts in underage drinking habits.

Among infrequent studies concerning microeconomic analysis of demand for alcohol in the Czech Republic let us name a paper by O. Přibyl (2005), who examines consumer behavior in the Czech alcohol beverage market and elasticities of demand for specified alcoholic brews. This study however does not offer much implication for the tax system and public finance policy in general. Our study will concentrate within these fields of research.

1.2 Aim of the Study

First, we will introduce the general environment of the problem by stating some facts about Czech alcohol consumption and role of alcohol in Czech society. While doing so, we will focus on three basic groups of alcoholic beverage – beer, wine and spirit. To put the data in broader context, we will also discuss past consumption trends and analyze the figures in an international context.

The following chapter will introduce the primal motivation for our study. We use simple economic theory to develop a simple definition of social optimality. To do so, we first need to make some assumptions about consumer behavior and social optimality in general. We will simplify the problem by looking at two groups, abusers and non-abusers, stating some presumptions about their relation to negative externalities of alcohol consumption. We will focus especially on discussing costs brought about by consumption of alcohol, namely by its abuse. First, some medicinal definitions of abuse will be outlined. Then we will try to identify particular problems and evaluate their impact on society. We will try to quantify the problems (both tangible and intangible) by translating them into financial terms. Such conversion can only be done by using simplifying assumptions, which will be both justified and subject to criticism in comparison with other relevant papers.

The next chapter will comprise a quick overview of Czech excise tax legislation, assessing its impact on individual alcohol producing segments. Moreover, we will decide on the basis for later calculating the "optimal tax".

After the aforementioned identification of both benefits and costs of alcohol consumption, we proceed to the core part of the project, where ewe use economic theory to develop multiple models examining the relationship between tax-induced decrease in abuse costs and dead-weigh loss due to decrease in consumer surplus. Depending on our previous assumptions, we will sketch multiple scenarios to be implemented while modeling the optimal tax.

Afterwards, elasticities of demand for particular alcoholic beverages will be estimated using AIDS (Almost Ideal Demand System) based on data from Household Budget Statistics gathered by Czech Statistical Office. This final piece of the puzzle will allow us to calculate all our scenarios and therefore to estimate the optimal level of tax on alcohol.

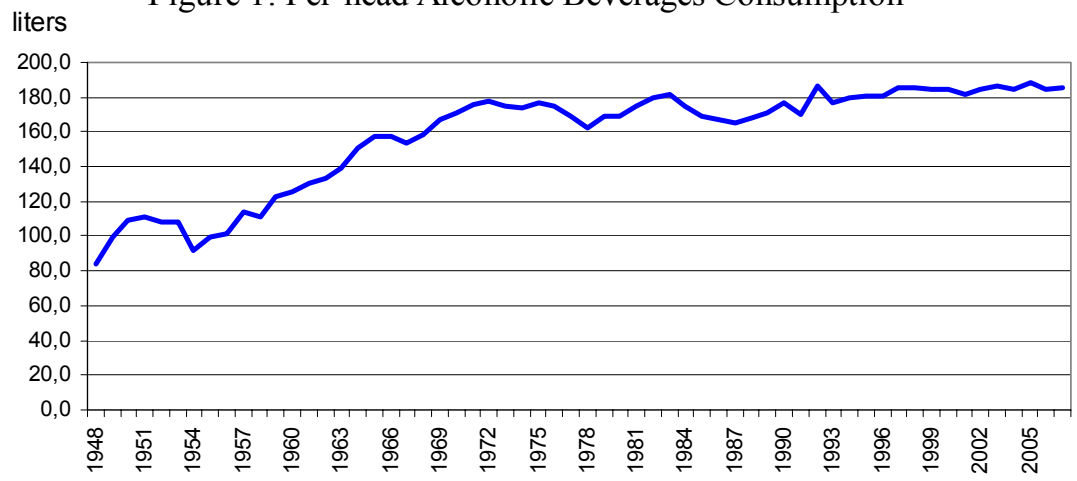
In the final two chapters, we will introduce results of the analysis together with remarks on sensitivity analysis of the model. We then link the outcomes of our optimization problem to the economic reality, discussing possible implications for economic policy.

2 Alcohol in the Czech Republic - Facts and Remarks

2.1 Alcohol in General

Alcohol production and consumption are an important part of Czech history and culture. It is globally famous for its beer, and well "equipped" with popular spirit brands. Despite not possessing optimal climate conditions, wine production of the country is almost capable of serving domestic demand. Total consumption of alcoholic beverages has doubled over the last five decades and since the 1990s it has stabilized at an approximate annual value of 180 liters per head[1)]. For a graphic representation of consumption development over time see the next figure.

Figure 1: Per-head Alcoholic Beverages Consumption



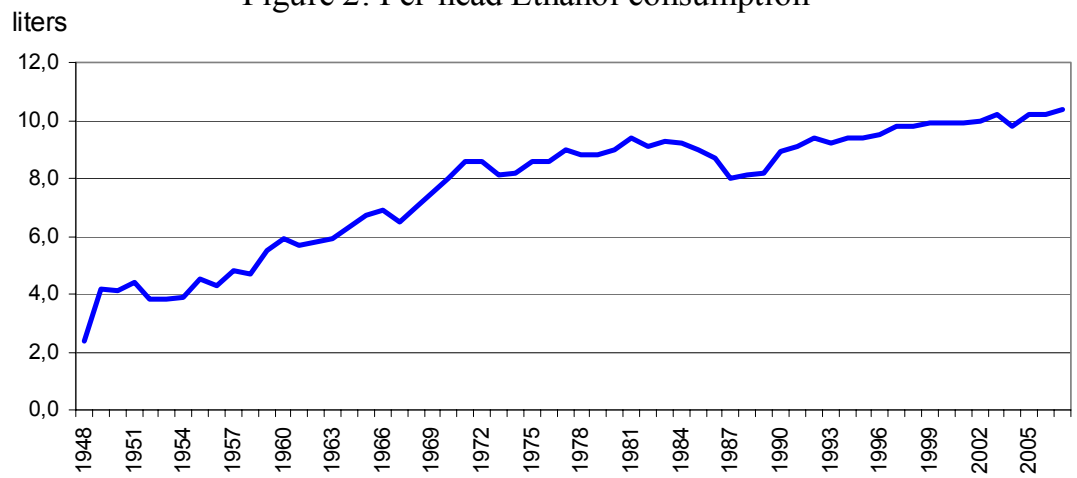
Source: Czech Statistical Office

The dominant position among all alcoholic drinks in the Czech Republic belongs to beer, which accounts for more than 85% of total volume consumed. Therefore in order to compare the level of Czech alcohol consumption to other countries, we should

[1)] This average figure refers to the whole population, including under-18's, pregnant women and other abstinent members of population.

instead use the "ethanol content equivalent" measure, which is independent from consumption composition.

Figure 2: Per-head Ethanol consumption



Source: Czech Statistical Office

With reported annual consumption at over 10.4 liters[2)] of pure ethanol per head, the Czech Republic consistently maintains its position in the world's "top 10" group together with for example Luxembourg, Ireland and Hungary. However, in 2002 World Health Organization (WHO) carried out extensive research in an attempt to map also unrecorded consumption across the world. According to this survey, some developing countries exhibit much larger real alcohol consumption than reflected in official statistics. For comparison of official figures with estimates including unrecorded consumption, see table 1.

[2)] Source: Czech Statistical Office, 2007. The average is calculated across whole population, including under-aged groups.

Table 1

World Leaders in Alcohol Consumption						
Recorded				**Including Unreported**		
	Country	**2002 Per-head consumption (liters)**			**Country**	**2002 Per-head consumption (liters)**
1	Saint Helena	14.8		1	Republic of Moldova	25.0
2	Luxembourg	14.7		2	Uganda	18.6
3	Ireland	13.7		3	Hungary	17.4
4	British Virgin Islands	13.4		4	Croatia	17.0
5	Hungary	13.3		5	Ukraine	15.6
6	Republic of Moldova	12.9		6	Russian Federation	15.2
7	Croatia	12.8		7	Republic of Korea	14.8
8	**The Czech Republic**	**12.8**		8	Ireland	14.7
9	Aruba	12.8		9	Romania	14.7
10	France	12.7		10	Slovakia	14.6
11	Greenland	12.3		11	Luxembourg	14.2
12	Germany	12.3		**16**	**The Czech Republic**	**13.9**

Source: World Health Organization. Note: the average is calculated across adult population only.

According to WHO we can therefore see that consumption in developing countries might be much higher than suggested by official statistics. The estimation of unrecorded part of consumption, however, can only be seen as a rough approximation as we talk about unofficial, and in most countries also illegal, part of production. In the case of the Czech Republic, WHO (in 2002) reported legal consumption at 12.81 liters per adult (of age above fifteen) person annually. The unrecorded consumption was then estimated to amount to an additional 1.12 liters. Alternatively, CSO (in 2006) estimated that tax avoidance amounted to around 6.5% of total excise tax receipts. Basically in all countries, the unreported consumption consists mainly of spirits, where the smugglers' profit per unit of volume is the largest. The Czech Republic is no exception from this trend. In case of the Czech Republic, this would mean unregistered spirit production (and imports) of around 10.1%. In our analysis, we are not able to fully account for unrecorded consumption in the calculation since our data (Household Budget Survey) is generally unable to identify illegal alcohol sales from legal sales. The extent of this problem is partially limited because unregistered alcohol production is not influenced by taxes (at least not directly). However, we are facing a much more serious aspect of the problem. It is legitimate to assume that alcohol tax rate and the level of illegal alcohol (specifically spirit) production might be positively correlated. This would in fact have an impact on the calculated level of "optimal tax", which will be discussed later.

Concerning Czech consumption composition, more than 50% of the alcohol (of pure ethanol content) in the Czech Republic is consumed in the form of beer, whereas wine and spirits account for only 20% and 30% respectively. Despite different speeds of individual brews' consumption growth, the above ratio is quite stable over time (see Appendix 6). It is also worth mentioning that individual brews' consumption is very unevenly distributed with respect to gender. According to CSO, men drink about ten times more beer and threefold of spirits. With regard to wine, consumption by both men and women is quite comparable.

For the purpose of our analysis it is worth examining also the cheapest products in each beverage group. It is legitimate to assume, that many alcohol-addicted persons from low-income social groups often seek the cheapest source of ethanol in order to satisfy their craving. Historically, the dubious honor of lowest-cost alcoholic drink has always been held by beer. Presently however, this position is increasingly under threat, as the same level of cost per alcohol unit has almost been attained by so-called "junk wine". This sort of wine, usually sold in paper packaging or in high volume demijohns (e.g. 5 liters), has also become one of the cheapest sources of ethanol. The price of the cheapest wine fluctuates slightly around the CZK 22 mark. Given the average alcohol content of about 10.2%, this equates to CZK 220 per liter of pure ethanol. Equivalent prices of alcohol in beer range from CZK 150 to CZK 200 per liter. For spirits, the same measure is usually well above CZK 400. These facts might have a non-negligible impact on our analysis, while examining the alcohol-related consumer behavior of low income social groups which will be discussed in the third section.

Let us now devote our attention to each of the three alcoholic beverages separately. For broad comprehension of their role in contemporary Czech society, it is necessary to understand the history and evolution that each has undergone to date. To present the data in a broader context, it will also be comparatively assessed against a range of other countries' relevant statistics.

2.2 Beer and Brewing

2.2.1 Beer, a Phenomenon in Czech Society.

Beer is being brewed and drunk on each continent. Estimated world's production in 2006 reached 1699 million hectoliters[3)]. However, for the Czech Republic, beer does not represent only a "common drink". In both Czech and foreigners' view, beer is an inseparable part of Czech society and its culture.

The origins of brewing reach the very dawn of Czech history. Tribes of Slavs who pushed out Celtic tribes and settled in the area 6th century are told to be the first to use hops in beer-brewing (Chodounský 1910). Its importance grew as beer has become an article of trade from 12th century also long-lasting object of conflict of power between the king, aristocracy and emerging burgher class. Last third of 19th century meant a crucial breakpoint for Czech brewing industry. Technological innovations[4)] together with industrialization of the manufacturing process have opened a wide opportunity to tap the economies of scale. This was crucial for further development in Czech beer industry, and emerged characteristics could be observed until today. Fast growth of the industry created sustained excess of supply over domestic and even foreign demand (Kratochvíle 2005). Therefore industrial breweries launched an aggressive campaign to increase sales, sometimes called "hectoliter fever" (Chládek 2007). Price-cutting strategies have been combined with subsidies for the retail segment of the market. This included either selling beer on credit or direct financial aid for purchase of tapping gears, ice and other necessities for beer distribution, in exchange for exclusive supply contracts. Czech brewing industry has maintained this highly competitive atmosphere until now. Despite the fact that communist and its central planned economy (from 1948) have broken much of previous price settings, brewing industry and beer prices in particular remained almost untouched. Reason for this could bee seen in fact that governing nomenclature was treating beer as one of the basic food commodities which should be affordable to anyone. After the market control was relaxed in 1989, ancient cutthroat price cutting competition among the breweries has therefore reappeared with new intensity.

[3)] Source: Brauwelt - Brevier Statistical Survey

[4)] such as steam engine, Lindel's refrigeration machine and Pasteur's discovery of yeast cells.

In the Czech Republic and other countries with strong brewing tradition, beer is also perceived as a national article. Czechs as well as Belgians or Irish often pronounce that they are proud of their beer. Large and continuously increasing exports of Czech beer could serve us as evidence that it is perceived as guarantee of quality. Given the fact that Czech beer is, according to author's experience, being recognized by inhabitants of many countries, it could be also treated as a part of Czech "international fame". Even nowadays, consumers' fidelity to national or even local brands gives a rise to an interesting aspect of brewing industry. Customers often prefer local production to other brands, because they feel tied to its origins and tradition. Popular "gratitude" to local breweries is even expressed in various folk songs[5)]. However, this *Local Beer Patriotism*[6)] has its non-trivial market consequences. It is the main reason why beer never became one of really global goods. On the national level, beer patriotism seems to be the one of the reasons why even small breweries may survive current conditions of fierce competition.

For most of Czech people (shall we say, especially for men), beer is not a common commodity, just a popular drink or a simple means to get tipsy. This fermented substance has a very complex relation to Czech society both in individual and national scope of view. It has become a part of our customs, traditions or even rituals. The very cordial individual relationship between a drinker and his glass arises, in author's opinion, from the fact, that its consumption is being connected to various forms of relaxation[7)]. Moreover, alcohol has, at least in small volume, positive impact on actual consumer's mood.

In previous paragraph, the author did not intend to make an advertisement for alcohol consumption. The aim was to emphasize why beer could become so popular drink. Perhaps just the relative time-demandingness of its consumption has promoted beer to a socializing drink. Inviting someone for beer means expressing a friendly interest in talking with him for a longer than short while. In spite, inviting him for a shot of spirits means usually a shorter event. Moreover, the coldness and bitterness of beer often inspires the consumer to drink another glass,[8)] so that inns became a place of a really "long-term" socialization. Beer's capability to keep people at one place could be

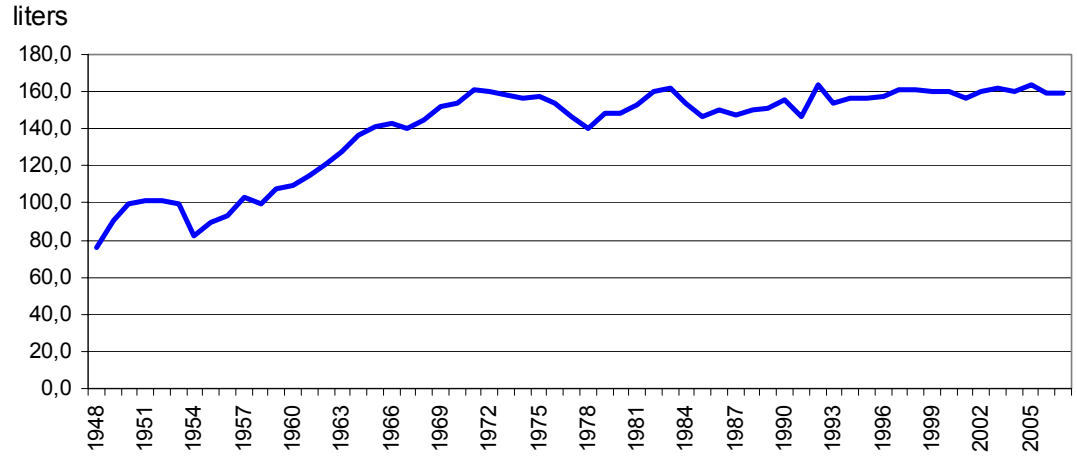
[5)] There is for example a still popular song blaming the fire-brigades that they let the local brewery fire down.
[6)] review Novotný (1997).
[7)] For more information about relaxing effect of beer drinking see article by Lachmanová (2004) – listed in internet sources.
[8)] Source: CMBA (2007).

illustrated also by important role of pubs and inns in Czech National Revival[9)10)] It is really difficult to decide, whether appetite for beer precedes need for conversation or if the causality is reversed. However, this does not decrease the importance of beer as a phenomenon which could enhance social cohesion and liven up interpersonal relations.

2.2.2 Beer, Statistics and Comparison in International Context

The space we spent above describing background of beer production in the Czech Republic was not purposeless. It was especially long tradition with consistently low prices which granted beer such a privileged position among other (not only alcoholic). It is perceived as an inseparable part of Czech cuisine as well as the most popular "social" drink. With consumption almost 160 liters per head, the Czech Republic is persistently "leading" world's beer consumer. If we realize, that this figure includes also abstinent and underage part of population, it means that each adult non-abstinent drinks on average at least one beer (half a liter) a day. In fact, the only region which would "outperform" the Czech Republic in terms of beer consumption would be Bavaria, if treated separately from other German states). Following figure illustrates the post-war development of Czech beer consumption. Please note the formidable stability from 70s until today.

Figure 3: Per-head Beer Consumption



Source: Czech Statistical Office

[9)] This is expression for Czech literal and nationally-political movement in 18-19 century.
[10)] Source: Novotný (1997).

To give a brief view into the composition of demand for beer we should say that about 64.72% of total production consists of mild beer, 29.82% of lager beer, 2.66% non-alcoholic beer, special and other beers account for 2.80%. Concerning beer color, pale beer accounts for 96.54% of production, dark beer for 3.43% and semi-dark beer for the remaining 0.03%[11)]. Average beer price taken from the Czech Household Budget Survey reaches CZK 23.01.

Despite the fact, that total beer production of around 19.8 million hectoliters does not qualify the Czech Republic in the group of first ten producers, the comparison relative to population shows the figures in brand new light. About 18% of the production is being exported (compared with only 13% of EU25 average), which ranks the Czech Republic as ninth biggest world beer exporter.

For list of leading beer producers, consumers and exporters see Tables 2, 3 and 4.

Table 2

World Leaders in Beer Production			
	Country	**2006 barrelage (mil. hl)**	**Share on world's production**
1	China	351.5	20.7%
2	USA	231.8	13.6%
3	Germany	107.2	6.3%
4	Russian Fed.	99.9	5.9%
5	Brazil	93.6	5.5%
6	Mexico	78.2	4.6%
7	Japan	63.0	3.7%
8	Great Britain	54.1	3.2%
9	Spain	33.6	2.0%
10	Poland	32.5	1.9%
--	**The Czech Rep.**	**19.8**	**1.2%**
--	**Total World**	**1 699.0**	**100%**

Per-head Beer Production			
	Country	**2006 barrelage (mil. hl)**	**Production per capita (hl)**
1	**The Czech Rep.**	**19.8**	**1.93**
2	Germany	107.2	1.30
3	Great Britain	54.1	0.89
4	Poland	32.5	0.84
5	Spain	33.6	0.83
6	USA	231.8	0.78
7	Mexico	78.2	0.73
8	Russian Fed.	99.9	0.70
9	Brazil	93.6	0.50
10	Japan	63.0	0.49
11	China	63.0	0.49
--	**Total World**	**1 699.0**	**0.26**

Source: Czech Beer and Malt Association

[11)] Source: Czech Beer and Malt Association

Table 3

Per-head Beer Consumption[12)]		
	Country	**2003 Per capita Consumption (liters)**
1	The Czech Republic	156.9
2	Ireland	131.1
3	Germany	115.8
4	Australia	109.9
5	Austria	108.3
6	UK	99.0
8	Belgium	93.0
7	Denmark	89.9
16	Finland	85.0
10	Luxemburg	84.4

Source: http://www.kirinholdings.co.jp

Table 4

World Leaders in Beer Exports			
	Country	**2006 Export (in mil. hl)**	**share of world's export**
1	Mexico	19.2	17.9%
2	Netherlands	17.7	16.5%
3	Germany	14.9	13.8%
4	Belgium	10.1	9.4%
5	Great Britain	5.3	4.9%
6	Denmark	4.4	4.1%
7	Ireland	4.1	3.8%
8	Canada	3.9	3.6%
9	**The Czech Rep.**	**3.7**	**3.4%**
10	USA	2.8	2.6%
	Total world	**107.8**	**100.0%**

Per-head Beer Exports		
	Country	**export per capita (in hl)**
1	Netherlands	1 075.8
2	Ireland	1 015.0
3	Belgium	974.3
4	Denmark	805.3
5	**The Czech Rep.**	**356.6**
6	Germany	180.7
7	Mexico	179.1
8	Canada	116.6
9	Great Britain	87.1
10	USA	9.3
--	**Total world**	**16.6**

Source: World Health Organization

Beer also plays an important role in Czech economy. Breweries' Sales reached CZK 25.2 billion in 2005, Value added counted for CZK 11.6 billion. This means 0.4% of nominal GDP[13)]. Note that these include only sales of breweries themselves. However, we should also include value added by malteries (CZK 447 million), hospitality and retail segment which would be quite difficult to estimate. Using

[12)] for more extensive list of countries see Appendix 5
[13)] source: CBMA 2008, CSO

estimates in a study by Ernst&Young[14)] for European beer production, total value added of all sectors attributed to beer production could be estimated to CZK 23.5 billion., and thus counts for 0.8% of Czech GDP. European average, for comparison, is only 0.55%[15)].

With CZK 2.2 billion paid in income tax, CZK 3.6 billion in excise tax and CZK 4.0 billion in VAT, brewing sector contributed 1.10% of government budget in 2006[16)]. This is of course a high ratio. However, it is still low compared to Belgian or Irish beer contribution (1.3% and 1.5% of total government income respectively)[17)], which is caused by relatively low beer prices in the Czech Republic compared to the western countries. Brewing industry also provides a large number of jobs. According to Ernst&Young, the Czech brewing industry employs directly about 8 600 workers, approximately 13 900 people in related supply fields, about 49 000 employees in gastronomic sector and additional 5 000 people in the retail sector of economy. Together this means almost 1.4% of Czech labor-force is connected to beer production or distribution. This is slightly above EU25 average, which is 1.2%. These figures have been also justified by estimates of Brau Beviale 2008 which account for around 164 000 direct employees and more than 2.6 million jobs indirectly connected to brewing.

Beer therefore seems to be not only an important component of Czech consumer's diet, but also an inseparable part of Czech economy. Given its high consumption it is also likely to induce large part of potential abuse costs.

[14)] Accorging to Ernst&Young (see Ernst&Young 2006), about 21% of value added connected to ber production is generated directly by the brewing sector, supply sectors count for 20%, hospitality sector for 56% and retail for the rest 3%.
[15)] for source of listed data see Ernst&Young 2006
[16)] As most of beer imports originates from EU member countries, beer customs gains to the national budget are almost negligible, amounting to about CZK 0.2 million.
[17)] source of data in the paragraph: Eurostat, Ernst&Young 2006.

2.3 Wine

2.3.1 Wine in Czech Society.

Given production of about 0.5 million hectoliters, the Czech Republic is considered to be a small world wine producer. Neither the average per capita consumption of 18.5 liters per year does rank Czechs among more than average wine consumers. Despite the above mentioned statistics and the fact that the Czech Republic does not have as favorable climatic conditions as for example Mediterranean countries, wine production and consumption has had significant impact on cultural evolution in some wine producing regions.

Generally, grapevine cultivation and production of wine has a long tradition in the Czech Republic. First grapes have been brought to Czech lands by Romans around 3rd century AD. However, real expansion of vineyards is dated from 13th century in Moravia and from 14th century in Bohemia region (thanks to Luxembourg dynasty). Reign of Rudolf II is then often called "golden age of Czech wine", as the area of vineyards reached 40 thousand ha. For comparison, this is approximately twice as much as in the beginning of 21st century. Given the fact, that population in 17th century was only fraction compared to that of todays, per head consumption must have been noticeably higher.

Unlike for brewing industry, viticulture has not undergone such dramatic changes during the global industrialization period. Wine production in is historically quite deconcentrated and from the ownership point of view, the Czech Republic is no exception. Reason for this is that wine producers still use very traditional technology, usually preferring quality to quantity. Viticulture is also often closely connected to family tradition. Unlike for micro-breweries, vineyards smaller than 0.1 ha are not subject to registration. Therefore real number of wine growers is likely to be even several times higher than of 20 000 officially registered (99% of whom are located in Moravia region). The slow process of industry concentration could be illustrated by the fact that whereas number of breweries decreased almost tenfold over 20th century,

number of wine producers remained quite high – around 850 registered wine producers[18)].

Despite the fact that Wine industry accounts only for about 6% of total Czech vegetable production, in some regions, its importance is non-negligible. In the Czech Republic, wine industry is geographically highly concentrated. About 96% of Czech vineyard area is being located in the South Moravian Region (one out of 14 Czech autonomous regions to the south-east of the country). This means approximately 18 000 ha out of total 18 700 ha of registered vineyards in the country. In many villages, more than 1/3 of population in productive age is economically engaged in viticulture. Again these numbers are even higher in reality as small vintners need not to register their production officially.

To summarize the employment importance of wine industry, grapes cultivation means a full-time job for about 10 000 persons. These numbers do not include self-suppliers, therefore real number of vintners is likely to be (even severalfold) higher[19)].

Wine production segment accounts for about 1200 jobs[20)]. Combining the estimates for breweries by Ernst and young (2006) and data from Czech Budget Survey, we could estimate number of jobs in restaurant and gastronomy sector related to wine to 10 500. Taken together, wine production and distribution concerns 0.4% of Czech labor force.

The role of wine in the Czech society is, to some extent, dependant on geographic location. In the South Moravia region, where most of the production is located, wine is a regular accompaniment of main dishes, inseparable part of friendly discussions and various feasts. In other regions, wine is drunk less frequently. Its consumption is often connected to relaxation and special events. Most usually, wine is being drunk in the evening or together with foreign cuisine.

[18)] Source: Czech Vintner Union

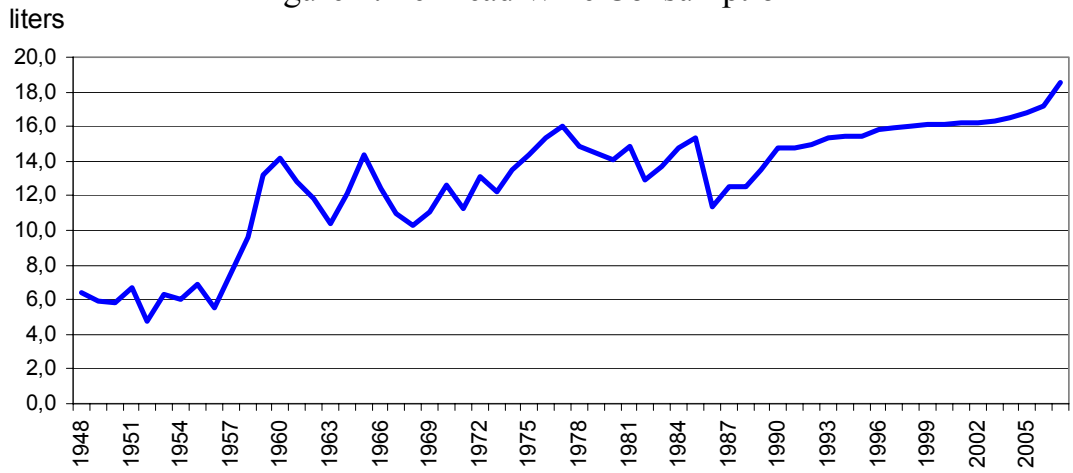
[19)] In our analysis, we do not take this part of wine production into account for obvious reason – it does not usually enter the market and thus is not likely to be much influenced by levied taxes (even if they were non-zero rate).

[20)] Grapes cultivation and fabrication of the final product are not necessarily separated (unlike for supply chain steps for other two beverages). The number of jobs in wine-production sector thus represents the industrial producers who specialize in grapes processing.

2.3.2 Wine, Statistics and Comparison in International Context

The composition of Czech wine production consists of about 69% of non-sparkling white wine and 30% of red wine cultivars. Sparkling wine accounts for only about 1% of production. The most common cultivars include Müller Thurgau, Riesling and Pinot Gris among white wines and Saint Laurent, Blauer Portigieser and Pinot Noir from the red wine specter. The per-head consumption of wine is growing steadily over the post war period, reaching 18.5 liters. However, this is only a third compared to leading consumers of Western Europe. For an overview of Czech wine consumption over past five decades see Figure 4.

Figure 4: Per-head Wine Consumption



Source: Czech Statistical Office

As mentioned before, the Czech Republic counts as only a small wine producer in international comparison. However, it is worth mentioning that due to strict EU rules on founding new vineyards in the member countries, area of vineyards has increased by about 22% in the years straight before the Czech Republic's accession to the Union. In other words, the vineyard area has been extended from about 15.7 thousands ha in the end 2002 to 19.2 thousands ha in 2005. The Czech government supported this process during the period with CZK 237 million. From this point further, the Czech Republic is only allowed to enlarge the cultivated area by 2%. However, even this extension did not change the country's position significantly. For wine statistics in international comparison see Tables 5 and 6.

Table 5

World Leaders in Wine Production			
	Country	**2005 barrelage (mil. hl)**	**Share on world's production**
1	France	56	20.7%
2	Italy	51	13.6%
3	Spain	42	6.3%
4	USA	19	5.9%
5	Argentina	15	5.5%
6	Australia	14	4.6%
7	China	11	3.7%
8	Germany	10	3.2%
9	South Africa	8	2.0%
10	Portugal	7	1.9%
--	**The Czech**	**0.6**	**1.2%**
--	**Total World**		**100.0%**

Per Head Wine Consumption		
	Country	**2005 Per head consumption (liters)**
1	Luxembourg	56
2	France	55
3	Portugal	53
4	Italy	51
5	Croatia	44
6	Slovenia	43
7	Switzerland	41
8	Argentina	33
9	Denmark	32
10	Hungary	31
11	Austria	31
--	**The Czech**	**16**

Source: The ISWR Global Wine Handbook

Table 6

World Leaders in Wine Exports			
	Country	**2005 Export (mil. hl)**	**Share of world's export**
1	Italy	9.7	21%
2	France	8.8	19%
3	Spain	8.8	19%
4	Australia	3.7	8%
5	Chile	2.8	6%
6	US	2.7	6%
7	Portugal	2.0	4%
8	Germany	1.9	4%
9	South Africa	1.8	4%
10	Argentina	0.9	2%
--	The Czech Republic	0.2	0.4%
	Total world	**46.3**	**100.0%**

Source: The ISWR Global Wine Handbook

The price of domestic wine varies largely with its quality from about CZK 25 for the cheapest junk wine, up to hundreds of Crowns for premium bottles. The average price taken from Budget Household Survey data reaches CZK 73.33 per liter.

Wine excise taxes do not play a crucial role in the national budget, as only sparkling wine (accounting for only about 1.2% of Czech wine production) is subject to tax. Moreover, tax receipts are highly correlated with quality of harvest, which is much more volatile than for other alcoholic beverages. In 2006, excise tax receipts reached

CZK 320 million, estimated VAT reached CZK 475 million and customs amounted to mere CZK 3 million (reason for such a low customs duty is a fact that most of imported wine originates in European union. In fact, the wine customs revenues shrunk almost six fold since the Czech Republic's accession). Estimated Income tax in 2006 amounted to CZK 62 million for the grapes cultivation segment and to CZK 95 million for the wine production segment. Again, we do not include tax income gathered from restaurant and hospitality sector as we treat them more as services sector.

To sum the above figures up, with tax contribution about CZK 0.9 billion wine industry does not seem to earn much funds to national budget (it is actually almost ten times less than for other segments). The real importance of wine industry for the Czech Republic arises from its cultural and employment aspects at regional level.

2.4 Spirits

2.4.1 Spirits in Czech Society.

Production and consumption of distillates does not have such ancient roots in Czech history as for viticulture or beer brewing. However, it has quickly gained a stable position among the other alcoholic brews. Despite the echoes of Soviet anti-spirits campaign during the Khrushchev and Brezhnev era, when spirits consumption was even lower than in the first post-war years, spirits' popularity set on a steep rise in 70s and per-head consumption has raised four fold since then. Spirits is with no doubt the most diversified class of alcoholic beverages including basically all drinks containing more than 22.5% of ethanol. The popularity of particular spirits has evolved over the time. Rum and rye distillates had been the most popular spirits in the beginning of 20th, but after the Second World War, vodka gained much popularity but was also replaced by another type of distillate. In the Czech Republic, unlike for most of European countries, prominent position among other spirits is held neither by whisky, nor by vodka. Far the most popular domestic distillates are herbal liquors, namely Fernet and Becherovka. According to the Union of Spirits Producers, herbal liquor account for 45% of Czech spirits consumption (Fernet is even counted among top 100 popular spirits).

Although first attempts for alcohol condensation in Europe had already been made by Greek alchemists, consistent method for alcohol distillation was not brought to Europe until Arabic physicians did so. Boom of alchemy in 13th century has extended

the knowledge to most parts of Europe including Czech lands. Moreover, until then, distilled alcohol has been used almost solely for (external) medicinal purposes. The most common source of distilled spirits was usually low quality wine[21)]. Due to the intensification of viticulture in Czech lands from 14th century, consumption distillates begun to spread gradually. Grapes were then progressively being replaced by other source of saccharide, mainly by rye, later on also by potatoes. The first regulation and tax legislation on distillery production is then dated to 17th century. A real boom of spirits production is connected with industrial revolution, particularly with the last third of 19th century. Similarly as in beer industry, distilleries begin a quick process of automation and centralization (both in geographical and ownership perspective).

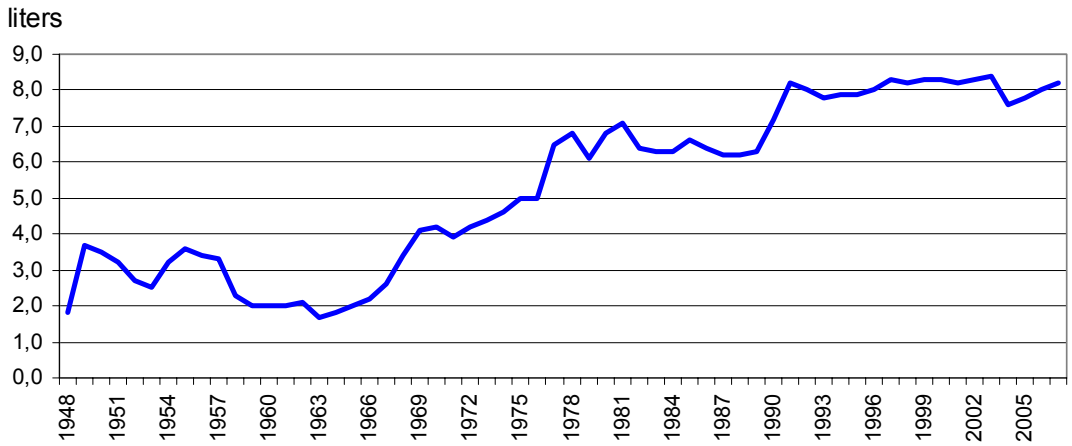
Spirits are being drunk at various occasions, also depending on geographic location. In some regions (mostly in Southern Moravia), where small private fruit distilleries are common, spirits very frequently serve as an aperitif or digestive drinks with almost each meal. Generally, spirits are drunk on celebrations occasions, "for courage" and sadly also with an intention to get drunk quickly. Many sociologists (see for example Csémy and Sovinová 2003) treat spirits as the most dangerous beverage for teenage groups right because the latter purpose. However, social dangerousness of spirits is slightly diminished by the fact, that even despite their price diversity, they are all relatively expensive source of ethanol compared to beer or junk wine.

2.4.2 Spirits, Statistics and Comparison in International Context

As mentioned before, consumption of spirits in the Czech Republic has undergone a period of enormous growth in 70s and when the anti-spirits atmosphere become has been relaxed. After it has leveled in 80s there is another jump in consumption in beginning of 90s when the markets had been opened for foreign production. Another trend consistent over time is growing women's share on total spirits consumption[22)]. According to the Union of Spirits producers there is also a significant negative relation between spirits consumption and degree of "automobilism" in the country. Trends in Czech spirits consumption are depicted in the figure below.

[21)] The appellation "spirit" originates from latin "spiritus vini" which means "spirit of wine" or "wine's soul".
[22)] Source: Union of Spirits Producers

Figure 5: Per-head Spirits Consumption



Source: Czech Statistical Office

As shown in the tables below, the production and exports of spirits do not rank the Czech Republic among the World's leaders, which is illustrated in tables 7 and 8.

Table 7

World Leaders in Spirits Production

	Country	2003 barrelage (mil. hl)	Share on world's production
1	UK	82 195	17.2%
2	China	57 749	12.1%
3	France	36 345	7.6%
4	Rep. of Korea	29 093	6.1%
5	South Africa	26 118	5.5%
6	Italy	24 219	5.1%
7	Poland	20 446	4.3%
8	India	15 486	3.2%
9	Viet Nam	15 079	3.2%
10	Venezuela	12 455	2.6%
11	Ireland	11 216	2.3%
22	**The Czech Rep.**	**5 764**	**1.2%**
--	**Total World**	477 741	**100.0%**

Per Head Spirits Consumption

	Country	2003 Per capita Consumption (liters of ethanol equivalent)
1	Rep. of Moldova	11.2
2	Saint Helena	10.8
3	Bosnia and Herzeg.	9.4
4	Bahamas	8.1
5	Haiti	7.6
6	British Virgin Isl.	7.5
7	Russian Federation	7.4
8	Saint Lucia	6.9
9	Latvia	6.8
10	Dominica	6.4
11	Martinique	6.2
12	Lao People's Dem. Rep.	6.0
--	**The Czech Rep.**	**4.4**

Source: World Health Organization

Table 8

World Leaders in Spirits Exports			
	Country	**2006 Export (mil. hl)**	**share of world's export**
1	UK	8.4	27.2%
2	France	4.2	13.7%
3	Italy	2.9	9.5%
4	US	1.3	4.2%
5	Ireland	1.2	3.9%
6	Mexico	1.1	3.7%
7	Spain	1.1	3.6%
8	Germany	1.0	3.4%
9	Netherlands	1.0	3.1%
10	Rep. of Korea	0.9	2.8%
11	Sweden	0.7	2.4%
12	China	0.4	1.3%
13	Russian Federation	0.4	1.3%
--	**The Czech Republic**	**0.1**	**0.3%**
--	**Total world**	**30 783**	**100.0%**

Source: World Health Organization

This group is naturally the most diversified with respect to all product attributes including alcohol content (basically from 22,5% for mild liquors up to more than 70% for some brands of absinth) and the price from CKZ 180 for the cheapest distillates (such as low-quality rum) up to hundreds of Czech Crowns for premium whisky brands. The average price observed in Czech Household Budget Statistics reaches CZK 230.09 per liter.

In 2006, Excise taxes on spirits production amounted to CZK 6.8 billion and customs reached only CZK 13.1 million[23)]. As mentioned before, excise taxes losses due to the illegal spirits production and distribution estimated by Ministry of Finance in 2006 exceed CZK 0.6 billion. Estimates of the Union of Spirits Producers are almost two times higher. However, the magnitude of illegal alcohol sales seems to be decreasing as the state regulation and penalization becomes more efficient over time. With income tax receipts of CZK 0.3 billion and CZK 0.3 billion of VAT income, total budget contribution from the spirits industry in 2006 reached CZK 7.4 billion, thus approximately 0.83% of Czech National budget.

[23)] Again, accession to EU meant more than significant reduction in customs gains. In case of spirits the reduction was almost thirty fold – from CZK 372 mil in 2004 to only CZK 13 mil in 2005.

Spirits employment statistics in the Czech Republic are much more problematic issue than data for previous two sectors. Only producers with more than 20 employees have to report to the official survey and this information is also unavailable for small fruit distilleries. In 2006 there were 185 direct employees in Stock Plzeň a. s., the largest Czech producer and only 99 employees in Jan Becher – Karlovarská Becherovka a. s., as the follower. The third and the last producer with market share over 10%, Palírna u Zeleného stromu – Starorežná Prostějov a. s., had 108 employees in the same time[24)]. Given the fact that above mentioned producers account for about 60% of total (legal) Czech production, and assuming that the ratio of product on employee could be from five to ten times lower for smaller producers (especially for small fruit distilleries), we come to an estimate of 1 200 workers in the sector. For comparison, the estimated number of jobs created by the spirits industry in whole Europe is 50 000 of direct jobs and 250 000 of places indirectly connected to distilleries[25)]. Following the same logic in case of the Czech Republic, we could state the mean estimate of the number of jobs indirectly related to (legal) spirits production to be 6 000.[26)] Again, economic benefits for society from illegal spirits production are very limited, as unregistered production by definition avoids or tries to avoid the most of the taxes. Together with the fact, that the number of jobs created in this "grey zone" should not be excessively large, it seems there is a fair justification to neglect the benefits of unregistered production to society.

[24)] Source for the data: Individual firms annualstatements accessed through www.justice.cz
[25)] Source: Brau Beviale (2008)
[26)] The alternative approach to estimating the number of jobs in spirit-related retail segment using estimates by Ernst & Young (2006) would lead to 5800 jobs. The similarity of the two results is quite encouraging.

3 Alcohol and the State

3.1 Alcohol and the Government - Historical Links

As mentioned in the previous chapter, alcohol has been in interest of governing authorities since the very dawn of Czech nation. As medieval rulers could hardly impose income taxes on their serfs, either because of lack of accountancy standards or because of large "barterization" of the economy, excise taxes offered a much more suitable way to gather resources to the state budget. With emergence of urban class, alcohol, namely beer, has become a tool of power as the ruler could use various privileges[27)] connected to beer production to promote his or her influence over society. With gradual extinction of guilds, this aspect became weaker. However, economical importance of alcohol excise taxes has had been growing. Transition from household production through manufacturing to industrial production has made tax control over the production much more simple and effective. The total volumes produced grew as well. The government's interest in alcohol taxation could be illustrated by the fact that excise alcohol excise tax legislation[28)] includes 36 articles, distinguishing various types of beer, wines and spirits, dividing beer producers into six categories according to their size, and stating a complex system of tax advance payments (ensurance). In fact the only more complex part of Czech excise tax legislation is the one, concerning tobacco products taxation.

Total tax receipts from direct taxes on alcohol amounted to CZK 10.7 billion in 2006. This figure is composed of CZK 10.7 billion in excise taxes and CZK 5.1 billion in other tax (income and VAT) revenues. Table 9 lists the tax contributions by particular alcohol industry segments in 2006. The number in brackets means its share relative to national budget.

[27)] Recall exclusive brewing rights or the "mile law", mentioned in chapter 1.2 *History of Czech Brewing.*
[28)] 353/2003 Legislation on excise taxes; 26th September 2003; article 66-100

Table 9

Tax Receipts (in CZK billion)				
	Excise	**Income**	**VAT**	**Total**
Beer	3.6 (0.40%)	2.2 (0.25%)	4.0 (0.45%)	**9.8 (1.10%)**
Wine	0.3 (0.03%)	0.1 (0.01%)	0.7 (0,06%)	**1.1 (0.12%)**
Spirits	6.8 (0.76%)	0.3 (0.03%)	0.3 (0.07%)	**7.4 (0.83%)**
Total	10.7 (1.20%)	2.6 (0.29%)	5.0 (0.57%)	**18.3 (2.06%)**

Source: Czech Ministry of Finance, Czech Beer and Malt Association, Czech Vintner Association, own calculation based on official annual statements of relevant firms. Annual statements accessed through from www.justice.cz.

Besides the economic revenues, in the past, control over beer production has also served as a tool to influence the public opinion and society as a whole. For example, it is legitimate to assume, that during the communist regime, the artificially low prices for beer have been enforced because of a belief, that large consumption of beer may keep people less discontent with the Establishment. On the other hand, the excise taxex imposed on alcoholic beverages, especially in northern Europe, might represent a common opinion that it is worth struggling against excessive alcohol consumption as it causes a large variety of costs to society.

3.2 Alcohol and the Czech Society

Modern national governments must take into account both revenues and costs of alcohol consumption while considering their policies. Moreover, as proposed for example by World Bank[29)], any anti-alcoholism policy should consist of a complex set of measures for reduction in alcohol consumption and its costs. This includes price increase (e.g. higher taxes), limitation of its availability (e.g. legal age restrictions, mandatory shop closures at predefined time, limiting the licenses for alcohol sale only to specialized vendors etc.).

[29)] Source: World Bank: Alcohol. 2007, available from http://web.worldbank.org/WEBSITE/EXTERNAL/TOPICS/EXTHEALTHNUTRITIONANDPOPULATION/EXTPHAAG/0,,contentMKD:20588494

Strength of voices calling for or against restrictions on alcohol consumption will be derived from two factors – the importance of beverage industry for the economy and the extent of alcohol consumption (or even abuse) in society. If there is a large export oriented beverage industry together with low level of alcohol consumption in the country, arguments emphasizing the revenues and positive impact on employment are likely to outweigh those calling for more restrictions. On the other hand, countries with minor importance of local brewing industry but high level of alcohol consumption could prefer to take some measures lowering the social problems and costs connected with alcohol abuse. This reasoning needs not to be applied for alcohol in general, but it can be used for analysis of particular alcoholic drinks separately. For instance, in United Kingdom, whiskey could be levied with less excise tax burden than beer, because only about 20% of whiskey production is purchased by domestic consumers[30]. On contrary, UK is the second biggest beer importer (net imports count for almost 10% of local beer consumption) and taken into account the fact, that average personal beer consumption is stably close to 100 liters per year,[31] it is likely that beer would be taxed more heavily than whiskey in UK.[32] However, in most of the countries, the magnitude of local beverage industry is tightly connected to the level of domestic alcohol consumption. For some countries, this statement holds even stronger if some beverage is considered to be a "national product" in the country. Frequent disputes accompanying creation of European Union policies concerning wine or beer production, lead mostly by France or Germany and the Czech Republic can serve us as a meaningful proof of how sensible these issues might be for some nations. Local governments of these countries must therefore be very careful while assessing the impact of their policies.

Concerning the Czech Republic, local government faces just the last type of situation mentioned above. Wine and spirits production would not be probably treated as one of the key parts of Czech economy. As mentioned above, wine consumption reached only 18.5 liters in 2007 (which means about 10% of total volume of alcoholic beverages consumed and only 20% of its pure ethanol content). Spirits per-head consumption reached 8.2 liters (meaning 4% of volume but 32% of ethanol content). However, as mentioned before, domestic production in wine segment is highly

[30] Source: www.whisky.com
[31] Source: Czech Beer and Malt Association, Ernst&Young 2006.
[32] This statement is being confirmed by the fact, that average excise tax of over € 75,5 per hl (Ernst&Young 2006) is one of the highest in Europe. On contrary, about 75% tax, including excise and VAT, is near to European average. (source: www.scotch-whisky.org.uk).

concentrated in southern Moravia (south-eastern part of the country). The same counts for concentration of small agricultural distilleries producing traditional fruit spirits. Therefore, tax policies concerning wine and agricultural production of spirits are very likely to elicit awkward response on regional level. Beer industry, on the other hand, is not regionally concentrated. However, it is definitely an important part of national economy, employing over 76 000 people, which 1.4% of Czech labor-force respectively. On the other hand, beer annual consumption reached 158.5 liters per head which means 48.1% of pure ethanol consumed. These statistics should be also accompanied by the fact that beer is the reason for sojourn of (approximately) seven out of ten patients in detention centers for drunk[33)]. Given these figures, we could argue that among all three beverages, beer tax policies are likely to have the biggest impact on both social costs on one side and national budget on the other.

3.2.1 Approaches to Alcohol-related Social Optimality

Literature on alcohol abuse costs has been always facing many conceptual problems. The most important difference between particular studies is usually the point of view, they are taking. Some researchers examine the problem from the government point of view, emphasizing its impact on income and excise tax revenues, customs, costs to the national healthcare and pension systems and costs related to alcohol-related criminality treatment. As mentioned for instance by Chalupka, Grossman and Saffer (2002), this approach might be particularly appealing when we realize that some of the above mentioned effects are likely to be closely interconnected and many of them do have opposite effects. For example alcohol-related mortality has negative impact on income tax revenues on one side but causes some level of savings in pension system. The addictive nature of alcohol offers even more interesting questions concerning excise tax revenues optimization. When perceived of purely material perspective (thus regardless any moral concerns), there might be even such set of conditions under which it would be rational for government to support alcohol consumption for sake of future tax revenues.

[33)] Source: Personal interview with Tibor Levák, head of alcohol detention centre in Jihlava.

Macroeconomic point of view covers all types of abuse costs e.g. both external (caused by the abuser but born by other members of the society, such as above mentioned healthcare costs, criminality etc.) and internal (thus with impact on the abuser himself, such as his or her own contribution to medical treatment, loss of income[34)], social prestige etc.). From the macro-perspective, any of these costs is in fact damaging the economy as a whole as even the personal income decrease is reflected (perhaps multiplicatively) in the whole economy. Note that transfers within the society (e.g. social benefits) are usually not counted in because total welfare of the society remains unchanged. However the transaction costs of these transfers should be included. This approach, indeed, needs really broad scope of research and implies large extent of estimation often without hope for obtaining solid statistical evidence.

Third possible point of view is built upon microeconomic investigation of consumer behavior, which is also a perspective taken by this study. Assuming that each drinker (including those whose consumption is treated as abusive), is aware of all own alcohol-related costs he is going to bear, such internal costs became a part of consumer decision and thus count as a result of consumer optimization. Let us assume that social welfare is a sum of individual welfares of its members. If none of those individual choices influences anyone else's welfare than, by definition, outcomes of individual utility maximization are also socially optimal. However, the latter assumption does not hold in general and in case of abusive alcohol consumption it is legitimate to assume that it does not hold at all. It is this utility "overlap", which is usually denoted as "external cost", which is of crucial interest to alcohol cost studies (let us name at least Saffer and Chalupka, 2002 or Pogue and Sgotz, 1989). External costs are then usually perceived as negative externalities[35)], economic distortions to the optimal allocation, which should be possibly compensated by some political measures such as taxation. Concerning treatment of externalities we often speak about Pigouvian tax, named after famous pioneer of welfare economics Arthur C. Pigou.

The above mentioned reasoning does have, of course, numerous pitfalls and is backed by lots of strong assumptions. First, this approach assumes it is possible to construct social welfare as an additive aggregation of individual welfares. This is an extremely strong assumption as it implicitly presumes that utility of each member of the

[34)] Rice et al. (1990) tor example estimated that income losses of alcohol addicted persons range from 1.5% to 18.7% in the U.S.

[35)] An economic actor is said to produce a negative (or positive) externality if he does not fully account for all costs (or benefits) of his or her actions.

society could be expressed in monetary terms, in other words we expect existence of cardinal utility function. Moreover, by assuming that social transfers per se are neutral with respect to the social optimum, we impose even more thigh restriction on individual welfare functions. Not only that each individual must follow the same welfare function, but in order to keep neutrality of transfers (note that at the whole-society level, tax could be perceived as simple money transfer), such function must exhibit constant returns to scale. In other words, it must be assured that marginal disutility from one currency unit taken from one member is equl to the marginal utility of any other member of the group to whom the unit is given. As a result, individual welfare functions must be linear and with the same slope. For further general discussion on welfare functions author would refer to another of the founders of modern welfare economy, Abram Bergson (1938).

It might also be legitimate to argue, that not all alcohol consumers, especially those who are considered to be abusers, are really aware of the full set of consequences their drinking habits might bring to them. This argument is particularly valid given the addictive nature of alcohol. It is also one of the reasons, why there is much research attention being paid to drinking patterns and related problems in youth population group, which is considered to be more likely not to be aware of all possible consequences of their behavior.

There are also many practical objections to the model. The problem is really complex and even if we would be able to identify each of the alcohol consumption related problems, it would still be hard to compare evaluate their importance in cardinal manner. It is also difficult to draw any precise line between the drinkers who do not cause any external costs and those whose abusive consumption causes such externalities, and any analysis must be again based on another assumption. This study does not undertake to solve nor overcome all above mentioned objections, which even may not be possible. However in following text, we should be always aware of the above mentioned assumptions and their implication to our models.

3.2.2 Social Costs of Alcohol Consumption

Despite the fact that consumption of alcohol brings many pleasant moments to the drinkers' life, it has also some seamier sides. Alcohol consumption might cause many problems both for the individual user and for society as a whole. Medical research has

confirmed a strong connection between alcohol consumption and various diseases and health complications (see for example Nešpor 2003 or Grant and Hartford 1991). Many of them are even treated as directly caused by alcohol consumption (for an illustrative list of selected alcohol-caused diseases see Appendix 4). Moreover, alcohol is also proven to increase the rate of car accidents and other injuries, decrease labor productivity, increase criminality, be the primary cause of many conflagrations and last but not least levy high intangible costs to the abuser's environment, especially to his or her family.

During the last decades, numerous economic studies estimating economic costs of alcohol consumption have been published. Despite many similar features within these papers, there is also large variance in their methodology and also a significant difference in their results. For illustration see the following table of selected studies and estimated alcohol consumption costs expressed relative to a country's domestic product.

Table 10

International Comparison of Alcohol-related Costs		
Study	**Country**	**Total costs as share of local GDP**
McDonnel & Maynard (1985)	Great Britain	0.5%
Adrian (1998)	Canada	1.6%
Rice et al. (1990)	U.S.	1.7%
Nakamura et al. (1993)	Japan	1.9%
Collins & Lapsley (1996)	Australia	1.0%
Single et al. (1998)	Canada	1.1%
Harwood et al. (1998)	U.S.	2.3%
Fenoglio et al. (2003)	France	1.4%
Review of literature by Anderson & Baumberg (2006)	E.U.	1.3%
Chung et al. (2006)	Korea	2.9%

Let us now focus on all the types of possible alcohol costs separately and relate them to the Czech situation. Local literature is rich in studies on the alcohol-health relationship, however there is no research covering estimates of socio-economic costs of alcohol consumption (with the exception of precise alcohol-related car accident statistics). For this reason, we will often need to follow the approach of other Czech researchers (see for instance Nešpor 2007) and use data from other European studies, which are summarized in a study by the Institute of Alcohol Studies (Anderson and Baumberg 2006).

The healthcare cost of alcohol consumption does not primarily consist of alcoholism treatment – in fact, the opposite is the true. For most countries (The Czech Republic being no exception) willingness of their addicted inhabitants to undergo medical treatment is pitifully low, usually reaching single digit percent shares (Nešpor 2007). This even occurs, despite the fact that for most of the member countries there is a slight improvement to this statistic, resulting from legislation – the protective alcoholism-treatment which is ordered by the court as a part of a sentence. A much larger part of healthcare costs is related to various diseases and health-complications directly or indirectly connected to alcohol consumption. According to the EU Commission[36)] alcohol is a net cause of 7.4% of ill-health and early death in the EU. Let us also mention that Příbramská (2007) states that about 50% of liver cirrhosis occurrence in the Czech Republic could be directly attributed to alcohol abuse. We also need to mention that a lot of medication does have contradictive or multiplicative effects in combination with alcohol, which may even result in the need for hospitalization. Using the results by Anderson and Baumberg we could estimate expenditures connected to treatment of alcohol related health problems in 2006 to CZK 6.7 billion. Costs of alcoholism treatment and prevention amount to CZK 2.0 billion. However, even these numbers need not to be finite. Ray et al. (2007) show that families of alcohol and drug addicted persons exhibit larger rates of health problems even for the non-addicted members.

The most significant losses to society with connections to alcohol arise as a loss of productivity. In literature, the most common approaches to this problem usually take into account multiple types of losses. First, the loss of productivity because of increased absence and loss of work effectiveness while influenced by alcohol consumption, which could be estimated to CZK 4.7 billion. For illustrative purposes let us say that, according to Anderson and Baumberg, alcohol was responsible for about 200 000 bouts of depression which means over 2.5 million disability-adjusted life years (DALY). Second, the income decrease due to job losses, because of alcohol-related reasons is estimated to be CZK 4.9 billion. Third, it is necessary to evaluate the lost labor potential due to premature death. Anderson and Baumberg report that after including positive

[36)] Source: COM(2006) 625, "An EU Strategy to Support Member States in reducing alcohol related harm.

health effects of alcohol consumption[37] alcohol is still a cause of premature death or disability for 12% of men and 2% of women. This ranks alcohol as the third most serious risk factor (after tobacco and high blood pressure). In the European context (in 2003) the alcohol death toll includes 17 000 deaths through car accidents, 27 000 mortal injuries, 2 000 murders (40% of all murders and manslaughters), 45 000 deaths due to liver cirrhosis, 50 000 due to cancer, 17 000 due to neuro-psychiatric problems. For the Czech Republic the estimated loss of production potential due to alcohol related death is then CZK 14.2 billion[38]. An interesting study by Renna (2007) also suggests that teen drinking may often postpone student graduation which means a loss of productivity to society. Moreover, Renna shows that there is a significant negative relationship between the age of graduation and the student's future wage.

Despite the fact that the Czech Republic legislation requires zero blood alcohol content, there were 8133[39] car accidents in 2006 (which is more than 4% all accidents in the country) where at least one participant driver was under the influence of alcohol. Alcohol was also responsible for more than 6% of all deaths in car accidents (in 2008 this ratio was even higher than 8%). More than one out of three alcohol-related car accidents result in injury. According to the Ministry of Transport, the probability of contributing to a car accident increases exponentially with blood alcohol content. Whereas with 0.05% content the probability is two times higher compared to being sober, with 0.18% the probability is about 30 times higher. It is also worth mentioning that most of the car accidents when under the influence of alcohol occur within the first three kilometers of the journey. It is also important to mention, that alcohol is responsible for one third of car accidents caused by pedestrians. Based on data from the Ministry of Finance, the estimated tangible cost of car accidents while under the influence of alcohol in 2006 amounts to CZK 0.5 billion. It is also worth mentioning that alcohol-related car incidents are closely linked to alcohol-related costs of crime as 60% of the incidents are treated as negligent crime.

Alcohol and crime are often closely linked, either concerning violent criminal acts committed under its influence, robberies because of alcohol addiction or mentioned

[37] mostly the postponement of death due to cardio-protective effect (particularly important for women above the age of 70)

[38] This estimates of lost productivity because of death are usually subject to large variance across the studies depending on used method for evaluation of the value of life. Anderson and Baumberg (2006) estimate € 36 billion lost economic income and € 145 – 712 billion as lost value of the life itself. In our analysis, we stay with the first figure treating only the economic loss.

[39] Source for all figures in the section: Czech ministry of transport; www.ibesip.cz

negligence crime connected to driving and other activities. Generally, crime-based costs of alcohol consumption include Police, prison and law costs. Last but not least we should also count in the lost economic potential because of lost imprisonment. These costs do not include only the dropout in income during the time of arrest in jail. There is also a significant reduction in future income because of the record in the criminal register. Using again the European data, we could estimate the legal costs of alcohol-related crime to CZK 5.9 billion, crime prevention (e.g. by police) and insurance costs to CZK 4.7 billion and property damage (excluding those from vehicle crashes) to CZK 2.4 billion.

Besides the above mentioned expenditures, there is also a set of intangible costs of alcohol consumption. Abuse of alcohol may adversely influence the social surroundings of the abuser. Using again the results by Anderson and Baumberg, we could estimate the intangible costs caused by Czech alcoholics to their families. On a European level, this category would include: problems of families from the 23 million people addicted to alcohol; 115 thousand families with a member lost due to alcohol consumption (this number already accounts for estimated cardio-protective effect of moderate drinking); unprotected sex by about 4% of 15-16 years old students; one out of six abused children, 5 – 9 million children living in a family adversely effected by alcohol; about 60 000 newborns with below standard weight and millions of people injured in alcohol originated brawls. This list is certainly not complete. Apart from these mentioned aspects, there exist many others for which the estimation of costs could not be done because of lack of data or the impossibility of their effect quantification. Using the aggregate results by Anderson and Baumberg, we estimate the costs to Czech families because of their members' alcohol consumption, to be CZK 26.8 billion and the intangible costs of physical and psychological consequences of alcohol-related crime to CZK 6.3 billion.

Last but not least it is worth mentioning an interesting issue of the relationship between beer drinking and smoking. It is broadly accepted in academic literature (Rajeev and Morey 1995) that for non-negligible part of drinking population (drinking of beer in particular) may increase their desire for cigarette. However, it is extremely difficult to evaluate this relation as the causality may be also reversed (it is questionable whether a cigarette evokes a desire for a drink or, on the contrary, if the cigarette is only an accompaniment of the glass).

In all of the above mentioned estimates, we could not avoid large generalization and it is legitimate to assume that our estimates would be largely inaccurate, as we needed to use average European data as a basis for the calculation in those areas, where appropriate Czech data was not available. However, now we face two other analytical problems. First, we need to determine which part of the cost is internal to the abuser (and thus is an implicit part of his or her consumer optimization problem) and which part is external (born by other members of the society). It is the latter part, which would be of crucial interest to our analysis. As there are no descriptive statistics covering this problem directly, it will be necessary to use partial statistics and best-guess estimates for each of the cost category.

According to the data from CSO, the average individual contribution to costs of drugs and medication in the Czech Republic is 62%. This ratio, however, decreases with the seriousness of the illness. Therefore a reasonable estimate for alcohol-related problems could reach 50%.

Alcoholism treatment therapy as well as preventative measures are fully covered by the national budget and thus treated entirely as external to the abuser.

The loss of productivity measures should probably be discounted with the effective personal income tax rate as it is the share of individual earnings which, roughly speaking, goes to the public budget. The effective income tax rate in 2006 was 42.7%[40)]. This factor applies to the productivity decrease caused by reduced effectiveness, job losses as well as alcohol-related mortality.

In the Czech Republic, car accidents cost are almost entirely covered by mandatory car insurance. At first glance this would suggest that these costs belong fully to the internal category. However, there are positive external costs caused by a well-known free-rider effect. Let us divide drivers into two theoretical groups – safe drivers, whose chance to cause an accident is primarily influenced by factors beyond their control, and hazardous drivers (including those who drive under the influence of alcohol), whose chances being increased by their own irresponsible behavior. Because the expense of a car crash is much larger than any single policyholder would pay within a short-run period, there is an implicit transfer of funds from those who do not cause accidents to those who do (including alcohol abusers). If we assume that the average blood alcohol content of drivers participating in alcohol related accidents would be

[40)] This rate was calculated given average nominal wage and includes taxes and social insurance payments by both employee and his or her employer.

0.05% then, given the fact that this concentration doubles the normal probability of participation in a car accident, we end up with 50% of external to the abuser. Together with average individual financial participation of roughly 9% of the damage in each accident caused[41)], this means that final share of external costs from all alcohol-related car accident costs would be around 45.5%.[42)]

According to the police statistics, the effectiveness of legal costs repayment enforcement on real culprits reaches only 30%. The remaining 70% of the costs thus enter our model as costs external to the abuser. Concerning property damage, the situation is likely to be even worse. No precise statistics for this issue exist. However, if we take into account, that this category consists mainly of vandalism damages and to the lesser extent of alcohol-related non-transport accidents, our best-guess estimate for the externality ratio would be around 80%.

The second analytical problem concerns the distribution of estimated eternal costs between our three beverages. According to Nešpor[43)], health consequences and medical treatment of alcohol abuse and its repercussions, are basically independent from the type of beverage preferred by a particular abuser. Based on common observations, it is also legitimate to assume, that for some groups of abusers, seeking for the cheapest source of pure alcohol content is the key demand factor. Therefore we could assume that one liter of pure ethanol has the same social cost no matter what form it is drunk. However, the distribution of the number of abusers may not follow the aggregate pattern. To tackle this, we will introduce two scenarios. In accord with literature (see Chalupka 1994), the author suggests that the best-guess estimate should be based on content of pure alcohol consumed from particular beverage (hereafter "Proportional scenario"), which is quite stable over time, reaching 48.08% for beer, 20.38% for wine and 31.54% for spirits[44)]. Alternatively, we could use the proportions patients in alcohol detention centers for these particular beverages (hereafter "Detention Centers scenario"). These are approximately 70% for beer, 10% for wine and 20% for spirits[45)]. Note that we do not claim that alcohol content in some particular beverage per se is more harmful. The difference is in the number of abusers connected to each of the drink

[41)] According to data by the Ministry of Transport and the Police, average cost of an accident with the influence of alcohol reaches CZK 58 700, which is about 23% higher than average cost across all accidents without alcohol influence.
[42)] Source for the paragraph: Czech Home Office
[43)] Personal communication with the Author, 12.5. 2008
[44)] Source: Czech Statistical Office, data for 2006
[45)] There are no precise statistics for this distribution, the mentioned numbers consist of qualified estimates by detention centres' representatives.

groups. Later in the final phases of our model we will use both these alternatives to show their impact on the result. For an overview on alcohol consumption distribution see table 11.

Table 11

Czech Alcohol Consumption Statistics in 2006				
Beverage	**Per capita consumption of the beverage**	**Per capita consumption in ethanol equivalent**	**Share on total ethanol consumed**	**Approx. share of patients in alcohol detention centers**
Beer	159.1	5.0	48.1%	70%
Wine	17.2	2.0	20.4%	10%
Spirits	8.0	3.2	31.5%	20%
Total	**184.3**	**10.2**	**100%**	**100%**

Source: Czech Statistical Office

Combining the facts and estimates mentioned above we finally reach expected values of losses caused by consumption of individual beverages. These are listed in table 12.

Table 12

Total Costs of Alcohol Consumption in 2006						
	Proportional scenario (CZK billion)			**Detention Centre scenario (CZK billion)**		
Beverage	**Tangible Costs**	**Intangible Costs**	**Total**	**Tangible Costs**	**Intangible Costs**	**Total**
Beer	22.1	15.9	38.0	32.2	23.2	55.3
Wine	9.4	6.7	16.1	4.6	3.3	7.9
Spirits	14.5	10.4	24.9	9.2	6.6	15.8
Total	**46.0**	**33.1**	**79.0**	**46.0**	**33.1**	**79.0**

Source: Own calculation based on Results by Anderson and Baumberg and Czech Statistical Office

In our model, we are interested in that part of alcohol-related costs, which is external to the abuser. Using the estimates for externality ratios of individual types of alcohol abuse costs mentioned above, we summarize the external costs in table 13.

Table 13

External Costs of Alcohol Consumption in 2006						
	Proportional scenario (CZK billion)			**Detention Centre scenario (CZK billion)**		
Beverage	**Tangible Costs**	**Intangible Costs**	**Total**	**Tangible Costs**	**Intangible Costs**	**Total**
Beer	11.4	15.9	27.3	16.6	23.2	39.7
Wine	4.8	6.7	11.6	2.4	3.3	5.7
Spirits	7.5	10.4	17.9	4.7	6.6	11.3
Total	**23.7**	**33.1**	**56.7**	**23.7**	**33.1**	**56.7**

Source: Own calculation based on Results by Anderson and Baumberg and Czech Statistical Office

Despite the fact that aggregate external costs for both of our scenarios vary significantly, the underlying assumption of equal harmfulness of their alcohol content leads us to estimates of costs per liter as depicted in Table 14.

Table 14

Per liter Costs of Alcohol Consumption in 2006		
Type	**Total Costs (CZK)**	**External Costs (CZK)**
Tangible	429.5	246.1
Intangible	309.1	309.1
Total	**738.6**	**555.3**

Source: Own calculation based on Results by Anderson and Baumberg and Czech Statistical Office

Now let us compare these figures with those from the more favorable side of alcohol. In the following chapter we will examine various benefits and gains to the society due to its production and consumption.

3.2.3 Alcohol Production Benefits

Whereas most of the social costs analyzed above concern adverse circumstances of alcohol consumption, most of the benefits to society arise from the production side of the business. Next, in the case of costs we need to take simplifying assumptions that the cost for a particular beverage is proportional to the volume of pure ethanol it contains, concerning benefits we should be able to list them individually for each beverage. Let us recall that we examined the benefits of alcohol production from the perspective of the whole society and we are not interested in benefits which are internal to the producer (or consumer) but the in the benefits for the other members. We will now introduce the most important types of contributions together with their economic evaluations (aggregated across all three beverages). First, we will name the straight forward benefits which arise directly from the production of alcohol as a commodity. Then we will continue with those benefits which are linked to alcohol production in an indirect manner.

Perhaps the most obvious revenue in this respect is the tax receipts. There would hardly be any dispute to including the contribution represented by excise tax receipts, which reached CZK 10.7 billion[46)], as it is exclusively linked to alcohol production. Because the burden imposed by this type of tax is carried solely by the commodity producers, excise tax is a natural candidate for our Pigouvian taxation. Although the focus of this study is to calculate the tax just in terms of *ceteris paribus* total price increase, we tacitly assume that it would be done using some sort of excise tax. Excise revenues are also the most precise part of the calculation as the statistics are gathered by the Ministry of Finance separately for each beverage.

Value added tax (hereafter VAT) represents another important revenue for the national budget. Unlike excise taxes, in the case of VAT there is no tax evidence which would treat individual beverage production separately, so that we need to estimate the values based on our estimates of value added within each sector. For the brewing industry we use the estimate by Ernst & Young (2006). For the other two beverages, a representative sample (accounting for more than 50% of the industry) of the firms' value added figures has been taken from their annual statements and extrapolated to the rest of the industry. This approach was particularly necessary for the wine industry where the number of wine producers is large and some of the producers are not necessarily obliged to publish their annual statements. The 2006 added value in (the legal part of) the alcohol-producing industry could be estimated then to CZK 25.3 billion which means CZK 4.8 billion in VAT[47)].

A similar extrapolation approach has been used for assessing the corporate income tax revenues of economic subjects in the three industries. However, we need to mention that this estimate is likely to be subject to large variance. Whereas the value added per volume unit of production is more or less comparable across all producers within each industry, profit proportions differ heavily from firm to firm (and also in time). Taking the above caution into account we use CZK 2.6 billion as the best-guess estimate for corporate income taxes revenues in alcohol-producing segments.

Let us now concentrate also on the indirect benefits to society brought about by alcohol production, which are the most important and relevant for the Czech environment. Among the tangible benefits we will focus on job opportunities in the sector and tourism enhancement. Concerning the intangible behoof of alcohol

[46)] Separate figures for beer, wine and spirit industry will be listed in the end of this chapter
[47)] In 2006 the VAT tax rate was 19% for most of the consumer goods, including alcohol.

consumption, we will mention the health effects of moderate alcohol consumption together with a phenomenon we could call cultural cohesion effect.

When assessing the impact of alcohol production on employment, we should again approach the problem from the perspective of external benefits. We should therefore include personal income taxes paid by the employees in the sector. For this purpose we use the official monthly average wage of 20 221 CZK[48)] as an approximation (as the average wage figures of selected alcohol producers' annual reports show only modest variation from this value, it seems like a suitable approximation). Given the effective income tax rate in 2006 of 42.7%[49)], we expect the alcohol industry income tax revenues to be CZK 10.9 billion.

It is legitimate to assume that besides the natural and historical jewels of our country, famous Czech beer is one dominant tourist attractions as well. For example, some breweries launched projects of "beer trails" which could attract tourists' attention by offering special programs connected with beer degustation, brewing exhibitions and countryside sightseeing.[50)] Beer is also one of the key components of Czech Tourism's fairs while promoting the Czech Republic abroad[51)]. Analogically, wine tourism is well developed in Southern Moravia (the south-eastern part of the country), including various wine festivals, visits to traditional wine cellars and the recently launched project of "wine trails" (historically-educational tracks for cyclists). Thus alcohol does not contribute only through taxes but also in increased incomes from tourism. If we assume that 3% of tourists are dragged to the Czech Republic by their interest in local beer and wine (which might be a rather conservative estimate), the tax income from implicit foreigners spending would be CZK 3.7 billion[52)]. For the purpose of our model, we need to split this estimated amount between the three beverages. After consulting with several restaurant managers, authors propose a 95%, 5% and 0% split (for beer wine and spirits respectively). The reason for such an asymmetric shift is that although the tourists usually consume wine and spirits in proportions larger than the domestic average, for those whose attention was captivated by or at least supported by Czech alcoholic beverages, beer was almost always the most attractive drink. Most of the

[48)] Source: Czech Statistical Office
[49)] This rate includes taxes and social insurance payments by both employee and his or her employer.
[50)] See: http://www.pratelepiva.cz/svet-piva/pivni-turisticke-stezky
[51)] Czech Tourism is an agency promoting the image of The Czech Republic as a Touristic destination all around the world. For moer information see www.czechtourism.cz
[52)] Total foreigners spending attributed to tourism has been CZK 124,7 billion in 2006. Source: www.czechtourism.cz, Ministry of Finance.

wine-related tourism in the Czech Republic is actually attributed to domestic holidaymakers.

Recent studies also confirm that moderate[53)] consumption of alcohol might even bring healthy benefits to the drinker, both from psychological and physical perspective. A review of literature by Baum-Baicker (1985) suggests that alcohol consumption can reduce stress, promote conviviality and pleasant carefree feelings. In the elderly, moderate drinking has been reported to stimulate appetite, promote regular bowel functions and improve mood. There is also a considerable body of evidence that low levels of alcohol consumption decrease mortality especially in coronary artery diseases both for men and women (see Boeffetta and Garfinkel, 1990 or Stampfer et al., 1988). Some researchers (see Marmot and Burnner, 1991) have suggested that the above mentioned results are heavily biased by the fact that higher mortality among abstainers results from including among them co called "sick quitters", people who have stopped drinking because of ill health. However, studies investigating the "sick quitter" effect (see Klatsky et al., 1990), do not support that conclusion stating that including this group into the abstainers category cannot completely explain the apparent protective effect of moderate alcohol drinking against coronary diseases. An economic evaluation of the above mentioned benefits is usually reflected directly as a reduction the alcohol-induced healthcare costs, the same approach has been taken by our study.

The most difficult contribution to evaluate seems be the cultural benefits from alcohol consumption. Pubs have always served as places to meet new people, to talk with friends or business partners, to settle past quarrels and to make plans for the future. In our analysis we label this group of benefits as *cultural cohesion effects*. It would be extremely difficult to evaluate these benefits in money terms. In the author's opinion, these benefits could reach billions of Czech Crowns. There is some evidence in literature testifying to this proposition. Park (2004) notes that U.S. college students reported that positive drinking outcomes (being less shy, getting to know someone better, expressing oneself, sharing optimism) were more common and "extreme" than negative outcomes. However, research in this area is very fragmented so far and authors usually stay with small-scale experiments (conducted usually in with a specific group of individuals, e.g. students) and thus the possibility of extrapolation of the results to the

[53)] According to NIAAA, moderate drinking is considered as daily consumption of from one to two *drinks* for men and one *drink* for women, where standard *drink* means one glass of wine, half-litre of beer or a shot of spirit, thus approximately 20 g of ethanol.

whole society is limited. Therefore our study will stay with highlighting such benefits without any vague attempt for their valuation. For list of direct and indirect external benefits from alcohol production see tables 15 and 16.

Table 15

Estimated Direct Contribution of Alcohol Production in The Czech Republic				
Contribution	**Excise tax (CZK billion)**	**VAT (CZK billion)**	**Income Tax (CZK billion)**	**Total**
Beer	3.6	4.0	2.2	**9.8**
Wine	0.3	0.5	0.1	**0.9**
Spirits	6.8	0.3	0.3	**7.4**
Total	**10.7**	**4.8**	**2.6**	**18.1**

Source: Own calculation based on the sources listed in the text above

Table 16

Estimated Indirect Contribution of Alcohol production in The Czech Republic			
Contribution	**Tourism Enhancement (CZK billion)**	**Personal tax and employment (CZK billion / No. of jobs)**	**Total**
Beer	3.6	7.9 / 76 000	11.4
Wine	0.2	2.3 / 22 000	2.5
Spirits	0.0	0.7 / 7 200	0.7
Total	**1.6**	**10.9 / 105 200**	**14.6**

Source: Own calculation based on the sources listed in the text above

In our models later on, we will be primarily interested in benefits per liter of ethanol equivalent. The results of this calculation are depicted in Table 17

Table 17

Estimated Per-litre Benefits From Alcohol Production			
	Direct contribution (CZK/litre)	**Indirect contribution (CZK/litre)**	**Total contribution (CZK/litre)**
Beer	190.53	222.11	412.64
Wine	50.44	113.05	163.48
Spirits	219.31	22.10	241.41
Total	171.05	136.80	307.85

Source: Own calculation based on the sources listed in the text above

The results of this stage of estimation are not surprising. Beer seems to contribute a larger proportion of benefits per unit of pure ethanol, as its brewing is relatively demanding compared to its mild alcohol content. Moreover Czech beer is internationally perceived as a premium drink and thus earning significant profits either from exports or from revenues due to enhanced tourism. Wine on the other hand exhibits only minor direct benefits as all non-sparkling production is taxed at a zero rate and its production still relies more on an agricultural type of production than on the industrial basis. On the other hand, its benefits due to jobs created are significant. Moreover, we should be aware of regional importance, which could not be reflected in the table. Although employing the least people, spirit production exhibits quite a large contribution per unit of ethanol, mainly because of high excise taxes and high alcohol content in the final beverage.

Let us now make a short diversion to an important topic and let us focus in detail on one of the benefits mentioned above. In the next chapter, the importance of excise taxes for our modeling will be explained properly.

4 Selected Features of Czech Excise Taxes

Taxes imposed on alcohol production consist generally of many parts. However, most of them (income tax, corporate tax, land tax etc.) do not enter our consideration as they are common for all business sectors and thus are not likely to create any differences between alcohol and other commodities. Even VAT does not seem to cause many problems in our model. Although other food is taxed at lower rate of 9% (historically 5%), alcohol has always been in the normal tax category of 19% (historically 23% and 22%), and it is unlikely, that it would ever fall into the lower one. Therefore the only tax which distinguishes alcohol from most other commodities is excise tax. Moreover, being able to exclusively target alcoholic beverage, excise tax seems to be a suitable candidate for the Pigouvian tax calculated in our model.

Alcohol excise tax legislation has been always well elaborated, which reflects its relative importance for the national budget. Current regulation[54] treats beer, wine and spirits separately, creating for them a unique legislative framework. Let us therefore briefly mention these individual rules.

4.1 Beer Excise Taxes

Beer excise tax is far the most complex, perhaps for the historical and political reasons. Unlike for other two beverages, beer excise tax base is not derived from volume or pure ethanol content, but from volume and ratio of extract of original wart in the brew. This ratio is calculated ex post using simplified or full version of Balling formula[55]. Usually, alcohol content of 4% roughly corresponds to 10% of original wart. Actual tax bracket is then dependant on the size of a brewery, offering a tax advantage

[54] law 353/2003 Sb.

[55] Simplified Balling formula: $p = \frac{E_S - E_Z}{q} + E_s$ where p is the original wart ratio, E_s is real extract, E_Z is seeming extract and q is attenuation coefficient.
Full Balling Formula: $p = \frac{(2{,}0665 * A + E_S) * 100}{100 + 1{,}0665 * A}$, where A is the mass content of alcohol. An empirical observation taken from ten most popular samples of Czech beer could lead us to simplified formula for alcohol content: $A = 0{,}521p - 0{,}01171$

to smaller producers (for to support product diversity in this traditional Czech industry). So called home-brewing, e.g. production of less than 200 liters per year, is not subject to tax supposed that produced beer is not used for sale. Actual tax brackets for non-home-brewing subjects are as follows:

Table 18

Beer Excise Tax	
Size of the brewery	**Tax rate for 1% of original wart extract in 1 hl[56)]**
0-200 l (not for sale)	Not subject to tax
0-10 000 hl	CZK 12.00
10 000hl – 50 000 hl	CZK 14.40
50 000hl – 100 000 hl	CZK 16.80
100 000hl – 150 000 hl	CZK 19.20
150 000hl – 200 000 hl	CZK 21.60
Over 200 000 hl	CZK 24.00

An important fact about excise tax on beer production is that it is being realized in advance payment regime (tax ensurance) which is equal to 1/12 of expected yearly tax duty, limited to CZK 80 million. Although this payment is only a guarantee deposit for the future tax to be paid, lost accrued interest from this deposit is, technically speaking, also a part of the tax. Furthermore, the fact that a brewery has to tap a non-negligible sum of money even before the actual production starts might cause serious problems to firm's budget. Given the CZK 80 million threshold, the ensurance measure works in fact slightly against the progressive (with respect to volume tax rate mentioned above.

4.2 Wine Excise Taxes

There is a large difference in tax treatment of two basic types of wine. Whereas sparkling wine is being taxed at positive rate, non-sparkling wine is not taxed at all at the moment. Virtually, all viticulturists with annual production above 2000 hl are subject to tax registration. However, current legislation imposes zero tax rate for them. This fact could be attributed to the fact, that viticulture plays a dominant role in several rural regions' employment rates and the tax relief is therefore intended to enhance this locally important industry. Sparkling wine, on the other hand, accounts only for 1% of

[56)] Approximate values for pure alcohol content will be listed at the end of this section.

Czech wine production and almost whole sparkling wine production is realized by two dominant (industrial) firms. For summary of wine excise taxes see following table.

Table 19

Wine Excise Tax	
Type of wine and size of the vinery	**Tax rate for 1 hl**
Non-sparkling wine, 0-2000 l [57)]	Not subject to tax
Non-sparkling wine, over 2000 l	CZK 0.00
Sparkling wine, any volume	CZK 2340.00

Despite the zero tax rate for non-sparkling wine, its producers still need to submit regular tax returns. This fact can be either perceived as an evidence of excessive bureaucracy imposed by the state or as a sign that the tax rate on wine production might be reconsidered in the near future. To be complete, we need to state that also of other countries of EU have adopted similar supportive policy for wineries.

4.3 Spirits Excise Taxes

Compared to the former two alcoholic beverages, spirits tax rates seem to be the simplest ones. Distilleries production is taxed with flat rate for units of pure ethanol equivalent, with an only exception for small agricultural (fruit) distilleries[58)]. Such production must use only own production of fruit, must not be used for commercial purposes and is limited to 30 liters of pure ethanol equivalent. According to the Customs Administration of the Czech Republic, agricultural distilleries account for 5.5% of Czech spirit production.

Table 20

Spirit Excise Tax	
Type of the distillery	**Tax rate for 1 hl of ethanol**
Spirits from agricultural distilleries	CZK 13 300.00
Other spirits	CZK 25 600.00

[57)] Unlike for beer, domestic sale of wine produced by small vineyards (with production up to 2000 litres) is not restricted. However, this wine is not allowed to be transported outside of The Czech Republic.
[58)] Defined in Sec. 4 law No. 61/1997, as amended in law No. 22/2000.

Spirits producers are also subject to ensurance payments. However, the amount is limited to CZK 40 million. Furthermore, those distilleries which are under official supervision of customs office do not need to deposit any ensurance.

4.4 Excise Taxes - Conclusions

Summarizing the above stated facts we conclude that in the case Czech Republic, excise taxes per liter of pure ethanol content differ significantly across the beverages, as depicted in table 21.

Table 21

Excise Tax Comparison For the Three Beverages			
Beverage	**Average alcohol content**	**Average tax per 1 liter (CZK)**	**Average tax per 1 liter of ethanol equivalent (CZK)**
Beer	4.2%	2.40	58.28
Wine	10.2%	0.28 [59)]	2.38
Spirits	40.0% [60)]	103.47	258.69

When applying optimal tax policy on alcoholic beverages, excise taxes seem to be a good way how to implement the intended price increase/decrease in reality. If we assume the ethanol content to be a good instrument for assessing negative externalities from alcohol consumption, then above table can serve as a first order approximation of method how to decompose calculated optimal tax for individual alcoholic beverages. For sake of transparency and comparability, we do not calculate the optimal tax in terms of particular beverages' excise tax. We rather calculate an optimal price increase for each of the three groups, treating the decomposition into VAT, excise tax (and its subcategories) as an ex-post problem. By doing so, we avoid multiple problems. First, as illustrated above, the excise tax regulation is quite complex and in order to calculate with respect to particular tax rates instead of price, we would need to distinguish more

[59)] Low value of excise tax for wine is a result of the fact, that non-sparkling wine production is taxed at zero rate and sparkling wine accounts for only about 1,2% of total domestic production. Source: estimate by Czech Vintner Union

[60)] Compared to beer and wine, spirits are generally far the most diversified group in terms of ethanol content, ranging from 20% in particular liquors to more than 70% for several types of absinth. Therefore in our analysis, we use standardized 40% of ethanol content rather than simple average, which would be slightly lower. This assumption will be particularly useful when estimating elasticity of demand for spirits in next chapters.

production groups in order to account for all tax brackets. Moreover, as we know from basic microeconomics, the impact of imposed tax on final commodity price is not straight forward, as it is given by price elasticities of supply and demand side of the market (it would be particularly hard to observe assess price elasticity of producers as data on their individual behavior is generally not available). For purposes of our analysis, it is therefore convenient to stay with prices instead of tax rates and calculate the "optimal tax" as an overall price increase in specified commodity price, regardless of whether this change is due to some *ad valorem, in rem* or other type of tax and irrespective to how the nominal tax rates are distributed between market actors.

5 Modeling the Optimal Taxation

Before approaching the proper definition of the model, it is necessary to set the framework of the model by defining "social optimality". Let social welfare be defined as sum of all individual welfares of society members. This implies that income effect of any tax should be neutral as the tax receipts mean just a redistribution of wealth from some members of society towards the others. Therefore in the model, we will be only interested in the allocation effect of the tax. In other words, we examine the tax-induced changes in alcohol consumption and resulting changes to consumers' welfare. These changes include two antagonistic effects. By lowering the alcohol consumption, levied tax could enhance the social welfare by decreasing harm being done by alcohol abusers to other members of society. In the same time, however, it produces a market distortion, so called „dead-weigh loss", which means a real decrease to the social welfare. Searching for optimal tax therefore means balancing these two antagonistic effects.

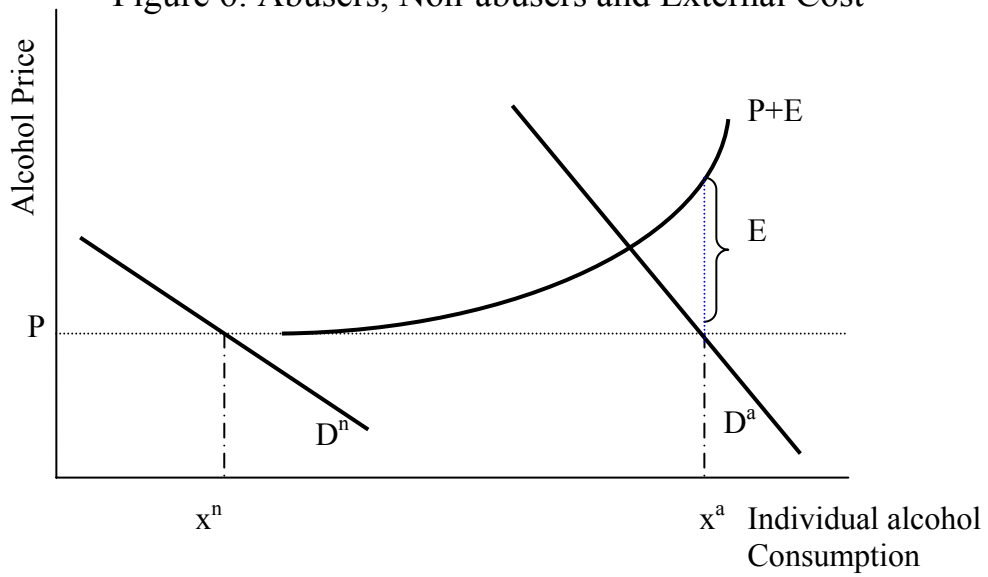
We will start building the microeconomic model from its most simple alternatives to the most elaborated ones, which will be calculated later on. We will combine two criteria – number of beverages in the model and number of separate consumer groups. However, we should always bear in mind that all the models still mean s significant simplification to the complex problem.

5.1 Model 1 – Single Beverage, Two Consumer Groups

First, we present the basic model which is only a slight modification of one represented by Pogue and Sgontz (1989), where alcohol is a homogenous product produced under situation of perfect competition and sold at a constant price **P** equal to the long run marginal cost and (minimal) average total cost. Let us divide the whole non-abstinent population of N people into two groups of beer consumers who differ in their relationship with alcohol. Let us call the two groups of drinkers "*abusers"* and "*non-abusers"* and let us denote their count by $\mathbf{N^a}$ and $\mathbf{N^n}$. Let price-quantity relation of individual alcohol consumption of each abuser and non-abuser be described by

individual demand functions $\mathbf{D^a}$ and $\mathbf{D^n}$ respectively**.** Assume also that these demand functions are in linear form. Moreover let us assume that demand of abusers is higher and perhaps less elastic than demand of non-abusers (while this assumption is not a necessary condition of the model, it is widely accepted). Now we will make some critical and very simplifying assumptions on consumers' behavior. Let all the drinkers correctly account for all internal costs of their own beer consumption (such as possible injuries, medical costs etc.), that means their demand reflects all the costs connected to beer consumption, born by individual drinkers themselves. Moreover let us assume that possible damage caused by non-abusive drinkers to other members of society is negligible, but with increasing consumption (such as of abusers), the chance of harming other people (by excess noise, damages to other's property, car crashes, violence, crime, government expenditures on health treatment etc.) rises. Therefore we define a function of marginal external abuse cost **E**, which is a positive function of individual alcohol consumption **x** with $E'>0$, $E'' \geq 0$ $\lim_{x\to 0} E = 0$ and $\lim_{x\to 0} E' = 0$. For graphical representation see figure 6.

Figure 6: Abusers, Non-abusers and External Cost

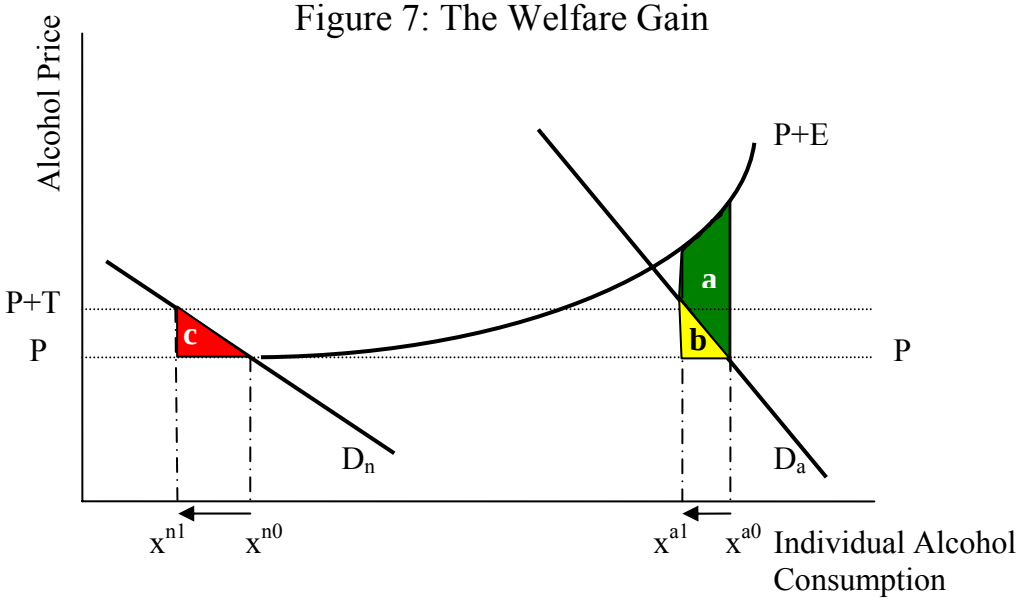


In this situation, non-abusers demand quantity x_n on average, which is socially acceptable, because it reflects all the costs (recall the assumptions from previous paragraph). On the other hand, quantity x_a, consumed by abusers is excessive from the perspective of the whole society as it creates positive external costs. This is in fact an almost classical Pigouvian situation calling for a mechanism, perhaps tax, which would correct the distortion made by negative externality (in this case external costs of alcohol

drinking). However, it is difficult to find the first best solution which imposes the tax only on the originators of the externality – the individual abusers. In real life, implementation of such measures would be probably both difficult, very costly and politically implausible. Therefore we could only tax the denominator of the externality – the alcohol consumption in general. By introducing say *ad valorem* tax, we force both abusers and non-abusers to consume less alcohol, paying more for each unit. After all, tax receipts mean simple transfer from some members of society to others. Given the "egalitarian" approach to social welfare described at the beginning of the chapter, such a transfer per se does not damage aggregate social welfare. However, by imposing the tax we create a Pareto-non-optimal situation, where both consumers and producers would have profited from lowering the price if it weren't for the external cost of alcohol abuse. We call such untapped market space "dead-weigh loss". Sum of these dead-weigh areas across all abusers and non-abusers determines the tax-imposed welfare loss.

Let us then impose a unit tax **T** on alcohol consumption, supposing the price will move up just by T. Quantity consumed by both groups of drinkers will fall according to the slope of their demand function (see figure 7).

Figure 7: The Welfare Gain



The welfare gain of the whole society will comprise of three parts. The first will be the gain from lowering the external abuse costs (area a+b) and the other will be welfare losses of both abusers and non-abusers (area b and c respectively). Mathematically we state the welfare gain function as:

$$W = N^a \int_{x^{a1}}^{x^{a0}} E(x)\, dx - \frac{1}{2} T\left(-\Delta x^a\right) N^a - \frac{1}{2} T\left(-\Delta x^n\right) N^n \qquad \textbf{(1)}$$

where $\Delta x_i = x_a^1 - x_a^0$, $\Delta x_n = x_n^1 - x_n^0$ is the reduction in individual demand caused by the tax.

For simplicity let $\overline{E}$ be a marginal net external abuse cost averaged over the reduction in consumption Δx^a. Let also

$$X^a = x^a N^a ,\ X^n = x^n N^n \qquad \textbf{(2)}$$

be the total alcohol consumption by whole abusers and non-abusers group respectively. In our study, we define the net cost as a difference between alcohol consumption costs and its benefits. If we accept an assumption that tax is fully reflected in alcohol price and thus $\Delta P = T$, then

$$\Delta x^a = \frac{T\varepsilon^a X^a}{P},\ \Delta x^n = \frac{T\varepsilon^n X^n}{P} \text{ where } \varepsilon^a = \frac{\frac{\Delta x^a}{x^a}}{\frac{T}{P}} \text{ and } \varepsilon_n = \frac{\frac{\Delta x^n}{x^n}}{\frac{T}{P}} \qquad \textbf{(3)}$$

are demand elasticities of both the consumer groups.[61)]

Then, using expressions (1),(2) and (3) we could simplify the model to following form:

$$W = \frac{\overline{E}\ T\left(-\varepsilon^a\right)X^a}{P} - \frac{T^2\left(-\varepsilon^a\right)X^a}{2P} - \frac{T^2\left(-\varepsilon^n\right)X^n}{2P} \qquad \textbf{(4)}$$

Maximizing W with respect to T brings us to following first order condition:

$$\frac{\partial W}{\partial T} = \frac{\overline{E}\left(-\varepsilon^a\right)X^a}{P} - \frac{T\left(-\varepsilon^a\right)X^a}{P} - \frac{T\left(-\varepsilon^n\right)X^n}{P} = 0 \qquad \textbf{(5)}$$

Solving the equation for the *ad valorem* tax $t = \frac{T}{P}$ and assuming $\varepsilon^a \neq 0$, we get

[61)] Note that given the construction of Δx (see above) we calculate the negative value of elasticities. Thus assuming beer is not a Giffen good, values of ε_a and ε_n are positive.

$$t = \frac{\overline{E}}{P}\left(\frac{1}{1+\frac{\varepsilon^n X^n}{\varepsilon^a X^a}}\right) \qquad \textbf{(6)}$$

Optimal *ad valorem* tax therefore increases with growing marginal external abuse costs and, which might be even more important, is dependent to ratio of abusers' to non-abusers' price elasticity. In other words, the less elastic is the demand of abusers compared to the non-abusers, the weaker effect of the tax. Note also that if all persons were abusers, the optimal tax formula would be reduced to T = $\overline{E}$ which is the original result found by Pigou.

5.2 Model 2 – Single Beverage, Multiple Consumer Groups

Analogically, we might extend the model by identifying **k** groups of alcohol abusers. Assuming their price elasticities and marginal external costs of their consumption to be known, we would come to following expression of welfare gain function:

$$W = \sum_{i=1}^{k} N^i \int_{x^{i1}}^{x^{i0}} E(x)\, dx - \frac{1}{2}\sum_{i=1}^{k}\left[T\left(-\Delta x^i\right)N^i\right] - \frac{1}{2}T\left(-\Delta x^n\right)N^n \qquad \textbf{(7)}$$

Analogically to Model 1, when we maximize this function with respect to T we obtain:

$$t = \frac{1}{P}\left(\frac{\sum_{i=1}^{k}\overline{E}^i \varepsilon^i X^i}{\sum_{i=1}^{k}\varepsilon^i X^i + \varepsilon^n X^n}\right) \qquad \textbf{(8)}$$

where $\overline{E}^i$ is marginal external abuse cost averaged over the tax-induced reduction in consumption of ith abuser group (Δx^i),(i = 1, 2, …, k), ε^i is elasticity of i-th consumer group demand and X^i is again the total alcohol consumption by particular group.

Implications of this model are analogical to those discussed in first model, with apparent extension that now, abusers group is composed of multiple subgroups. When

considering empirical testing of this model, we need to choose the method of categorizing the abusers. Socio-psychological literature usually uses differentiation according to sex or volume of pure ethanol consumed over certain period, or combination of both. Analogically, we could also differentiate separate groups of non-abusers. No matter which approach is chosen, estimating the model assumes presence of quality microeconomic statistical data.

5.3 Model 3 - Multiple Beverages, Two Consumer Groups

Both previous models followed rather unrealistic assumption that market for alcoholic beverages could be reduced to a single "normalized" beverage. In other words, we assumed that people were interested in consumption of ethanol regardless of its form. Let us now ease this assumption, distinguishing multiple alcoholic beverages. Since these are not likely to be produced with the same technologies, even their prices are not restricted to equal. Moreover it is legitimate to assume that besides the alcohol content, consumers perceive the other attributes of each beverage as well. This implies that demand elasticities of each such alcoholic drink could differ. Moreover, by introducing multiple dimensions to the model, we also need to take into account that demand functions for individual beverages might be interdependent. Thus we allow cross-price elasticities to have non-zero values. To limit the size of the model, we take similar approach as Saffer and Chalupka (1994) and stay with three basic beverages: beer, wine and spirits[62)]. Again we assume that all three beverages are produced in perfectly competitive conditions and thus with flat supply curves, where prices are equal to P_b, P_w and P_s respectively. As these beverages differ heavily in various attributes including alcohol content, it is logical to assume that marginal external costs of their consumption, E_b, E_w and E_s will differ as well. Unlike for Chalupka, we do not restrict the ratio between abusers and non-abusers to be the same for all of the three beverages. Our model is then slightly more complicated but we could utilize our assumptions on difference between proportions of ethanol consumed in form of individual beverages and the empirical proportions of alcohol detention centers' patients

[62)] This differentiation is broadly accepted in literature, review for instance Ornstein and Levy (1983). It is also broadly used in most statistical surveys, including Czech Statistical Office.

and their problematic drinks. The welfare gain function takes basically the same form as in (1), it is only summed over all beverages:

$$W = \sum_{j=b,w,s} N_j^a \int_{x^{j1}}^{x^{j0}} E_j(X_j)\,dx - \sum_{j=b,w,s} \left\{ \frac{1}{2} \sum_{j=1}^{k} \left[T_j\left(-\Delta X_j^a\right) \right] + \frac{1}{2} T_j\left(-\Delta X_j^n\right) \right\} \quad \textbf{(9)}$$

Moreover, the formula for change in consumption (3) will be extended to:

$$\begin{aligned}
\Delta X_b^a &= \frac{T_b \varepsilon_b^a X_b^a}{P_b} + \frac{T_w \varepsilon_{bw}^a X_b^a}{P_w} + \frac{T_s \varepsilon_{bs}^a X_b^a}{P_s}, \quad \Delta X_b^n = \frac{T_b \varepsilon_b^n X_b^n}{P_b} + \frac{T_w \varepsilon_{bw}^n X_b^n}{P_w} + \frac{T_s \varepsilon_{bs}^n X_b^n}{P_s}, \\
\Delta X_w^a &= \frac{T_w \varepsilon_w^a X_w^a}{P_w} + \frac{T_w \varepsilon_{wb}^a X_w^a}{P_b} + \frac{T_s \varepsilon_{ws}^a X_w^a}{P_s}, \quad \Delta X_w^n = \frac{T_w \varepsilon_w^n X_w^n}{P_w} + \frac{T_w \varepsilon_{wb}^n X_w^n}{P_b} + \frac{T_s \varepsilon_{ws}^n X_w^n}{P_s}, \\
\Delta X_s^a &= \frac{T_s \varepsilon_s^a X_s^a}{P_s} + \frac{T_b \varepsilon_{sb}^a X_s^a}{P_b} + \frac{T_w \varepsilon_{sw}^a X_s^a}{P_w}, \quad \Delta X_s^n = \frac{T_s \varepsilon_s^n X_s^n}{P_s} + \frac{T_b \varepsilon_{sb}^n X_s^n}{P_b} + \frac{T_w \varepsilon_{sw}^n X_s^n}{P_w}
\end{aligned} \quad (10)$$

Where

$$\varepsilon_b^a = \frac{\frac{\Delta x_b^a}{x_b^a}}{\frac{T_b}{P_b}}, \quad \varepsilon_w^a = \frac{\frac{\Delta x_w^a}{x_w^a}}{\frac{T_w}{P_w}}, \quad \varepsilon_s^a = \frac{\frac{\Delta x_s^a}{x_s^a}}{\frac{T_s}{P_s}}$$

represent abusers' own price elasticities of demand for the three beverages and

$$\varepsilon_{bw}^a = \frac{\frac{\Delta x_b^a}{x_b^a}}{\frac{T_w}{P_w}}, \quad \varepsilon_{bs}^a = \frac{\frac{\Delta x_b^a}{x_b^a}}{\frac{T_s}{P_s}}, \quad \varepsilon_{wb}^a = \frac{\frac{\Delta x_w^a}{x_w^a}}{\frac{T_b}{P_b}}, \quad \varepsilon_{ws}^a = \frac{\frac{\Delta x_w^a}{x_w^a}}{\frac{T_s}{P_s}}, \quad \varepsilon_{sb}^a = \frac{\frac{\Delta x_s^a}{x_s^a}}{\frac{T_b}{P_b}}, \quad \varepsilon_{sw}^a = \frac{\frac{\Delta x_s^a}{x_s^a}}{\frac{T_w}{P_w}}$$

denote all combinations of abusers' cross-price elasticities of demand for i-th beverage given change (tax) in j-th beverage price.

To find the optimal tax, we need to maximize the welfare function with respect to taxes on all three beverages. As all three derivations are analogical, we show only the beer equation: $\partial W / \partial T_b$.

$$\frac{\partial W}{\partial T_b} = -\left(\frac{\overline{E}_b \varepsilon_b^a X_b^a + \overline{E}_w \varepsilon_{wb}^a X_b^a + \overline{E}_s \varepsilon_{sb}^a X_b^a}{P_b} \right) +$$

$$+\left(\frac{T_b \varepsilon_b^a X_b^a}{P_b} + \frac{1}{2}\frac{T_w \varepsilon_{bw}^a X_b^a}{P_w} + \frac{1}{2}\frac{T_s \varepsilon_{bs}^a X_b^a}{P_s} + \frac{1}{2}\frac{T_w \varepsilon_{wb}^a X_w^a}{P_b} + \frac{1}{2}\frac{T_s \varepsilon_{sb}^a X_s^a}{P_b} \right) + \quad \textbf{(11)}$$

$$+\left(\frac{T_b \varepsilon_b^n X_b^n}{P_b} + \frac{1}{2}\frac{T_w \varepsilon_{bw}^n X_b^n}{P_w} + \frac{1}{2}\frac{T_s \varepsilon_{bs}^n X_b^n}{P_s} + \frac{1}{2}\frac{T_w \varepsilon_{wb}^n X_w^n}{P_b} + \frac{1}{2}\frac{T_s \varepsilon_{sb}^n X_s^n}{P_b} \right) = 0$$

This equation could be rewritten to:

$$\frac{\partial W}{\partial T_b} = -\left(\frac{\overline{E}_b \varepsilon_b^a X_b^a + \overline{E}_w \varepsilon_{wb}^a X_b^a + \overline{E}_s \varepsilon_{sb}^a X_b^a}{P_b} \right) + T_b \frac{\varepsilon_b^a X_b^a + \varepsilon_b^n X_b^n}{P_b} +$$

$$+\frac{1}{2}\left(T_w \left[\frac{\varepsilon_{bw}^a X_b^a}{P_w} + \frac{\varepsilon_{wb}^a X_w^a}{P_b} + \frac{\varepsilon_{bw}^n X_b^n}{P_w} + \frac{\varepsilon_{wb}^n X_w^n}{P_b} \right] \right) + \quad \textbf{(12)}$$

$$+\frac{1}{2}\left(T_s \left[\frac{\varepsilon_{bs}^a X_b^a}{P_s} + \frac{\varepsilon_{sb}^a X_s^a}{P_b} + \frac{\varepsilon_{bs}^n X_b^n}{P_s} + \frac{\varepsilon_{sb}^n X_s^n}{P_b} \right] \right) = 0$$

Microeconomic theory requires that cross-elasticities of demand for two goods are equal. In reality however, this assumption might not prove to hold. In fact, problems with symmetry assumption on Czech budget household data have already beer reported by Crawford, Laisney and Preston (2003). We will therefore develop both alternatives of the model, first with symmetry assumed, then we will ease this restriction.

$$\text{Note that } \frac{X_i \varepsilon_{ij}}{P_j} = \frac{X_i}{P_j}\frac{\frac{\partial X_i}{\partial Pj}}{\frac{X_i}{P_j}} = \frac{\partial X_i}{\partial Pj} \text{ and } \frac{X_j \varepsilon_{ji}}{P_i} = \frac{X_j}{P_i}\frac{\frac{\partial X_j}{\partial P_i}}{\frac{X_j}{P_i}} = \frac{\partial X_j}{\partial P_i}. \quad \textbf{(13)}$$

Together with the symmetry of cross-elasticities of demand given as

$$\frac{\partial X_i}{\partial P_j} = \frac{\partial X_j}{\partial P_i},$$

we could use (13) to simplify (12) into following expression:

$$\frac{\partial W}{\partial T_b} = -\left(\frac{\overline{E}_b \varepsilon_b^a X_b^a + \overline{E}_w \varepsilon_{wb}^a X_b^a + \overline{E}_s \varepsilon_{sb}^a X_b^a}{P_b} \right) + T_b \frac{\varepsilon_b^a X_b^a + \varepsilon_b^n X_b^n}{P_b} + \quad \textbf{(14)}$$

$$+ T_w \left[\frac{\varepsilon_{wb}^a X_w^a + \varepsilon_{wb}^n X_w^n}{P_b} \right] + T_s \left[\frac{\varepsilon_{sb}^a X_s^a + \varepsilon_{sb}^n X_s^n}{P_b} \right] = 0$$

Canceling out the P_b and solving for T_b we are left with

$$T_b = \frac{\left(\overline{E}_b \varepsilon_b^a X_b^a + \overline{E}_w \varepsilon_{wb}^a X_b^a + \overline{E}_s \varepsilon_{sb}^a X_b^a \right) - T_w \left(\varepsilon_{wb}^a X_w^a + \varepsilon_{wb}^n X_w^n \right) - T_s \left(\varepsilon_{sb}^a X_s^a + \varepsilon_{sb}^n X_s^n \right)}{\left(\varepsilon_b^a X_b^a + \varepsilon_b^n X_b^n \right)} \quad \textbf{(15)}$$

Deriving the first order conditions for remaining beverages using analogical technique, we get the desired system of equations (13,14 and 15):

$$T_w = \frac{\left(\overline{E}_w \varepsilon_w^a X_w^a + \overline{E}_b \varepsilon_{bw}^a X_w^a + \overline{E}_s \varepsilon_{sw}^a X_w^a \right) - T_b \left(\varepsilon_{bw}^a X_b^a + \varepsilon_{bw}^n X_b^n \right) - T_s \left(\varepsilon_{sw}^a X_s^a + \varepsilon_{sw}^n X_s^n \right)}{\left(\varepsilon_w^a X_w^a + \varepsilon_w^n X_w^n \right)} \quad \textbf{(16)}$$

$$T_s = \frac{\left(\overline{E}_s \varepsilon_s^a X_s^a + \overline{E}_w \varepsilon_{ws}^a X_s^a + \overline{E}_b \varepsilon_{bs}^a X_s^a \right) - T_w \left(\varepsilon_{ws}^a X_w^a + \varepsilon_{ws}^n X_w^n \right) - T_b \left(\varepsilon_{bs}^a X_b^a + \varepsilon_{bs}^n X_b^n \right)}{\left(\varepsilon_s^a X_s^a + \varepsilon_s^n X_s^n \right)} \quad \textbf{(17)}$$

If we could not take the symmetry condition as given the right-hand side of the equations remain more complex:

$$T_b = \frac{\left(\overline{E}_b \varepsilon_b^a X_b^a + \overline{E}_w \varepsilon_{wb}^a X_b^a + \overline{E}_s \varepsilon_{sb}^a X_b^a \right)}{\left(\varepsilon_b^a X_b^a + \varepsilon_b^n X_b^n \right)} -$$

$$- \frac{\frac{T_w}{2} \left(\left(\varepsilon_{wb}^a X_w^a + \varepsilon_{wb}^n X_w^n \right) + \frac{P_b}{P_w} \left(\varepsilon_{bw}^a X_b^a + \varepsilon_{bw}^n X_b^n \right) \right) + \frac{T_s}{2} \left(\left(\varepsilon_{sb}^a X_s^a + \varepsilon_{sb}^n X_s^n \right) + \frac{P_b}{P_s} \left(\varepsilon_{bs}^a X_b^a + \varepsilon_{bs}^n X_b^n \right) \right)}{\left(\varepsilon_b^a X_b^a + \varepsilon_b^n X_b^n \right)} \quad \textbf{(18)}$$

$$T_w = \frac{\left(\overline{E}_w \varepsilon_w^a X_w^a + \overline{E}_b \varepsilon_{bw}^a X_w^a + \overline{E}_s \varepsilon_{sw}^a X_w^a \right)}{\left(\varepsilon_w^a X_w^a + \varepsilon_w^n X_w^n \right)} -$$

$$- \frac{\frac{T_b}{2} \left(\left(\varepsilon_{bw}^a X_b^a + \varepsilon_{bw}^n X_b^n \right) + \frac{P_w}{P_b} \left(\varepsilon_{wb}^a X_w^a + \varepsilon_{wb}^n X_w^n \right) \right) + \frac{T_s}{2} \left(\left(\varepsilon_{sw}^a X_s^a + \varepsilon_{sw}^n X_s^n \right) + \frac{P_w}{P_s} \left(\varepsilon_{ws}^a X_w^a + \varepsilon_{ws}^n X_w^n \right) \right)}{\left(\varepsilon_w^a X_w^a + \varepsilon_w^n X_w^n \right)} \quad \textbf{(19)}$$

$$T_s = \frac{\left(\overline{E}_s \varepsilon_s^a X_s^a + \overline{E}_w \varepsilon_{ws}^a X_s^a + \overline{E}_b \varepsilon_{bs}^a X_s^a \right)}{\left(\varepsilon_s^a X_s^a + \varepsilon_s^n X_s^n \right)} -$$

$$- \frac{\frac{T_w}{2} \left(\left(\varepsilon_{ws}^a X_w^a + \varepsilon_{ws}^n X_w^n \right) + \frac{P_s}{P_w} \left(\varepsilon_{sw}^a X_s^a + \varepsilon_{sw}^n X_s^n \right) \right) + \frac{T_b}{2} \left(\left(\varepsilon_{bs}^a X_b^a + \varepsilon_{bs}^n X_b^n \right) + \frac{P_s}{P_b} \left(\varepsilon_{sb}^a X_s^a + \varepsilon_{sb}^n X_s^n \right) \right)}{\left(\varepsilon_s^a X_s^a + \varepsilon_s^n X_s^n \right)} \quad \textbf{(20)}$$

This system of three linear equations with three unknown variables will serve us as the final model for calculation of optimal tax rates for individual beverages. Although it may seem complicated, its logic is straight-forward and its algebraic calculation is not demanding.[63]. In order to solve the system we need to calculate all the right hand side exogenous variables. The external costs of individual beverages have been already evaluated. Next chapters will be devoted to this specification. The following one will examine the numbers of abusers and their consumption.

First, the statistical data concerning prices, resulting in elasticities of demand, will be discussed in "Data" section. Then, an AIDS method will be used to obtain estimates of both own price and cross price elasticities.

[63] The analytical re-arrangement of the solution is not presented in the paper to preserve space. Authors recommend simple numerical solution using inverse matrix of the coefficients, because the analytical version is technically very demanding.

6 Empirical Analysis of Microeconomic Behavior – The Theory

Now we approach the search for the last and perhaps most problematic set of variables necessary for calculation of our model. We need to find some technical measure to estimate the own-price and cross-price elasticities of demand for beer, wine and spirits. As we want to explore cross-price relations among the beverages, it is impossible to even consider simplification of examining them separately. We must therefore leave the comfortable world of "ceteris paribus" analysis and regard the problem as a complex demand system.

The pioneering role in estimating demand system derived directly form consumer's preferences theory is usually ascribed to Stone (1954) who first used the Linear Expenditure Systems developed by Klein and Rubin (1947-48) to estimate a whole demand system. Since then, a large number of models concerning the topic have been proposed. Let us mention at least the most renowned ones: the Rotterdam model (see Theil, 1967 and Barten 1969) and the translog model (see Christensen, Jorgenson and Lau, 1975). Our analysis is based on another influential model - the Almost Ideal Demand System (AIDS) developed by Deaton and Muelbauer (1980). To be more specific, it is based on the multi-stage budgeting modification by Edgerton et al. (1996). Before explaining the complex functional forms used in these model, let us first go through their basic assumptions. Next section will briefly mention the underlying microeconomic theory and then focus on its restrictions which should be applied to the model.

6.1 Notes on Consumer Demand Theory

In an Almost Ideal demand System, core of the model is based on a specific form of expenditure function. To handle the system of marginal expenditure functions properly, we first need to state some basic assumptions on consumer preferences.

Suppose that consumer faces decision problem on consumption set $Q \in R^{+}$, which consists of individual goods. For purposes of our model, we would group goods with very similar consumers attributes (such as pale and dark beer) into consumption

bundles, which we hereafter call commodities. Let consumption alternative $q = (q_i,...,q_n) \in Q$ be vector of n commodities, where q^i denotes the quantity of i[th] commodity consumed. Let $\succ$, $\succeq$, and ~ represent the strict preference, weak preference and indifference relations respectively. Denoting arbitrary consumption alternatives $q^a, q^b, q^c \in Q$ we assume consumers preferences to be:

a **Rational**

i) **Reflexive** – For each alternative q, $q \succeq q$.

ii) **Complete** – consumer is able to assign a preference relation ($\succ$, $\succeq$, or ~) to any pair of alternatives q^a and q^b.

iii) **Transitive** – $q^a \succeq q^b \wedge q^b \succeq q^c \Rightarrow q^a \succeq q^c$

b **Continuous** - $\forall q^b$, sets $q^a \left| \left(q^a \succeq q^b \right) \right.$ and $q^c \left| \left(q^c \succeq q^b \right) \right.$ are closed sets

c **Strongly monotonous** – $\forall q^a, q^b, q^a \succeq q^b \wedge q^a \neq q^b \Rightarrow q^a \succ q^b$

d **Strictly convex** -

$\forall q^a, q^b, q^c \; q^a \neq q^b \wedge q^a \succeq q^c \wedge q^b \succeq q^c \Rightarrow tq^a + (1-t)q^b \succ q^c \; t \in (0,1)$

These assumptions are a necessary condition for existence of continuous utility function $\upsilon(q)$ which represents consumer's preferences (to the extent of increasing transformation). Moreover, let us choose such functional form of $\upsilon(q)$ which is twice differentiable. There are two ways how to derive expenditure function.

First, let $p = (p_1,..., p_n)$ be price vector for n commodities and $x = \sum_{i=1}^{n} p_i q_i$ be the total expenditure. Note that if we consider all goods, services (including) available to the consumer in our demand system, the total expenditure will be equal to his or her disposable income. Maximizing $\upsilon(q)$ subject to a linear budget constraint $x = pq$, we obtain Marshallian demand functions $q_i^* = g_i(x, p)$, where q_i^* denotes the optimal quantity of i-th commodity given certain x and p. Substituting q_i^* into the (direct) utility function $\upsilon(q)$ we get the indirect utility function $u = \omega(p, x)$. Finally, inverting the indirect utility function we obtain desired expenditure function $x = c(p, u)$.

Alternatively, we could solve so called "dual problem". Minimizing the expenditure $x = pq$ while the utility $u = \upsilon(q)$ is held fixed could bring us to Hicksian

demand functions $q_i^* = h_i(p,u)$. Finally, substituting q_i^* into the dual objective function $x = pq$ we again get the expenditure function $x = c(p,u)$.

Expenditure function is of crucial interest in AIDS model. Therefore it is worth mentioning some of its basic properties. Expenditure derived with one of methods mentioned above is:

e **Homogeneous of degree one –** $\forall t \in R^+ \quad c(tp,u) = tc(p,u)$

f **Strictly increasing in u –** $u^1 > u^2 \Rightarrow c(p,u^1) > c(p,u^2)$

g **Non-decreasing in p –** $p^1 > p^2 \Rightarrow c(p,u^1) \geq c(p,u^2)$

h **Concave -** $\forall t \in (0,1) \quad c(tp^1 + (1-t)p^2, u) = tc(p^1,u) + (1-t)c(p^2,u)$

i **Continuous -** $\forall \varepsilon, \varphi \in R \quad \exists \delta \in R^+ \,|\, c(p+\varepsilon, u+\varphi) \in U(c(p,u),\delta)$

j **Derivable -** $\frac{\partial c(p,u)}{\partial p} = h(p,u)$ where $q^* = h(p,u)$ is Hicksian (compensated) demand function. This property is known as Sheppard's lemma.

6.2 Basic AIDS Model Specification

In their proposition of demand system, Deaton and Muellbauer use a specific class of preferences (known as PIGLOG[64]), which allows for exact aggregation over consumers. These preferences are represented straight with expenditure function. Its AIDS form is:

$$\log c(p,u) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \log p_k + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \gamma_{jk}^* \log p_j \log p_k + u\beta_0 \prod_{k=1}^{n} p_k^{\beta_k} \quad \textbf{(21)}$$

Where α_i, β_i and γ_i are parameters of the model. It may be easily shown that this functional form fulfils all requirements imposed on expenditure function mentioned above provided that $\sum_{i=1}^{n} \alpha_i = 1, \;\; \sum_{j=1}^{n} \gamma_{jk}^* = \sum_{j=1}^{n} \gamma_{kj}^* = 0, \;\; \sum_{j=1}^{n} \beta_j = 0$ (these conditions will be discussed in detail later on). Moreover, demand functions could be derived directly from (21) applying Shepard's lemma. Multiplying both sides of the applied lemma by $p/c(p,u)$ we get

[64] for more details on PIGLOG preferences see Muellbauer (1975).

$$\frac{\partial \log c(p,u)}{\partial \log p_i} = \frac{p_i q_i}{c(p,u)} = w_i \qquad \textbf{(22)}$$

Where w_i denotes i[th] commodity's budget share i.e. the weight of spending on i[th] good on total expenditure. When we apply this on (21), we get

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i u \beta_0 \prod_{k=1}^{n} p_k^{\beta_k} \qquad \textbf{(23)}$$

$$\text{where } \gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^{*} + \gamma_{ji}^{*}\right)$$

Generally, the expenditure function of a utility maximizing consumer, $x = c(p,u)$ could be inverted to obtain the indirect utility function $u = \omega(p,x)$. Applying this on (21) and substituting the result to (23), Deaton and Muellbauer get the desired AIDS demand functions in budget share form

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P}\right) \qquad \textbf{(24)}$$

$$\log P = \alpha_0 + \sum_{k=1}^{n} \alpha_k \log p_k + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \gamma_{kj} \log p_k \log p_j \qquad \textbf{(25)}$$

Where again w_i denotes i[th] commodity budget share, β_i and γ_i represent the changes in i[th] good budget share caused by changes in prices and real expenditure respectively[65)], P represents price index and thus x/P stands for "real" expenditure[66)]. Setting $p = 1$ and $u = 0$ in (23) we could see that α_i represents the subsistence budget share of i[th] good (i.e. its budget share when expenditure is at subsistence level). Analogically we could find that α_0 denotes logarithm of subsistence expenditure measured in base year prices.

We have already mentioned conditions our system must fulfill in order to comply with common microeconomic theory. Now let us discuss them individually:

$$\sum_{i=1}^{n} \alpha_i = 1 \quad \textbf{(26)} \qquad \sum_{j=1}^{n} \beta_j = 0 \quad \textbf{(27)} \qquad \sum_{k=1}^{n} \gamma_{kj} = 0 \quad \textbf{(28)} \qquad \gamma_{kj} = \gamma_{jkj} \quad \textbf{(29)}$$

Restriction (28) ensures homogeneity (of degree 0) of the demand function. Formula (29) expresses Slutsky symmetry condition. Restrictions (26, 27, 28) taken together

65) note that β_i and γ_{ij} do not stay for price and expenditure elasticities for demand as they are not related to quantities but to budget share. However, they bear the same signs and have similar meaning, e.g. $\beta_i > 0$ means luxury good and $\beta_i < 0$ signifies a necessity. Exact formulas for classical elasticities will be derived later.

66) The price index P and real expenditure x/P become of particular interest when we include the time scope of our analysis later on.

ensure that the system of demand functions adds up to total expenditure (e.g. $\sum w = 1$). Another important condition arises from the properties of Slutsky equation[67]. Given the concavity of expenditure function, matrix its second derivatives $\partial^2 c(p,u)/\partial p_i \partial p_j = \partial h_i(p,u)/\partial p_i$, often referred as "substitution matrix", must be negative semi-definite. When applied to AIDS functional form, we impose the negative semi-definiteness on elements

$$\frac{\partial^2 c(p,u)}{\partial p_i \partial p_j} = \gamma_{ij} + \beta_i \beta_j \alpha_i \log\left(\frac{x}{P}\right) - \delta_{ij} w_i + w_i w_j \qquad \textbf{(30)}$$

Where δ_{ij} is Kronecker's delta, which is 1 when $i=j$ and 0 elsewhere.

However, it should not be forgotten that it is own and cross-price demand elasticities e_{ij} which are of our primary interest. These elasticities, together with expenditure elasticity E_i could be easily obtained from (24) as

$$E_i = 1 + \frac{\beta_i}{w_i} \qquad \textbf{(31)}$$

$$e_{ij} = \frac{\gamma_{ij} - \beta_i\left(\beta_j \log(x/P) - w_j - \frac{1}{2}\sum_{k=1}^{n}(\gamma_{kj} - \gamma_{jk})\log p_k\right)}{w_i} - \partial ij \qquad \textbf{(32)}$$

Given the symmetry assumption (26) the last term in denominator would simply cancel out and the formula is reduced to

$$e_{ij} = \frac{\gamma_{ij} - \beta_i(\beta_j \log(x/P) - w_j)}{w_i} - \partial ij \qquad \textbf{(33)}$$

We have just derived the full form of static AIDS model applicable on individual (say household) level. For it to be generalized to aggregate level, we need to include a few more assumptions. Moreover, we should also impose some simplifying restriction on the whole demand system in order to avoid calculation which might be too complex even for modern computation tools.

6.3 AIDS on Aggregate Level

[67]) by Slutsky equation we mean $\frac{\partial g_i(p,x)}{\partial p_j} = \frac{\partial h_i(p,u)}{\partial p_j} - \frac{\partial g_i(p,x)}{\partial x} g_i(p,x)$ where $g(p,x), h(p,u)$ represent consumer's Marshallian (uncompensated) and Hicksian (compensated) demand functions.

When perceived from the aggregate point of view, AIDS model still performs very well. If w_i is considered as aggregate budget share of ith good and x as aggregate expenditure divided by number of consumers. It may be difficult to find an appropriate measure of population size. Ideal calculation would reflect all demographic changes (such as size of age groups, immigration etc). However, this would per se lead to very complicated models. In time series, as proposed also by Edgerton et al. (1996), the rate of demographic change is rather slow; therefore we may use total population or total number of households as a suitable approximation. Data used in our study, as mentioned in previous chapter, are gathered from household-based survey. Our model will therefore work in terms of per (per household) demand and expenditures, and therefore aggregation will not be needed.

6.4 Simplifications to AIDS

While estimating the model we face one obvious problem – the non-linearity of price index in (25). Although this would not mean a large problem for single equation estimation, for more complex system and long series the calculation could become quite time consuming. While looking for suitable approximations, Deaton and Muellbauer suggest replacing the last two terms in (25) with Stone's price index

$$P^* = \sum_{k=1}^{n} w_k \ln p_k \qquad \textbf{(34)}$$

this means replacing (25) with

$$\ln P = \alpha_0 + \sum_{k=1}^{n} w_k \ln p_k \qquad \textbf{(35)}$$

which would be measured in every point in time. This leads to so called Linear Almost Ideal Demand System (LAIDS), which is being extensively applied in literature[68)] and is obtained by substituting (35) into (24)

$$w_i = \left(\alpha_i^*\right) + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P^*}\right) \qquad \textbf{(36)}$$

It is worth mentioning, that α_0 is usually not identified in the system as it is absorbed in constant term $\alpha_i^* = \left(\alpha_i - \beta_i \alpha_0\right)$. In fact, empirical identification of α_0 is usually very

[68)] See Alston et al. (1994) or Edgerton (1996)

problematic. Deaton and Muellbauer therefore propose taking logarithm of an a priori chosen value for real subsistence expenditure.

Moreover, Chalfant (1987) proposed an approximation formula for calculation of elasticities. Its reliability has been (among others) confirmed by Edgerton et al. (1996). While the expenditure elasticity still remains given by (31), the uncompensated price elasticities (which we will use also in our study) become:

$$e_{ij} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} - \delta_{ij} \qquad \textbf{(37)}$$

6.5 Multi-Stage Budgeting

Even in simplified versions of the model mentioned above, we face a fundamental problem concerning the enormous number of goods and services available to the consumer, which would result in exponentially greater number of equations to be estimated. Not only that such estimation would be time consuming but given lost degrees of freedom we would need really large amounts of data to be able to estimate the system. Given the data available for our study, such „full“ approach would be simply impossible.

To overcome this problem, we need to introduce an a priori given structure of consumer preferences which would effectively limit the complexity of the problem. In literature, the most common approach takes so called weak separability assumption, which implies that individual goods and services could be divided into groups which enter the system (to some extent) separately. Weak separability suggests that whereas goods in the same group follow classic behavior concerning price changes of other within-group goods, influence over goods in other groups is made indirectly through interaction of whole groups. In other words this means that price change of a good affect all goods in another group in the same manner.

To put the problem more rigorously, let us consider a two-stage (which can be readily extended to multi-stage process), where the first stage comprises of n groups of goods. In the second stage, r^{th} group ($r = 1,...,n$) consists of m goods. Let demand for ith ($i = 1,...,m$) good of r^{th} group be denoted as q_{ri} and let q_r denote vector of quantities in whole r^{th} group. The utility function satisfies the condition of weak separability if it can be written as

$$u = f\left[\upsilon(q_1);\upsilon(q_2);...;\upsilon(q_n)\right] \quad \textbf{(38)}$$

where $\upsilon(q_r)$ is a "sub-utility" which is maximized separately in the second stage. This maximization follows usual rules of demand theory, just with overall expenditure replaced with group expenditure $x_r = \sum_{i=1}^{m} p_{ri} q_{ri}$, determined in the first stage. It takes form of

$$q_{ri} = g_{ri}(p_1,...,p_i,...,p_m,x_r) \quad \textbf{(39)}$$

Another key implication of weak separability is that marginal rate of substitution of goods in one group is independent of price change of goods in other groups, meaning

$$\frac{\partial\left(\frac{\partial u}{\partial q_{ri}} \Big/ \frac{\partial u}{\partial q_{rj}}\right)}{\partial q_{sk}} = 0 \quad \textbf{(40)}$$

Whereas the second stage of the model (maximizing the within-group utility) is quite straight-forward, for the first stage some more assumptions need to be taken as we could not simply replace all prices by simply taking n price indices (one for each group). Deaton and Muellbauer show that demand for r^{th} group goods may be approximated, when we express it in real terms as.

$$Q_r = g_r(P_1,...,P_n,x) \quad \textbf{(41)}$$

Where Q_r is real r^{th} group expenditure expressed in some base year prices, P_i are true cost of living indices for a specific utility level u. If we assume that these indices don't vary heavily in u, we could approximate them by using standard Paasche or Laspeyers indices[69] The proper form of three-stage budgeting used in our model will be discussed in the following section.

[69] The true cost of living indices would be independent of utility level if and only if the preferences were homotetic. However, Wilks (1938) shows that the quality of our approximation increases with increasing number of commodities in the model.

7 The Data

7.1 Basic Characteristics of the Dataset

Empirical part of our study is based on Household Budget Statistics (HBS) by Czech Statistic Office. It is an annual survey on microeconomic behavior of Czech households which provides information on their expenditure and structure of their consumption. In fact, it is also the only survey which is detailed enough to provide consistent information on Czech alcohol consumption on individual (household) level. The survey monitors over 3000 households chosen on specific quota-based system. The quota tries to mimic real composition of Czech society, i.e. structure of all Czech households, as tightly as possible. Composition of respondent group is being altered operatively to reflect all shifts in basic household attributes (their composition, economic activity, income level etc). The key parameters of the quota system are:

a) Social class of the household determined by social affiliation of head of the household (regardless of other household members' social affiliation). For purposes of HBS these classes are: employees, farmers, self-employed, retired[70)]
b) Net per-head income, which characterizes purchasing power of the household[71)]
c) Number of economically inactive children
d) Geographical affiliation, including region, size of the residential community.

The quota method follows an a priori chosen frequency of all combinations of above mentioned attributes. Fundaments for this structure are derived from Microcensus survey, which is a socio-demographic survey based on random sampling techniques. Given this structure, a representative sample is then chosen from the set of all respondents. For illustration of socio-demographic composition of the population sample see table below.

[70)] Household is classified into *retired* group if all its members are economically inactive or if their activity is neglectable.
[71)] in case of self-employed head of the family, only expenditure assigned to needs of the household is reflected in the survey. In other words, the research does not include expenditure on business purposes.

Table 22

Sample Composition of Household Budget Survey 2007	
Social group	**Number of households in the sample**
Households managed by economically active member	**2335**
Employees with lower education	843
Employees with higher education	870
Self employed	445
Unemployed	177
Households managed by economically inactive member	**665**
Households with ec. active members	149
Households with no ec. active members	516
- managed by retired person	467
- managed by other person	49
Total number of households	**3000**

Respondents contribute to the database on daily basis, recording all revenues and expenditures summarized over all household members. Some budget items, such as certain industrial goods, food and last but not least alcoholic beverages, are reported also on volume basis (e.g. in kilograms, liters or pieces). This is crucial for further calculation as it allows us to calculate unit price for each household and allows us to examine price differentiation across various demographic groups or geographic regions.

Since 2006 daily expenditure on food and non-alcoholic drinks is carried out only for two months in a year (due to excess reporting burden of the respondents). Respondents of the survey are remunerated for filling the report forms; therefore quality of the dataset is likely to be better than for non-profit surveys.

7.2 Multi-stage Budgeting in Household Survey

Czech household budget survey is well suitable for application of multi-stage budgeting models because it captures multiple aspects of household cash-flow, namely: Income items, food expenditures (including physical volumes where applicable), manufacturing and other consumer goods (both durables and non-durables), services expenses, transfers and payments, even natural incomes and expenditures and gifts. In our analysis, a three stage method has been chosen. First, we evaluate the system concerning distribution of total expenses on food, industrial sector and services. Then

we will focus on food part, examining the consumer choice between: drinks; animal and products; vegetables and fruit; cereal products and other food group. Finally, we focus on the drinks segment estimating the elasticities for: beer; wine; spirits; and non-alcoholic drinks[72)]. Naturally, it is the last stage, which is of crucial interest to this study, as we need to input own-price and cross-price elasticities to our model. The two superior stages serve mainly for obtaining the income elasticity, which enters the price-elasticities equations.

The number of observations in particular stages varies because of technical restrictions of the model. First, BHS is not constructed as a fully balanced panel. The condition of reflecting demographic composition (taken from Microcensus survey) is superordinate to continuous tracking of an individual household. In fact, only 288 households are tracked for the whole period (2002-2007), and 3832 households are observed only within a single year (and thus inapplicable for our purposes). Moreover, the logarithmic form of our model prevents us from using such observations in stage 3, which exhibit zero consumption of particular beverage (for first two stages, positivity is assured by aggregation of the data across multiple consumption items). Moreover, in order to assure at least partial homogeneity in observed beverage quality, we need to exclude such observations, which exhibit deviant values of the beverage price and which would potentially cause biases and leverage effects. In case of beer, the limits (price greater than CZK 5 and less than CZK 100 per liter) do not exclude many observations. In case of wine, however, the lower bound of CZK 25 per liter (which is the lowest market price for junk wine) limits over 300 observations. The reason for this could be attributed to semi-barter wine purchases in some Moravian regions, where the actual price might be lowered by non-economic factors such as natural exchange or various interpersonal relationships. The restriction is even more important for spirit part of the estimation. Compared to the other two beverages, spirit group is the most diversified, with alcohol content raging from mere 20% for several liquors to 70% for absinth. To eliminate the disrupting effect those beverages with low alcohol content, we need to set a lower price boundary to reflect the cheapest market price of normalized spirit. Given that cheapest rum with alcohol content of 40% could be purchased for about CZK 180 per liter and the given the fact that excise tax on distilled products per se reaches CZK 103 CZK, we set the lower limit to CZK 160.

[72)] For a full list of items in particular group see appendix 6.

7.3 Abusers and Non-abusers

Unfortunately, the Household Budget Survey (BHS) is not applicable when we ask how many consumers of particular alcoholic beverage do so in abusive manner. By definition, the survey is constructed on a household level and thus the possible excessive drinking by one family member is "diluted" by the remaining members of the household. Therefore some study on individual level must be used. One such a survey has been published by Matoušková (2001) and examines individual consumption of all alcoholic beverages. In accord with most of the literature (Matoušková 2001, Nešpor 2003, Anderson and Baumberg 2006) let those consumers, who drink more than 50g of ethanol (approximately 1.6 liters of beer, 0.6 liters of wine or 0.2 liters of spirit) per day on average, fall in the abuser category and let the rest be treated as non-abusing part of the population. Applying the distribution to the 2006 population data, we end up with about 8 190 000 persons who drink alcohol without abuse and about 615 000 abusers. These results correspond very tightly with estimates, recently published by Karel Nešpor.[73] Using again the distribution by Matoušková, we calculate those two groups to be responsible for 70.3% and 29.7% of domestic alcohol demand respectively. In other words, group consisting of about 7% of non-abstinent population is responsible for drinking almost 30% of total alcohol consumption. An average *non-abuser* therefore consumes about 9.19 liters of pure ethanol equivalent per year, whereas an *abuser* drinks 51.64 liters.

For the list of total ethanol consumption $\left(X_i^j = N_i^j x_i^j \;\; i \in \{b,w,s\} \;\; j \in \{a,n\}\right)$ separated for individual beverages under the assumptions of "Proportional scenario*"* and "Detention Centers scenario*"*, see Table 23.

[73] see Nešpor (2008), who estimates "over 600 000 alcohol addicted persons.

Table 23

Separated Ethanol Equivalent Consumption				
	Proportional scenario (Million liters)		**Detention Centers scenario (Million liters)**	
beverage	**Abusers**	**Non-abusers**	**Abusers**	**Non-abusers**
Beer	15.27	36.17	22.23	34.93
Wine	6.47	15.33	3.18	15.92
Spirits	10.02	23.72	6.35	24.38
Total	15.27	36.17	22.23	34.93

An important question which does not have any simple solution concerns relationship between abusive/non-abusive consumption and elasticities of demand. As discussed above, it is not possible to distinguish abusers and non-abusers from the rest of population in BHS. Therefore we cannot even test for any empirical evidence of a difference between abusers' and non-abusers' elasticity of demand. To overcome this drawback (at least partially), we introduce an alternative set of scenarios. First one assumes equal elasticities for both consumer groups (hereafter "Equal Elasticities scenario"). The second scenario will include artificially modified elasticities – with all abusers' own-price elasticities set to one half of estimated values (hereafter "Modified Elasticities scenario"). Similar approach has also been taken by Pogue and Sgotz (1989). Results of such this scenario will serve us as a sensitivity test of our model. Moreover, model including a group with lower responsiveness to a price change could be also helpful, when assessing the presence of illegal alcohol market, as the consumers of illegal beverages are likely not to reflect the tax in full.

8 Empirical Analysis of Microeconomic Behavior – The Results

For estimating the systems given in (35) on the data from Czech Budget Household Survey, a structured dated panel has been created for each stage. For reasons discussed in section 7.2, the number of observations for each stage varies from 11 238 at stage 1 and 2 to only 10 856 observations at stage 3. Within each step, we estimate a system of N-1 equations where N is number of commodity groups. This is because of the adding-up condition, which ensures that the last equation is a linear combination of the former equations. At stage 1, we exclude the services equation, at stage 2 it is the cereals and other food equation and at the last stage we exclude the non-alcoholic drinks part.

The estimation has been done using one-way Seemingly Unrelated Regression technique. This approach seems to be suitable for our analysis as it is able to capture the efficiency due to correlation of the disturbances across equations. For detailed specification of the approach review Baltagi (2008). In case of our study, it is able to account for non-included factors such as hot weather, which might support beer consumption in a particular year. The basic AIDS model frequently suffers from autocorrelation problems, which is confirmed also in our study. System residual Portmonteau Tests basically rejects no-autocorrelation hypothesis for the first lag for all three beverages with Q-stats over four thousand. Alessie and Kapteyn (1991) and Assarsson (1991) proposed Dynamic AIDS model, which could (at least partially) solve this problem by introducing a vector of lagged dependent variables into each equation of the system. This method, however, is not applicable for our data as the length of our panel series is too short and cannot withstand such loss of degrees of freedom[74)]. Concerning the hetoreskedasticity tests, Verbon LM test, which is appropriate for our data does not seem to report too large problems (with only minor exception for one equation at Stage 1) .

Despite strong significance of many individual coefficients (particularly at stage 3 estimations), the model in general shows rather low explanatory power, with R-squared

[74)] For some examined households, only 2-3 observations have been collected, therefore introduction of lag structure is virtually implausible.

reaching values lower than 0.3. However, for cross-sectional data and especially for non-aggregated form of the model, these values could be treated as quite natural.

In the text below, we present the estimated elasticity values for individual budgeting stages, given by (31) and (37). The number in brackets represents t-statistic of corresponding coefficient in the system (36), which is γ_{ij} for price elasticities and β_i for income elasticities. For the figures of the non-estimated equations, the unobserved t-statistic is taken from an auxiliary regression (with exclusion of the first equation from the system instead). These figures are denoted with denoted with "*". For a full list of regression outputs see appendix 8.

The results of stage 1 estimation are in accord with common economic observation. Industrial and mfg. goods exhibit features of luxury goods with income elasticity of 1.34 (42.300), services show almost unity value reaching 0.98 (-3,422*). Finally, results show food as a necessity with elasticity of 0.60 (-58.187).

The second stage brings estimates for the food segment. Again, the income elasticities show expected pattern: Animal products, Vegetables and Cereals & other food exhibit the features of slight within-group necessities, with group-expenditure elasticities of 0.95 (-11.820), 0.99 (-0.945) and 0.92 (-15.637*). Drinks group, on the other hand, behaves as a within-group luxury with group-expenditure elasticity of 1.22 (24.615). This means that total income elasticity of demand for drinks reaches 0.74, therefore drinks again count as necessity.

Finally, in the third stage, we are interested not only in the income elasticities but also in the own-price and cross-price relations. The within-group expenditure elasticities show following pattern. Whereas wine and spirits behave as necessities – with corresponding group-expenditure elasticities 0.76 (-24.439) and 0.47 (-69.519), beer and non-alcoholic drinks show a luxury pattern – with corresponding elasticities 1.33 (35.030) and 1.06 (12.056*). In terms of total income elasticities this means total elasticities of 0.98 for beer, 0.56 for wine, 0.35 for spirits and 0.78 for non-alcoholic beverages. This pattern might seem a little surprising at first sight. However it might be readily explained by structural properties of particular beverage groups. Our dataset includes both consumption at home and consumption in restaurants. For wine and spirits, the volume share consumed at home reaches 90% and 92% respectively of total consumption. For beer and non-alcoholic drinks, on the other hand, these proportions reach only 75% and 39% respectively. The placations to income elasticities is straight

forward – ac a result of wealth change, consumers of beer and non-alcoholic drinks may tend to increase their consumption in restaurants in larger proportion than their consumption at home. Data from BHS do support this statement. For example share of draught beer seems to increase by 1.27% per additional CZK 1000 in drinks expenditure. The general consumption trends from bottled beer towards draught beer, and from mild to lager beer types are also confirmed by Czech Beer and Malt Association (2007).

All alcoholic beverages show negative own-price elasticities, amounting to -0.97 (-4.452) for beer, -1.09 (-6.693) for wine and -1.21 (-12.8535) for spirits. It is legitimate ask whether the beer elasticity should not be lower in real world. Again, the effect of price increase might result in transition from draught to bottled beer. This effectively reduces beer's group-expenditure share leaving real volumes virtually unchanged[75)].

Concerning the cross-price elasticities, our results confirm the symmetry assumption. In fact, Wald tests reject the hypothesis at any usual level of significance. The results of the estimation together with overview of all other variables of the model are listed in table 24 (listed t-statistics represent values for estimates of appropriate γ_{ij} and β_i coefficients.) To preserve space, we do not include results connected to non-alcoholic drinks as they do not enter our model.

Table 24

Empirical Analysis – The Results			
Elasticity of demand for good X given change in price of good Y (X – Y)	**Symbol**	**Value**	**t-stat.**
Beer - beer	ε_b	-0.9715	-4.452
Wine - wine	ε_w	-1.0880	-6.693
Spirit - spirit	ε_s	-1.2104	-12.853
Beer – wine	ε_{bw}	-0.1143	-3.969
Wine – beer	ε_{wb}	-0.0681	-6.693
Beer – spirit	ε_{bs}	0.2047	8.821
Spirit – beer	ε_{sb}	0.0933	-1.276
Wine – spirit	ε_{ws}	0.2302	6.790
Spirit - wine	ε_{sw}	0.0491	-1.729

Source: Own calculation based on data from Czech Household Budget Survey
Note: For full list of elasticity estimates see appendix 9.

[75)] Lower price elasticity of demand for beer is also reported by other studies. Smith (1999) estimates reach -0.76 for United Kingdom, Nelson (1997) presents only -0.16 for US data.

It is thus straight forward that in order to respect the results of our empirical analysis we need to use the cross-price elasticities without imposing symmetry condition.

Having calculated the above estimates of microeconomic behavior, it is natural to seek for similar micro-level analyses to obtain comparison. A straight forward parallel to our study should have been represented by mentioned master's thesis by Ondřej Přibyl (2005), who also examined Czech Household Budget Survey Using AIDS method. Results of the paper, however, are not applicable in the end for two reasons. First, the econometric estimation is carried out on a single year of data (2002) which means in fact calculating the elasticities not using price-quantity responses by one or more subjects (or aggregate entities) in time. The study in fact deduces conclusions on individual behavior by pooling a set of different households together, which would only be possible under the assumption of identical preferences of all the households. Such an assumption Moreover, due to a mistaken variable definition in underlying TSP code, the estimation uses logarithms of commodity weighs instead of prices. This leads to a model based on a system of equations in form of:

$$w_i = \alpha_i + \gamma_i \ln(w_i) + \sum_{j \neq i} \gamma_j \ln(w_j) + \beta_i \ln(X/P^*)$$

which reports great explanatory power of individual equations (with R-squared over 0.85 which is rather unusual for cross-sectional data) but which has no real economic interpretation.

Another paper similar to our study is already mentioned estimation by Crawford, Laisneyb and Preston (2004), who also use HSB data, utilizing the implicit price information given by its volume-expenditure scope. Although their analysis does not concern alcohol beverages in particular, it gives us additional confirmation on empirical problems with symmetry of cross-price elasticities at non-aggregated level.

9 Optimal tax calculation for The Czech Republic

9.1 Scenarios Description

Finally, we have covered all the variables needed for our model (see section 5.3) and we may approach its calculation. As discussed above, four scenarios of the model are carried out.

Case 1: ("Proportional – Equal Elasticities scenario") assumes that the proportion of consumers abusing each of our three beverages is equal to their aggregate share of total ethanol consumed. As the scenario uses precisely the estimated set of elasticities, it serves as a conservative benchmark of our model with most solid underlying assumptions.

Case 2: ("Detention Centers – Equal Elasticities scenario") differs in number of abusers attributed to each alcoholic beverage, which no longer follows the aggregate statistics but relies on observations from detention centers. In this scenario, particular attention is being paid to beer.

Cases 3 and 4: The remaining two alternatives ("Proportional – Modified Elasticities scenario" and "Detention Centers – Modified Elasticities scenario") serve as sensitivity tests of our estimates using an artificial (but legitimate) hypothesis that price elasticity of demand for all three beverages among alcohol abusers halved compared to the price responses by non-abusing part of consumers. Although we are not able to support this scenario with evidence from the data (due to of reasons discussed in section 7.3), this assumptions seems to be backed by common sense and elementary empirical observation, which is also supported in literature. Similar hypothesis has been by Pogue and Sgotz (1989) to illustrate the effect of changes in price responsiveness of abuser group on the optimization problem.

Now we use the model defined in section 5.3 together with all its input variables including average prices mentioned in section 2, net costs discussed in section 3.2, abuser/non-abuser distribution of population touched in section 7.3 and the results of our empirical analysis of consumer behavior summarized in section 8.

9.2 Calculation Results

Solving the system of equations given by (18), (19) and (20) and following the assumptions mentioned in section 9.1 we obtain results listed in table 25.

Table 25

Case 1 - Optimal Tax Calculation						
	Tax per liter of ethanol (CZK)	**Tax per liter of the beverage (CZK)**	**Relative tax**	**Reduction in abuse costs (CZK million)**	**Dead-weigh loss (CZK million)**	**Welfare Gain (CZK million)**
beer	138.08	5.80	25.20%	1 539	-745	2 285
wine	415.96	42.43	57.86%	4 554	-2 418	6 971
spirit	284.09	113.67	49.40%	6 332	-1 702	9 198
average	240.77	---	39.49%	---	---	---
total	---	---	---	12 425	-4 864	18 454

This scenario proposes that in order to set a welfare maximizing situation[76)] price of individual beverages should be increased by 25% - 58% (see column "Relative tax"). If this was to be achieved by an increase in excise taxes, it would mean 241% increase fro beer excise tax and 110% growth in spirit tax. In case of wine, we should rather speak about tax introduction rather than tax increase (given the current zero rate for non-sparkling wine). Generally, in both scenarios based on the assumption of *Proportional* distribution of alcohol abusers (Cases 1 and 3), the level of optimal tax is inversely related to the per-liter benefits brought to the society by particular beverage. This results in heavy taxation of wine accompanied by lower tax for spirits and only moderate tax for beer, for which the production benefits seem to be the largest. Introduction of the optimal tax in this scenario reduces the average cost per one abuser by CZK 20 200. This means that after subtracting the dead-weigh loss due to lower consumer's surplus for all consumers, the total welfare gain due to induced tax reaches CZK 18.45 billion.

On the other hand, while assuming that beer (Case 2), wine and spirits account for 70%, 10% and 20% of abusers respectively, the situation changes significantly – see table 26.

[76)] For discussion of assumption on social optimality problem review section 3.2.1 and section 3.1

Table 26

Case 2 - Optimal Tax Calculation						
	Tax per liter of ethanol (CZK)	**Tax per liter of the beverage (CZK)**	**Relative tax**	**Reduction in abuse costs (CZK million)**	**Dead-weigh loss (CZK million)**	**Welfare Gain (CZK million)**
beer	415.37	17.45	75.81%	14 535	-7 627	22 161
wine	104.90	10.70	14.59%	395	-190	585
spirit	110.34	44.15	19.19%	867	-432	1 300
average	255.88	---	45.47%	---	---	---
total	---	---	---	15 797	-8 249	24 046

As clear outcome of both Detention Centers scenarios (Cases 2 and 4), we can observe that the contributions of labor-intensive beer production is no longer able to compensate for beer abuse costs and its optimal price increase reaches almost 76%. Resulting welfare gain reaches even CZK 24.05 billion and an average abuse cost reduction per abuser reaches CZK 25 700. However, the matter-of-factness of this scenario could be readily contested when we take into account the fact that its optimal allocation requires a 71% reduction in total beer consumption. We need to bear on mind that elasticity estimates we used in our model are related to a single point on the demand curve. It is very likely, that as an accompanying effect of tax-induced consumption reduction, the demand for beer would become more and more inelastic. This would change the input variables of the model in gradual manner which is hard to imitate. However, we could at least partially simulate the outcome of the process. For each 0.1 change in elasticity of demand for beer, the final welfare gain reduces by approximately CZK 2 billion, hitting bottom around elasticity of -0.15. In the same time, the final reduction in beer consumption decreases by 3% fro each 0.1 elasticity point. Similar trends could be to some extent observed in all other scenarios. In Case 2, however, the impact it the most significant.

Now we proceed with more sensitivity tests by allowing the abusers' demand functions to be (twice) less elastic than those of their non-abusing counterparts. In table 27 and 28, we can se a dramatic change in the result.

Table 27

Case 3 - Optimal Tax Calculation						
	Tax per liter of ethanol (CZK)	**Tax per liter of the beverage (CZK)**	**Relative tax**	**Reduction in abuse costs (CZK million)**	**Dead-weigh loss (CZK million)**	**Welfare Gain (CZK million)**
beer	85.30	3.58	15.57%	540	-278	818
wine	250.11	25.51	34.79%	1 306	-780	2 086
spirit	117.37	46.96	20.41%	1 308	-417	1 725
average	129.01	---	21.01%	---	---	---
total	---	---	---	3 154	-1 475	4 629

Table 28

Case 4 - Optimal Tax Calculation						
	Tax per liter of ethanol (CZK)	**Tax per liter of the beverage (CZK)**	**Relative tax**	**Reduction in abuse costs (CZK million)**	**Dead-weigh loss (CZK million)**	**Welfare Gain (CZK million)**
beer	277.57	11.66	50.66%	4 880	-2 708	7 588
wine	55.61	5.67	7.74%	141	-58	199
spirit	42.84	17.14	7.45%	168	-59	227
average	158.29	---	28.28%	---	---	---
total	---	---	---	5 189	-2 825	8 014

Concerning the comparison of individual beverages, both scenarios (Cases 3 and 4) exhibit similar relative pattern of optimal tax distribution. The proportion of the shift in optimal tax for beer, between the *Proportional* and *Detention Centers* alternatives even slightly increased. However, the major difference from the first pair of scenarios rests on the overall effectiveness of taxation. Lower elasticity of abusers' consumption causes that the tax-induced reduction in abuse costs is compensated by large loss of consumer's surplus on the other side. On average, the 50% decrease in all abusers elasticity figures reduce the optimal tax by about 40% and cuts the total welfare gain down by two thirds. This observation has serious consequences, particularly concerning economic policy.

9.3 Implications

A common outcome of all examined scenarios of our model is that current situation on the Czech alcohol market is not optimal from the social-welfare

perspective. This is basically assured by presence of positive net external costs of alcohol consumption and by presence of negative own-price elasticities for all of the beverages. Such a situation is therefore calling for such a measure, which would reduce this negative externality and thus maximize the social welfare. This study shows that taxation is one of possible ways how to handle this problem. But the particular form of the taxation is to large extent dependent on assumptions on microeconomic behavior of the consumers and on the macroeconomic gains from each beverage production. Precise calculation of the optimal tax rates requires identification the number of abusers attributed to each beverage. We also need to account for on price-quantity responses correctly for both abusers and non-abusers group.

The above results, among others, also implicitly suggest that tax harmonization (e.g. leveling the taxes to the same level for all beverages, perhaps on pure ethanol content basis) is not likely to be the first best solution. The reason for this is that there are numbers of attributes in which individual beverages differ significantly and which have crucial impact on the optimization outcome. Apart from straight forward cost-benefit assertions, the model suggests that:

- the more inelastic demand for particular beverage compared to others, the higher optimal tax
- the higher ratio between non-abuser and abuser groups elasticity of demand, the lower optimal tax and lower tax-induced welfare gain
- the optimal tax vector is not determined by the absolute differences in elasticities but by their relative proportions. In fact the function is homogenous of degree zero with respect to elasticities.
- the higher proportion of abusers consumption attributed to particular beverage consumption, the higher optimal tax for the beverage

Given the particular set of assumptions in our model, the model proposes introduction of such taxes, which would cause an average price increase for each beverage ranging between 7% and 76%, depending on the beverage type and the scenario used.

10 Conclusions

Concerning economic policies treating alcohol production and consumption, the Czech Republic faces an uneasy situation. Alcohol industry has traditionally been one of the dominant parts of Czech economy with long tradition and significant impact on the national budget, employment, tourism, culture and various other social aspects. Brewing industry employs more than 1.4% of the Czech labor-force and its tax contributions to the economic system are non-negligible. Wine industry on the other hand represents a very important employment driver on regional level, accounting for dominant proportions of workers in particular rural areas, especially in the South-Moravian region. Although spirit industry does not represent such an important employment driver neither at national nor at local level, its excise tax receipts highly exceed the other two beverages. The estimated total benefits per-liter of ethanol equivalent reach CZK 413 for beer, CZK 163 for wine and CZK 241 for spirits.

On the other hand, given the large average rate, there is a significant amount of costs arising from its consumption. The scale of costs is very broad, including healthcare costs, loss of productivity, alcohol-related car accidents, crime and many others. We assume that the number of abusers is not necessarily proportional to the total ethanol share consumed in form of particular beverage. However, we do assume that marginal external abuse costs per se are proportional to the volume of ethanol consumed regardless its form. The average external cost of alcohol consumption reaches CZK 555. As a result, there might be a need for some tool, perhaps a tax mechanism, which would balance the profits and costs in order to achieve a socially optimal situation.

Form the microeconomic perspective, after taking a set of simplifying assumptions, we treat the social welfare as sum of individual welfares of all the members of the population. Separating those who do fully account for all the repercussions of their alcohol consumption from those whose behavior imposes a cost to the other members of society, we are able to create an economic model treating the relationship between tax-induced reduction in abuse costs and the loss of consumer surplus due to involuntarily decrease in alcohol consumption. After taking some simplifying but justifiable assumption, the model could be reduced to a system of n equations, where n is the number of examined beverage groups.

To solve the optimization problem we need not only the estimates of net external abuse cost per liter of abusive alcohol consumption, but we also need to estimate the microeconomic properties of demand for individual beverages. We did so using an Almost Ideal Demand System method, applied on a six-year panel data from Czech Household Budget survey. Results shown that own-price elasticity of demand for beer (-0.97) is the lowest, followed by wine (-1.01) and spirits (-1.21).

When all the variables of the model had been estimated, we used two sets of key assumptions to create four different scenarios of the model. In the set case we evaluated an assumption that number of abusers is proportional to the aggregate share of particular beverage on total ethanol consumption against an alternative that number of abusers corresponds to the number of patients in detention centers who prefer the specific beverage. In the second dimension of assumptions, we test the calculated elasticity figures against an alternative assuming that price response by abusers is one half lower than for the rest of the population.

The results show that the vector of optimal tax rates, expressed as such an increase of total beverage's price, which would maximize the social welfare, is largely dependent on the assumptions. The "detention centers" based scenarios largely penalize beer production since beer is assumed to be responsible for 70% of abusers. On the other hand, in the proportional scenario, it is beer, which should be taxed the least. When we introduce the assumption of lower elasticities for abusers, the effectiveness of tax introduction decreases dramatically as the reduction in external abuse cost is compensated by much larger sacrifice in a form of dead-weigh loss. The proposed optimal tax rates vary greatly across particular beverages and scenarios ranging from 7% to 76%. This also gives an answer to often pronounced question, whether taxes on all the beverages should be harmonized. Given the fact that the beverages differ in most of the attributes important to the model, it is highly improbable that an optimal allocation would be achieved right by the equal tax. However, the numerical outcomes of the estimation might not be the only outcome of the analysis. Perhaps even more important are the general features of the model - the effectiveness of a tax measure not dependent on nominal elasticity levels but on the ratio between abusers and non-abusers elasticities of demand.

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11 Appendices

List of Appendices:

Appendix 1: Consumers Price Indices in 2005 Constant Prices

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
68.5	73.6	77.2	81.1	85.0	85.9	90.1	92.6	92.1	91.8	97.0	100.0	101.5	105.7

Source: Czech Statistical Office

Appendix 2: Per Capita Beer Consumption by Country (2003)

Rank	Country	Per capita volume Consumption (l)	Total consumption (million l)
1	The Czech Republic	156.9	1,878
2	Ireland	131.1	521
3	Germany	115.8	9,555
4	Australia	109.9	1,678
5	Austria	108.3	885
6	UK	99.0	5,92
7	Belgium	93.0	970
8	Denmark	89.9	486
9	Finland	85.0	437
10	Luxemburg	84.4	39
11	Slovakia	84.1	456
12	Spain	83.8	3,376
13	US	81.6	23,974
14	Croatia	81.2	365
15	Netherlands	79.0	1,269
16	New Zealand	77.0	313
17	Hungary	75.3	755
18	Poland	69.1	2,67
19	Canada	68.3	2,183
20	Portugal	59.6	627
21	Bulgaria	59.5	448
22	South Africa	59.2	2,53
23	Russia	58.9	8,45
24	Venezuela	58.6	1,525
25	Romania	58.2	1,302
26	Cyprus	58.1	45
27	Switzerland	57.3	426
28	Gabon	55.8	76
29	Norway	55.5	249
30	Mexico	51.8	5,435

Source: http://www.kirinholdings.co.jp

Appendix 3: Alcohol and the Population

Author is aware of the fact that restriction to adult population, while estimating the parameters of microeconomic behavior, could be misleading in case of the Czech Republic, as there is high consumption of alcohol even among children say in age 15 – 18. Sovinová and Csémy (2003) state that among 15 years old children 15,1% of girls and 36,9% of boys drink beer at least once a week. However, this "tacit" consumption could be compensated by decreased consumption on the other side of the age spectre, because medication used by some elderly people prevents them from drinking alcohol. Author still suggests that the calculated average beer consumption of an average drinker is likely to be underestimated, given the method of estimation.

Appendix 4: Health problems caused by alcohol

Somatic	**Psychic**
Infectious diseases (especially lung infectious diseases)	Alcohol addiction
Malignant tumours (cancer of nasopharynx and rectal tumours)	Disturbed intellect
Diseases of endocrine glands (livers, testicles)	Disturbance of personality
Indigestion	Deprivation syndrome
Blood diseases (insufficient hemocoagulation, macrocytar anaemia)	Delirium tremens
Neural diseases (Alcohol withdrawal tremor)	Alcoholic hallucination
Skin diseases	Korzakovov alcohol psychosis
Muscle diseases	Paranoic alcohol psychosis
Injuries and intoxication	
Foetal alcohol syndrome	

Source: Hampl (2003)

Appendix 5: List of items in particular step of multistage budgeting

Stage 3: Drinks

- **Beer**: beer (at home), beer (in a restaurant)
- **Wine**: wine (at home), wine (in a restaurant)
- **Spirit**: spirits (at home), spirits (in a restaurant)
- **Non-alc**.: syrup and concentrates, fruit and vegetable juices (at home), other non-alcoholic drinks (at home fruit and vegetable juices (in a restaurant), other non-alcoholic drinks (in a restaurant)

Stage 2: Food

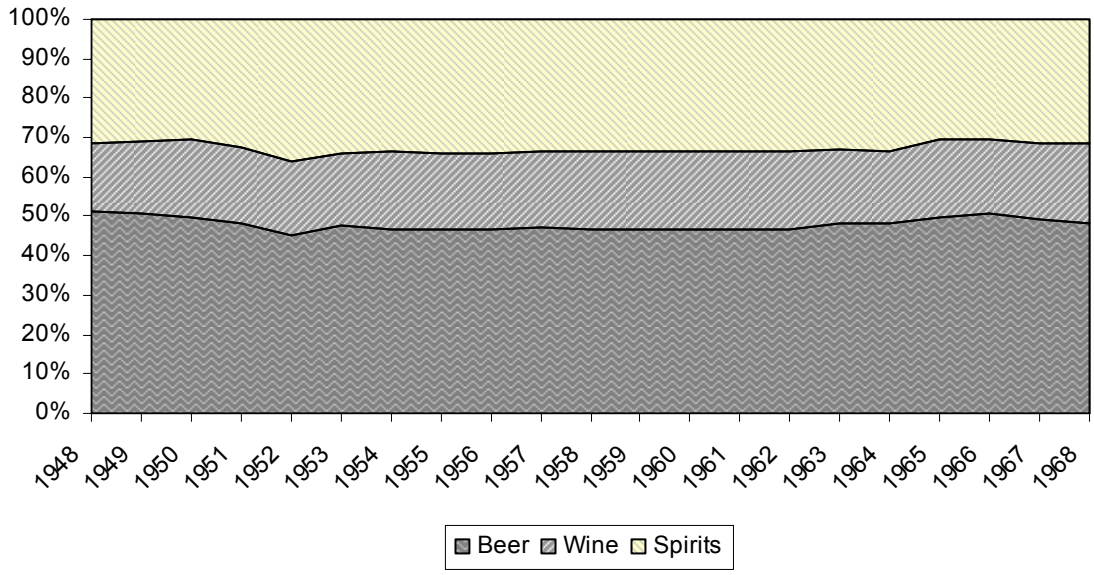
- Drinks (see Stage3)
- **Animalia**: pork, beef, other meat, smoked meats, meat cans, poultry, fish, butter, animal fat, eggs, egg products, fresh milk, canned milk, dried milk, cheese, yogurts, dried milk, other milk products.
- **Vagetablia:** rice, potatoes, potato products, vegetables, vegetable products, citrus fruits, bananas, apples and other pomiferous fruit, stone fruit, other fruit, jam and marmalade, fruit products, dried fruit
- **Cereal + other:** bread, pastry, other breadstuff, flour, pasta, other cereal products, sugar, chocolate, candy, cacao, honey and other sweeteners, coffee substitutes, coffee, tea, soups and sauces, salt and spices, baking stuff.

Stage 1: All consumer goods

- **Food:** (see stage 2)
- **Industrial products:** all industrial products and manufactured goods listed in Czech Household Budget Statistic.
- **Services:** all services listed in Czech Household Budget Statistic.

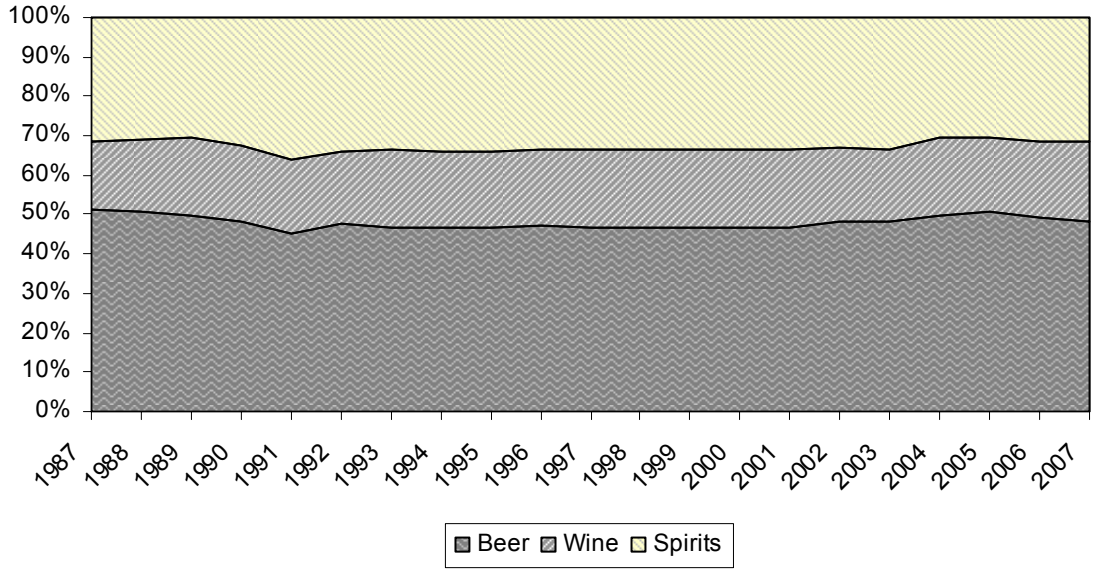
Note: Natural expenses and gifts have not been taken into account, because neither of this groups is subject to normal trade conditions and it is legitimate to assume that influence of minor price changes over these goods is negligible.

Appendix 6: Share of individual beverages on alcohol cons. – in terms of ethanol content



Source: Czech Statistical Office

Appendix 7: Share of individual beverages on alcohol cons. – in terms of total volume



Source: Czech Statistical Office

Appendix 8: Regression outputs

Stage 3

Estimation Method: Seemingly Unrelated Regression
Included observations: 10856
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha_{\_beerW}$	-0.43103	0.03585	-12.0214	0.0000
$\gamma_{\_beerW\_beerP}$	0.02225	0.00499	4.45234	0.0000
$\gamma_{\_beerW\_wineP}$	-0.01515	0.00381	-3.96911	0.0001
$\gamma_{\_beerW\_spiritP}$	0.05454	0.00618	8.82193	0.0000
$\gamma_{\_beerW\_nonalcP}$	0.04489	0.00531	8.44832	0.0000
$\beta_{\_beerW}$	0.07281	0.00207	35.02972	0.0000
$\alpha_{\_wineW}$	0.04053	0.02315	1.75092	0.0800
$\gamma_{\_wineW\_beerP}$	0.04101	0.00322	12.7112	0.0000
$\gamma_{\_wineW\_wineP}$	-0.01650	0.00246	-6.69330	0.0000
$\gamma_{\_wineW\_spiritP}$	0.02710	0.00399	6.79020	0.0000
$\gamma_{\_wineW\_nonalcP}$	0.03033	0.00343	8.84118	0.0000
$\beta_{\_wineW}$	-0.03280	0.00134	-24.43921	0.0000
$\alpha_{\_spiritW}$	0.67446	0.01737	38.81020	0.0000
$\gamma_{\_spiritW\_beerP}$	-0.00309	0.00242	-1.27594	0.2020
$\gamma_{\_spiritW\_wineP}$	-0.02378	0.00185	-12.8535	0.0839
$\gamma_{\_spiritW\_spiritP}$	-0.00518	0.00299	-1.72861	0.0000
$\gamma_{\_spiritW\_nonalcP}$	-0.01294	0.00257	-5.02494	0.0000
$\beta_{\_spiritW}$	-0.07004	0.00100	-69.51860	0.0000

Equation: BEER			
R-squared	0.108440	Mean dependent var	0.219606
Adjusted R-squared	0.108029	S.D. dependent var	0.168076
S.E. of regression	0.158738	Sum squared resid	273.3949
Prob(F-statistic)	1.038239	Portmonteau Q-stat 1st lag	5313
		Verbon LM het. test	0.2877

Equation: WINE			
R-squared	0.107079	Mean dependent var	0.136557
Adjusted R-squared	0.106667	S.D. dependent var	0.108444
S.E. of regression	0.102497	Sum squared resid	113.9857
Prob(F-statistic)	1.164769	Portmonteau Q-stat 1st lag	4018
		Verbon LM het. test	0.7849

Equation: SPIRIT			
R-squared	0.313310	Mean dependent var	0.131777
Adjusted R-squared	0.312994	S.D. dependent var	0.092824
S.E. of regression	0.076938	Sum squared resid	64.22603
Prob(F-statistic)	1.321314	Portmonteau Q-stat 1st lag	4619
		Verbon LM het. test	0.4556

Stage 2

Estimation Method: Seemingly Unrelated Regression
Included observations: 11238

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha_{\_drinksW}$	-0.3286	0.0207	-15.8464	0.0000
$\gamma_{\_drinksW\_drinksP}$	0.0604	0.0018	32.6843	0.0000
$\gamma_{\_drinksW\_animalP}$	0.0080	0.0033	2.3999	0.0164
$\gamma_{\_drinksW\_vegetP}$	0.0195	0.0024	8.1572	0.0000
$\gamma_{\_drinksW\_otherP}$	-0.0050	0.0023	-2.1334	0.0329
$\beta_{\_drinksW}$	0.0440	0.0018	24.6150	0.0000
$\alpha_{\_animalW}$	0.9181	0.0192	47.9341	0.0000
$\gamma_{\_animalW\_drinksP}$	-0.0190	0.0017	-11.1445	0.0000
$\gamma_{\_animalW\_vegetP}$	-0.0482	0.0031	-15.5824	0.0000
$\gamma_{\_animalW\_otherP}$	0.0001	0.0022	0.0248	0.9802
$\gamma_{\_foodW\_servP}$	-0.0346	0.0021	-16.1057	0.0000
$\beta_{\_animalW}$	-0.0195	0.0017	-11.8203	0.0000
$\alpha_{\_vegetW}$	0.0702	0.0133	5.2620	0.0000
$\gamma_{\_vegetW\_drinksP}$	-0.0028	0.0012	-2.3920	0.0168
$\gamma_{\_vegetW\_animalP}$	0.0216	0.0022	10.0429	0.0000
$\gamma_{\_vegetW\_servP}$	-0.0291	0.0015	-18.9076	0.0000
$\gamma_{\_vegetW\_otherP}$	0.0222	0.0015	14.8352	0.0000
$\beta_{\_vegetW}$	-0.0011	0.0011	-0.9451	0.3446

Equation: DRINKS

R-squared	0.1261	Mean dependent var	0.1981
Adjusted R-squared	0.1257	S.D. dependent var	0.0764
S.E. of regression	0.0714	Sum squared resid	57.2574
Prob(F-statistic)	1.1365	Portmonteau Q-stat 1st lag	3995
		Verbon LM het. test	0.8832

Equation: ANIMAL PRODUCTS

R-squared	0.1000	Mean dependent var	0.3758
Adjusted R-squared	0.0996	S.D. dependent var	0.0695
S.E. of regression	0.0660	Sum squared resid	48.8583
Prob(F-statistic)	1.1716	Portmonteau Q-stat 1st lag	4877
		Verbon LM het. test	0.3881

Equation: VEGETABLE PRODUCTS

R-squared	0.0524	Mean dependent var	0.1498
Adjusted R-squared	0.0520	S.D. dependent var	0.0472
S.E. of regression	0.0459	Sum squared resid	23.6991
Prob(F-statistic)	1.1458	Portmonteau Q-stat 1st lag	4234
		Verbon LM het. test	0.5696

Stage 1

Estimation Method: Seemingly Unrelated Regression
Sample: 2002 2007
Included observations: 11239

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha_{\_foodW}$	3.66580	4.29781	0.85294	0.3937
$\gamma_{\_foodW\_foodP}$	-0.04196	0.20302	-0.20669	0.8363
$\gamma_{\_foodW\_industP}$	-0.32639	0.75623	-0.43160	0.6660
$\gamma_{\_foodW\_servP}$	-0.20507	0.37373	-0.54870	0.5832
$\beta_{\_foodW}$	-0.10787	0.00185	-58.1872	0.0000
$\alpha_{\_industW}$	-6.98323	6.40998	-1.08943	0.2760
$\gamma_{\_industW\_foodP}$	-0.05694	0.30279	-0.18803	0.8509
$\gamma_{\_industW\_industP}$	1.04864	1.12788	0.92974	0.3525
$\gamma_{\_industW\_servP}$	0.42190	0.55740	0.75690	0.4491
$\beta_{\_industW}$	0.11695	0.00276	42.2999	0.0000

Equation: FOOD

R-squared	0.240232	Mean dependent var	0.272437
Adjusted R-squared	0.239961	S.D. dependent var	0.090129
S.E. of regression	0.078575	Sum squared resid	69.35913
Prob(F-statistic)	1.359519	Portmonteau Q-stat 1st lag	4380
		Verbon LM test	1.3822

Equation: INDUSTRIAL PRODUCTS

R-squared	0.138213	Mean dependent var	0.346437
Adjusted R-squared	0.137906	S.D. dependent var	0.126217
S.E. of regression	0.117191	Sum squared resid	154.2844
Prob(F-statistic)	1.451514	Portmonteau Q-stat 1st lag	2118
		Verbon LM test	0.9160

Appendix 9: Calculated elasticities of demand for alcoholic beverages

Income elasticities		
Variable	**Value**	**p-value of related coefficient**
E_beer	0.9829	0.0000
E_wine	0.5609	0.0000
E_spirit	0.3458	0.0000
Own-price elasticities		
Ebb	-0.9715	0.0000
Eww	-1.0880	0.0000
Ess	-1.2104	0.0000
Cross-price elasticities		
Ebw	-0.1143	0.0001
Ewb	-0.0681	0.0000
Ebs	0.2047	0.0000
Esb	0.0000	0.2020
Ews	0.2302	0.0000
Esw	0.0000	0.0839