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INDREK SAAR

Optimal alcohol taxation in Estonia

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I Articles in international journals

1. **Saar, I.** (2011), "Optimal alcohol taxation: Simulation results for Estonia," Baltic Journal of Economics, 10(2), pp. 65–90.
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II Conference presentations

1. Regulating Pedestrians' Behavior as One of the Most Effective Way Towards safer Traffic. 9th World Conference on Injury Prevention and Safety Promotion. March 15–18, 2008, Merida, Mexico.
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III Other publications

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2. Hein, P., Ahermaa, E., Martens, K., **Saar, I.,** Josing, M., Liivaauk, P. (2008), „Alcohol market, consumption and harms in Estonia. Yearbook 2008," Tallinn: Estonian Institute of Economic Research, 100p, [http://www.ki.ee/publikatsioonid/valmis/Alkoholi_aastaraamat_2008.pdf], 10.01.2011

INTRODUCTION

Motivation for research

Alcohol has an important cultural role worldwide often being present in different social events. For that reason alcoholic beverages are considered to be a natural part of people's everyday life. Alcohol is also often considered as a means to improve social interaction between people or for relief in enhancing people's ability to cope with stress. However, alcohol as a commodity has deserved ubiquitous negative attention due to its damaging consequences, which may arise even when it is consumed in small quantities. The latter aspect has induced a huge number of authors to address various alcohol-related issues. It has been usually found that there are rationales for some kind of government interventions since alcohol lays a substantial social and economic burden on society. In monetary terms, it has often been estimated that economic costs of alcohol account from 1% to 2% of GDP in different countries[1] (Thavorncharoensap et al., 2009).

In this regard, Estonia is not an exception. Several authors have shown the remarkable role of alcohol in generating negative consequences. The main concern of Estonian researchers has been alcohol-related morbidity and mortality (Lai et al., 2003, Kaasik et al., 2004) as well as the effects of excessive drinking on the health care sector (Reinap, 2009). However, the impacts of alcohol, as well as policies aimed to solve alcohol-related problems, are much more extensive affecting other spheres of society strongly. A huge gap in the corresponding literature needs to be filled, in order to reach a better understanding of the problem and to ascertain the appropriate solutions for Estonia.

International literature, however, has made some general suggestions regarding alcohol policy. Alcohol taxation, among other policy alternatives, has often been advised to be one of the most effective policy measures to deal with alcohol-related problems. Its curbing impact on negative drinking consequences, as well as cost-effectiveness, has been shown by many authors (Ludbrook et al., 2002). In Estonia, there was at least one study conducted which compared different alcohol control strategies (Lai et al., 2007). It was concluded that a rise in alcohol taxes would be the most cost-effective intervention. However, it shares the limitation with other Estonian studies mentioned above – only the effect on the health care sector was analyzed. In addition, these kinds of studies whether conducted in Estonia or abroad, rather show the impact of alcohol taxation on social costs of alcohol or on prevalence of some specific

[1] It is important to note that comparing alcohol costs with GDP, here and throughout the thesis, is mentioned only to reflect the extent of the monetary value of alcohol consequences with the overall economy. Although a certain proportion of the costs (e.g. alcohol-related health care costs) are part of the GDP, there is no direct relationship between the value of GDP and the economic costs of alcohol. For example, a considerable proportion of alcohol costs are attributed to premature mortality in terms of lost wages and are not included in the computation of GDP.

alcohol-related problem, but have little to say in regards to the socially optimal level of taxation. For the purpose of the latter, a solid theoretical framework should be developed to take into account multifarious costs and benefits of alcohol drinking and their interactions with other spheres of society. This kind of approach has had much less attention paid to it in the literature and is completely missing in the Estonian context.

Of these scarce studies, most have addressed optimal alcohol taxation in a partial equilibrium setting to increase inefficiency by correcting negative externalities in alcohol markets (e.g. see Pogue and Sgontz 1989). According to that approach, the optimal level of taxation directly depends on the level and dynamics of the social costs of alcohol, or more specifically, the parts of the social costs that are considered either external or internal but not internalized. Therefore, the optimal policy would concern internalizing un-internalized alcohol-related costs. Even then, this approach completely ignores fiscal aspects. In the Estonian context, however, fiscal considerations are of high importance. For example, alcohol excise tax represented approximately 4% of the total tax revenues of the central government budget in 2009 and even exceeded revenues from personal income tax (Statistics Estonia, 2010a). This means that changes in tax rates could considerably affect the budget position. In fact, during the economic recession in 2009, tax rates on alcohol were raised in order to reduce the fiscal deficit.

To the author's knowledge, only Parry et al. (2009) have considered both external and fiscal rationales simultaneously for obtaining optimal levels of alcohol taxation in the US. The theoretical model presented in their study, however, fails to account for several other relevant factors. For example, they only consider drunk driving while alcohol-related violence is ignored. Secondly, in the Estonian context, the model should be extended to account somehow for tourists' alcohol purchases as the latter, consisting mainly of purchases by Finnish tourists, represent approximately one fourth of the total alcohol sales (Orro et al., 2010). Possible expansion of the black market, which is often considered as a relevant counterargument for raising alcohol taxes, would also require some kind of reckoning.

To conclude, the discussion above refers to several challenges the field of alcohol research faces in the future since many relevant aspects remain un-solved. It is also revealed, that at the present state of alcohol research in Estonia, it is almost impossible to say something concrete about the appropriate level of alcohol taxation for two reasons; first, there has not been any comprehensive cost study carried out; second, even if there were, theoretical framework research applied in the literature would require some extensions to have higher policy relevance in Estonia. The current thesis is going to contribute to both empirical as well as theoretical literature, in ways laid out as follows.

The aim and research tasks

The aim of the thesis is to evaluate the optimal rate of excise tax on alcohol in order to accomplish two separate public goals in Estonia – correcting externalities and raising revenues for the government. Although this thesis is limited to addressing the average tax rate on alcohol only, while the obtaining of specific taxes on individual alcoholic beverages are left for future research, the thesis simulates numerical values for average tax rates and accordingly makes specific policy recommendations as regards to the current stance of alcohol policy in Estonia. Accordingly, the current thesis addresses the following research questions:

- What is optimal with respect to the two goals?
- Can the models of optimal alcohol taxation and optimal environmental taxation published in English literature be applied to Estonia as well?
- How should such a model be formulated and adapted to Estonian conditions?
- What are the outcomes in general and for Estonian alcohol taxation policy?

In order to arrive at the answers to the research questions and to achieve the aim of the thesis, research tasks are set up as follows. The *first research task* concerns understanding the problem, as it is a common procedure for any policy analysis (e.g. see Weimer and Vining, 2011). This mainly involves assessing the symptoms and considering alternative intervention measures. As regards to the latter, since the focus of this thesis is tax policy, alternative policies are discussed as much as necessary to determine the role and effectiveness of alcohol taxation.

The *second research task* is to introduce the models from literature used to address optimal alcohol taxation in order to analyze their applicability to Estonia. As this thesis bases itself on and extends upon optimal taxation theory, only models from this strand of public finance literature are explored. Since the empirical part of this thesis aims to apply both partial equilibrium and general equilibrium models in order to obtain estimates for optimal alcohol tax in Estonia, both types of models are studied. The most general forms of these models are laid out as well. This means that they are somewhat modified versions of those published in literature to overcome the unnecessary technicalities.

The *third research task* is to examine empirically the role of alcohol in traffic mortality, which is expected to contribute to creating an empirical basis for obtaining the optimal excise tax policy. Of the many alcohol-drinking consequences, traffic mortality was chosen to be studied more thoroughly for many convincing reasons. At first, traffic harm represents a remarkable share in social cost estimates worldwide affecting the health care sector, the criminal justice system as well as the insurance system, not to mention victims' health and overall productivity through injuries and premature mortality (e.g. Varney and Guest, 2002; Johansson et al., 2006). Second, many authors have shown that

alcohol taxation is an effective measure to control traffic harm (Grossman and Saffer, 1986; Wagenaar et al., 2010) implying that the level of optimal alcohol taxation is directly related to circumstances in traffic. In fact, several authors have considered drunk driving as the main external effect alcohol taxation should be designed to control (e.g. see Kenkel, 1996; Parry et al., 2009). Third, alcohol policies with regard to traffic accidents have usually concentrated on drunken driving legislation while drunken pedestrians are considered as victims. Empirical evidence, however, implies that alcohol is often more present among killed pedestrians (Peden et al., 2004). Accordingly, this thesis differentiates between drivers and pedestrians and thereby requires a close picture of traffic victims. Finally, as traffic accidents and its consequences have been one of the most important public concerns during the last decade in Estonia, empirical investigation of traffic mortality patterns was considered as a suitable starting point for empirical analysis in the present thesis. As concerns the study itself, data from post-mortem reports in 2000–2002 at the Estonian Bureau of Forensic Medicine are analyzed statistically to disclose the profile of victims and their association with alcohol intoxication.

The *fourth research task* is to estimate the level and the structure of economic costs of alcohol in Estonia. Similarly, to the third research task, it provides empirical basis for optimal tax estimates. Specifically, cost estimates are the main inputs into the alcohol taxation model in order to obtain optimal alcohol tax. For that purpose, cost-of-illness prevalence based approach is used and both direct and indirect costs attributed to alcohol are estimated for 2006.

The *fifth research task* is to develop the theoretical model that would allow obtaining empirical estimates for the tax rate on alcohol in Estonia. For that purpose a static, one-period, general-equilibrium model developed by Parry et al. (2009) is extended upon to account also for violence and other alcohol-related misdemeanors besides drunk driving. Additional important extensions concern the decomposition of tourists' alcohol purchases from other variables and accounting for administration costs of more stringent tax policy.

Finally, the *sixth research task* is an empirical simulation of the theoretically derived optimal taxation model. For that purpose, optimal tax parameters are estimated empirically, mostly for 2009 and are applied to the derived model. The basis for parameter values regarding costs and traffic mortality is on a large scale provided by accomplishing the third and the fourth research tasks. In fact, the main function of empirical analyses concerning traffic mortality and overall economic costs of alcohol is to equip the theoretical model with empirical parameter values. Simulation results of this model lay the main basis for conclusions and corresponding policy proposals of the thesis.

The thesis structure

The thesis consists of three chapters, which are divided into several subchapters. Figure 1 presents the logic of composition and mutual relationships as regards to the core subchapters. It can be seen that the thesis is divided into three parts: the first part reviews previous theoretical and empirical literature related to optimal alcohol taxation, the second part studies empirical alcohol-related externalities in Estonia, the third part obtains empirical estimates for optimal alcohol taxation in Estonia.

The first chapter is divided into three subchapters and details the issues that build the basis for optimal alcohol taxation. Alcohol-related consequences and their estimation issues, alternative alcohol policies and the responsiveness of alcohol-related harm with respect to alcohol taxation are discussed in different sections. The second subchapter involves the literature directly targeted at optimal alcohol taxation. The third subchapter discusses the most relevant issues in the literature in order to bring out limitations and research gaps in the context of the aim of the thesis.

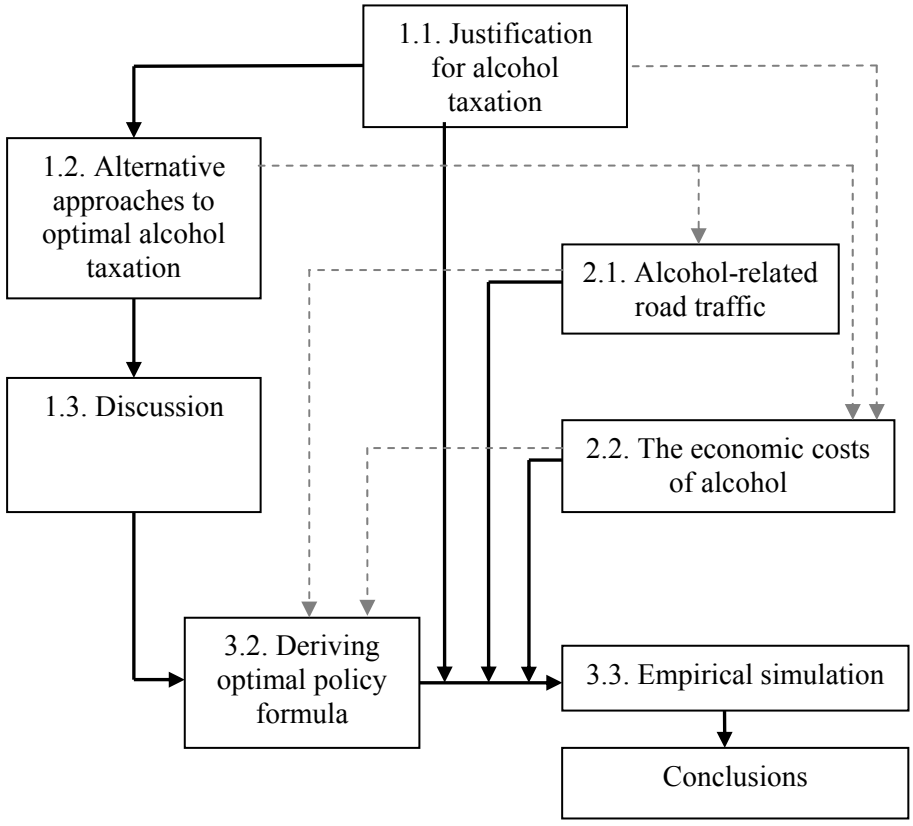

Figure 1. The relationships between chapters and subchapters
Source: Compiled by the author

The second chapter presents two empirical studies. Both studies are of empirical examination of alcohol externalities in Estonia. The first one concentrates solely on traffic mortality while the other presents comprehensive estimation of economic costs of alcohol misuse in Estonia. The need for such studies arise from externality-correcting literature discussed in subchapter 1.2 as the results of the studies are the main input data for obtaining the optimal alcohol tax. A connection between subchapters 1.1 and 2.2 has also been drawn to show that the former discusses issues related to estimation procedures of alcohol costs carried out in the latter.

Finally, there is the third chapter that presents the theoretical model from which the optimal tax formula for Estonia is derived. The latter is simulated empirically in order to obtain the main results of the thesis presented in subchapter 3.3. Empirical evidence taken from studies presented in the second chapter as well as in the first chapter was used to obtain parameter values for optimal policy formula. There are two arrows connecting empirical studies and subchapter 3.2, which reflect the fact that the theoretical model developed for Estonia accounts for several empirical findings from the second chapter as well.

The contributions of individual authors

All parts of this thesis except one have been written solely by the author of the thesis. Only subchapter 2.1 is a newer version of the paper published in 2007 in cooperation with two co-authors Aidule-Taie Kaasik and Marika Väli. The role of the author in preparing this paper was mainly to conduct the statistical analysis, while the writing and communication with the publishing house was carried out by Aidule-Taie Kaasik. Marika Väli contributed mainly by obtaining required data and preparing it for the analysis.

Subchapter 2.1, however, has considerably been changed by the author, compared with the published paper, since the focus in this thesis is somewhat different. The study is rewritten to support more directly the derivation of the theoretical model for obtaining optimal policy formula and the derivation of empirical estimates for parameter values to conduct the model parameterization. For that purpose, irrelevant statements and related references are eliminated. For example, approximately half of the Introduction section is rewritten to prevent unnecessary background information concerning epidemiological literature. Only a short overview of the literature concerning the role of alcohol and vulnerable road users in traffic accidents is discussed. In addition, related literature as well as background statistics presented in the Introduction section is updated for 2011.

The Methodology section has been changed moderately. As the data has been additionally analyzed by estimating a couple of logit models, the Methodology section is complemented by the short descriptions of these models. Although the Results section has been completely restructured, the main findings have not been changed but rather complemented with results from logit

models. However, some other modifications serve the purpose of getting a better picture of the role of alcohol in pedestrian fatalities and elimination of some unnecessary results in the context of the thesis.

The Discussion section is complemented with a subsection on Policy implications, which addresses traffic mortality issues in the context of optimal alcohol taxation. This section is completely written by the author of the thesis. The remaining part of this section, which mainly compares the results with previous literature concerning the main characteristics of victims and accidents like age, gender, location, time, etc., is relatively similar to the published paper.

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1. THEORETICAL AND EMPIRICAL BASIS FOR THE RESEARCH

1.1. Justification for alcohol taxation

1.1.1. Alcohol consumption and its socio-economic impact

Alcohol is often said to be an extraordinary commodity due to its remarkable socio-economic impacts. Although these impacts may be positive to some extent, the net impact is usually considered negative. The latter means that alcohol is often associated with different illnesses, accidents, premature mortality, violence etc. (e.g. see Rehm et al., 2008; Easton, 2008). All these consequences have been considered as the most convincing arguments for governments worldwide to implement some kind of intervention policies, including alcohol taxation. It must be acknowledged, however, that for most of the drinking consequences alcohol is only one contributing factor among many others. Therefore, the extent of the potential gain from alcohol policy hinges critically on the assumptions regarding the share of drinking consequences that can be attributed to alcohol alone. This subchapter aims to qualify this issue by laying down the key patterns of alcohol consumption as well as the main types of drinking effects and by briefly discussing methodologies to disclose their association with each other. In addition, as optimal alcohol taxation analysis requires estimates of drinking effects in monetary terms, the most common approaches used to accomplish this aim, along with prior empirical estimates, are discussed as well. Although the main aim is to give a general overview of these issues, special attention is also paid to the Estonian situation and its comparison with other countries.

General patterns of alcohol consumption

Alcohol consumption refers to drinking beverages, which contain ethanol[2]. Although acknowledging huge differences across countries, these kinds of beverages have acquired a notable cultural role worldwide. Whether having a meal, celebrating or meeting friends, alcoholic beverages are often present. As a result, alcohol has become an important commodity of which the production, sale and advertising represent an important share of the economy and consequently creates thousands of jobs. This applies especially to the European region where consumption of pure alcohol per capita is more than two times higher than in the rest of the world (Rehm et al., 2003a). Specifically, it has been recorded that during the last fifty years the overall level of alcohol consumption in countries with advanced economies, of which most are European

[2] In most countries, alcoholic beverages are legally defined in terms of certain alcohol content (see WHO, 2004). The Estonian Alcohol Act (Alkoholiseadus) defines alcoholic beverages as beers with alcohol content higher than 0.5 percent by volume and other liquids with alcohol content higher than 1.2 percent by volume. While evaluating optimal alcohol taxes for Estonia, this thesis applies the term "alcohol" to all beverages falling into one of these categories.

countries, has fluctuated around 10 liters of pure alcohol per capita. The per capita levels of recorded[3] drinking by type of beverages in selected countries in 2003–2005 are depicted in Figure 2. Considering the fact that in European countries people drink more than in most other countries, Estonia can be regarded as a country that experiences one of the highest consumption levels in the world. WHO (2011a) data for 2003–2005 reveals only a few countries in the world, such as the Czech Republic, Andorra and the British Virgin Islands, where the consumption level was estimated to be higher.

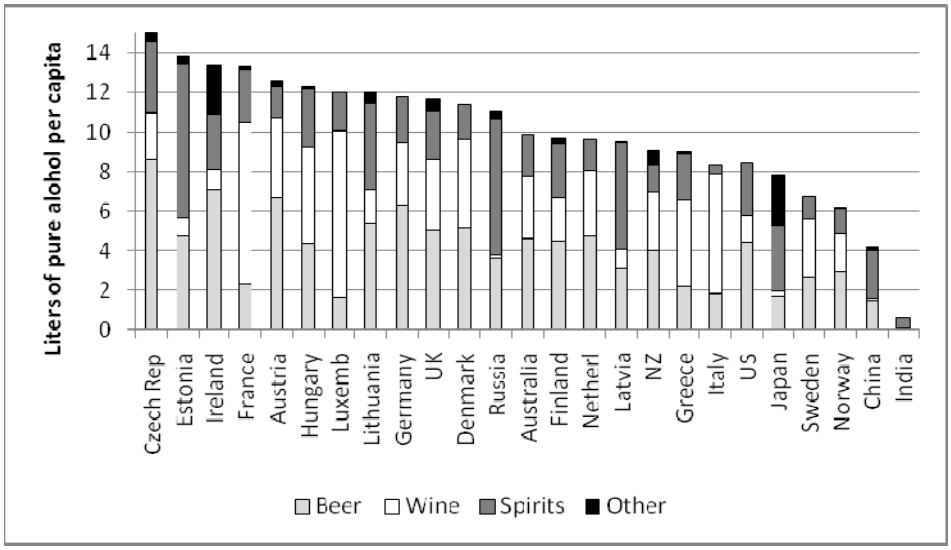

Figure 2. Recorded adult (15+ years) per capita consumption in liters of pure alcohol (average 2003–2005)
Source: WHO (2011a), compiled by the author

It should be stressed that the high level of alcohol consumption does not necessarily have to be damaging to public health. In many countries it is common that light alcoholic beverages such as beers and wines are consumed during meals only in small quantities which could be even beneficial to one's health. It appears in Figure 2, however, that in former soviet countries such as Russia, Latvia, Lithuania as well as Estonia, the consumption of spirits represents a substantial share of total alcohol consumption. In some countries, including Estonia, these are the most common alcoholic beverages. As a result, the level of spirit consumption in the first half of the 2000's in Estonia was higher than the level of overall alcohol consumption in countries such as Sweden or Norway. This

[3] The term "recorded" indicates that only alcoholic beverages, which are taxed by the government, are considered, while alcohol that had been acquired from illegal markets or via border trade has not been taken into account.

implies that Estonians drink a large part of alcohol for other purposes than just eating their meals. Therefore, both the level and structure of alcohol consumption in Estonia definitely indicates a potential problem in this field.

In addition to the level and the structure of alcohol consumption, another relevant issue, which illustrates drinking patterns, concerns the distribution of alcohol consumption. While Figure 2 presents the consumption levels in terms of per capita, it does not reflect the fact that most people drink considerably less and some people do not drink at all. It means that a large proportion of alcohol is consumed by a limited number of people. Empirical evidence revealed in many studies shows that of all alcohol available for consumption, the share consumed by the top 10% of drinkers, ranges from one-third to two-thirds (e.g. see Kerr and Greenfield, 2007; Lemmens, 2001). In other words, the distribution of alcohol consumption is positively skewed. Although this may lead to the belief that the most effective policy in controlling excessive drinking would be the one targeted at a small number of heavy drinkers, this may not be the case in practice. Rather convincing evidence from literature can be found according to which the distribution of alcohol consumption is relatively consistent (Cook 2007). It means that changes in the level of consumption per capita actually describes pretty well the changes in drinking patterns among all types of drinkers. As a result, the policy should aim to reduce drinking among the entire population by causing a downward shift of the entire distribution.

As regards to public concerns, alcohol consumption, as such, is not the problem. The main concern, which calls for public intervention, arises from the consequences of drinking. The public expects that these consequences be controlled through restricting alcohol consumption. This, however, depends critically on the accuracy of the assumptions regarding the relationship between drinking and its consequences. As follows, this relationship and its specification procedures applied in the literature are more closely described.

When examining the link between alcohol and its consequences it is convenient to employ the model presented by Rehm et al. (2003b). This model, basing itself on findings from the earlier literature, lays out the main causal pathways from alcohol consumption to a set of health and social consequences. Three intermediate outcomes are identified: direct biochemical effects, intoxication, and dependence. Biochemical effects include all effects of alcohol on human body functions. These effects can lead to beneficial consequences, such as the benign effect of moderate drinking on coronary heart disease, or harmful consequences, such as pancreatic damage. Intoxication mediates acute consequences, including traffic accidents, injuries, violence, premature mortality, etc. The third intermediate outcome in the Rehm et al. model is alcohol dependence. Being a disorder in itself, it sustains alcohol consumption and thereby mediates all possible effects alcohol drinking can cause.

It should be noticed that both biochemical and intoxication effects can arise even from relatively small quantities of consumed alcohol. Specifically, the human body can metabolize only a limited quantity of alcohol in a certain amount of time. Although this varies among individuals, the average amount is about 10 grams of

pure alcohol per hour[4]. The alcohol excess of that quantity increases blood alcohol concentration and consequently harms various organs in the human body (Zakhari, 2006). In regards to the acute consequences from intoxication, there are relatively convincing evidence which confirms that even small quantities of alcohol consumed impairs visual performance, interpretation of complex sensory information, rate of information processing and the ability to steer a vehicle as well as divide one's attention between two or more sources of visual information (Moskowitz and Burns, 1990). This can be explained by the fact that as initial alcohol concentration is high in the organs with abundant blood supply including brain, the neurological effects of drinking are seen almost at once (Knight, 2001). Therefore, both epidemiological and medical literature, only shortly discussed here, offer enough evidence about how consumption of ethanol affects the human body and a person's mental state, predicting various kinds of harmful consequences.

Quantification of the drinking consequences

Acknowledging that alcohol is a risk factor for negative consequences, the question concerning the extent of alcohol-related harm arises. Specifically, one could wonder whether there is enough ground for public intervention. For that purpose, drinking consequences must somehow be quantified. One relatively primitive indicator is provided by WHO (2011b). WHO publishes regular alcohol-related standard death rates of which the dynamics for Estonia and the EU are presented in Figure 3.

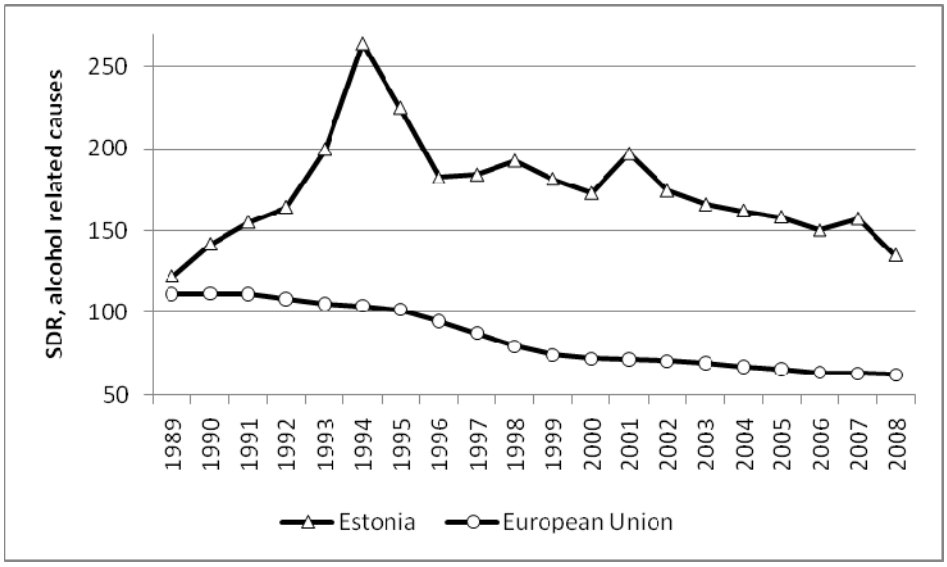

Figure 3. Alcohol related mortality in Estonia and the EU (per 100 000)
Source: WHO (2011b), compiled by the author

[4] Alcohol metabolism is the process through which ethanol is eliminated from the human body. For more details, e.g. see NIAAA (2007), Zakhari (2006), Knight (2001).

This indicator includes selected causes of mortality, which are known from literature to be related to alcohol consumption. These are cancer of the esophagus and larynx, alcohol dependence syndrome, chronic liver disease, cirrhosis and all external causes such as injuries, falls etc. Though being a highly indirect way to capture the volume of alcohol-related problems, it is appropriate for comparative purposes. For example, Figure 3 shows that while both Estonia and the EU in average have experienced a decreasing trend from the 1990's, there are more than two times more fatalities per 100,000 in Estonia. Considering that this indicator reflects the level of most serious consequences, it certainly implies the need for some kind of intervention policy in Estonia. However, this is pretty much all that can be said, as this kind of rough indicator does not suffice for a more sophisticated analysis. For example, while this death rate includes all traffic fatalities, a considerable proportion of traffic accidents could be attributed to several other factors such as inappropriate speed or defects of road design. It means that, while being useful in assessing the alcohol-related symptoms, this indicator fails to reflect the potential gain alcohol policy could achieve because deaths attributed to alcohol alone are unknown. A well-weighed policy, however, should satisfy this requirement.

To attain a better understanding of the burden caused by alcohol, all the consequences, regardless of which intermediate outcome they arise from, could be divided into two categories: those, which are caused solely by alcohol and those in the case of which alcohol is just one contributing factor among others. One example that could be included in the first category is alcoholic liver disease, as these kinds of diseases would not exist in an alcohol free society. It means that for such diseases there is certainty in determining the role of alcohol: all of them can be attributed to alcohol alone. However, there are wide ranges of effects that are associated with alcohol only partially, which means that the strength or even the existence in some cases, of this association requires profound analysis.

There is a rather well developed methodology to estimate the relationship between alcohol and different chronic health conditions. The most common way to accomplish this is to combine relative risks estimates with information about drinking patterns. Formally, this is carried out by using the following formula to derive the alcohol-attributed fraction for a specific alcohol-related health condition (English et al., 1995):

$$AAF = \sum_{i=1}^{k} P_i(RR_i - 1) / \left[\sum_{i=0}^{k} P_i(RR_i - 1) + 1\right] \qquad (1.1)$$

In (1.1) i denotes the drinking or exposure category from abstention to harmful. P is the prevalence rate of alcohol consumption of the certain exposure level and RR is the relative risk of a certain exposure category compared to no exposure. The value of AAF derived by using formula (1.1) practically shows the proportion of health conditions that without alcohol would not exist.

Relative risks are usually obtained from international surveys[5] while prevalence rates should reflect the drinking patterns of the nation being studied. Using this methodology, alcohol has been found to be a contributing factor fuelling the prevalence of different kinds of cancers, including breast, mouth, liver, esophagus and colon cancers, as well as diseases like cirrhosis of the liver, cerebrovascular diseases, pancreatitis, diseases of the esophagus, stomach and duodenum, etc.

Methodology for obtaining reliable AAFs for acute consequences, like drowning and injuries for instance, is not as advanced as in the cases of chronic diseases. The easiest way to create a link between drinking and acute consequences is to use fractions of cases where victims were found to have a blood alcohol concentration above a certain level. In addition, clinical methods are used consisting of an examination of a history of alcoholism or the finding of alcohol-damaged organs at post-mortem (English et al., 1995).

Another category of drinking consequences that require estimates of AAF results from violent or criminal behavior. A causal link between drinking and crimes is ambiguous. Pernanen (1996) and Pernanen et al. (2002) have reviewed the literature and have discussed different theoretical models; from those which see direct causal relationship between drinking and crime through an alcohol-induced so-called disinhibition process[6], to those according to which the association is based on socially meaningful constructions[7]. The former types of models support the simplest and the most direct, but they are, probably, not the most reliable way to obtain AAF. More specifically, it could be assumed that the proportion of criminal behavior committed under the influence of alcohol or the proportion of victims under the influence of alcohol become approximations of AAF. As this method may give biased results, interviews could be conducted with arrested persons, offenders and victims to gather background information (e.g. see Harwood et al., 1998; Pernanen et al., 2002). However, the development of more reliable methods remains for future research.

In addition to the negative effects of alcohol there is quite extensive literature providing evidence about positive effects of alcohol consumption. Gutjahr et al. (2001a, 2001b) have reviewed the literature of alcohol-related health consequences and referred to four types of health conditions for which drinking in moderate quantities may offer protective effects. These are cardiovascular disease, cerebrovascular disease, diabetes and cholelithiasis (gall-

[5] One often cited study conducted by English et al. (1995) has reviewed international literature regarding relative risks, which were used by the authors to estimate the attributable fractions for Australia. For recent updates of global AAF as well as a review of relative risks, see Rehm et al. (2008).

[6] According to this process, criminal behavior is assumed to occur after drinking due to psycho-pharmacological effects of alcohol and probably together with the drunken person feeling frustrated, threatened, provoked or insulted.

[7] For example, based on these theories one could link drinking and crime by assuming that in order to avoid responsibility for a criminal act a person drinks alcohol before such behavior.

stones). The attributable fractions for these health conditions can be found in the same manner as described above. In addition to health benefits, Heather (2001) also describes the research about psychological and social benefits. Positive psychological and social effects are obvious as most people drink to get into a better mood or use alcohol as a means to increase the enjoyment of each other's company. Nevertheless, literature also supports the role of alcohol in reducing tension or helping to cope with stress. Psychological types of benefits, however, are extremely difficult or even impossible to quantify. This is why quantitative studies have ignored them and mostly negative effects of alcohol are considered. One justification for excluding stress-relieving benefits of alcohol, however, is the assumption that a person who drinks alcohol knows about these benefits and pays the fair price for receiving them. Therefore, if the study aims to quantify only external effects or internal effects those individuals are incapable of internalizing[8], these benefits can be ignored. Even then, there are still probably external benefits this person with reduced stress passes on to others, e.g. to her or his family. This thesis, however, is not designed to solve this problem and thereby follows the prior literature in concentrating more on alcohol-related harm, which is easier to quantify[9].

There are also certain economic benefits. For example, alcohol production may generate considerable amount of public as well as private revenues and increase employment. However, benefits such as employment cannot be considered as social benefits in a strict sense because without the alcohol sector the resources would find employment in other sectors where their productivity may be even higher. Therefore, they can be ignored. Roughly speaking, the same applies to public revenues from taxing alcohol, as they are transfers within society, rather than social benefits[10].

Attaching monetary values

Even if the reliable association between alcohol and its consequences has been established, all above-mentioned drinking effects are rather difficult to compare with each other. This also means that it is difficult to reflect the total impact of alcohol on society. One often-used method to achieve comparability in public health literature is to convert the overall burden of diseases into disability-

[8] This is actually the appropriate approach for optimal taxation analysis. See subchapter 1.2.1 below.

[9] Obviously, there are many types of alcohol-related harm such as domestic violence, which is extremely difficult to quantify as well. Therefore, one strategy to overcome this problem could be to assume that unquantifiable benefits and harm offset each other and they can be ignored when net-effects of alcohol consumption are calculated.

[10] Tax revenues may generate social benefits if their collection is less costly than in the case of some other tax. In fact, fiscal considerations of alcohol taxation are the focus of this thesis (see subchapter 1.2 and chapter 3). In general terms, however, the tax payment from taxpayer to government, per se, does not directly generate any value and can be considered as a pure transfer.

adjusted life years (DALY)[11]. In Estonia, at least one study has been undertaken in which alcohol attributable fractions were calculated to obtain the burden in terms of DALY. It showed that almost 7% of the burden of diseases (measured in life years) was attributable to alcohol (Lai et al., 2003).

Another possibility is to place monetary value on each consequence. In order to obtain optimal tax rates on alcohol, which are expressed in monetary terms as well, this is inevitable. The typology of alcohol-related monetary costs is shown in Figure 4. There are first-hand consequences of drinking in the middle circle and their monetized values in four separate boxes[12]. At first, it is seen that alcohol lays a substantial burden on the public sector, because government must finance treatment of alcohol-related diseases, proceedings for alcohol-related misdemeanors and crimes, also fire and rescue operations. For this purpose, the government uses tax revenue, which means that the final cost bearers are all taxpayers regardless of their involvement in these incidents. What it means is that alcohol abusers affect non-abusers through higher taxes or reduction of quantity or quality of public goods and services. In those countries, which rely more on the private sector, the burden is carried to non-abusers through the insurance system.

Productivity losses arise from three main sources. At first, alcohol-related premature mortality may reduce the workforce and as a consequence the volume of production. Secondly, due to alcohol abusers' poorer health, their frequent drinking or absenteeism, they may find it difficult to find a job, so that there is probably a higher unemployment rate among alcohol abusers. This also applies to victims of alcohol-related accidents who have become partially/ totally disabled. Thirdly, even for those who have found a job, their performance may still be impaired. All types of productivity losses are borne by employers who must deal with lower labor productivity, by employees who face lower wages as well as by all taxpayers since lower productivity also cuts down tax revenues used to provide public goods.

There are three more cost categories pointed out. Property damage is mostly related to houses destroyed in fires and cars damaged in traffic accidents. In addition to tangible costs, there are also intangible effects. For example, practically every injury causes physical suffering to victims. Suffering from family violence, for instance, is one of the most important social problems in which alcohol plays a significant role. However, as was discussed above for benefits, these

[11] Disability-adjusted life-year (DALY) is defined as the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability. A technically similar concept is the quality-adjusted life-year (QALY), which instead of health loss measures health gain from some intervention policy. These are widely used measures to quantify the burden of disease from mortality and morbidity in public health literature.

[12] Although the discussion here as follows seems to be concentrated on alcohol costs, these are rather net costs as at least some benefits are usually monetized as well. For instance, it is quite common in alcohol costs studies to include benefits of drinking in terms of lower prevalence of some illnesses.

kinds of psychological effects are difficult to convert into monetary value and are often left out from the analysis. Finally, the value people place on loss of life could also be considered. It is different from the tangible value of life in which case the death of an individual is valued through their productivity.

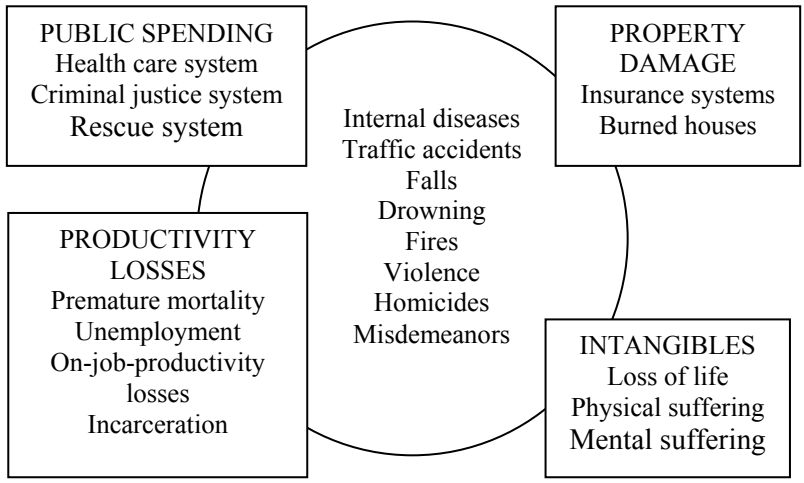

Figure 4. Consequences of alcohol consumption
Source: Compiled by the author

There has been a wide range of empirical estimates all over the world conducted to examine the burden alcohol lays on society. Before discussing the results, a couple of comments regarding methodological aspects deserve attention. At first, it should be noted that the different cost estimates vary considerably due to the cost components included. However, the most frequently used framework to estimate economic burden of diseases or health risks from alcohol is the cost-of-illness (COI) approach. In case of alcohol, COI studies estimate the costs of alcohol compared to the hypothetical situation that there was no alcohol consumption. Costs are categorized as direct and indirect. Direct includes costs like alcohol-related public health care expenditure, property damage etc. Indirect costs include productivity losses from premature mortality or illnesses, for instance.

In addition, COI studies vary on whether they are incidence-based or prevalence-based, top-down or bottom-up and a prospective or retrospective approach (see details from Robson and Single, 1995). Different approaches may considerably affect the results. It is also important to note that COI studies are usually conducted from a social perspective. It means that the included costs measure the value of the forgone opportunity, used in a different way than those resources, which are used or lost due to alcohol. Therefore, in the COI framework, although alcohol-related transfer payments lay a burden on a fiscal system, they are not interpreted as costs because resources are not used but shifted within a society. As regards to consumers' expenditures on alcoholic

beverages, these costs are excluded as well because they are offset by benefits from alcohol consumption[13]. Different use of cost terminology may also be confusing as some researchers use social and external costs as synonyms while private costs are those borne by consumers or producers. In mainstream economics, however, social cost is the sum of private costs and external costs that are more prevalently interpreted in the literature.

Although the COI study has become one of the most frequently used approaches estimating economic costs of alcohol, it has often been criticized by economists for its dubious policy relevance. A review by Tarricone (2006) presents three important limitations discussed in the literature. At first, it has been suggested that COI studies do not give any guidance in decision-making because any policy program is not evaluated. Secondly, COI studies are criticized due to their embedded circularity. The latter means that high health care costs attributed to a certain alcohol-related disease is the consequence of decisions made in the past. Therefore, the costs indicated by the COI study just show the actual resource allocation. Third, the human capital approach that is used to evaluate morbidity and mortality costs, reflecting loss of productivity through lost wages primarily, has little or nothing to do with the value people place on their lives. Therefore, results of COI studies do not indicate the benefit people receive when social costs would be curbed. Regardless of this critique, COI studies show the amount of scarce resources consumed due to alcohol and as a result fits into the framework of alcohol taxation after some adjustments have been made. The latter mainly concerns the categorization of costs into external and internal, as only the former is appropriately taken into account when optimal taxation problems are addressed. Specifically, optimal taxation literature is based strongly on mainstream economics. Standard models in economics, however, assume rational consumers, which mean that internalized costs of alcohol are not sufficient rationale for government policy intervention[14]. This approach is also followed in this thesis.

Empirical estimates of the economic cost of alcohol worldwide, of which most have used the COI approach, certainly imply that alcohol lays substantial burden on societies. There have been studies undertaken in the USA, Australia, New Zealand, the UK, Canada and Japan in the 1980's and 1990's indicating that the social costs of alcohol misuse range from 0.4% to 1.9% of GDP (Richardson and Crowley, 1992; Crowley and Richardson, 1997; Robson and Single, 1995). Recently, a literature review conducted by Thavorncharoensap et al. (2009) disclosed that the economic burden of alcohol in 12 selected countries was estimated to range from 0.45% to 5.44% of GDP. An almost identical range appears in Table 1, which lists studies conducted in 1993–2010. It should be

[13] These benefits could also include alcohol-induced relief of psychological stress, briefly discussed above. Therefore, both benefits and expenditures can be excluded.

[14] Un-internalized, internal costs such as some internal illnesses due to information failures could also be taken into account, even if the consumer is assumed to be rational. This is discussed in subchapter 1.2.1 in more detail.

noticed that the study conducted by Anderson and Baumberg (2006) presented in Table 1 is based on 21 surveys conducted in Europe based on which the cost of alcohol in the European Union has been estimated. It was found that the total tangible cost of alcohol in the European Union is EUR 125 billion, representing 1.3% of GDP.

Table 1. Comparison of cost estimates

Authors and year of study	Country and year of data	Result (% of GDP)
Nakamura et al. (1993)[2]	Japan, 1987	1.9%
Devlin et al. (1997)	New Zealand, 1991	1.4%–5.4%[1]
Rice et al. (1990)[2]	USA, 1985	1.7%
Harwood et al. (2000)	USA, 1998	2.1%[1]
Single et al. (1998)[3]	Canada, 1992	1.1%
Rehm et al. (2006)[4]	Canada, 2002	1.3%[2]
Fenoglio et al. (2003)	France, 1997	1.4%
Lima and Esquerdo (2003)	Portugal, 1995	0.6%
Johansson et al. (2006)	Sweden, 2002	0.8%[1]
Anderson and Baumberg (2006)	European Union, 2003	1.3%
Collins and Lapsley (2008)	Australia, 2004/2005	1.2%[1]
Thavorncharoensap et al., (2010)	Thailand, 2006	2.0%
Kaasik et al. (2004)	Estonia, 2001/2002	1%
Reinap (2009)	Estonia, 2006	1.1%
Saar (2009)	Estonia, 2006	1.6%–2.3%

Source: Compiled by the author

Notes: [1] Ratio was calculated by the author using original results and GDP value from OECD database (2007). [2] In Robson and Single (1995). [3] In ICAP (1999). [4] In Johansson et al. (2006).

Table 1 also shows that most of the estimates range from 1% to 2% of GDP. Relatively low costs in Portugal are due to the purpose of estimating only costs to the health care system. Therefore, the Swedish study, that includes all important cost components, has disclosed the lowest estimate among studies presented in Table 1. There may be many reasons for this result from methodological issues to the more severe alcohol policy in Sweden. High social cost estimates for New Zealand that exceeds 5% of GDP assumes the prevalent rate of alcohol abuse of 17.6% for males and 10.8% for females. Under low estimates, these figures were 6.5% and 2.2%, respectively. Similar variation was applied to other parameters as well.

As regards to the Estonian studies, the earliest one conducted by Kaasik et al. (2004) estimated that the alcohol-related economic burden in Estonia that can be attributed to premature injury mortality amounted to 1% of GDP in 2001/2002. In obtaining this result the authors included all fatalities in which victims were known to be intoxicated. A recent study by Reinap (2009) ac-

counts for only health costs, both direct and indirect and reveals similar result to Kaasik et al. The results of the Estonian study carried out by the author of the present thesis in 2009, as well as its methodological details are presented in the empirical chapter below.

For alcohol policy, social costs estimates alone have little to say. They can only illustrate the extent of the problem. The question of an acceptable level of economic costs of alcohol, as well as an appropriate mix of policy measures, remains unanswered. For that purpose, the following subchapter discusses alternative policy measures and their implementation in practice.

1.1.2. Alcohol policies in practice

Large-scale drinking harm is usually considered sufficient justification for government intervention. Alcohol policy is even defined as measures implemented to reduce this harm (e.g. see Monteiro, 2007; WHO, 2004). In practice, however, there is a wide variety of alternative instruments. It means that government faces the task of finding an appropriate mix of alcohol policies for alcohol control. This section at first briefly reckons different areas of alcohol policy and presents some evidence of their effectiveness. In the second half of the subchapter, alcohol policy implemented by the Estonian government and corresponding EU regulations are discussed as well. The primary focus is to reveal the role of alcohol taxation compared with other measures and its present application in practice.

Areas of alcohol policy

In addition to tax policy, mainly six different alcohol policy areas can be found in the literature, which are presented in Table 2. Controlling availability of alcoholic beverages and enacting certain drunken driving legislation are probably the most common alcohol policy areas after taxation policy. As it is shown in Table 2, physical availability of alcoholic beverages can be governed by restricting the number of outlets and their geographical location through an established licensing system or state monopoly. In addition, government could restrict hours and days in which alcohol can be sold or places in which it can be consumed. Drunken driving legislation usually determines the minimum blood alcohol concentration under which it is allowed to drive a car, a motorcycle or even a bicycle. These requirements, to be effective, are usually complemented by breath testing that involve random stops of drivers who are required to take a breath test to establish their blood alcohol concentration or by testing after justified suspicion arising from a traffic accident, for instance. Both availability and drunken driving measures can be targeted to a specific subgroup by setting restrictions on age below which alcohol purchase and consumption is prohibited or applying so-called zero-tolerance laws, which set lower BAC limits for young drivers.

Table 2. The main areas of alcohol policy

Policy areas	Specific interventions
Availability	Number of outlets Selling places Time of sale
Drunk driving	Blood alcohol concentration level Random breath testing Testing after justified suspicion
Advertising	Advertising bans Places of advertisement Sponsorship Health warnings
Health care interventions	Screening Brief intervention
Alcohol-free environments	Consumption places
Prevention	Alcohol education in schools Media campaigns
Pricing	Excise taxes Non-pecuniary penalties Fines

Source: Nelson (2010), WHO (2009; 2004), Holder (2008), Monteiro (2007), Chisholm et al. (2004), Cook and Moore (2002), compiled by the author

Although the other policy areas have received somewhat less public attention, they have important and indispensable roles in dealing with alcohol-related problems. Specifically, two related areas are advertising and different preventive strategies. The former includes restrictions on alcohol advertisements and sponsorship by the alcohol beverage industry as well as requirements of health warnings for advertising or labels on bottles. The aim of the latter is to raise the public awareness by providing information about alcohol risks through media campaigns or the education system if youth is considered as the target group. Health care interventions such as brief interventions or screening are directed at individual drinkers. Specifically, brief intervention may range from 5 minutes of brief advice to 15–30 minutes of brief counseling in order to facilitate behavior change (Henry-Edwards et al., 2003). Screening for alcohol consumption also involves activities such as educating patients in primary care and therefore provides an opportunity to give brief intervention to those that require it (Monteiro, 2007). Finally, alcohol policy could aim to create alcohol-free environments by restricting drinking in different settings such as public places in order to minimize the risks arising from alcohol abuse.

The essence of last measure listed in Table 2 – pricing policy – which is the concern of this thesis, arises from the law of demand. More specifically, as price rise is expected to decrease the quantity demanded, government may impose or raise the tax on alcoholic beverages in order to curtail alcohol consumption. Fines and non-pecuniary penalties for unlawful behavior committed under influence of

alcohol could also be categorized into the pricing policy area since the idea is similar to tax policy. For example, raising fines for drunk-driving increases the expected costs of a drunken driving trip for drivers, which should decrease the number of drunken driving trips they decide to take. This branch of alcohol policy has probably the most sophisticated and developed theoretical framework that has enabled several economists to obtain empirical estimates for optimal alcohol tax and penalties. This literature is discussed in detail in subchapter 1.2.

One of the most profound surveys concerning different alcohol policy areas compiled by WHO (2004) revealed that the degree of which each policy area is covered in different countries varies considerably. It is obvious that the optimal mix of policies is not identical among countries and depends on economical, political as well as cultural context. However, research on the effectiveness of different measures has disclosed some general guidelines regarding the most effective and cost-effective policy interventions. Reviewing the literature, Ludbrook et al. (2002) for instance, have found that there is a strong evidence base to show the effectiveness of taxation and brief interventions. In addition, the rising legal age of drinking, the lower permitted blood alcohol level when driving, random breath testing and lower outlet density were found to be effective. The effectiveness of the latter policy measure to curb adolescent drinking was recently confirmed by Truong and Sturm (2009). According to Chisholm et al. (2004), optimal policy mix varies with respect to the levels of hazardous[15] alcohol use. More specifically, brief interventions and taxation was shown to be the most cost-effective in regions with high rates of hazardous drinking. In regions with low levels of hazardous drinking, on the contrary, intervention programs targeted at special subgroups, drivers for instance, were found to be much more cost-effective compared with taxation.

Holder (2008) divides policy measures into three categories each suitable for different countries depending on the policy already in the place. Accordingly, for countries with less developed alcohol policy in place the first most effective and the least costly choice would be taxation. For countries with appropriate tax policy already in practice, but who further aim to reduce alcohol-related harm, it is recommended to implement different sales restrictions and to reduce density of alcohol outlets. The final step could entail complementing the existing policy arsenal with more targeted measures, like lower minimum drinking and purchase ages, random breath testing, lower BAC limits for drivers, etc.

Therefore, taxation is considered to have highly relevant role among alcohol policy instruments. It can be implemented with relatively low costs and it has widespread effects on alcohol consumption. Although it may create deadweight loss due to price distortions concerning moderate drinkers, it is important to note that a considerable proportion of alcohol is consumed by a small proportion of abusive drinkers. This means that the alcohol tax falls most heavily on abusive drinkers and the effect on the welfare of moderate drinkers cannot be

[15] Authors define hazardous alcohol use as an average rate of alcohol consumption of more than 20g pure alcohol daily for women and 40g daily for men.

too large. In addition, charging penalties for alcohol-related misdemeanors and crimes enable to internalize external effects without harming moderate drinkers. This way, the optimal level of alcohol taxation can be reduced.

The most important concern undermining the effectiveness of tax policy is the possible expansion of the illegal alcohol market. This may at least, to some extent, offset the reduction in legal alcohol consumption. However, Chisholm et al. (2004), for instance, have found that tax policy is one of the most effective alcohol policy measures even when 10%–15% increase in illicit production or smuggling is considered. Therefore, illegal production is not a sufficient argument for ruling out the tax policy per se.

Alcohol policy in Estonia

All the policy measures reckoned above are at least to some extent applied to the Estonian alcohol market as well. For example, there are certain restrictions in Advertising Act on advertising alcohol (Reklaamiseadus). In addition, according to Alcohol Act alcohol consumption is prohibited in public places (Alkoholiseadus). Even media campaigns on alcohol-related harm have been carried out. Probably two areas utilized by the Estonian government most actively in the last decade are drunken driving legislation and physical availability. However, none of them has been used systematically to control the economic costs of alcohol. Specifically, according to the drunken driving legislation the legal limit for blood alcohol concentration is 0.02 mg/100ml. This is lower than in most of the EU countries (for international comparison, see WHO, 2004). In addition, pecuniary penalty rates for a drunken driving trip were doubled in 2002 up to EUR 1200 (Liiklusseadus) and there have been random breath testing operations carried out as well. However, pecuniary penalty rates have been held constant regardless of the fact that by 2010, compared with 2002, nominal wages have practically doubled (Statistics Estonia, 2011a) and the standard of living in terms of real GDP have improved by more than one fifth (Statistics Estonia, 2010c).

Physical availability of alcohol has been somewhat restricted from 2008, as nationwide restrictions on hours in which alcohol retail sales can be conducted were implemented (Alkoholiseadus). More specifically, sales of alcoholic beverages are only allowed from 8.00 a.m. to 8.00 p.m. Before this policy change retail sales of alcoholic beverages was regulated by local governments and there was rather different practices across different regions (Saar et al., 2008). Regardless of the nationwide restrictions, the availability can be still considered relatively high. For example, the number of strong alcohol retail shops per 100 000 inhabitants is more than 30 times higher than in northern countries like Norway, Sweden or Finland (Orro et al., 2010).

Until recently, the excise tax policy has been rather inactive and it has not certainly served the main purpose of alcohol policy – to reduce alcohol-related harm. However, several tax raises have been carried out, especially in the years from 2008 to 2010. As a result, compared with excise levels in 2004, by 2010 rates were raised as follows (Ministry of Finance of Estonia, 2011):

- from EUR 3.5 to EUR 5.4 per 1% by volume of ethanol in 100 liters for beer;
- from EUR 20.1 to EUR 31.7 per hectoliter of product for wines (degree of alcohol less than 6%);
- from EUR 66.5 to EUR 73.1 for wines (degree of alcohol more than 6%);
- from EUR 926.7 to EUR 1418.8 per hectoliter of pure alcohol.

In order to get a better picture of how these rates fit into the dynamics of the overall economy, Figure 5 shows the changes in the ratio of the average nominal monthly wage rate to the prices of alcoholic beverages per liter. This indicator shows how many liters a person who earns an average wage is able to purchase when he or she is spending all their money on a respective beverage. For example, in 1998 this imaginary person could have purchased a little bit more than 200 liters of beer. By 2008, the purchasing power had been increased more than twice.

Figure 5. Economic availability of alcoholic beverages in Estonia
Source: Orro et al. (2010), Statistics Estonia (2011a), compiled by the author

Black signs in Figure 5 denote the years in which there was a rise in alcohol excise rates. In 2005, rates were raised by 5%, however, in the following years Estonia experienced substantial economic growth as well as an increase in the general price level, the effect of this policy change remained marginal. One obvious reason behind this sharp increase in purchasing power of alcohol arises from the fact that alcohol excise rates are levied on per unit of absolute alcohol

basis. As a result, tax rates fail to account for changes in producer prices. In 2008, however, rates were raised by about one third. During economic depression, rates were increased by additional 10% in 2010 to reduce fiscal deficit. As a consequent the trend of rising economic availability was stopped. Even then, purchasing power is still considerably higher than in 1990's.

It should be acknowledged that for membership in the EU, Estonia must follow certain rules that are established for free-trade purposes due to the EU harmonization policy. Specifically, the minimum rates are applied to alcohol excise duties each member state must meet (Council Directive 92/84/EEC). However, this has not put a significant pressure on tax rates. Specifically, tax rates implemented in Estonia have exceeded required minimum levels two or three times during the entire last decade. The only concern has been to avoid discrimination between different beverages that is prohibited in the EU for the purpose of free trade. Accordingly, the Estonian government had to raise the tax rates on some alcoholic beverages. This however, has had a marginal effect on overall level of alcohol taxation.

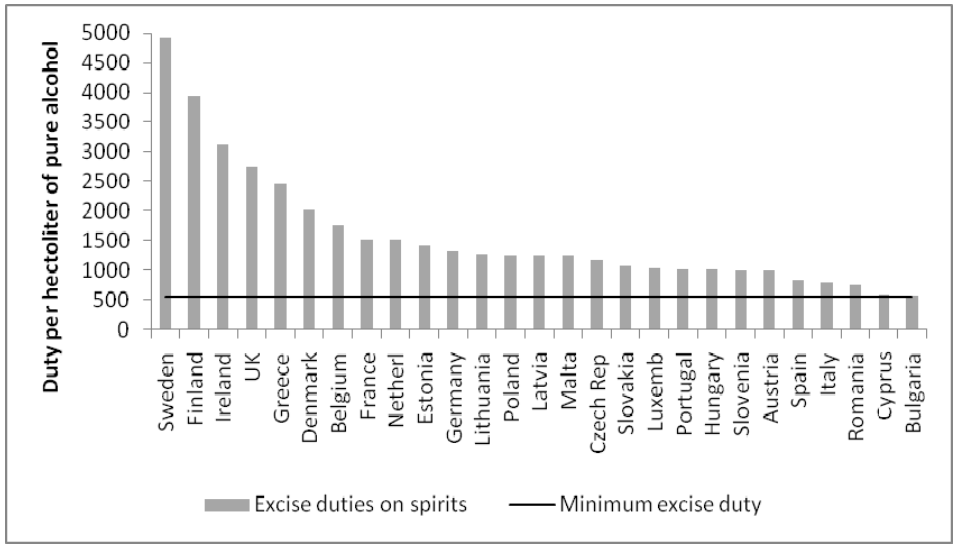

Figure 6. Excise duties on spirits in the EU in 2011
Source: European Commission (2011a), compiled by the author

This more or less applies to other EU member states as well. Specifically, the EU has set minimum levels of alcohol excise duties in 1992 each member country must meet. However, considering actual taxes implemented in most of the member states presented in Figure 6, minimum rates had been set at an inappropriately low level. Only two countries in the EU impose the minimum level of duties on spirits. The same also applies to beer duties – only Romania imposes the minimum level, which is EUR 1.87 per 1% by volume of ethanol in 100 liters.

As concern still wines, these beverages have maintained their special status. EU minimum rate for wine is zero, as almost half of the countries do not tax wines.

Another important factor affecting tax policies in the EU member states should be noticed. Specifically, low minimum levels of excise rates in the EU mean that member states can independently implement the taxation policy appropriate for each individual country. As a result, alcoholic beverages are substantially more heavily taxed in Northern European countries such as Finland and Sweden, but also in the UK and Ireland (London Economics, 2010). For example, regardless of the zero required rates for wines, Finland, Sweden, Ireland and the UK all impose more than EUR 200 per hectoliter of product. In other wine taxing countries such as the Baltic States, Denmark, Belgium, Netherlands and Poland, tax rates range from EUR 40 to EUR 90, except France where it is EUR 3.6. However, the main point here is that price differences, stemming from variation in excise taxes and amounting to more than four-fold in some cases, obviously stimulate massive border trade due to rather large intra-EU excise duty allowances. Specifically, within the EU one can transport from one member state to another beer up to 110 liters, wines up to 90 liters and spirits up to 10 liters, without paying additional excise taxes in the destination country (European Commission, 2011b). For Estonia, this creates motivation not to raise alcohol taxes as to maintain lower price levels compared with Finland or Sweden in order to attract alcohol purchases by tourists.

To conclude, although the tax policy has been actively used in recent years in Estonia for fiscal purposes and the EU legislation create certain motives for the use of alcohol taxation, there seems to be no well-weighed strategy of an appropriate taxation level as well as of alcohol policy in general. Considering the fact that there is practically no single analysis conducted that would address optimal alcohol taxation in Estonia, based on the present state of knowledge, it is almost impossible to say something convincing about the appropriateness of the current policy.

1.1.3. Effectiveness of alcohol taxes: empirical evidence

The preceding subchapter presented some results from literature concerning effectiveness of taxation compared with other alcohol policy instruments. However, to get a better understanding of the potential of tax policy to curb alcohol-related harm, specific empirical evidence concerning the impact of alcohol taxes on drinking and its consequences is required. In fact, effectiveness estimates presented above directly rely on how alcohol consumption responds to tax policy. In addition, this kind of evidence, as it appears in the subsequent chapters, becomes especially useful in order to obtain the optimal level of taxation. Accordingly, this subchapter serves the purpose of introducing the main relevant empirical results from the corresponding literature.

Before presenting the results, some comments on concepts used to measure price responsiveness are made. Specifically, since taxes imposed on alcohol

raise the price level of alcoholic beverages, usually price responsiveness is of interest. This is usually measured by different price elasticities. Mainly two types of elasticities are relevant in the context of alcohol taxation. At first, alcohol demand own-price elasticities are computed by finding the ratio of percentage change in alcohol consumption to percentage change in alcohol price. Secondly, to express the effect of change in alcohol price on drunken driving or on any other alcohol-related or non-alcohol-related effects, usually cross-price elasticities are used. These elasticities reflect the ratio of percentage change in these effects to percentage change in alcohol price. Cross price elasticities show whether two commodities, drunk driving and alcohol, for instance, are substitutes or complements. In case of the latter, tax policy, which reduces drinking, has the same impact on drunk driving as well. In case of the substitutes, such as some other drugs, adverse effects due to drinking may just be replaced with some other harm.

Instead of price elasticities, some studies also report tax elasticities to disclose the effect of taxes directly. This may be necessary when there is reason to believe that taxes are not completely shifted onto consumers. As follows, empirical evidence about the effect of changes in alcohol taxes and prices are demonstrated. At first, evidence about four different types of alcohol-related outcomes is presented. These are aggregate alcohol drinking, youth drinking, heavy drinking[16] and acute drinking consequences. Secondly, some evidence of potential substitutes of alcohol is presented as well.

Aggregate drinking

There is a vast body of literature concerning price responsiveness of alcohol demand. Most of them also provide estimates for elasticities whether for alcohol in general or for individual alcoholic beverages. In case of the latter, usually elasticities for three different beverages have been estimated – spirits, beer and wine. Selections of the studies reporting elasticities, of which most are reviews, are presented in Table 3. It can be seen that all studies indicate values that stay within a range from –0.3 to –1.5. This means that the law of demand applies to alcohol as well and in principle, tax policy can be used to control alcohol-related harm as it was also discussed in previous subchapter. However, in most cases the elasticity coefficient is below 1.0 (in absolute terms) referring to relatively low responsiveness. Quantitatively, the latter means that when price is increased by 1%, for instance, alcohol consumption decreases less than 1%. In addition, beer seems to be the most inelastic while wine and spirits are more price responsive beverages.

Some additional notes are relevant. Specifically, Fogarty (2004) has discovered increasing elasticity as one move toward 1969 and decreasing elasticity post 1969. This pattern was speculated to arise due to greater availability of substitute products post 1969. Interestingly, changing pattern of elasticities has

[16] While the exact definition of heavy drinking differs across studies, here it is used in general terms to refer to the level of alcohol consumption that may harm drinker's health.

been also confirmed by Gallet (1999) but in the opposite direction. He showed with US aggregate data from 1964–1992 that price elasticities of distilled spirits have decreased over time implying that preceding studies may have over-estimated their price responsiveness. He estimated that pre-1966 elasticity for spirits was –1.35 while post-1978 it had decreased to –0.16.

In addition, probably the most recent review has been conducted by Elder et al. (2010). While Table 3 presents median elasticities, which had been derived from studies carried out at the aggregate level, the review included 78 papers, which nearly all found negative relationships between price and alcohol consumption. In addition, considering 16 studies that have used individual level data, Elder et al. concluded that irrespective of methodology or type of data, the majority of estimates range from –0.3 to –1.0.

Table 3. Empirical estimates of price elasticities of alcohol

Authors	Study design	Estimates
Leung and Phelps (1993)[1]	Review of 15 studies, aggregate level data	–0.3 for beer –1.0 for wine –1.5 for spirits
Fogarty (2004)	Review of 64 studies from 1945–1991	–0.4 for beer –0.8 for wine –0.7 for spirits
Elder et al. (2010)	Review of 38 studies prior to 2005, aggregate level data	–0.5 for beer –0.6 for wine –0.8 for spirits
Cook (2007)	Panel data of the US states from 1971–2000	–0.7 for beer –0.5 for wine –1.5 for liquor

Source: Compiled by the author
Note: [1] In Chaloupka et al. (2002)

Some recent studies carried out in northern countries such as Denmark, Finland and Sweden have disclosed results that somewhat contradict the prior literature. Specifically, Mäkelä et al. (2007) and Grittner et al. (2009) followed the effect of the reduction in alcohol taxes and increase in travelers' allowances for the import of alcohol in northern countries in 2003–2006. They used individual level data and on the contrary, to the expectations, they did not find any sign of increase in alcohol consumption. Grittner et al. explain their results by wondering whether a saturation level of alcohol consumption had been reached. Bloomfield et al. (2009) analyzed the same period from 2003 to 2005 in Denmark but used time-series data for acute alcohol intoxication. Estimating ARIMA models, the authors detected a 26% increase in the number of acute alcohol intoxication hospitalizations among people aged 15 years and younger after tax reduction on spirits by 45%. This result implies that preceding studies by Mäkelä et al. and

Grittner et al. just failed to capture certain effects probably due to methodological shortcomings. Therefore, the main message from the literature is still rather unambiguous by stating that in general aggregate level of alcohol consumption is price responsive.

Regardless of the bulk of evidence, it should be noticed that most of the studies presented above come from highly developed countries. One could question whether these results apply to less developed countries as well. However, there is no convincing reason to think that they do not. This is also supported by some rare empirical evidence (e.g. see Fogarty, 2004 or Room et al., 2002). In addition, Leppänen et al. (2001) have compared price elasticities across 14 European countries. Although all of them are developed countries there are considerable gaps in GDP levels. For example, as regards to countries such as Portugal and Denmark, both included in this study, GDP in the former represents only about 60% of the latter (Eurostat, 2010b). In fact, currently Estonia is in a somewhat similar position in regards to the EU average GDP level as Portugal was in regards to Denmark (Eurostat, 2010b). In this study, it was shown that alcoholic beverages are normal goods but not luxuries, which means that its consumption probably does not vary considerably across countries due to different income levels. Authors rather suggested that the absolute values of elasticities are higher in countries with higher price levels. Therefore, it is reasonable to believe that the results presented above are generalizable to less developed countries as well.

Youth drinking

Studies conducted at the individual level possess an important property to show the price responsiveness of different subgroups. For alcohol policy to be effective in curbing social harm, elasticity of young drinkers and heavy drinkers are especially relevant and deserves extra attention. In regards to youth dinking, Grossman et al. (1993) have reviewed studies conducted in the USA in 1987–1993 utilizing data from 1974–1989. Although elasticities were not reported it was concluded that tax policy can effectively reduce youth drinking. In addition, this effect is not limited to infrequent drinkers; quite on the contrary frequent drinkers seemed to be more price responsive. Grossman et al. (1995) reached similar results by estimating an empirically rational addiction model[17]. Utilizing the US panel, whose members range in age from 17 to 27, the authors reported average long-run elasticity –0.65 and average short-run elasticity[18] –0.41. Elder et al. (2010), by reviewing studies carried out in 1987–1999, also found that majority of studies constantly reported that higher prices or taxes

[17] According to rational addiction theory, developed by Becker and Murphy (1988), current consumption is affected by changes in both past and future consumption, caused by changes in past or future prices.

[18] In the case of the short-run elasticity, past consumption was not allowed to affect current consumption.

were associated with lower prevalence of youth drinking, elasticities ranging from –0.29 to –3.54.

Dee (1999), however, has referred to limited econometric specifications in previous studies. More specifically, while studies reviewed by Grossman et al. (1993), applied cross-sectional US state data; they have failed to account for unobserved attributes that may be correlated with taxes. Utilizing pooled cross-sectional data, Dee found that alcohol taxes (more specifically beer taxes) had a relatively small and insignificant effect on teen drinking. Regardless of these contradicting results, there is recent evidence in favor of the negative relationship between alcohol taxes and youth drinking. Kuo et al. (2003) used data from 2001 that included 10,000 students at 118 colleges in the US and found that the lower the price of beer in the surrounding community, the higher the binge drinking rate at the college. Bishai et al. (2005) used individual level data in a structural equation model that simultaneously accounts for each individual's smoking, drinking, and sexual behavior. The sample comprised of more than 20,000 teenagers with a mean age of 16 from 20 different US states and cities. Authors reported that elasticity of participation in drinking with respect to beer tax is –0.08 that means that one percentage point increase in beer tax would be associated with a 0.08% decrease in probability of any alcohol use by teenagers

Heavy drinking

There is also specific evidence that tax policy may be effective to curtail heavy drinking. For example, Kenkel (1996) estimates frequency and intensity elasticities with US data of 1985 for heavy and moderate drinkers and also considers drinkers' possession of information about health effects of drinking. Defining heavy drinking as drinking five or more drinks in one day, he found that for moderate drinkers elasticity was –0.8 while elasticity of heavy drinkers' who are well aware of potential illnesses ranged from –0.9 to –1.7. In case of least-informed heavy drinkers, elasticities were no statistically significant that may arise from the fact that these drinkers are alcoholics.

In addition, Farrell et al. (2003), using individual level data of more than 40,000 persons in the US, have demonstrated that a rise in alcohol prices could reduce the prevalence of alcohol dependence, which is considered as the primary chronic-disease consequence of long-term, heavy alcohol consumption. Based on mortality data in Alaska from 1976 to 2004, Wagenaar et al. (2009) observed statistically significant sustained reductions in alcohol-related disease mortality after two separate increases in alcohol taxes occurring 19 years apart. As alcohol-related diseases, especially those attributed to alcohol alone, are the consequence of long-term excessive drinking, the results indirectly imply to a negative relationship between taxes and heavy drinking. More recently, a review conducted by Elder et al. (2010) found that at least five studies have confirmed the negative relationship between alcohol prices and liver cirrhosis. The latter could be considered as an indication of excessive drinking.

Acute drinking consequences

Negative effects of alcohol consumption often appear in the form of acute consequences, such as injuries or premature mortality. As a large share of these effects can be categorized as externalities, i.e. drinkers harm not only themselves but others also; it is often considered one of the most important goals of alcohol policies to control these consequences. In addition, as these acute consequences may arise even from consuming small quantities of alcohol, it means that effective policy can reduce this harm relatively fast, compared with internal illnesses that develop during a longer period.

Several papers have shown that tax policy could be used to reduce incidence of violence. For example, Grossman and Markowitz (1999) employed data that contained approximately 120,000 college students in the US and found that violence[19] is inversely related to the price of beer. Another study conducted by Andreasson et al. (2006) has tried to predict future effects of tax cut on alcohol-related harm, including assaults and homicides. Based on the historical relationship between overall alcohol consumption and different drinking consequences, which was obtained from the time series data, authors estimated that a tax cut by 40 % on spirits and by 15% on wine in Sweden would increase assaults by 2.5% (i.e. 1 617) and 4.4% (i.e. 4 289) homicides. Recently, literature review conducted by Wagenaar et al. (2010) suggests that doubling the alcohol tax would reduce violence by 2%.

Much more attention has been paid to disclose the relationship between alcohol policies and traffic-related harm. Most of the papers have found the negative relationship between alcohol tax and traffic mortality. Grossman and Saffer (1986) were the first who examined the price responsiveness of youth traffic mortality by using time-series of state cross-sections consisting of the contiguous states of the US for the years 1975 through 1981. They reported that elasticity of the motor vehicle death rate with respect to real price of beer would range from –0.7 to –1.3 for youth aged 17–24. Beer tax elasticities were lower as (from –0.09 to –0.17) only part of the tax was assumed to pass on to consumers. Chaloupka et al. (1991) utilized similar data from 1982 to 1988 for general population and for age group 18–20. The authors disclosed similar tax elasticities as –0.07 and –0.21, respectively. These estimates have been confirmed by Ruhm (1995) employing the same type of data for the same period but including some additional control variables.

More recently Dee (1999) and Young and Likens (2000) have questioned these results by employing additional control variables and different methodological perspective. However, these studies have not provided conclusive evidence but rather have somewhat undermined previous results that suggested unambiguously that tax policy is very effective measure to curtail traffic morta-

[19] Violent acts in this study were divided into four categories: getting in trouble with the police or college authorities, damaging property or pulling a fire alarm, getting into an argument or fight and taking advantage of another person sexually or having been taken advantage of sexually.

lity. In fact, a recent review conducted by Wagenaar et al. (2010) which reviewed 21 studies concerning the effects of alcohol taxes or prices on traffic safety outcomes, estimated that doubling the alcohol tax would reduce traffic crash death by 11%.

Substitutes of alcohol

The fact that alcohol tax can be a good instrument to curb alcohol consumption along with its related effects may not be enough. If at the same time the consumption of some other problematic commodity increases, for example cannabis is substituted for alcohol; the alcohol policy may even reinforce negative externalities. However, there is not very convincing empirical evidence that this could happen. For example, many authors have found that alcohol and cigarettes are complements (Tauchmann et al., 2008; Cameron and Williams, 2001), which means that more stringent alcohol policy would reduce the consumption of both commodities. As regards to cannabis, the studies have revealed ambiguous results (e.g. see Cameron and Williams, 2001) based on which it cannot say that reduced drinking would be followed with increased cannabis consumption. Chaloupka and Laixuthai (1994) have shown that this could happen with marijuana. However, they also find that regardless of this kind of substitution higher alcohol taxes lead to net reductions of at least some consequences of drug and alcohol abuse. This rare evidence presented here obviously does not prove that the problem of substitutability does not exist. However, it is reasonable to assume that the substitution could be weak enough and does not affect considerably optimal policy.

To conclude, the review of selected papers has disclosed rather convincingly that higher alcohol taxes have a curbing effect on drinking as well as on several drinking consequences. More importantly, this effect does not seem to be limited to moderate drinkers alone. Although some puzzling evidence can be found as well, these rare papers so far rather undermine the strength of the relationship but not its existence per se. In addition, simulation results revealed by Cook et al. (2005) also rule out the possibility that rise in alcohol taxes would increase mortality among middle and old aged people due to the protective effect of moderate drinking on their health. Specifically, combining estimates of the effect of per capita alcohol consumption on drinking patterns with a summary estimates from the literature of the relative risks associated with different levels of drinking, authors simulate one-percent reduction in drinking by the population aged 35–69, and find a negligible effect on the death rate.

Regardless, the evidence presented above only reveal the effects of alcohol taxes on alcohol-related harm. The question regarding optimal level of taxes remains unanswered. As follows, the subsequent subchapter addresses this issue by discussing theoretical models as well as their empirical application found in the literature.

1.2. Alternative approaches to optimal alcohol taxation

Taxation policy has different purposes. Its main function is to raise revenues for government. However, there are also other aims such as correcting market failures, increasing equity or stabilizing the macro-economy. Alcohol excise taxation is used to carry out both the raising of revenue and market failure-correcting functions. To accomplish the purpose of this thesis, which concerns optimal alcohol taxation in Estonia from the social point of view, sophisticated theoretical framework must be developed. To do that, at first it is acknowledged that Pareto efficiency can be used as criterion for achieving both goals, i.e. to raise revenues and correct market failures. Specifically, in case of raising revenues it is common to assume in optimal taxation literature that government aims to raise revenues as efficiently as possible. As regards to correcting market failures, it is in itself an efficiency improving activity. This subchapter discusses both issues as well as their integration below.

1.2.1. Externality-correcting partial equilibrium approach

In widely accepted economic literature mainly three general rationales for government intervention can be found – efficiency, fairness and paternalism.[20] Fairness is not usually considered the most relevant issue regarding alcohol policy and is not discussed here. The need for alcohol policy is usually considered on efficiency or paternalistic grounds. This section discusses briefly both concepts. Special attention is paid to efficiency, as this is the main criteria for optimality of alcohol policy in this thesis. The concept of paternalism is discussed as much as required to differentiate it from efficiency.

Inefficiency in the alcohol market

In modern mainstream economics the main criteria for assessing the desirability of patterns in production and consumption is the notion of Pareto efficiency. It states that the use of resources is efficient if it is not possible to raise anyone's welfare without harming the welfare of another individual. In other words, limited resources are used to produce goods, which are the most valued by consumers and the maximum amount of these goods and services is produced with given resources. It has also been shown by economists that in market economies under certain conditions the behaviors of profit-maximizing firms and utility-maximizing consumers actually do lead to this Pareto efficient state. Specifically, the economy is efficient under perfect competition. This kind of market structure to exist assumes the following:

- many buyers and sellers so that no one has an influence on market prices;
- homogenous goods that lead each firm to being price takers;

[20] Obviously, one could suggest also other social values such as human dignity, certain institutional values, etc. However, this thesis has confined itself to the most traditional social value applied in the modern economic literature, which is Pareto efficiency.

- low barriers to entry and exit that prevents firms to earn more than normal profit in the long run;
- perfect information about prices and products;
- there are no externalities arising from production or consumption.

Alcohol markets primarily fail to meet the last two conditions. More specifically, in case of externalities, although alcohol consumers receive benefits from drinking, they may harm others during or after the process. This harm may be whether pecuniary, physical or mental, as was shown in the preceding subchapter. For example, others may have to finance the health care system or criminal justice system to deal with alcohol-related diseases or criminal activity. In addition, drunken people may cause physical or mental harm by aggressive behavior towards others or by causing traffic accidents. Assuming that consumers only take into account internal effects and ignore the harm caused to others, a result is that alcohol consumption and production is inefficiently high. Besides the externality problem, drinking is also characterized with information failures. More specifically, consumers may inflict harm on themselves. This arises because consumers do not possess information that would be necessary to make utility maximizing decisions. For instance, they may not know that drinking leads to some serious health condition. Both externalities and information failures induce people to drink too much because market prices fail to reflect the real cost of alcohol.

The problem of inefficiency due to negative externalities in alcohol markets is easily captured in the partial equilibrium framework. This is shown in the left panel of Figure 7 of which kind of interpretation can be found in most economics textbooks. There is a market depicted for alcohol, comprising the demand that coincides with marginal private benefit of alcohol (MPB), and supply that coincides with marginal private cost of alcohol (MPC). The former is associated with the pleasure of drinking, the positive effect that alcohol may have on health (when consumed in moderate quantities) and other possible benefits drinkers may receive. The latter reflects the production costs alcohol producers must bear when producing alcoholic beverages. As constant returns to scale are assumed, the supply curve is horizontal. This just simplifies graphical analysis but does not affect the analytical results in essence[21]. Altogether, there is market equilibrium at point Q_M where the demand and supply equalize. In case of ordinary private goods, this would be an efficient level of production from the social point of view because the marginal social costs equal the marginal social benefit.

In case of alcohol or any other externality-generating good, however, this is not the case. The main reason comes from the fact that marginal social costs (for now the line denoted, as MSC^{cn} should be followed) are higher than marginal private costs. The difference between these costs measure the external

[21] It makes a difference for optimal alcohol taxation, though. This is discussed in the following subsection.

costs or harm that drinkers cause to others. The total external costs are measured by the area A + B + C + D. The empirical value for this area can be derived from social cost estimates. However, while social cost estimates usually also comprise internal costs such as mortality, only external costs must be included to apply them in optimal taxation framework.

In terms of Pareto efficiency in the presence of negative externalities, it follows that, without affecting the welfare of many others, it is possible to raise at least one individual's welfare. For example, if it could be possible to induce some people to drink less, the welfare of these people may decrease less than increases the welfare of other people. The latter arises because the harm they must bear decreases. As this kind of Pareto improvement possibility exists, it is the main justification for government to implement alcohol policy on the grounds of efficiency.

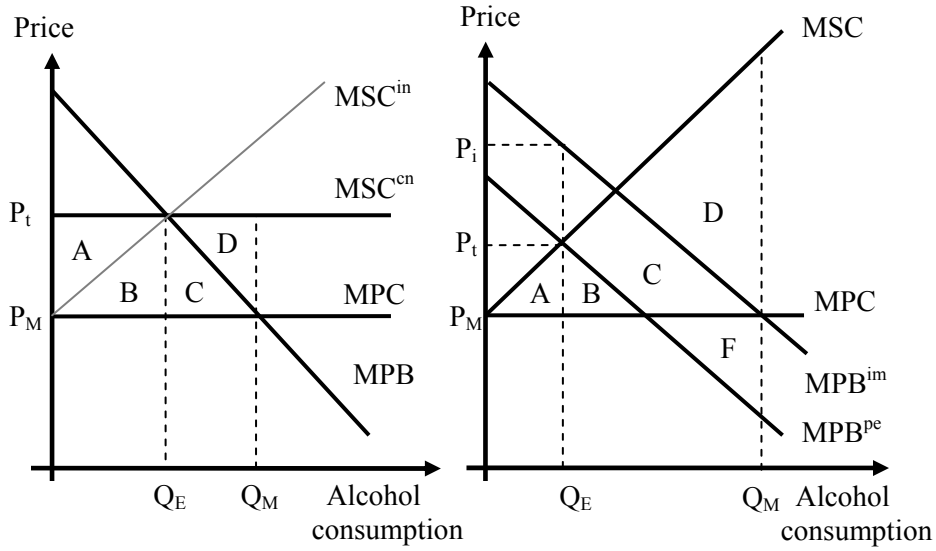

Figure 7. Inefficiency in alcohol market and Pigouvian taxation
Source: Kenkel (1996), compiled by the author

It is important to note that the efficiency cost in the left panel of Figure 7 is much smaller than total external costs and is measured only by the area D. This is the difference between MPB and MSC^{cn} from Q_E to Q_M as the former denotes the efficient level of alcohol consumption. Below Q_E benefits drinkers receive exceed the burden or harm they are putting onto others. Therefore, although in this situation it would be possible to raise others' welfare by inducing drinkers to drink less but then the welfare loss of drinkers would be higher than the decrease in external costs borne by others. Although this could be justifiable on the ground of fairness, it would not improve efficiency.

Externality, per se, is not a sufficient argument for government intervention as has been argued by Coase (1960). More specifically, according to the Coase theorem, under zero transaction costs, externality problems would be fully cured by bargains. This means that an individual who bears the externality could trade with an individual who causes the externality to find a better solution for both. However, this is unrealistic in case of alcohol externalities due to high monitoring costs and the number of people involved (Barker, 2002). For example, the bargain would need to define what kind of consumption an individual cannot undertake. The potential externality bearer may find it very difficult to monitor whether the bargain is implemented. As a result, the market is unable to achieve efficiency without the help of government.

The information failure in an alcohol market is modeled in the right panel of Figure 7 in the spirit of Kenkel (1996). The only difference from the situation depicted in the left panel concerns the additional marginal private benefit curve. Marginal private benefit of alcohol under imperfect information MPB^{im} is higher than marginal private benefit under perfect information MPB^{pe} because without complete information about internal consequences of alcohol consumption, consumers overestimate consumption benefits. The vertical distance between MPB^{im} and MPB^{pe} measures the value of internal costs that consumers fail to take into account. It means that external costs are measured by the area A + B + C + D, while the efficiency costs is measured by the area C + D + F. The efficiency costs can be divided into two separate components. Part of it is caused by external effects, this is represented by the area D. C + F, however, arises from imperfect information as this area reflects un-internalized internal costs, sometimes called also as intrapersonal external costs. The latter is often considered as additional rationale for government to intervene.

Optimal alcohol taxation with homogeneous drinkers

The subsection above has illustrated the nature of inefficiency in the alcohol market in a partial equilibrium setting. As follows, identical framework is used to model the optimal tax policy to correct this market failure. Specifically, this is a classical solution to an externality problem, first introduced by Arthur C. Pigou (1920) and widely accepted in the literature. This solution, according to which the only concern is to correct externalities, also creates the main basis for the optimality of alcohol taxation in the present thesis. Although in subsequent sections the general-equilibrium framework is introduced to integrate externality motives with fiscal ones, externality rationale maintains its special status in regard with the optimal alcohol taxation problem. In fact, in most cases, it is independent from the other rationales and is exclusively captured within the partial equilibrium model.

In addition, the partial equilibrium framework gives specific economic meaning to results of COI studies and becomes independently relevant when the main policy goal is to control the social costs of alcohol. Therefore, before the general equilibrium approach is taken, it is reasonable to address externality-correcting policy separately. At first, the problem is analyzed with homogenous

drinkers. This kind of approach is a highly stylized way to address the problem of alcohol externalities in a single market with taxing alcohol consumed by identical individuals. However, it is quite often used in public debates as well as in some less sophisticated economic analysis. In the following section, a more sophisticated approach with heterogeneous drinkers and information failures will be discussed which has been the most common approach to address optimal alcohol taxation in both a theoretically or empirical method.

The so-called Pigouvian taxation suggests that external generating goods should be taxed with a rate equal to marginal external costs (MEC). In this way, externalities are internalized and as a result economic agents take into account both private and external costs to maximize their utility. This can be read from Figure 7 above. Concentrating on the left panel at first, there is an alcohol market with both constant marginal external costs (the difference between MPC and MSC^{cn}) and increasing marginal external costs (the difference between MPC and MSC^{in}). In both cases, the optimal tax is the one which raises the market price to P_t. Formally, under the assumption that MPB = MPC + MEC at the optimum, optimal ad valorem and unit tax rates would be $t_{av}^{*} = \frac{MEC}{MPC}$ and $t_{ut}^{*} = MEC$, respectively. Under these tax rates, the consumer does not have incentives to increase consumption above a socially efficient level. More specifically, individuals increase the consumption until the marginal benefit received from the last unit of alcohol equals with the marginal social cost of that last unit. This last unit is at consumption level Q_E, which satisfies the efficiency condition.

To set the tax to the optimal level under constant MEC with homogeneous drinkers and perfect competition, there is not much information needed. As in this case MEC is equal to the average external cost, MEC as well as optimal tax is easily derived by dividing total external costs by the quantity of alcohol consumed. As was mentioned in the preceding subchapter, total external costs can be obtained from COI studies by excluding internal costs. Under increasing MEC, however, the problem is much more complicated. In addition to the shape of relationship between alcohol consumption and MEC, information about price elasticity of alcohol demand is also required. Under these assumptions, the lower the price elasticity of alcohol demand, the more severe should be the tax policy. For example, at the consumption level Q_M which is chosen by the private market without government intervention, optimal tax does not equal to MEC (see left panel in Figure 7). Therefore, in practice, it may be quite hard to hit the socially desirable tax rate.

One possibility to overcome this difficulty is to compare total external costs and tax revenues from alcohol tax. This approach is very common in public debates. Specifically, the question is whether tax revenues cover the social costs. When examining the left panel in Figure 7, it appears that under constant MEC this is the correct approach. More precisely, under the Pigouvian tax rate, area A + B measures tax revenue from alcohol tax as well as total external costs. It means that it is quite simple to assess current tax policy on the optimality ground.

Under increasing MEC, however, tax revenue from Pigouvian tax is measured by area A + B, that patently exceeds external costs B by area A. In this case, the level of external costs compared with tax revenues show the lower boundary of the tax rate and this kind of comparison may be helpful only when tax rates implemented in practice are considerably lower when compared with the optimal level. The latter then indicates whether there is a need for a tax raise.

Using this simple framework to address the externality problem means that following question is raised: Do alcohol consumers pay their way. To put it another way: Is tax on alcohol high enough to internalize negative externalities of alcohol? To answer this question, average external costs per unit of pure alcohol is used as a rough indicator for the optimal level of taxation. Another possibility is to compare total excise tax revenues and total external costs of alcohol consumption. When revenues are lower than costs, there is rationale for a tax raise. It should be stressed, however, that in economic terms, the purpose of alcohol tax is not to cover external costs as is often mistakenly interpreted. As it was shown above, under the Pigouvian tax, revenues exactly cover external costs only when MEC is constant. Otherwise, the relationship between external costs and tax revenue is more complicated. The main idea of Pigouvian tax is to achieve the situation in which the price of alcohol would reflect marginal social costs of alcohol. If it does not, economic agents receive price signals that impede the achievement of efficiency.

This kind of simple approach has been used for example by Manning et al. (1989), Barker (2002), Easton (2002) and Cnossen (2007). All concluded that taxes on alcoholic beverages are justified or a certain rise is warranted. For the US, Manning et al. (1989) estimated that external cost per ounce is USD 0.48 compared with average excise and sales tax of USD 0.23. Accordingly, in the authors' view, a strong case can be made for an increase in alcohol taxes. Barker (2002) found that as external tangible costs of alcohol in New Zealand were quite similar to the level of collected alcohol taxes the current excise rate could be justified on externality grounds. Easton (2002) is even more categorical by stating that excise revenue from ethanol in New Zealand appears to be only about a fifth and a quarter of gross fiscal costs due to alcohol misuse. Based on the latter, an increase in excise duty of around 28% was suggested. Cnossen (2007) argues that according to social cost studies for the UK, alcohol excise collections do not cover the tangible costs of harmful alcohol use. As this is also the case in many other member states of the European Union with similar drinking patterns, but lower alcohol excise duties, this implies that heavy drinkers do not pay their way.

Partial equilibrium approach with homogeneous drinkers modeled above has several limitations. At first, the assumption regarding consumer homogeneity is probably inappropriate since most of the alcohol-related externalities are caused by a relatively small proportion of abusive drinkers. Secondly, the model in Figure 7 does not consider internal effects that consumers fail to internalize due to information failures. Thirdly, there are different kinds of alcoholic beverages with different alcohol content, price elasticities and roles in generating externalities.

All these shortcomings can be eliminated in a partial equilibrium setting. Corresponding literature is discussed in the subchapter immediately following.

Optimal alcohol taxation with heterogeneous drinkers

In reality, the optimal solution becomes much more complicated due to the heterogeneity of drinkers. What it means is there are many consumers who drink alcohol in moderate quantities. Under the Pigouvian tax they must pay higher price for alcohol regardless of whether they have caused externalities or not. As a result tax on alcohol may cause deadweight loss that exceeds benefits that arise from reduction in external costs. Therefore, an efficient tax policy must balance the deadweight loss against benefits from the reduction of external costs. Diamond (1973) was probably the first who stated that in the case of consumption externalities, the optimal tax would be a weighted average of externalities, the weights being the responses of demand to price increases. As regards alcohol, this would mean that an optimal uniform tax rate is equal to the sum of the weighted average of marginal externalities generated by each drinker, marginal externalities weighed by each drinker's price elasticity of alcohol demand. This rule, however, has small practical value due to the unrealistic data requirement. Nevertheless, it is possible to obtain empirically applicable optimal policy rule by dividing drinkers into two categories: abusers and non-abusers. This is shown below by obtaining, analogously to Pogue and Sgontz (1989), an optimal tax formula accompanied by a graphical illustration.

The alcohol market is modeled in Figure 8. There are alcohol demands and marginal costs of moderate and abusive drinkers on the left and on the right panel, respectively. D_n denotes alcohol demand by a non-abuser and D_a is alcohol demand by an abuser. Both types of consumers face the same market price set by firms. Assuming competitive markets, the market price is equal to marginal private costs. However, in the case of alcohol consumed by an abuser, the marginal social cost is higher than the marginal private cost due to negative externalities. Since non-abusers do not generate negative externalities, marginal social costs of alcohol consumed by them are equal to the marginal private cost. Without government intervention, non-abusers would consume the quantity of Q^n that is efficient also from the social point of view because at this level MPB = P_M = MSC. Abusers, however, over-consume because at the consumption level Q^a chosen by them, MPB = P_M < MSC.

Government has now an incentive to intervene to reduce abusers' drinking. The problem is that it is not possible to tax just abusers. Therefore, imposing a tax rate T_A on alcohol, whether bought by abusers or non-abusers, alcohol consumption is reduced in both markets. Q_T^n and Q_T^a denote post-tax alcohol consumption of non-abusers and abusers, respectively. As a result, deadweight loss arises from taxing non-abusive drinkers by area B in the left panel. The efficiency gain from reduction in the abuser's drinking is measured by the area E + D – F in the right panel. Assuming that there are Z^n moderate drinkers and Z^a abusive drinkers, the overall welfare change is given by $Z^a \cdot (-E - D) + Z^n \cdot B$.

Based on these assumptions, the optimal alcohol tax formula can be obtained. At first, using basic triangle geometry, welfare change W can be expressed as follows:

$$W = Z^a \cdot \Delta Q^a \left(\frac{1}{2} T_A - \overline{MEC}\right) + Z^n \cdot \Delta Q^n \cdot \frac{1}{2} T_A \quad (1.1)$$

In (1.1), $\overline{MEC}$ denotes marginal external costs averaged over the relevant change in consumption of alcohol, ΔQ^a and ΔQ^n are reductions in alcohol consumption of abusive and non-abusive drinkers, respectively. The next step is to define demand elasticities of abusers and non-abusers with respect to price, respectively, as follows:

$$\eta^a = (\Delta Q^a / Q^a)/(\Delta P / P_M) \quad (1.2)$$

$$\eta^n = (\Delta Q^n / Q^n)/(\Delta P / P_M) \quad (1.3)$$

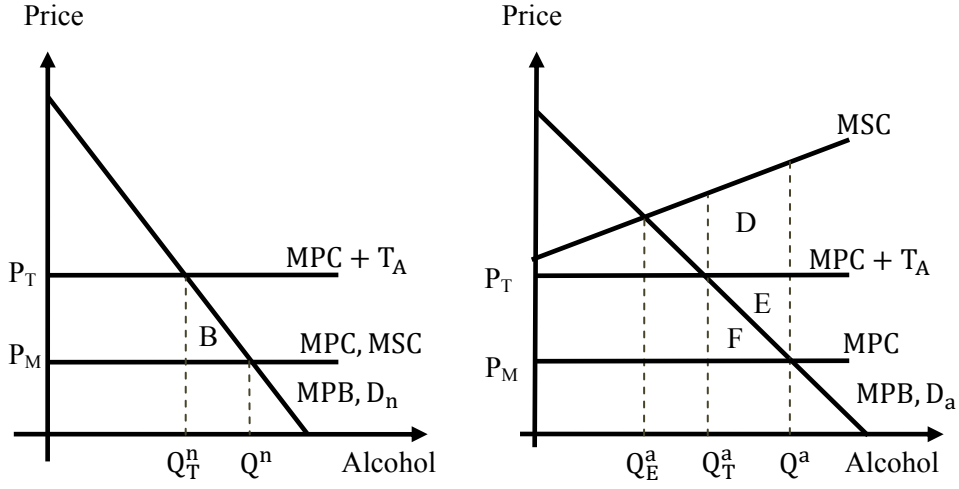

Figure 8. Controlling externalities with heterogeneous drinkers
Source: Pogue and Sgontz (1989), compiled by the author

Solving these for ΔQ^a and ΔQ^n, substituting in (1.1) and noting that $\Delta P = T_A$, gives:

$$W = \left(\frac{1}{2} T_A^2 - T_A \cdot \overline{MEC}\right)(Z^a \cdot Q^a \cdot \eta^a)/P_M + \frac{1}{2}(T_A^2 \cdot Z^n \cdot Q^n \cdot \eta^n)/P_M \quad (1.4)$$

Differentiating (1.4) with respect to T_A, gives marginal welfare effects of alcohol tax:

$$\frac{\partial W}{\partial T_A} = (T_A - \overline{MEC})\,(Z^a \cdot Q^a \cdot \eta^a)/P_M + (T_A \cdot Z^n \cdot Q^n \cdot \eta^n)/P_M \qquad (1.5)$$

Equating (1.5) with zero and solving for T_A, optimal unit tax on alcohol is obtained:

$$T_A{}^* = \overline{MEC}/\left(1 + \frac{Z^n}{Z^a} \cdot \frac{Q^n}{Q^a} \cdot \frac{\eta^n}{\eta^a}\right) \qquad (1.6)$$

The optimal tax formula (1.6) suggests that the optimal tax on alcohol is increased relative to $\overline{MEC}$ under the following terms:

- the number of abusive drinkers is increased relative to moderate drinkers;
- the amount of alcohol consumed by abusive drinkers is increased relative to moderate drinkers;
- the price elasticity for alcohol demand of abusive drinkers is increased relative to moderate drinkers.

Building this framework, Pogue and Sgontz (1989) also differentiated between abusers with and without the disease alcoholism, which means that also variables reflecting the fraction of abusive consumption consumed by non-alcoholics and internal cost of alcoholic abusers enter the optimal tax formula. The authors assumed the former to be 26.5% and estimated that although either taxes near the present level or very high taxes may be optimal for the USA, depending on the values of parameters, the available information implies that the present tax rate in 1983 should probably have been doubled. More specifically, while external abuse costs averaged $127 and internal abuse costs averaged $441 per gallon of pure alcohol consumed by abusive drinkers, the best guess was that the average tax rate would be $53. This result was obtained under a scenario, which assumed that abusive and non-abusive drinkers are equally responsive to price change. Assuming lower responsiveness of abusive drinkers obviously will reduce the optimal taxation level. For instance, the authors calculated that if abusers would be only one-fourth as responsive to price changes as non-abusers, the optimal level would be only $20 and would have stayed below the actual rate.

Saffer and Chaloupka (1994) extended the model of Pogue and Sgontz allowing also substitutability between wine, spirits and beer and estimated optimal taxes to individual beverages. They found that the optimal average tax rate, as well as differences between taxes on individual beverages, would be further increased when beverage substitutability increases. Richardson and Crowley (1992) and Crowley and Richardson (1997) have used a similar approach to estimate effects of the alcohol tax as well as its optimal level in Australia. However, they did not make a difference between abusive and non-abusive drinkers. Although both welfare gains from the reduction of drinking and welfare costs due to price distortions were taken into account, the former was derived through constant relationships between social costs and overall alcohol consumption.

Both papers suggested that the rise in current tax rates would generate substantial net welfare gains. In addition, in both papers the authors included wine, spirit and beer separately, similarly to Saffer and Chaloupka (1994) it was revealed that in addition to average taxation levels optimizing the structure of alcohol taxes might also considerably increase social welfare.

Kenkel (1996) addressed the optimal tax problem quite similarly to Pogue and Sgontz. However, in addition to differentiating between abusive and moderate drinkers, consumer heterogeneity was extended by differentiating between drinkers and drunken drivers. This is reasonable as alcohol-related traffic accidents and its consequences represent a substantial proportion of the social costs of alcohol. In addition, preexisting drunk-driving penalties should be taken into account as they already have internalized at least part of the externalities. Kenkel also differentiated between abusive drinkers dividing them into three categories: informed, less informed and the least informed heavy drinkers. Assuming average external cost per drink to be $0.30, average external cost of a drunken driving incidence to be $60.20, average internal costs of uninformed drinkers to be $0.56 per drink, it was obtained that the best guess for optimal alcohol tax is 106% of the net-of-tax price or $0.38 per drink. This result was obtained under the assumption that moderate drinkers are less price responsive than informed heavy drinkers and less informed heavy drinkers but considerably more responsive than the least informed drinkers. In addition, ignoring both external costs of drunk driving that could be internalized through drunk driver penalties as well as internal costs, which would be appropriate when all consumers were perfectly informed about the consequences of drinking, the optimal rate would have been reduced to 41% of the net-of-tax price.

Regardless of their influential effort, all the papers discussed above, as well as the partial equilibrium approach in general, share one important limitation. They only address the externality problem but fail to account for fiscal rationale as well as the interaction with the rest of the tax system. These aspects are considered in the following subchapter.

1.2.2. Revenue-raising approach

One of the oldest strands in public finance literature concerns optimal commodity taxation. The primary focus of commodity taxation literature has been to find optimal structure of commodity taxes to raise a certain amount of public revenues with minimized deadweight loss. Therefore, in order to include fiscal considerations into the Pigouvian taxation framework, main lessons from this research deserve attention. The aim of this subchapter, however, is not to give an overview of optimal commodity taxation literature per se, but rather to explain the main findings, which are relevant in the context of alcohol taxation. Specifically, two separate rationales for differential commodity taxation are discussed. At first, the development of the idea to tax commodities, which are leisure complements, is followed as alcoholic beverages probably fall into this

category. Secondly, it is discussed whether commodity taxation literature has something to say about taxation of tourism. The latter is especially important to study in an Estonian context as alcohol is often assumed as one of the most popular commodities for tourists and even a pull-factor for visiting Estonia from neighboring countries.

The most influential work in the field of optimal commodity taxation dates back to the beginning of the 20th century. Ramsey (1927) showed under certain simplifying assumptions that in order to collect a given amount of revenue with commodity taxes there are rather plain rules to follow for minimizing utility loss to consumers. More specifically, noting that leisure cannot be directly taxed and assuming zero cross-price elasticities between commodities, the optimal set of commodity taxes leads to an equal percentage reduction in the compensated demands for all goods. From this property, the well-known inverse elasticity rule has been obtained, which states that the rate at which a commodity is taxed should be inversely proportional to the absolute value of its elasticity of demand (e.g. see Sandmo, 1976).

The intuition behind this result is simple: as leisure is directly un-taxable, uniform commodity taxation would cause distortions between commodities (or labor) and leisure. Therefore, imposing higher tax on commodities with lower elasticity decreases labor-leisure distortion compared with uniform taxation. Another way to interpret this result is to note that it would be optimal to impose higher taxes on leisure complements and lower taxes on leisure substitutes (Corlett and Hague, 1953). For example, if alcohol were a leisure complement, it would be a good idea to impose higher taxes on alcoholic beverages compared with other commodities as this causes people to drink less. When drinking and leisure are complements, people also consume less leisure, which means that they will choose to supply more labor. As a result, preexisting distortions caused by uniform taxation are offset to some extent.

The Ramsey rule has been often criticized because of its low policy relevance. For example, the differentials in the tax rates would certainly increase administration costs for government and compliance costs to the taxpayer (Alm, 1996). In addition, the commodities put forth to be taxed more heavily under an inverse elasticity rule, more often than not, happen to be necessities. This would lay a substantial burden on the poor. In order to account for this problem, Diamond and Mirrlees (1971) showed that goods consumed particularly heavily by the poor should experience smaller percentage reductions in demands compared with other goods. As a result, somewhat lower taxes could be imposed on such goods on the grounds of fairness.

Probably the most influential criticism came from Atkinson and Stiglitz (1976) who showed that whenever the individuals' utility function is weakly separable between labor and other commodities, individuals differ only in earning abilities and non-linear income tax is optimally employed, optimal commodity taxes should be uniform. The general intuition behind this result is that as income tax can be used for both raising revenue and redistributing

income, consumption distortions caused by differential commodity taxation can only deteriorate economic efficiency.

Subsequent studies have examined this result in more depth to test its robustness. Several conditions under which Atkinson and Stiglitz's result breaks down have been revealed. At first, Naito (1999) showed that when taking into consideration the production side and relaxing the assumption of constant marginal cost of production, non-uniform commodity taxation could improve welfare. More specifically, differential commodity taxation enables to change factor prices and as a result relaxes the incentive-compatibility constraints associated with the optimal income tax problem[22]. Secondly, Cremer et al. (2001) has extended Atkinson and Stiglitz's model by assuming that individuals differ not only in earning abilities but also in endowments. The authors stated that under this assumption, optimal income tax would not suffice and there is rationale for non-uniform commodity taxation. In addition, Saez (2002) relaxes the assumption of homogeneity in individuals' tastes for goods and indicates that non-uniform commodity taxation may be justified.

However, more recently, Saez (2004) has shown that Atkinson and Stiglitz's result is strengthened when labor supply responses are modeled through occupational choices instead of choices of hours of work, which is reasonable under long-run considerations. In addition, Kaplow (2006a) extended the Atkinson and Stiglitz's result by stating that differential commodity taxation is not optimal regardless of whether non-linear income tax is optimal. This result is obtained by considering the reform of elimination of differential commodity taxation combining it with distribution-neutral adjustment in income taxation to offset any effect on individuals' utility. As this reform, by taxing away individuals' utility gains arising from elimination of consumption distortions, yields revenue surplus for the government, there is a possibility for Pareto improvement.

Regardless of the debate presented above, one of the key assumptions of Atkinson and Stiglitz's results rests on its weak separability. The latter assumes that allocation of income among commodities is independent from labor decisions. This assumption rules out the possibility that a tax on a commodity could affect individuals' choices between labor and leisure (Kaplow, 2006b). This, however, could be desirable since income tax has distorted this choice in favor of leisure. To correct this distortion, in the second best setting, it would be therefore optimal to tax commodities that are leisure complements. This policy to be optimal with preexisting income taxation has been also demonstrated by Christiansen (1984) and more recently by Kaplow (2008). Therefore, besides

[22] When government is using income tax to redistribute income from skilled workers to unskilled workers, incentive-compatibility constraint emerges as skilled workers have an incentive to mimic unskilled workers. To prevent mimicking while achieving redistribution involves imposing a positive marginal tax rate on the unskilled, decreasing their labor effort below the efficient level. Differential taxation can relax this constraint by imposing higher taxes on skilled labor intensive goods. For more details see Naito (1999).

externality rationale, alcohol taxes could be imposed on fiscal grounds as well since it is reasonable to assume that alcohol is a leisure complement.

Optimal commodity taxation literature provides an additional rationale to tax alcohol. More specifically, one relatively new strand of this research field has concentrated on tourism taxation. A tax can be categorized as a tourism tax when it is levied on goods or services consumed by tourists. From literature, five business sectors can be found that are considered as sectors providing goods and services to tourists. These are airlines and airports, hotels and other accommodation, road transportation, food and beverages and providers of tourism services (Goorochurn and Sinclair, 2005). Taxes levied on these sectors can be divided into two broad categories. At first, they can be part of the general tax system, such as value added taxes. Secondly, they can be specific taxes targeted at tourists, such as taxes on hotels and restaurants, visa fees, passenger services, etc. More detailed lists of alternative tourism taxes can be found in papers written by Goorochurn and Sinclair (2003, 2005) or Barron et al. (2001).

As regards to alcohol excise taxes, they are directly related to the food and beverage sector. Tourists obviously visit pubs, restaurants or nightclubs and naturally consume alcoholic beverages. In addition, in some cases alcohol is a commodity experiencing a massive border trade. This happens when there is a considerable gap in price levels between two countries due to differences in overall price levels or in the excise rates and is reinforced excise duty allowances. This kind of situation is evident for example between Sweden and Denmark but also between Estonia and Finland (Cnossen, 2007). In this regard, Aronsson and Sjögren (2010) have analyzed the effect of these allowances to tax policy from the perspective of the country of which citizens are importing alcoholic beverages from foreign countries. They argued that border trade allowances in the EU might result in using other than alcohol taxes to control alcohol-related harm because imported alcohol cannot be taxed. Therefore, under the assumption that leisure and alcohol are complements, government may find it optimal to decrease income tax in order to induce people to consume less leisure, which in turn reduces drinking.

In the Estonian context, however, the situation is reversed, as Estonia is the country from which foreigners are exporting alcohol and tax on alcohol can be considered as a tourism tax. Although there is evidence of border trade with Russia in the case of which Estonian citizens are importers of cheaper alcohol (Hein et al., 2010) this is probably not as massive as tourists' purchases in Estonia. Situations like this create specific tax policy implications. Although the principles of optimal taxation apply to tourism taxes as well, these types of taxes share one very interesting characteristic. Specifically, on the contrary to most of the other taxes, tourism taxes have the ability to raise tax revenues without causing any deadweight loss (Gooroochurn and Sinclair, 2003). This happens because at least part of the tax burden is borne by non-residents of whose welfare is not the concern of the hosting government. As a result, fiscal revenues could be gathered and used for public purposes without laying any cost on people whose welfare government aims to maximize. Naturally, this

holds true only if the tax burden is completely borne by tourists. As the tax incidence depends on elasticity of tourism demand, then if it is very elastic, a large proportion of the burden could be shifted to the supply side of the tourism sector. The latter means that local producers bear the burden and deadweight loss would rise. In addition, commodities or services supplied by the tourism sector are often consumed by the local resident as well. Therefore, the optimal tax should balance benefits from tax revenues with welfare losses of local producers and consumers. Just like in the case of the standard optimal taxation framework, price elasticities have an important role to play here as well. As shown by Gooroochurn and Sinclair (2003) the welfare gain from tourism tax is larger, the more inelastic tourism demand is relative to domestic demand and the higher the share of tourism demand relative to total demand.

Several authors have used general equilibrium models to estimate empirically the effects of changes in tourism taxes. Jensen and Wanhill (2002), for instance, have analyzed the economy-wide effect of reduction in value added tax rates for hotels and holiday centers by 50% in Denmark. The authors found that this would have a positive effect on hotel and holiday centers overnights as well as on expenditures generated from tourists. The paper, however, does not estimate welfare effects from changes in tax revenues. According to the discussion above, under inelastic tourism demand, for instance, tax revenues as well as the welfare of Danes would probably decrease under this kind of policy. Some researchers have considered the welfare effects and they have found that in this respect tourism taxation is justified. Specifically, Cago et al. (2009) and Blake (2000) showed that an increase in tourism taxes such as value added tax or some specific taxes have positive welfare effects in Spain. Gooroochurn and Sinclair (2005) confirm this in Mauritius stating that taxing tourism is relatively more efficient and equitable than levying other sectors.

The discussion presented in this subchapter implies at first that regardless of substantial research on the field of optimal commodity taxation, the results obtained more than fifty years ago by Corlett and Hague (1953) in a Ramsey setting has survived the active debate in literature and still provides influential guidance for policymaking. In regards to alcohol, this means that besides the externality argument there is an additional rationale to impose higher taxes on alcohol as it is reasonable to assume that alcohol is a rather leisure complement than leisure substitute. This has also been shown empirically by West and Parry (2009). Secondly, alcohol taxation can be considered as a specific tax on the tourism sector in countries where a large proportion of alcoholic beverages are purchased or consumed by tourists. To the author's best knowledge prior literature has not integrated tourism taxation and externality-correcting taxation into the same framework. Nor there is a single paper in the field of optimal taxation, which would have accounted simultaneously for Ramsey, Pigouvian and tourism taxation principles. Therefore, as follows immediately, the principles of Ramsey taxation are integrated with the principles of Pigouvian taxation to comprise them simultaneously into a single framework as it appears in the literature. The inclusion of tourism taxation is remained for the third

chapter where the model is specified for the Estonian context in order to obtain empirical estimates as well.

1.2.3. Integration of externality-correcting and revenue-raising approaches

Until the middle of the 20th century, revenue-raising taxation and externality-corrective taxation had been analyzed separately in the literature. Pigouvian tax was designed to address only externalities. It was assumed that revenues collected under these taxes were returned in a lump-sum fashion. Ramsey taxation had dealt with the question of how to raise public revenues with minimized deadweight loss of taxation. Existence of externalities was ignored. In practice, however, both types of taxes exist simultaneously. This raises the question of whether and how the Pigouvian rule, that is commonly considered, as a basis for taxing externality-generating goods such as alcohol, would be changed under preexisting taxes.

Convergence of these two branches began with the paper by Tullock (1967). He was the first to notice that externality-corrective taxation could also serve another purpose – collect revenues for the public sector. Formally, Ramsey and Pigouvian taxation was integrated by Sandmo (1975) who examined in a general-equilibrium framework the optimal commodity taxation problem under the assumption that in addition to other commodities there is one externality-generating good. By solving the model with a representative consumer, he showed that optimal tax on externality-generating good is the weighted average of two components. The first is Pigouvian tax, being equal to marginal social damage. Second component follows the inverse elasticity rule that is well known from the Ramsey taxation problem. In addition, it was shown that the optimal tax structure was characterized by additivity property, meaning that the marginal social cost of externality-generating goods enters the tax formula for that good additively. In other words, it is not optimal to impose a tax on complements or subsidize substitutes of an externality-generating good only because this good creates externalities.

Until the 1980's not much attention was paid to these papers. The rising importance of environmental issues regarding pollution and climate warming, however, gave an impulse for further development of this approach. Nichols (1984), Terkla (1984), Lee and Misiolek (1986) all contributed to the development of the idea of using environmental taxes to reduce preexisting distortionary taxes. Pierce (1991) was the first who started to use the concept of "double dividend" by stating that environmental taxes not only improve environmental quality but also reduce the distortionary cost of the tax system. The latter has been named as revenue-recycling effect in literature. These papers suggested that optimal environmental tax could be well above Pigouvian tax.

In the first half of the 1990's, however, several authors started to question the validity of the double dividend hypothesis. Modeling incremental tax reforms in a general equilibrium setting, Bovenberg and Mooij (1994) showed

that environmental taxation has an exacerbating effect on preexisting tax distortions. More specifically, an environmental tax raises the prices of consumption goods and as a result reduces the real wage rate. This induces individuals to supply less labor and consume more leisure, amplifying tax distortions in the labor market. Due to a narrower base of environmental taxes compared with income taxes, a drop in the latter which is financed by revenues from environmental levies, do not offset the adverse effect of environmental taxes. The latter means that an environmental policy, which follows the Pigouvian rule, could actually increase distortions in the economy and are inefficient. Previous studies, which were using a partial equilibrium framework, had overlooked this effect.

It should be noted that Bovenberg and Mooji (1994) did not suggest that double dividend does not exist at all. Specifically, double dividend is often divided into two categories: strong and weak forms. The former states that the revenue neutral substitution of tax on externality-generated goods, for distortionary taxes, involves a zero or negative gross cost. According to the latter, using revenues from tax on externality-generated goods to finance a reduction in existing distortionary taxes, the cost savings relative to the case where the tax revenues are returned to taxpayers in a lump-sum fashion, could be achieved (e.g. see Goulder, 1994). Bovenberg and Mooji acknowledged the existence of the latter but did not find any support for the former.

This finding activated a vivid academic debate in the literature. One of the most often asked questions was whether the optimal level of taxation is below or above the Pigouvian rate. Double dividend proponents would say that the optimal tax rate exceeds the Pigouvian tax. Results from general equilibrium models say otherwise. While Bovenberg and Mooji had considered only incremental tax reforms, Parry (1995) and Bovenberg and Ploeg (1992) were probably the first who derived formulas for the optimal level of taxation. They confirmed that the optimal tax should lie below the Pigouvian tax. A subsequent paper by Bovenberg and Goulder (1994) contributed previous literature in mainly two ways. At first, intermediate inputs were included in the model. Secondly, the authors complemented theoretical models with numerical simulations. As a result, both extensions confirmed the failure of the double dividend hypothesis. They argued that the larger the preexisting tax distortions are, the lower is the optimal carbon tax.[23]

In the context of the present thesis, it must be stressed that Parry (1995) was the first who decomposed the optimal tax formula into three separate effects. Previous literature, as stated by Parry, had combined these effects together with one optimization model. Parry (1995), using a diagrammatic approach, differentiated between the Pigouvian tax, revenue-recycling effect and tax-interaction effect[24]. More specifically, while the revenue-recycling effect accounts

[23] More detailed overview of the debate in the first half of 1990's can be found in Goulder (1994).

[24] Originally, Parry (1995) termed revenue-recycling effect as revenue effect and tax-interaction effect as interdependency effect.

for efficiency gains from a reduction in preexisting taxes, the tax-interaction-effect reflects welfare effects arising from interaction with labor markets. This framework was further developed by Goulder et al. (1996) and Parry et al. (1997) by providing utility-maximizing basis for the results. In subsequent papers this has become a common way to analytically address double dividend hypothesis, e.g. see Goulder (1998), Goulder et al. (1998), Schwartz and Repetto (2000), Williams (2003), Caffet (2007), Parry et al. (2009). Since the current thesis applies the same framework as well, the simplest version of the model imaginable is laid out as follows. It is done in the spirit of the consumption externalities framework ignoring intermediate inputs, as their inclusion is unnecessary in respect with alcohol[25]. More sophisticated version adjusted to address alcohol taxation policies in Estonia, along with its empirical calibration, can be found in the third chapter of the thesis.

In this representative agent model, it is assumed that all consumers are identical. The representative consumer has the following utility function:

$$U(g(X,Y,l),Q) \tag{1.7}$$

In (1.7) X and Y are consumption goods of which the former is considered alcohol that generates consumption externalities. In addition, l is leisure, Q, exogenous to the consumer, is a variable through which the consumer bears the harm caused by others. In the environmental literature, it denotes environmental quality, in the case of alcohol it could denote health risks such as injuries or illnesses arising from others' alcohol consumption, for instance. Consumption of X affects Q, so that $\frac{dQ}{dX} < 0$. It is important to note that there is weak separability between Q and other commodities, which mean that demand for X, Y and l is independent of Q. Separability assumption was commonly used by all authors until Schwartz and Repetto (2000) raised the question about its validity. The effect of relaxation of this assumption is discussed below.

The consumer's budget and time constraint are as follows:

$$(1 - t_L)wL = (1 + t_X)X + Y \tag{1.8}$$

$$T = L + l \tag{1.9}$$

In (1.8) and (1.9) L is labor, w is wage rate equal to the value marginal product of labor, t_L is tax on labor, t_X is tax on externality-creating good, T is time endowment. Government faces the budget constraint:

$$G = t_L wL + t_X X \tag{1.10}$$

[25] Unlike commodities generating environmental externalities, alcoholic beverages are usually final products.

Government aims to maximize the welfare of the representative consumer by supplying public goods G and by choosing the optimal level of t_X and t_L. At the same time, government must keep its budget balanced. The latter is achieved by adjusting t_L. It should also be noted that public goods G has no direct effect on consumer's utility. This simplification is applied as to bring out the main message from the literature and to ignore unnecessary technicality. In the model presented in the third chapter, this assumption is abandoned.

As noted above, the purpose of the government is to maximize the utility of representative consumer. This way government maximizes the social welfare as the society in this model consists of identical consumers. Accordingly, optimal alcohol taxation should target the level of alcohol taxes under which consumer's utility is maximized. In order to accomplish that goal, the model is solved by maximizing indirect utility function, which is defined as follows[26]:

$$V(t_L, t_X, Q) = maxU(g(X, Y, l), Q) + \lambda[(1 - t_L)wL - (1 + t_X)X - Y] \quad (1.11)$$

Differentiating equation (1.11) with respect to t_X, gives

$$\frac{1}{\lambda}\frac{dV}{dt_X} = -X - wL\frac{dt_L}{dt_X} + U_Q\frac{dQ}{dt_X} \quad (1.12)$$

Totally differentiating government budget constraint while assuming $\frac{dG}{dt_X} = 0$, gives[27]:

$$-wL\frac{dt_L}{dt_X} = t_L w\frac{dL}{dt_X} + X + t_X\frac{dX}{dt_X} \quad (1.13)$$

Substituting (1.13) into (1.12), gives:

$$\frac{1}{\lambda}\frac{dV}{dt_X} = U_Q\frac{dQ}{dt_X} + t_L w\frac{dL}{dt_X} + t_X\frac{dX}{dt_X} \quad (1.14)$$

Further, defining labor supply effects as follows:

$$\frac{d(wL)}{dt_X} = w\frac{\partial L}{\partial t_X} + w\frac{\partial L}{\partial t_L}\frac{dt_L}{dt_X} \quad (1.15)$$

Using (1.13) and (1.15), it is obtained:

$$\frac{dt_L}{dt_X} = -\left(X + t_X\frac{dX}{dt_X} + t_L w\frac{dL}{dt_X}\right)/\left(wL + wt_L\frac{\partial L}{\partial t_X}\right) \quad (1.16)$$

[26] The main steps in solving the model are similar to Parry et al. (2009).

[27] This assumption just says that the government budget is kept balanced only by adjusting labor tax while government expenditures are held constant.

Substituting (1.15) and (1.16) into (1.12), marginal welfare effects from increase in t_X can be expressed as follows:

$$\frac{1}{\lambda}\frac{dV}{dt_X} = (E - t_X)\left(-\frac{dX}{dt_X}\right) + MEG_{t_L}\left(X + t_X\frac{dX}{dt_X}\right) + \left(1 + MEG_{t_L}\right)t_L w\frac{\partial L}{\partial t_X} \tag{1.17a}$$

where

$$MEG_{t_L} = -\frac{t_L\frac{\partial L}{\partial t_L}}{L + t_L\frac{\partial L}{\partial t_L}}, E = -U_H\frac{dQ}{dX} \tag{1.17b}$$

It is seen from (1.17) that the marginal welfare effects of a tax increase can be divided into three categories. The first is Pigouvian component comprising marginal external cost E, borne by the consumer due to an increase in health risks, less tax on alcohol and multiplied by the reduction in goods, X. The second component, termed as revenue-recycling effect, comprises marginal tax revenues from an alcohol tax, multiplied by marginal efficiency gain MEG_{t_L} to account for reduced distortions in the labor market after tax revenues have been used to reduce the labor tax. Marginal efficiency gain, defined in (1.17b), reflects the marginal efficiency gain from reducing the labor tax divided by the marginal labor tax revenue. The third component, termed as the tax-interaction effect, captures the interactions between the alcohol tax and the labor supply. More specifically, a rise in the prices of taxed goods increases the labor supply if the taxed goods and leisure are complements. In case of substitutability between the taxed goods and leisure, the labor supply decreases and the tax-interaction effect would be negative. The tax-interaction effect is multiplied by $(1 + MEG)$ to account for changes in t_L to keep the government budget balanced. In this model, the optimal tax is the one, which maximizes the sum of all three effects. In the environmental policy literature, the tax-interaction effect was found to be negative and offset the revenue-recycling effect. Accordingly, the optimal tax would be lower than Pigouvian tax.

In the second half of the 1990's, several authors concentrated on the comparison of different policy measures. For that purpose large policy changes instead of incremental tax reforms were assessed by Goulder et al. (1996), Parry et al. (1997), Goulder et al. (1998). The authors extended the analytically tractable models by including also intermediate inputs and solved the models numerically. The main findings from these studies declared that policies that generate revenues are less costly and thereby confirmed the results from preceding theoretical models. The intuition behind this argument is that since both taxes and regulations cause a tax-interaction effect, only implementation of the former enables revenue recycling. It means that if a policy has small environmental effects it may actually amplify inefficiency. Policies with revenue-raising ability could at least partly offset the tax-interaction effect and are certainly more cost-effective.

In the late 1990's and in the 2000's, the active debate continued and several authors showed that the preceding literature had ignored several aspects that may overrule the standard result in a general equilibrium framework as concerns the failure of the double dividend hypothesis. For example, Parry and Bento (1999) referred to the consumption distortions due to the deductibility of certain types of spending from labor taxes, which substantially reduce the costs of environmental taxes. In addition, Schwartz and Repetto (2000) argued that the assumption of weak separability between environmental quality and leisure, used by the preceding authors, is peculiar. The authors presented empirical evidence, according to which air quality has an effect on labor supply. Assumption of weak separability ignores this possibility. Following the Schwarz and Repetto proposal and relaxing this assumption, the utility function (1.7) becomes:

$$U(X, Y, l, Q) \tag{1.18}$$

Following the same derivation steps as above, now the tax-interaction component in the equation, reflecting the marginal welfare effects from increases in t_X is expressed as follows:

$$\left(1 + MEG_{t_L}\right) t_L \left(w \frac{\partial L}{\partial t_X} + w \frac{\partial L}{\partial Q} \frac{\partial Q}{\partial X} \frac{\partial X}{\partial t_X}\right) \tag{1.19}$$

It is seen from (1.19) that the tax-interaction effect is complemented by an additional term indicating that as an increase in t_X improves Q, the latter in turn affects labor supply. If Q denotes environmental quality, this may have a positive effect on the labor supply which decreases leisure demand. Therefore, Schwartz and Repetto (2000) claimed to prove the limitations of standard results in previous literature. Williams (2003), on the contrary, argues that the same effect implied by Schwartz and Repetto (2000) actually has the opposite effect because it lowers the consumer's medical expenditure due to his or her better health. This causes an income effect that increases the demand for all goods including leisure. This debate is to be continued and can be further followed elsewhere (e.g. see Caffet 2007).

An additional caveat, at which recent papers have pointed, concerns the fact that prior literature had concentrated on distortions caused by labor taxes. However, capital income taxes may, in some cases be even more distortionary. Takeda (2007) found in Japan for the carbon tax that while the strong double dividend does not arise from reduction in labor and consumption taxes, it arises from reduction in capital taxes. More recently, Glomm et al. (2008) confirmed in the US that the swap of green taxes for existing capital taxes decreases deadweight loss of the tax system.

Finally, all prior studies had ignored the Corlett-Hague rule discussed in a previous subchapter above, according to which leisure complements should be taxed more heavily. In fact, although leisure had been commonly included into the analyses, it has been typically assumed that all goods, including externality-

creating goods, are equal substitutes for leisure. This simplifying assumption has been made due to scarce empirical evidence regarding cross-price elasticities with leisure. This assumption, however, rules out the rationale to tax any goods on the grounds of Ramsey taxation. What it means is that, when equal substitutability for leisure is assumed then due to the Ramsey approach, there is no rationale to impose differential taxes and as a result, environmental taxation above Pigouvian level turns out to be inefficient. Higher tax rates should be imposed only on goods that or weaker substitutes for leisure than other goods (for more detailed discussion see Bovenberg and Goulder, 2002). It means that whenever it is reasonable to relax the assumption of equal substitutability for leisure considerable changes may appear in the results. West and Williams (2007) have confirmed this for gas. They used the Almost Ideal Demand System and found that gas and leisure are actually complements, which considerably raises optimal tax on gas.

It is reasonable to assume that alcohol is this kind of commodity as well. There is also some recent evidence in this respect (see West and Parry, 2009). What it means is that the optimal taxation level of alcohol may be considerably higher than the Pigouvian tax. However, to the author's knowledge, only Parry et al. (2009) have used the Pigouvian-Ramsey framework to address alcohol policies in the US. Compared with the model presented above, the Parry et al. model splits up the welfare effects arising from interaction with the labor market. Specifically, at first it is assumed that $\frac{\partial Q}{\partial t_X} < 0$, which in the context of alcohol taxation means that a higher tax on alcohol reduces health risks arising from drinking and drunk driving. In addition, reduced health risks are assumed to increase the effective labor supply, the latter is expressed as the product of wage rate w and labor supply L. As a result, an analogous equation to (1.19) would be:

$$\left(1 + MEG_{t_L}\right) t_L w \frac{\partial L}{\partial t_X} + \left(1 + MEG_{t_L}\right) t_L \frac{\partial (wL)}{\partial Q} \frac{\partial Q}{\partial t_X} \tag{1.20}$$

The last component was termed as a productivity effect that reflects the efficiency gain from health-induced increase in effective labor supply. The authors also assumed perfect competition, 100% tax shifting on to alcohol prices, rational addiction and a complementary between drinking and drunk driving[28]. Using a more sophisticated version of this model to derive an optimal tax formula compared with one presented here, i.e. accounting also for a broader range of revenue uses, Parry et al. obtained an optimal tax for the US that ranges from $68 to $799 per gallon of pure alcohol under alternative scenarios. They assumed external costs of drunk driving per gallon of alcohol to be $64.1 and external costs of heavy drinking to be $24 per gallon. As the actual tax rate was estimated to be $24.20, a rise in the tax rates was suggested. Therefore, in

[28] The limitations of these assumptions as well as this approach in general are discussed in more depth in the following subchapter 1.3.

contrast to findings in environmental literature, the fiscal component of an optimal alcohol tax was shown to exceed considerably the Pigouvian tax under several plausible combinations of parameter values. This means that in the case of alcohol, there is less ambiguity as regards to the question of whether the optimal tax is above or below the Pigouvian rate. However, it must be acknowledged that future research should more convincingly confirm the weak substitutability or complementary between alcohol and leisure.

Parry et al. (2009) also compared the alcohol tax policy with its possible alternatives or complementary measures, such as drunken driving penalties, whether pecuniary or non-pecuniary. Although non-pecuniary drunk driving penalties may have considerable effect on public expenditures by reducing the costs of health care or criminal justice, the authors found that taxation generates larger welfare gains due to its larger fiscal effects and high implementation costs of penalties. This result is similar to that found in environmental literature and similarly to findings in subchapter 1.1, it implies that tax policy could be more preferred compared with any kind of regulations.

Thus, the model arising from environmental literature but elaborated by Parry et al. (2009) to address alcohol policies provides a solid general-equilibrium analytical framework to analyze optimal alcohol taxation. It is suitable for both theoretical and empirical analysis and is certainly more appropriate compared with partial equilibrium approaches. Most importantly, the latter completely fails to account for one of the most important principles from optimal commodity taxation literature suggested by Corlett-Hague (1953). Even then, the Parry et al. model ignores several other aspects that are naturally related to alcohol taxation. These shortcomings of the model along with other key issues revealed in the first chapter are detailed in the Discussion section as follows.

1.3. Discussion

General remarks

The first chapter has addressed a wide variety of alcohol-related issues, from the consequences of drinking to policies to control these consequences. In regards to the focus of the present thesis, five main points revealed in this chapter must be stressed:

- while there are only a few narrowly targeted studies concerning the socio-economic impact of alcohol in Estonia, empirical studies worldwide have disclosed that economic costs of alcohol are relatively high, ranging from 1% to 2% of GDP;
- alcohol taxation has been empirically shown to be one of the most effective as well as cost effective policy measures to control drinking consequences;
- the optimal alcohol taxation is commonly modeled in a partial equilibrium setting to follow Pigouvian taxation principles, according to which the tax rate should be equated to marginal external cost of alcohol and the

common result in literature has been that prevailing taxes should be raised;

- during the last two decades environmental literature has stressed the fiscal rationale in taxing externality-generating goods, suggesting that the optimal tax could differ considerably from the Pigouvian tax due to double dividend hypothesis;
- in regards to the optimal alcohol policy, only recently Parry et al. (2009) have confirmed the importance of the fiscal role in the US where the optimal tax was shown to exceed the Pigouvian tax as well as the currently implemented tax.

In short, the first two points imply that alcohol taxation is a highly relevant policy measure to control alcohol-related problems, while remaining points refer to lack of papers, which would obtain the optimal level of alcohol taxation considering both externality as well as fiscal goals. As was discussed in the previous subchapter, this has been recently accomplished by Parry et al. (2009), using the framework actively applied in the environmental policy literature. Based on this approach, called also as "double dividend" theory, the answer to the first research question of the thesis can be formulated. The question concerned the definition of the optimality in regard with the two different goals of alcohol taxation: externality correction and the raising of revenue. In recent "double dividend" literature, the optimality was defined through two well-known taxation principles. Both principles consider efficiency as the only value to follow. Specifically, the optimal alcohol tax is the one, which maximizes representative consumer's utility and is the sum of the two components: Pigouvian and fiscal. The role of the Pigouvian component is to internalize external costs of alcohol consumption in order to correct the market failure in the alcohol market. The fiscal component arises whenever alcohol taxation causes lower marginal deadweight loss compared with other taxes in order to gather a certain amount of revenue for the government. If this is the case, consumers' welfare can be increased by (partially) replacing other taxes with alcohol taxes.

This kind of optimality formulation, which bases itself on classical optimal taxation literature, delivers nicely the solution that is required to accomplish the aim of this thesis. As it originates from the market failure approach pursuing efficiency, it seems to be appropriate to Estonia as well. Specifically, Estonia is a market economy with relatively small government. It means that the resource allocation in most markets, including the alcohol market, is determined by the forces of demand and supply as holds true for any market-oriented economy. Therefore, identifying the states of the alcohol market not satisfying the conditions of Pareto efficiency seems to be a reasonable point of departure towards optimal alcohol policy. This, however, does not mean that the current thesis acknowledges alcohol-related problems only in market economies. In market economies, the market failure approach is just the easiest way to identify inefficiency, as there are certain patterns according to which free markets are assumed to behave. Even more, through price signals, free markets provide

information about the welfare of consumers, which turns out to be necessary when one formulates utility maximization as the main policy goal.

This approach should have high policy relevance as well, given the efficiency-oriented taxation policies implemented by the Estonian government in the last decade. For example, the overall tax system in Estonia has been designed to be as simple as possible with minimal distortions in terms of different deductions or differences in tax rates. Specific examples are the uniform personal income tax and almost uniform value added tax with only a highly limited number of goods taxed with reduced rates. Therefore, while the optimality criterion is basing on the Pigouvian and Ramsey principles, both aiming to find an efficient mix of taxes, it seems an appropriate choice in regard with the policy implemented by the Estonian government[29].

Limitations in the preceding literature

In this integrated Pigouvian-Ramsey framework, Parry et al. (2009) showed that compared with the partial equilibrium solution, the general equilibrium models may lead to substantially higher estimates regarding the level of optimal alcohol taxes. This mainly arises from the assumption that alcohol and leisure are complements reinforcing the efficiency gain from using alcohol tax revenue, whether for reducing preexisting taxes or increasing public spending. Regardless of the influential contribution by Parry et al., there are several limitations. As follows, a brief overview of these shortcomings is given in order to point at research gaps in the optimal alcohol taxation literature as well as to answer the second and third research questions of the thesis concerning the application and adaptation of the Parry et al. model to Estonia. The discussion is focused on the Parry et al. model, as to author's best knowledge, this is the only model applied to address optimal alcohol taxation in the way that fits the purpose of the thesis. Therefore, the thesis seeks for ways this model could be extended upon or improved.

At first, it is important to recognize one important caveat of the Parry et al. framework – the assumption of nearly the first best world with perfect competition. Specifically, besides distortions in the labor market caused by preexisting labor income taxation, the Parry et al. model considers alcohol externalities as the only type of market failure. In reality, this is definitely not the case. There are reasons to believe that even the alcohol market itself is not necessarily perfectly competitive whether in the US or Estonia. In the Estonian

[29] Although Ramsey taxation suggests different rates on different commodities, which seems to conflict with uniform value added taxation in Estonia, it must be recalled that its main idea is still to minimize tax distortions in order to collect public revenues. Moreover, as it was discussed above, post-Ramsey literature has questioned the optimality of differential taxation, except if it is justified to tax leisure complements with higher rates. In addition, although differential taxation may be administratively infeasible, in the case of alcohol this is not a relevant issue as alcohol is already taxed higher than other commodities and the question addressed in this thesis concerns only the level of taxation.

alcohol market, 60–70% of the two main beverages – beer and spirits – are produced by three or four local producers (Martens et al., 2010). Therefore, at first view it seems nothing like perfect competition. It could be oligopoly instead. Thus, the theory of the second best, proposed first by Lipsey and Lancaster (1957) already more than fifty years ago, is relevant. It states that if there are some irremovable distortions existing in the same or related markets then it may not be optimal to fix removable market failure. What it means is that it may be optimal to let these distortions cancel each other out rather than correcting either one. One way to overcome these problems in the model is just to assume that government is able to remove this market failure by turning the alcohol market into a perfectly competitive one and that the alcohol market interacts only with the labor market, while interactions with other markets are insignificant. However, as this assumption is probably relatively far from the reality, it is important to tackle also the second best considerations rather than resting only on the first best solutions.

Considering the possibility that alcohol markets are not perfectly competitive the question regarding the corresponding implications to the optimal alcohol taxation arises. The main thing to understand is that under imperfect competition, firms are not price takers like they are under perfect competition. Accordingly, firms set prices above marginal costs. Therefore, while the main idea of both Pigouvian and Ramsey taxation is to correct relative market prices by imposing additional costs to firms, market prices under imperfect competition do not reflect the private marginal cost any more. In fact, they are higher. As a result, imperfect competition as a market failure may at least partly offset inefficiency arising from externalities or preexisting labor taxes[30] and the results obtained under a perfect competition model may mislead the optimal policy solution.

Even more, under imperfect competition the impact of taxation on market prices stays ambiguous. Specifically, under perfect competition it is reasonable to assume that at least in the end, taxes are fully shifted onto market prices. This arises because in a competitive industry, the market price is equal to the long run marginal cost and the long run average cost, the latter being at its minimum level. In other words, the marginal cost can be assumed constant in the end. This means that the supply curve is horizontal and increasing tax by a certain amount would shift the supply curve along with equilibrium of the market price upward by exactly the same amount. In contrast, a tax-induced increase in marginal private costs need not cause identical rise in prices under imperfect competition. Therefore, the relaxation of the perfect competition assumption would most likely mean that the tax-induced rise in market price would be smaller or greater than the tax increase. This, as well as related issues, has been theoretically addressed, for example, by Seade (1985), Delipalla and O'Donnel

[30] While the original idea of Ramsey taxation was to correct labor-leisure distortions caused by uniform commodity taxation, in the Parry et al. model, the Ramsey tax corrects inefficiency caused by preexisting labor taxation.

(1998), Hamilton (1999) and others. It has been shown that the tax incidence under imperfect competition depends on several factors such as the relative curvature of industry demand, firms' cost functions and the form of taxation (i.e. unit or ad valorem tax). Recently, Peitz and Reisinger (2009) showed that the over and under shifting, could be more pronounced in a two-layer industry with both layers being under oligopolistic competition[31]. In addition to these theoretical works there is also some empirical evidence implying particularly to possibility of over-shifting of alcohol taxes in the US (Young and Bielinska-Kwapisz, 2002).

Whether the alcohol tax is over-shifted or under-shifted under imperfect competition, the optimal tax obtained under the assumption of perfect competition would probably overestimate the optimal level of taxation. To be more specific, when tax is under-shifted to consumers, at first, it may seem that the corresponding optimal alcohol tax must be higher under imperfect competition, compared with perfect competition, to compensate for this difference. However, it must be noted that under imperfect competition, the market price is already higher than the marginal private cost. It means that some inefficiency caused by negative alcohol externalities has been already offset by imperfect competition. Therefore, if any, a lower price rise is needed to correct the externality problem compared with perfect competition. Accordingly, it could be speculatively assumed that under imperfect competition these two factors together, i.e. imperfect competition and under-shifted alcohol tax will do the required work. More specifically, they would raise the price to the level where it is equal to the marginal social cost of alcohol. In this case, the optimal tax on alcohol would be on the same scale in both market structures. Under over-shifting, however, imperfect competition certainly would call for lower taxes than perfect competition.

However, there are several points to bring out that would justify the perfect competition assumption in the Estonian context. At first, it should be noted that Estonia is an open economy where local producers are not necessarily free to set prices to earn economic profits. Specifically, approximately 20% of the total alcohol sold in Estonia is imported (Martens et al., 2010). Even more, imported beer prices, for instance, are often even lower than locally produced beer prices (Vähi, 2010). Therefore, although there are only a few local producers, they must compete with foreign producers. Secondly, as Estonia is a small country it is the price taker in the international market. The same could also apply to the Estonian producers in the Estonian market, as alcoholic beverages are easily tradable products. Thirdly, even if there is oligopolistic competition in the production side of the industry, the retailing side is certainly less concentrated.

[31] A two-layer industry model may be appropriate for the alcoholic beverages industry since the latter could be roughly divided into two sectors: production and retailing. Most of the prior literature had assumed that the upstream sector, i.e. production, is competitive. However, Peitz and Reisinger (2009) showed that when imperfect competition prevails in both sectors, results regarding over and under shifting obtained in prior literature would be amplified, especially in the long run.

Specifically, due to low legal barriers there are relatively many alcohol sales points, which should make it rather difficult to set prices higher than it is necessary to earn a normal profit. For example, in 2009 there were almost 3000 sales points in Estonia, which equals 4.4 sales points per 1000 inhabitants (Orro et al., 2010). Finally, even an oligopoly itself may experience hard competition, much similar to perfect competition. This has been shown in economic literature with classical Cournot and Bertrand models from the 19th century. Recent analyses of these models have been conducted, for example, by Tremblay and Tremblay (2011) and by Lofaro (2002). Therefore, considering all these aspects, perfect competition could be still a reasonable approximation of the reality, without losing the essence of the analysis.

The second fundamental issue of the Parry et al. model concerns the application of a representative agent model, which has been under serious criticism (e.g. see Kirman, 1992). For example, for this approach to be valid it must assume that the aggregate behavior coincides with representative agent. Even more, Kirman (1992) has argued that it can be the case that when individuals A and B both prefer the choice z to y, then the aggregate choice of a representative agent could be y instead. Therefore, ranking alternative economic situations on a welfare basis, this approach may lead to false conclusions. Considering that, there are at least three completely different types of drinkers – moderate drinkers, heavy drinkers, young or adolescent drinkers – the application of this kind of framework to alcohol policy issues may seem highly questionable.

In spite of the critique, it has been widely used in economic literature as this framework allows individual optimization for use as the basis for aggregate behavior of economic agents. Several defensive points can be made to justify the use of this approach for issues addressed in this thesis as well. At first, it must be noted that distributional effects stay above the scope of this thesis, which means that it is not necessary to take into account policy effects on the welfare of different subgroups. In addition, in the context of optimal alcohol taxation, the key point is to capture the marginal welfare effects of alcohol taxation in terms of marginal reduction in aggregate levels of crimes, misdemeanors, illnesses, injuries, leisure demand, productivity losses as well as alcohol consumption in general. Efficiency gains arise directly from these effects on individuals' welfare and from their impact on the public budget through which labor market distortions are reduced. Therefore, when monetizing these effects, it is relatively easy to account for heterogeneity of drinkers. For example, attaching values to saved lives one just has to find out the value of life for the saved individuals. As concerns reduced distortion in the labor market due to reduction in labor taxes, one can even employ labor supply elasticities reflecting aggregate labor supply as the reduction in labor taxes concern all workers.

One additional aspect of the representative agent model must be clarified. Several authors have defined the optimal tax in a partial equilibrium setting as the one, which balances efficiency gain from reduced externalities against deadweight loss of alcohol taxation arising from distorted choices of moderate

drinkers. In this setting under the assumption of low demand elasticity of heavy drinkers and high elasticity of moderate drinker's optimal alcohol tax would be somewhat lower compared with the model, where such heterogeneity is ignored. The reason is that under these assumptions the gain from the reduction in externalities is small due to low elasticity of heavy drinking but the deadweight loss of taxation would be high, due to high elasticity of moderate drinkers. In the representative agent framework, the heterogeneity of drinkers cannot be taken into account in the same manner. There is only one type of agent with elasticity of alcohol demand reflecting the price responsiveness of aggregate alcohol consumption. However, this problem can be solved through parameterization of the model in a similar manner as described above. For example, if it is known that the demand elasticity of alcohol of heavy drinkers is low, one should apply low demand elasticity for drunk driving, for instance. This way the model with representative agent can successfully take into account the fact that the responsiveness of harm caused by alcohol abuse with respect to alcohol price is low which reduces optimal taxation level as well[32].

The third important aspect of alcohol taxation is its addictive nature. While the model developed by Parry et al. (2009) assumed that individuals are rational and internalize all the future costs of addiction, it is completely static. Addiction issues, however, are more appropriate to address in dynamic settings. Probably the simplest model imaginable to deal with addiction has been applied by Kenkel et al. (2002) who showed in a two-period overlapping generation model with rational addiction, that higher taxes on addictive goods could positively affect a representative young person's lifetime utility. This fact arises as an addiction induces people to save less. It is further reinforced by "peer pressure". As a result, it reduces productivity, which could be corrected with tax policy, implying that in dynamic settings the optimal level of taxation would be increased. However, their model is simple, does not account for preexisting taxation and concentrates only on distortions that arise from consumption-savings decisions. More recently, Bossi et al. (2010) have analyzed the taxation of addictive goods in a dynamic rational addiction setting in the presence of labor income taxation. They found, surprisingly, that addiction could actually moderate the optimal tax rate and that taxing addictive goods becomes less attractive over time. More specifically, assuming that alcohol is an addictive good, at first, the alcohol tax would reduce "effective" alcohol consumption, i.e. the consumption in excess of that required to sustain addiction. In the future, however, due to the tolerance property of addictive goods "effective" alcohol consumption increases. Assuming that the latter and leisure are complements, demand for leisure increases and labor supply decreases. As a result, tax revenues decrease as well. In the current thesis, however, dynamic issues are ignored in order to maintain the model empirically applicable.

[32] This approach, however, does not eliminate other fundamental limitations of representative agent models. More profound analysis of these issues as well as their potential implications stay above the scope of the thesis, though.

One strand of related literature, often called paternalism, has relaxed the rationality assumption. At first, it must be noticed that there is a fragile line between information failures and paternalistic justification for government intervention. Both views suggest that government should intervene because the consumer is not able to make the best decision in terms of maximizing utility. In the case of paternalistic policy, however, it is assumed that the problem concerns inadequate reasoning. For example, under imperfect information one solution would be informing while leaving the final decision to the individual herself or himself. The paternalistic approach, however, aims for more severe intervention such as making decisions on behalf of individuals. In particular, the paternalistic view questions the rationality of individuals.

Recent literature, often called "new paternalism", has addressed the irrationality of individuals in terms of self-control problems (e.g. see O'Donoghue and Rabin, 1999, 2003; New, 1999). According to this approach, individuals' preferences are assumed to be present-biased in a sense that when considering trade-offs between future moments, people give stronger relative weight to the earlier moment as it gets closer (O'Donoghue and Rabin, 1999). This property takes into account the people's inclination to grab the immediate benefits and to avoid immediate costs. As a result, individuals impose external effects on their future selves. If there were some policy measure, which could correct this problem, government intervention would be justified on paternalistic grounds.

As regards to taxation policy, O'Donoghue and Rabin (2006) have shown that it is optimal to tax unhealthy commodities when some consumers have self-control problems. They argue that this kind of tax policy may even create Pareto improvement as such taxes restrict over-consumption by individuals with self-control problems while they redistribute income to individuals with no self-control problems. More recently, Aronsson and Thunström (2008) have developed this issue further by including the stock of health capital into consumer's utility function. As a result, they showed that while taxing unhealthy food could generate welfare gain, subsidy directed to the stock of health capital would be more preferable. However, as the authors conclude, in practice tax policy is much easier to implement due to the complications for observing health capital at the individual level.

The most recent developments in paternalistic literature, briefly discussed above, have given an important and interesting effort into optimal taxation literature. Specifically, additional rationale for taxing alcohol on the grounds of self-control failure is advocated. Regardless, this strand of literature requires substantial evolvement in order to give a persuasive answer concerning appropriate policies implemented in practice. Accordingly, the current thesis strictly follows the efficiency criteria and assumes that individuals are rational.

Finally, it should be also noticed that the framework applied in the literature usually assumes a balanced budget. One could wonder whether this is a realistic assumption, considering the fact that even highly developed countries have huge foreign debts. Although the balanced budget assumption is unrealistic for many countries, it is a reasonable and practical assumption in Estonia. Specifi-

cally, Estonia has one of the lowest public debts in the world and even in the economic recession in the second half of the 2000's, during the which real GDP decreased more than 15%, the Estonian public budget deficit stayed below 3% of GDP.

Suggested extensions for application to Estonia

While accepting these limitations of the model, the third research question of the thesis concerns the possible extensions and adaptation of the model for Estonia. In this regard, the shortcomings of the Parry et al. model are raised. At first, as was also noted by Parry et al. themselves, the model could be extended to consider other types of alcohol-related problems as well, like violence, for instance. Violence may be even more important than drunk driving as all corresponding health effects could be considered as external while the traffic fatalities or injuries are often internal. In addition, for the criminal justice system, offences against persons may be more expensive to proceed than traffic crimes or misdemeanors, as offenders are often unknown when the crime is registered. There are also quite harsh penalties, including jail sentences, the implementation of which consumes vast of public resources. As several authors have confirmed a negative relationship between alcohol taxes and violence, as was referred above in subchapter 1.1.3, ignoring these types of crimes may result in underestimation of welfare gains from alcohol taxes.

In addition, Parry et al. had totally ignored the fact that imposing higher taxes on alcohol may also require more resources to control the possible expansion of the black market. The role of the black market, more specifically illegal production, has been theoretically analyzed by Aronsson and Sjögren (2010). They showed that under illegal production, the optimal tax might fall short of the marginal social damage of alcohol because tax on alcohol is not a perfect instrument to control drinking any more. In addition, there may be rationale to use income tax or taxes on other commodities instead for alcohol control. The latter also means that the additive property introduced by Sandmo (1975) and further confirmed by Kopczuk (2003) may no longer apply. What it all means is that considering illegal alcohol considerably changes the results offered by standard approaches. So far, literature more or less has ignored this problem by concentrating mainly on externality issues.

The limitations of the Parry et al. model concerning the administrative costs of black market alcohol are of high importance in Estonia. The active illegal market has been often considered as one of the most important obstacles in raising the alcohol taxes to a more appropriate level. This issue is directly related to the administrative burden of the tax system as the effectiveness of controlling the illegal market at least partly depends on administrative capability. For these reasons, administrative aspects are incorporated into the model extended for Estonia in the third chapter of the thesis.

The third issue concerns the role of tourists' purchases in Estonia. It has been estimated by the Estonian Institute of Economic Research (Orro et al., 2010) that tourists' purchases represent approximately one fourth of the alcohol

market in Estonia. This arises partially due to the lower price level compared with neighboring northern countries, which reinforces border trade as well as regular tourism. This kind of large share of tourists' purchases means that optimal tax policy may be strongly affected. Although the Parry et al. model accounts for both principles of Pigouvian and Ramsey taxation, it does not differentiate between fiscal effects related to residents and non-residents. Therefore, in this respect the model must be extended to suit better the Estonian context. This problem is solved in the current thesis and is carried out in the third chapter.

Finally, as was shown in subchapter 1.1, the economic costs of alcohol other than health-related costs are practically unknown for Estonia. Besides several elasticities, cost parameters, however, are the main input data required for obtaining optimal tax estimates. Thus, before it is possible to analyze the optimal alcohol taxation policy, comprehensive cost studies must be carried out. This research gap is filled in the second chapter of the present thesis as immediately follows.

2. EMPIRICAL STUDIES: ALCOHOL EXTERNALITIES IN ESTONIA

2.1. Alcohol-related road traffic mortality

2.1.1. Introduction

Traffic-related mortality is a major public problem worldwide. For instance, according to WHO (2011c), in the injury and mortality regional estimates for 2004, there were more than 1.2 million people killed in traffic accidents. The magnitude of traffic-related consequences has induced an extensive number of studies all over the world. Several factors contributing to traffic mortality have been disclosed. One of the most profound papers, which have examined traffic-related problems, was issued jointly by WHO and the World Bank (Peden et al. 2004). In this report, in addition to inappropriate speed, fatigue, being a young male, being a vulnerable road user, travelling in darkness, vehicle factors, defects in a road design, inadequate visibility due to environmental factors and poor road user eyesight, the presence of alcohol and drugs were considered as the main risk factors influencing crash involvement in traffic.

The association between traffic-related problems and alcohol has also been confirmed in social cost studies, which show that traffic-related harm represents a remarkable share of the total economic costs of alcohol in many countries (e.g. see Varney and Guest, 2002; Johansson et al., 2006). This implies that traffic-related consequences deserve special attention when alcohol policies are designed. This remains valid for alcohol taxation policy as well. Specifically, as was discussed in the previous chapter, alcohol taxation appears to be an effective traffic policy measure as many authors have provided empirical evidence that higher taxes are associated with lower traffic mortality. Accordingly, several researchers have included drunk driving as one of the most important side effects of drinking into the framework of optimal alcohol taxation (e.g. see Kenkel, 1996; Parry 2009). The present thesis follows a similar pattern. For that purpose, the consequences of drinking and its empirics on traffic mortality was selected and is studied more thoroughly.

However, from epidemiologic literature another reason arises which justifies special interest in traffic mortality and offers the way optimal alcohol taxation analysis can be innovated. Specifically, policy analyses have usually overlooked the fact that drivers are not the only one responsible for traffic accidents. Several papers have stressed the high prevalence of alcohol in road user fatalities other than car occupants, especially in pedestrian fatalities. For example, Östrom and Eriksson (2001) investigated autopsied fatalities in Sweden from 1977 to 1995 and found that out of 201 killed pedestrians 22% of them had BAC positive. Even much higher proportions have been shown elsewhere. For example, Törõ et al. (2005) examined autopsy reports from 1999 to 2001 at Forensic Institute of Budapest and found that out of 416 vulnerable road users, 48% of them had BAC over the legal limit. Recently, Prijon and Ermenc (2009) disclosed similar results in Slovenia in regard with pedestrians. They reviewed

the autopsy documentation from 1999 to 2006 and included 125 pedestrian fatalities, of which 53 were alcohol positive.

These results strongly suggest that any alcohol policy, including taxation, should pay special attention not only to drivers but also to other categories of road users. This in turn could completely change the categorization into external and internal traffic mortality costs, which is highly important in regard with optimal alcohol taxation. For example, when a pedestrian is drunk and as a result is killed on the road due to her or his inability to stay in the pedestrian zone, the pedestrian's death from this accident should be categorized as internal costs. In literature, however, pedestrians are usually considered as vulnerable road users whose deaths are external for pedestrians.

As concerns traffic safety in Estonia, traffic mortality has been one of the most acute public problems during the last two decades. In the beginning of the 1990's more than 300 people were killed in one year. This makes more than 20 victims per 100,000 inhabitants. Traffic mortality increased rapidly along with the development of the free market economy in the period of "perestroika" (i.e. reconstruction) and "glasnost" (i.e. openness) in the late 1980s, most likely due to the hasty increase of old imported cars and the number of inexperienced drivers. It was soon discovered that fast growth in alcohol consumption, after the withdrawal of Gorbachev's alcohol restriction policy in force from 1985 until 1987, also played an important role (Leon et al., 1997; Schkolnikov et al., 1997; Kaasik et al.; 1998).

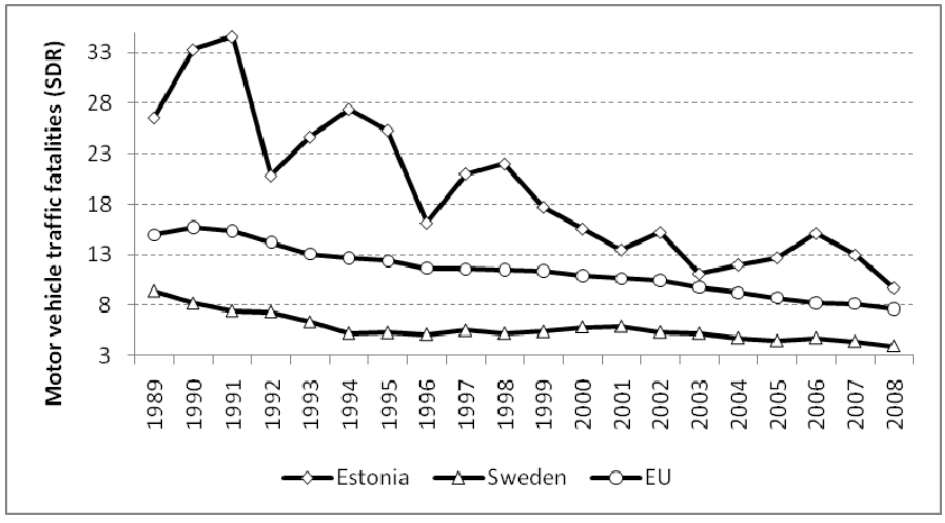

Figure 9. Traffic fatalities in Estonia, Sweden and the EU
Source: WHO (2011d), compiled by the author

However, as is shown in Figure 9, where standard death rates (SDR) per 100,000 for Estonia, Sweden and the EU are depicted, by the year 2008 traffic mortality in Estonia has decreased to the average level of the EU. The number of victims has been falling from 500 in 1991 to 100 in 2009. In terms of SDR this makes less than 10 fatalities per 100,000 inhabitants in a year. In 2010, the decreasing trend in the number of traffic fatalities has continued – there were 78 fatalities. This is probably the result of many factors including the use of safer cars, changes in traffic regulations and law enforcement (random breath testing, installation of speed cameras), higher alcohol taxes (see Figure 5), but also the impact of economic recession cannot be ruled out. However, traffic mortality in Estonia is still approximately two times higher than in Sweden, for instance. Comparison with Sweden shows how far Estonia is from the safest countries in the world, which could be the following target to achieve.

Regardless of relatively high rates of traffic mortality in Estonia during the last decade, it is surprising to find that there are virtually no studies on the causes and contributing factors of traffic fatalities. Studies on total injury mortality in Estonia have also included traffic fatalities, but not by categories of road users (Kaasik et al., 1998; 2004; 2006). There is also a study on the behavioral, biological and personality-related risk factors of drunk driving in Estonia (Eensoo et al., 2005), and a study on the influence of seasons on alcohol consumption at the same time discovering that the number of traffic accidents caused by drunk drivers increased significantly during summer months (June–August) (Silm and Ahas, 2005).

In the context of optimal alcohol taxation, however, a more comprehensive study is needed to disclose the presence of alcohol in a more precise manner. Otherwise, it would stay ambiguous whether tax policy could have significant welfare effect in Estonia. In order to serve this purpose, this subchapter has three main concerns. At first, the presence of alcohol in different fatalities is examined and compared with the results as disclosed in other countries. Secondly, special emphasis is laid on the comparison between different categories of road users. Specifically, it is analyzed whether there is enough ground to target pedestrians separately from drivers, when an optimal alcohol taxation problem is modeled, as is implied by international literature. Last but not the least, an attempt to divide traffic deaths into external and internal costs is made in order to apply this categorization in optimal tax calculations in subsequent chapters. The analysis presented here has been published earlier (Kaasik et al., 2007). In this thesis, however, the analysis is somewhat modified compared with the published paper. More specifically, related literature is updated, the role of drunken pedestrians and association with alcohol taxation is more strongly stressed and the methodology is complemented with logit regression models. Neither did the published paper address the issue concerning the differentiation between internal and external deaths as it is done here.

2.1.2. Data and methods

The study, approved by the Ethics Review Committee on Human Research of the University of Tartu, involves all traffic injury victims aged 15–64 years, who died during 2000–2002, in Estonia, and upon whom autopsies were performed by the Department of the Estonian Bureau of Forensic Medicine (EBFM). The age range from 15 to 64 was selected to exclude influences of childhood and old age physiological dispositions to injuries. The definition of traffic injury in our study is any condition which is coded by an International Classification of Diseases, 10th Edition, between V01–V79 with the exception of the subdivisions for injury to a person by motor-vehicles off of public roads, e.g. in a courtyard. According to Estonian regulations valid for the selected years, all cases of unnatural deaths should have undergone forensic autopsies. Statistics Estonia (2010b) confirms that during the above-mentioned years, autopsies were performed on at least 97% of all traffic victims. Therefore, only a few cases may be missing from our study. Unpublished data of the Estonian Road Administration confirmed that there were no drivers killed among children under age 15 years and only six drivers killed among the population aged over 65 years during the years under study.

The data for the study were gathered from the autopsy protocols of the EBFM and the Estonian Police Records. The data were gender, age, category of victim (car driver, passenger, pedestrian, cyclist, motorcyclist and unspecified car occupant), month, day of week and time of the event, where and how the accident occurred, the place of death and the results of blood tests for alcohol and illegal drugs.

BACs were available only if death occurred at the scene or a blood test was taken upon hospital admission before starting treatment, but not later than within the first five hours. The drugs were assessed only in cases of a suspicion of drug-impaired injury because drug testing is not part of the routine post-mortem accident protocol in Estonia.

Alcohol-related deaths were defined as those with BAC equal or above 0.05 g/100 ml. This is in accordance with most studies on alcohol-related traffic accidents (Moskowitz and Fiorentino 2000).

Alcohol intoxication was categorized in accordance with the above-mentioned Regulation into three classes, 'i.e.' into low, moderate and high degree of intoxication, respectively, 0.05–0.15, 0.151–0.25, and more than 0.25 g/100 ml.

Several factors that may influence the likelihood and severity of traffic accidents, such as speed, location of passengers in the car, seatbelt usage and weather conditions were left outside the scope of the study. Nor did we analyze drivers' fatalities in age and gender groups per kilometer driven because of the absence of the respective data.

For comparison of death rates by sex and age, the victims were distributed by a range of 10 years into 5 age and sex groups: 15–24, 25–34, 35–44, 45–54 and 55–64 years. For calculation of traffic mortality rates for age and gender groups per 100,000 of the population in these groups, the respective population figures were obtained from the database of Statistics Estonia (2006).

The Student's t-test was performed to assess the significance between differences in the means of continuous variables, and a chi-square ($\chi 2$) test was used for testing differences in proportions of categorical variables. To disclose the factors that most likely predict alcohol prevalence in fatalities, binary unconditional logit models were estimated. In these models, categorical variable reflecting whether the victim was sober or not, was applied as dependent variable. Two models were estimated, the one which comprised the data only for drivers and pedestrians and the one which comprised all victims upon whom the BAC was measured.

2.1.3. Results

General characteristics

Data were gathered on 512 traffic deaths. Among victims, 401 (78.3%) were males and 111 (21.7%) were females. Table 4 shows that males exceeded females in every age group ($p<=0.00$), with the highest predominance between ages 25–44 years. Males aged 25–34 years showed the highest, and females aged 35–44 years the lowest death rates. The total traffic death rates were higher in the younger age groups in comparison with the groups of middle ages. Most (67.7%) of the fatalities in the male group of highest death rates were car occupants, 47.5% were drivers and 20.2% were passengers.

Table 4. Number (N) and death rate (per 100 000) of traffic victims by age and gender groups

Age groups	Males		Females		Total	
	Number	Rate♣	Number	Rate♣	Number	Rate
15–24	92	29.9	31	10.5^	123	20.4ˇ°
25–34	99	35.9*	19	6.8	118	21.3*’
35–44	78	28.1	13	4.3^˜	91	15.8’°
45–54	67	26.3*	22	7.4	89	16.1*ˇ
55–64	65	33.0	26	9.9˜	91	19.8
Total	401	30.5	111	7.7	512	18.6

Source: Kaasik et al. (2007)

Notes: ^˜ $p \leq 0.01$ between the indices marked with the same symbol. *ˇ’° $p < 0.05$ between the indices marked with the same symbol. ♣ $p < 0.00$ between the death rates of all respective male and female groups.

Table 5 demonstrates a strong majority of males among all types of road users, and mean age of them by categories. Car drivers and passengers were significantly younger than pedestrians and cyclists ($p<0.01$). The number of drivers under 18 years who were killed and who had no driving licence was five, the youngest two of those were 15 years old.

Gender differences were highest among drivers in comparison with pedestrians. The highest number and death rate for male drivers was in the age group of 25–34 years (n=47, rate 17.0 per 100 000). These exceeded the analogous indices of females by 12 times. Among pedestrians, the number and death rate per 100 000 were the highest among males aged 55–64, 31.0 and 15.7, respectively, exceeding the analogous rate for women by about 3 times. Calculations also showed that 65% of drivers were younger than 40 years of age, while 65% of pedestrians were 40 years and older. Car drivers and passengers were significantly younger than pedestrians and cyclists ($p<0.01$). The number of killed drivers under 18 years and having no driving license was five; the youngest two of those were 15 years old. In addition, it is seen from Table 5 that when passive road users, i.e. passengers, are excluded, the number of killed pedestrians, cyclists and motorcyclists patently exceeded the number of drivers. The number of car drivers and pedestrians was almost equal.

More than one-third of fatal injuries occurred at weekends or public holidays. The safest period was from Tuesday until Thursday. Autumn months, from October until December, gave the largest, and March and April, the smallest number of deaths. At the same time, there were seasonal differences between fatalities among drivers and pedestrians. The peaks for driver fatalities were in June and in November, while for pedestrian fatalities it was the darkest period of the year, in November and December. Among those for whom the hour of the accident was registered (n=361), almost 40% occurred between 6.00 p.m. and midnight, and about a quarter between noon and 6 p.m. The rest was divided almost equally between midnight and 6 a.m., and from 6 a.m. till noon.

Table 5. Males and females and mean age of traffic victims

	Males		Females		Total		Age
	No.	%	No.	%	No.	%	mean±SD
Drivers	146	88.5	19	11.5	165	100	35.2±13.3*°
Passengers	87	65.4	46	34.6	133	100	33.1±13.9 ′ ˇ
Pedestrians	118	73.3	43	26.7	161	100	43.7±13.4* ′
Cyclists	34	91.9	3	8.1	37	100	43.9±12.9° ˇ
Motorcyclists	8	100.0	0	0.0	8	100	27.6±7.5
Unspecified	8	100.0	0	0.0	8	100	36.5±13.8
Total	401	78.3	111	21.7	512	100	37.9±14.2

Source: Kaasik et al. (2007)
Notes:*° ′ ˇ $p<0.01$ between the indices marked with the same symbol.

Most car occupants in fatalities, 266 (86.9%), were on highways and rural roads. The mechanism of fatal accident was known for 126 (76.4%) drivers. Fifty (39.7%) of these drivers collided with another motorcar, 36 (28.6%) drove off the road, and 36 (28.6%) crashed into a fixed object (mostly trees) and four (3.1%) collided with trains. The majority of pedestrian fatalities (N=96, 59.6%) occurred on rural roads. Forty-five pedestrians (28.0%) were run over on urban streets.

Twenty pedestrians (12.4%) were hit by trains while crossing or walking on the railway. Most motorcyclists and cyclists (7 and 27) were involved in fatal accidents on highways or rural roads, including one cyclist who collided with a train on a level crossing. One motorcyclist and ten cyclists were killed on urban roads. Most of the fatally injured (80.1%) died at the place of the accident, and others in the hospital (19.1%) and on the way to the hospital (0.8%).

Presence of alcohol

BAC was assessed in 486 (94.9%) victims: in 382 (95.3%) men and 104 (93.7%) women. The number of alcohol-related deaths was 313 (64.4%), 267 (69.9%) among men and 46 (44.2%) among women. The highest number of alcohol-related cases, 50 out of 59 deaths, was registered in the age group 35–44. The level of BAC equivalent to a low, medium and high degree of intoxication in a live person was disclosed in 55 (11.3%), 109 (22.4%), and 149 (30.7%) of all victims, respectively.

Among pedestrians, the percentage of alcohol-related fatalities, especially those having 0.251 g/100 ml and more alcohol in their blood, was higher than among drivers (Figure 10). The mean BAC of pedestrians (0.20±0.15) was also higher than that of drivers (0.14±0.13) ($p<0.00$). However, of those drivers who drove off the road or crashed into a fixed object, 73% were under influence of alcohol. No statistically significant relationship was disclosed between the age of dead drivers and their BAC as well as the age of dead pedestrians and their BAC. As regards pedestrians, Figure 10 also shows that among pedestrians who were hit by motor-vehicle in the pedestrian zone there was not any victim with BAC above 0.15 g/100 ml. At the same time, half of killed pedestrians hit by motor-vehicles on the road or walking on the railway had BAC level above 0.25 g/100 ml.

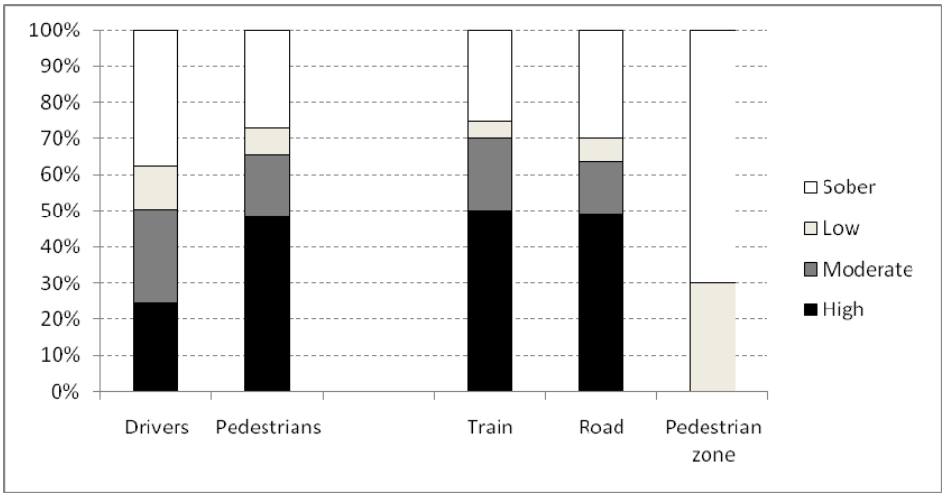

Figure 10. Proportions of victims by different levels of BAC
Source: Compiled by the author

Among the 37 cyclist fatalities, 25 victims were intoxicated. None of the female cyclists had alcohol in their blood. Four of the eight motorcycle fatalities were under the influence of alcohol, but BAC was not measured in two of them.

Among the 133 passenger casualties, BAC over 0.05 g/100 ml was detected in 72 (54%). Among the four drivers who collided with trains, three had no alcohol in their blood, but one had a BAC equivalent to a low degree of intoxication in a live person. Among 20 pedestrians who were killed by trains, 15 were under the influence of alcohol. Most of those (11) had a BAC over 0.25 g/100 ml.

Drugs were assessed in 174 (34%) of the traffic victims, among those, in 66 (40.0%) drivers. The results were positive for 14 fatalities: for six drivers, four passengers and three pedestrians, and one unspecified car occupant. Two-thirds of those under the influence of drugs, including five drivers, also had a BAC equivalent to low or medium intoxication in a live person. Two-thirds of victims with positive drug tests were from 15 to 26 years old. Drugs found were amphetamines, opiates, cocaine, benzodiazepines, Phenobarbital and caffeine.

Table 6. Factors predicting alcohol intoxication of the killed victims

	Odds Ratios (z-statistic in paranthesis)	
	Drivers and pedestrians (n=304)	All (n=484)
Male	1.967** (2.17)	3.395*** (5.35)
Road	1.842** (2.08)	1.591* (1.95)
Vulnerable user	1.794** (2.18)	1.702** (2.54)
Weekend	1.223 (0.77)	1.321 (1.35)
Log-likelihood	–191.801	–303.447
Pseudo R^2	0.0273	0.0588

Source: Author's calculations
Notes: ***p<0.01, **p<0.05, *p<0.1.

The relationship of preceding characteristics with BAC indicated by victims was further analyzed by assessing logit model, results of which are presented in Table 6. In the left panel, only drivers and pedestrians were included, which means that vulnerable road users include only pedestrians. In the right panel, the latter group includes all vulnerable road users. It was revealed that when the victim is a male, killed in the accident that occurred on the road and is not a car-occupant, it is more likely that she or he had positive blood alcohol concentration. There is also higher likelihood of intoxication in case of victims who had got into fatal accidents in the weekends. Latter association, however, was not statistically significant.

2.1.4. Discussion

Gender and age

The findings of present study show that males had four times in total and in some age groups ‘from five to six times the incidence of traffic fatality compared to females. Such a great difference between the genders is typical of low- and middle-income countries (Peden et al., 2004). The findings of our study that the gender difference is smaller among pedestrians than among motor-vehicle drivers are in agreement with the results of the other studies (Östrom and Eriksson, 2001; Törõ et al., 2005). The underlying causes of high premature mortality among men in eastern European countries are analysed elsewhere (Watson, 1995; Kaasik et al., 1998; McKee and Shkolnikov, 2001; Kaasik, 2002).

The findings concerning the mean age of drivers and pedestrians are in agreement with the results of the other traffic injury studies, which confirm that young male drivers are at higher risk for traffic accidents and fatalities than the middle-aged (Horwood and Fergusson, 2000; Turner and McClure, 2003; Laapotti and Keskinen, 2004). Older pedestrians are more prone to serious traffic injuries than younger ones (Harruff et al., 1998; Öström and Eriksson, 2001; Zajac and Ivan, 2003). The high incidence of fatal traffic accidents among young male motor-vehicle drivers is explained by their inexperience and proneness to risk-taking and sensation-seeking behaviour, including alcohol and drug consumption (Turner and McClure, 2003; Møller, 2004; Schwebel et al., 2006).

Time and location

The peak period of traffic fatalities for Estonian drivers is summer, from June to August, but also the weekends. This was also registered by Silm and Ahas (2005) for alcohol-involved traffic accidents. The explanation is that public holidays and festivities that are connected usually with consuming a lot of alcohol and increase of traffic density are mostly concentrated at summer-time and/or weekends. Analogous results are shown in the study from Lithuania (Chenet et al., 2001) and by Farmer and Williams (2005) in the USA.

The proportion of traffic victims who died at the location of the accident is high probably because the vast majority of accidents occur on rural roadways. Roadway characteristics and delayed access to emergency care is shown to contribute to higher fatality rates (Baker et al., 1992; Grossmann et al., 1997). Still, the concrete causes of a high proportion of deaths at the scene remain to be studied.

Road users

The results of several studies have proved that pedestrians, cyclists and moped and motorcycle riders account for most road traffic deaths in low- and middle-income countries, and car drivers and passengers account for the majority of road traffic deaths in high-income countries (Bunn et al., 2003; Peden et al. 2004). The results of present study show that profile of people affected by road traffic injuries in Estonia differs from both above-mentioned patterns. More

than half of our traffic victims were car occupants (58%), and an overwhelming number of those were drivers. The number of pedestrian fatalities was almost equal to the number of driver fatalities. In Sweden, pedestrian fatalities constituted 12–20% of the total number of traffic fatalities in the late 1990s with a decreasing tendency (Östrom and Eriksson 2001) while the percentage in present study group was 31. The Hungarian study (Törõ et al. 2005) registered 56% of pedestrian traffic deaths over three years (1999–2001), but since children and the elderly were involved the portion of their pedestrian victims might be increased. There are no studies involving the same age range as ours does.

Concerning pedestrians, our study results are in agreement with the results of the study by Öström and Eriksson (2001), showing that the majority of pedestrians receive their fatal injury on rural roads. Their study area, Umeå in Sweden, was mainly rural. In Estonia, only about 30% of the population lives in the country. It is striking that there is a noteworthy difference between the number of pedestrian victims in the Swedish region studied and Estonia. The mean number of pedestrian fatalities, excluding those hit by trains, in the Swedish region under study was 15 per year per 907 000 inhabitants, but the analogous index was 47 per 916 217 inhabitants in the age groups studied by present study. Therefore, the pedestrian death rate in our study group is more than three times higher than for all age groups in Umeå.

The role of alcohol

The results of our study show that 69.9% of men and 44.2% of women were under the influence of alcohol during fatal accidents. Such high portion of intoxicated people among traffic victims can rarely be found in studies conducted in the other countries. Sjögren et al. (2006) detected that the above-mentioned percentages were 32.8 and 9.5, respectively. The Hungarian study provides the data on males and females as one group, showing that BAC was over the legal limit (0.05 g/100ml) in 42% of fatalities (Törõ et al. 2005).

The percentage (62.3%) of intoxicated drivers killed in traffic in Estonia is close to the upper index shown for middle-income countries (Peden et al. 2004). A Swedish study with the data of the same years as ours shows about three times lower percentages, 19.8–21.8% (Holmgren et al. 2005). Pedestrians killed in Estonia were more often under the influence of alcohol than drivers (72.7%). The analogous ratio was found by Törõ et al. (2005) only the percentages were lower, 48% for pedestrians and cyclists taken together, and 33% for motor vehicle occupants. The study done in Sweden detected alcohol only in 22% of pedestrians killed in traffic (Östrom and Eriksson 2001).

A special feature of alcohol-involved traffic fatalities was the prevalence of a high degree of intoxication among pedestrians (48.7% of all pedestrian fatalities) and a great proportion of drivers (24.5%) with a high degree of intoxication (see Figure 10). Further analysis showed that being a pedestrian was shown to be one of the most decisive characteristics of a victim, besides being a male or caught in the accident on a rural road, which predicts the presence of alcohol. Some comparative data can be found from the study by Törõ et al. (2005) with

much lower indices: the BAC levels equivalent to high degree of intoxication were found in 4% of car occupants and about 20% of pedestrians.

Knowing the social and economic situation in rural areas in Estonia, we can speculate about some factors contributing to the high number of alcohol-related fatal pedestrian accidents on rural roadways. Firstly, it is known that the speed of motor vehicles is higher in rural areas than in urban areas and pedestrian accidents occurring there are more severe. Secondly, a large proportion of people in the Estonian countryside suffer from social and economic deprivation because jobs and money are concentrated in cities and towns. It is well known that alcohol consumption is higher among the less well off in comparison with relatively higher social groups (Mäkelä et al., 1997). This is just in rural areas of Estonia. Due to economic deprivation, these people are less likely to use a car for going from one place to another. They just walk or cycle, often under the influence of alcohol. Graham et al. (2005) found that deprivation of an area is itself related to an increased incidence of pedestrian casualties. Thirdly, in most rural areas, pedestrians have to share non-illuminated roadways with motor-vehicle traffic because of absence of pedestrian and cyclist zones beside or near the roadways. The importance of environmental components in addition to alcohol intoxication of pedestrians who were killed on highways is shown in the study by Harruff et al. (1998). Most of the pedestrian fatalities occurred during the dark periods of the year and the day that was also found by the other authors (Sullivan and Flannagan, 2002; Tyrrell et al., 2004).

Policy implications

In the context of present thesis, the results of this study have certain implications for optimal alcohol taxation policy. At first, although the study was not designed to assess directly the association between alcohol taxes and traffic mortality, both high prevalence of alcohol in traffic fatalities and relatively low alcohol taxes in Estonia, as was shown in preceding chapter, imply that the rise in alcohol taxes could generate substantial benefits from lower traffic mortality. Therefore, it is highly likely that the effectiveness of alcohol taxation, proved true in the prior literature, under current circumstances holds true for Estonia as well. In fact, relatively sharp decrease in traffic mortally in the latter years has been probably at least partly induced by the rises in alcohol taxes in 2008 and 2010. This does not necessarily mean that additional increase in alcohol taxes is not warranted as whether the overall decrease in traffic fatalities in the latter years has been temporary or permanent remains unknown. For example, economic recession, during which the real GDP decreased in 2009 more than one tenth, has probably played some role in reducing traffic mortality as well.

Secondly, the high prevalence of alcohol in pedestrians' fatalities in Estonia supports even more convincingly than international literature the view that special attention should be paid to pedestrians. More specifically, when designing optimal alcohol policy, drivers and pedestrians should be treated separately by complementing drunken driving legislation with "drunk pedestrian" legislation. This is not completely new view though. These kinds of proposals, such as

imposing a legal alcohol limit for pedestrians similar to drivers for instance, can be also found in the prior literature (Hutchinson et al., 2009). In fact, in Estonia there are specific penalties for pedestrians. Although it is not prohibited to be in traffic under the influence of alcohol, according to paragraph 74 of the Estonian Traffic Act (Liiklusseadus) drunken pedestrians who have violated traffic regulations are facing more stringent penalties than sober pedestrians are. This is probably too little to affect pedestrians' behavior.

In regard with optimal alcohol taxation, pedestrian penalties make a difference. Specifically, these penalties work analogously to Pigouvian tax by internalizing at least part of the external cost within pedestrians. The optimal level of taxation would be reduced and consequently must be taken into account, when the optimal taxation problem is addressed. Prior optimal taxation literature as well as alcohol policy literature in general has not addressed this and usually only drivers' behavior has been the concern. Differentiation between drivers and pedestrians, however, leads to several specifications. It affects one of the most ambiguous issues in optimal alcohol taxation such as the division of alcohol costs into internal and external. As was discussed in the preceding chapter, on the efficiency grounds there is rationale to tax alcohol only when the costs of alcohol are external. Therefore, it is necessary to determine the proportion of death considered as external. In this respect, considering pedestrians separately makes a difference.

Levitt and Porter (2001) have addressed the issue of traffic externalities in the US. They suggested that approximately one fourth of people killed in alcohol-related fatal crashes should be classified as external. Using relative risk estimates obtained from mortality data for 1994, they estimated that the following proportions of deaths could be categorized as externalities. 50% of the deaths in two-vehicle crashes in which both drivers were drinking, 76.5% of the passengers of vehicles driven by a sober driver who had died in two-vehicle crashes with drinking drivers and 86.6% of pedestrians killed by drinking drivers. Although the authors noted that a substantial proportion of pedestrians involved in fatal crashes had been drinking, these deaths were considered as external. In the present study, there is evidence that suggests the opposite. For example, while all victims killed in pedestrian zones were sober or had a low BAC level; most of the victims who were killed on the road had a moderate or high BAC level (see Figure 10 above). This implies that alcohol plays at least some role in pedestrians' ability to stay in a pedestrian zone to avoid a crash with a motor vehicle. What it means is that often pedestrians themselves are the cause of crashes and under these circumstances, it is not reasonable to consider the deaths of pedestrians as external. Naturally, this applies only when pedestrians are perfectly informed about the risks of being in traffic under the influence of alcohol. Otherwise, these costs could be considered as un-internalized, internal costs as was discussed in the previous chapter (see Figure 7 and its discussion above).

In addition to the fact that many pedestrians' deaths are internal, it should be also acknowledged that external harm arising from traffic accidents caused by

pedestrians is probably not as severe as in the cases of accidents caused by drunk drivers. Although, while the crashes in which pedestrians are responsible put a substantial burden on the health care system, criminal justice system and private auto insurance companies, external mortality costs are small. More specifically, since pedestrians are more vulnerable in traffic than car occupants are, most of the fatalities attributed to pedestrians' inadequate behavior are probably borne by pedestrians themselves. If a pedestrian is walking in the middle of the road, which induces the driver to drive off the road or even crash into a tree or some other fixed object, there is no evidence that in these kinds of events car-occupants were regularly killed (Estonian Road Administration, 2011). It means that in the externality-corrective taxation framework most of these deaths where a motor vehicle runs over a pedestrian could be considered as internal since the risk of being killed had been taken into account by the victims.

As follows, based on the discussion above, an attempt to categorize all deaths in 2000–2002 as external or internal is made. This is necessary input for the subsequent subchapter as well as for the third chapter of this thesis, which obtains optimal tax rates on alcohol. For the start, it must be stressed that data obtained for the current study comprises information only about individual victims and it is not known whether there were also other victims in the same accident or whether other parties were under influence of alcohol. It means that in order to differentiate between external and internal deaths, it is not possible to use the same logic for drivers and passengers as did Levitt and Porter (2001) described above. However, after making some simplifying assumptions, some inference can be drawn.

In the present study, approximately one fourth of victims were drunken pedestrians. Using this as a rough estimate for determining internal effects borne by pedestrians themselves, a considerable proportion of deaths are eliminated from the Pigouvian taxation estimation. In case of passengers, it could be assumed that every driver death is accompanied by the same number of passenger deaths. Thereby, as 60% of killed drivers had a positive BAC level, probably the same proportions of passengers died in accidents involving the drinking driver. In addition, assuming that half of these passengers were in a vehicle where the driver was drunk, this could be considered passengers' rational choice and their subsequent deaths were internal. Therefore, the remaining 30% of killed passengers, being in a vehicle of which the driver was sober, are considered as external. In 2000–2002, this makes 40 lost lives.

As regards to drivers, it was revealed that approximately 40% of them, about whom the mechanism of the accident was known, had crashed with another motor vehicle. Of these, 30% were under the influence of alcohol. Therefore, it is reasonable to assume that approximately 12% of drivers who had crashed with a drunk driver and the same proportion of deaths among drivers are considered as external. This makes 20 lost lives. Assuming that among drivers who had run over pedestrians or crashed with motor cyclists or bicyclists, the same proportion (i.e. 12%) was under the influence of alcohol as well, 12% of

the deaths of sober vulnerable road users could also be considered as external. This makes an additional 8 lives. Altogether, this speculative derivation finds that 68 deaths could be considered as alcohol externalities. This represents 13.5% of all traffic fatalities in 2000–2002.

Final comments

It is important to note that the patterns revealed in the present study reflect the situation in 2000–2002 while the thesis in general is discussing the situation in the second half of the first decade in 2000's by the time which the traffic mortality has decreased approximately two times. However, according to aggregate data published by the Estonian Road Administration (2010) the distribution of road users in 2009 is rather similar to the period 2000–2002. The proportion of pedestrians among the killed road users have decreased from one third to one fourth while the proportions of the two other large groups, drivers and passengers, have somewhat increased. The proportion of intoxicated victims has decreased as well. In this study, it was disclosed that more than 60% of the victims were intoxicated, while through personal communication with the specialists at the Estonian Forensic Science Institute (2011), it was revealed that in 2009 this figure has somewhat lower but still exceeds 50%. Therefore, no cardinal changes have been experienced in the structure of killed traffic victims. In general, the results certainly imply that pedestrians as a subgroup should be considered as one separate target group when alcohol policy is designed. Future research, however, should more precisely determine the magnitude of the harm caused by them. For example, there is no direct evidence about the health care costs attributed to pedestrians.

2.2. The economic costs of alcohol

2.2.1. Introduction

As was shown in chapter 1, alcohol misuse can place a substantial economic burden on society. In Estonia, only few studies (Kaasik et al. 2004, Reinap 2009) have tried to convert this burden into monetary values. There are no studies so far, except one published by the author[33] of current thesis in 2009, which would have tried to include other than health-related costs. However, alcohol may impose major costs not only on the health care system, but also on other spheres of society. It causes a variety of consequences like criminal and aggressive behavior, property damage, etc. These effects should also be monetized in order to find the appropriate level of alcohol taxation. The present

[33] Compared with the published paper (Saar, 2009), a longer version with more specific descriptions of the results is presented here and one additional cost component is included as well. In addition, analysis is complemented with optimal tax estimates based on a simple partial equilibrium Pigouvian rule. Otherwise, however, only minor insignificant adjustments have been made.

subchapter aims to fill this gap. The main purpose is to show the extent of the consequences of alcohol misuse in society, which can then be regarded as a starting point in designing effective alcohol policy. Specifically, the results of the study create the basis for optimal taxation analysis in chapter 3, in the general-equilibrium framework, as the latter requires empirical estimates for several cost parameters. This chapter itself obtains a partial-equilibrium optimal alcohol tax based on the formula (1.6) derived in the previous chapter. This is carried out in the Discussion section. For this purpose, alcohol costs are divided into external and internal costs. Specific proposals for public policy, however, are beyond the scope of this chapter.

In estimating the net social costs[34] of alcohol misuse in Estonia, a cost-of-illness (COI) approach was used. The main idea of a COI study is based on the concept of opportunity costs, meaning that only costs related to the use of resources due to alcohol misuse are relevant (Single et al. 2003), excluding all sorts of alcohol-related transfers within society. In addition, all costs of drinking alcohol that are not offset by benefits to consumers are included. This also means that some costs are borne by alcohol users themselves (e.g. premature mortality and several diseases) because it is usually assumed that consumers are not aware of the total costs that consumption imposes on them (Single et al. 2003, Choi et al. 1997). Internal costs like consumer expenditures on alcohol are excluded, because they are offset by certain benefits of consuming alcohol (Single et al. 2003).

In this study, the prevalence-based method was followed, estimating the costs that arose in 2006 from both the use and abuse of alcohol, regardless of when the use took place – whether in the past or in the present. As a consequence, the results do not directly show the reduction of costs that could be attained in the future by the implementation of some type of an intervention program (Single et al. 2003). However – since alcohol consumption in Estonia has increased during the last decade (Orro et al. 2010), potential cost reductions could be even larger than the COI analysis indicates. In addition, because of its modest data requirements, this is the most frequently used approach (Choi et al. 1997) and provides results that most clearly describe the present extent of consequences associated with alcohol misuse. In interpreting the results of this study, it also has to be kept in mind that the analysis was based on rather conservative assumptions and that many substantial cost components, such as intangible costs (pain, suffering, etc.), were excluded.

Seven cost components were estimated in this study. These are costs to the health care system and to the criminal justice system, property damage, indirect

[34] Although the "net costs" implies that an attempt was made to consider also certain benefits of alcohol drinking, this study is clearly cost-oriented. As was discussed in the first chapter, there is evidence of a considerable amount of benefits arising from alcohol consumption. The problem is that they are difficult to quantify. The issues regarding benefits and their inclusion into policy analysis deserve attention and future research should address this problem more carefully.

costs from premature mortality, incarceration, disability and lower workplace labor productivity. Sources of data and the exact methodology used in this study are presented in the following section.

2.2.2. Data and estimation procedures

Costs to the health care system

Data about health care costs associated with alcohol-related diseases came from the Estonian Health Insurance Fund (2007), through which two thirds of health care costs are financed in Estonia (Ministry of Social Affairs of Estonia, 2004). Benefits derived from alcohol consumption were also considered (see Appendix 1). In case of diseases that are only partly caused by alcohol, no original alcohol attributable fractions (AAF) were calculated. More than half of these were drawn from Lai et al. (2003), in which fractions were estimated based on prevalence data of alcohol consumption in Estonia in 2002. The remainder of the fractions was drawn from studies undertaken in the USA (Harwood et al. 1998) and New Zealand (Devlin et al. 1997) (see Appendices 1 and 2). In consideration of the fact that the level of alcohol consumption in Estonia was higher than in both of these countries during the last decade (WHO 2011a) and since the burden of cancers attributable to alcohol (for which AAFs were mainly drawn from studies conducted outside Estonia), has also been estimated to be one of the highest in the region that includes Estonia (Boffetta et al., 2006), the analysis should produce a conservative estimate and consequently serves the purpose of this study.

Costs to public institutions

The cost computation pertaining to the criminal justice system and the rescue system are based on a calculation of the average cost of output for each institution using their operating expenses (Ministry of Finance of Estonia, 2006a, 2006b). The output of the relevant institution was measured by a statistical figure that reflected the number of main activities that were carried out in 2006 (see Table 7). The next step entailed determining the proportion of output attributed to alcohol, using fractions that were mainly drawn from Harwood et al. (1998) and Lai et al. (2003) (see Appendix 3). Finally, average cost was multiplied by alcohol attributable output in order to get the estimate of the costs of alcohol misuse.

Some details require mentioning in the process of cost computation. First, in the case of the Prosecutor's Office and the courts, only operating expenses relating specifically to misdemeanors and criminal matters were used to calculate the average cost of output, because the civil and administrative matters that are also initiated in these institutions are not generally connected to alcohol. Assuming that operating expenses are proportionately related to the duration of a court case, statistics about the duration of different court cases (Ministry of Justice of Estonia, 2006) made it possible to exclude expenses related to proceedings restricted to civil and administrative matters. Secondly, in the case of lawsuits, it was assumed that the structure of registered offences by type and the

structure of court cases by type coincide, which made it possible to determine which lawsuits were related to alcohol, in exactly the same way as in the case of registered offences.

Table 7. Public institutions and their output

Institution	Output	Source of Data
Police Board	Registered criminal offences and misdemeanors (by type)	Request to Estonian Police Board (2007)
Courts of first and second instance	Initiated proceedings – criminal offences and misdemeanors (by type, based on structure of registered offences)	Data from Ministry of Justice of Estonia (2007)
Prosecutor's Office	Initiated proceedings – criminal offences and misdemeanors (by type, based on structure of registered offences)	Request to Estonian Police Board (2007)
Bureau of Forensic Medicine	Expert studies and autopsies (by cause of death or injury)	Request to Bureau of Forensic Medicine of Estonia (2007)
Rescue Board	Calls (by type)	Request to Estonian Rescue Board (2007)
Prisons	Prisoners (by criminal offences)	Data from Ministry of Justice of Estonia (2006)

Source: Compiled by the author

Thirdly, in computation of costs accruing to the Bureau of Forensic Medicine (BFM), it was assumed that the average cost of expert studies and autopsies was three times higher than expert examinations conducted on living persons. This assumption was arrived at based on a government regulation that establishes the price list for examinations performed at state expert institutions (Riiklikes ekspertiisiasutustes …, 2001) and on a personal communication with the Director of the BFM. In addition, since blood alcohol concentration was assessed in the case of every cadaver, the expenses involved in these procedures were calculated separately, assuming that the average cost of each performed test was EUR 11.80, as fixed by the government regulation.

Property damage

Alcohol-related property damage mainly involves damage caused by traffic accidents and fires, but the latter were not included in this study on account of insufficient data. Data about traffic damage was obtained from the Estonian Traffic Insurance Fund (2007) through personal communication. Insurance firms made payments of EUR 44.2 million in 2006, of which 87% included damage to property. The alcohol attributable fraction used here was the same as in the case of injuries caused by transport accidents (see Appendix 2).

Premature mortality

Alcohol-related deaths in 2006 were calculated based on mortality statistics by cause of death (Statistics Estonia 2007a) and attributable fractions presented in Appendices 1 and 2. In estimating future costs, life expectancy statistics by age and sex group were used (Statistics Estonia 2007b). Based on this data, the years which would have been lived in an alcohol-free society were established, which enabled the making of a calculation for estimating the lost years of working-age persons (aged 15–74). The human capital approach was used. The value of each life year was assumed equal to the Estonian GDP per laborer (Statistics Estonia 2007c) in 2006, which figure was modified to account for employment rates by age and sex groups (Statistics Estonia 2007d). The real growth of GDP was taken into account, and the value of production foregone in the future was discounted back to 2006. Since results may be very sensitive to the choice of real GDP growth rate and discount rate, both conservative (2% and 10%, respectively) and non-conservative (4% and 5%, respectively) rates were applied. Using GDP per laborer may result in a somewhat higher estimate of productivity losses, compared with other studies in which earnings by gender and age groups or GDP *per capita* were primarily used. However – Since the human capital approach has been criticized because it underestimates, the value of life compared with the willingness-to-pay approach (Cook and Moore 1999), and since production of the household sector was completely excluded in this study, the GDP per laborer approach is not expected to overestimate the value of lost life.

Incarceration

Although the main objective of incarceration is to isolate persons who are detrimental to society, it is also seen as being harmful to productivity, unless detainees are employed in prison. At the beginning of 2006 – according to the Estonian Prison System and Probation Supervision Yearbook (Ministry of Justice of Estonia, 2006) – 48% of convicted prisoners were not employed. However, since all pre-trial prisoners are unemployed, the rate for all detainees was 61%. Applying this rate and the overall employment rate in the economy in 2006 (61.6%) (Statistics Estonia 2007d) to the total number of detainees, the number of prisoners who were lost to the labor market due to their imprisonment was established. The number of prisoners whose cases are related to alcohol use was derived by assuming that the structure of unemployed detainees by crime type coincided with the overall structure of detainees by crime type. The value of productivity of detainees was assumed to be equal to 50% of GDP per laborer.

Disability

Disability is categorized as temporary and permanent[35]. In case of the former, the number of lost workdays attributed to alcohol was calculated with data

[35] Earlier published paper on Social Costs of Alcohol in Estonia (Saar, 2009) did not included permanent disability costs.

about the duration of illnesses (Estonian Health Insurance Fund, 2007). Only costs associated with patients aged 15–74 were included, which were multiplied by the overall employment rate in the economy. Separate records are kept by hospitals and family doctors of the duration of illnesses. In the former case, patients were assumed to be incapable of working during the whole period of illness, but in the latter case, only 25% of days were categorized as lost work-days, since very often patients continue to work, even after a registered visit to or by a family physician. Lost days related to alcohol were obtained by using the same fractions as in the calculation of direct cost for health care (see Appendices 1 and 2). The productive value of one day was assumed to be equal to GDP per laborer in 2006, divided by the number of days in a year.

Data about the number of permanently disabled individuals by the cause of disability in 2006 was obtained from the Estonian National Social Insurance Board (2011). As for each individual the data revealed the degree of disability as well, this was used as the reference value to obtain productivity losses. For instance, for a disabled person whose degree of disability was 20%, productivity losses related to this individual was obtained by taking 20% of GDP per laborer. In order to estimate total productivity losses of permanent disability attributed to alcohol, final value was also multiplied by the employment rate of 62% to take into account circumstances in the labor market. Analogously to temporary disability costs alcohol attributable fractions presented in Appendices 1 and 2 were applied to obtain alcohol-related number of permanently disabled individuals.

Lower workplace labor productivity

Alcohol abusers are generally less productive compared with nonabusers, because of their poorer state of health and more frequent absences from work. These kinds of costs should be included in the social cost estimation. As in the study by English et al. (1995), it was assumed that the harmful level of alcohol intake per day is over 60g for males and over 40g for females. Data about prevalence of alcohol abusers among the workforce came from the National Institute for Health Development (2007), which conducts the "Health Behavior among the Estonian Adult Population" survey once every two years. Productivity impairment rates of 10% for males and 5% for females were applied, using GDP per labourer as the productivity level for nonabuser persons. The choice of impairment rates was supported by Shurcke et al. (2006), according to which male labourers in Estonia who assessed their health to be bad earned wages 30% lower than the average. For females, the respective rate was 20% (Suhrcke et al. 2006). Kaldaru et al. (2004) presented even larger differences – labourers who assessed their health to be very bad earned 45% less than the ones who thought their health was very good. Thus, the 10% and 5% that were used as rates of impairment in this study should produce rather conservative estimates.

2.2.3. Results

The economic costs to society resulting from alcohol misuse in Estonia in 2006 amounted to EUR 230–329 million, representing 1.7–2.5% of GDP (see Table 8). The exact value would depend on the chosen discount rate and the real GDP growth rate. Over 75% of total costs were associated with the indirect burden of alcohol misuse, over 75% of which arose from premature mortality. Direct costs were mainly associated with the criminal justice system.

Table 8. Estimate of the social net costs of alcohol misuse in Estonia in 2006 (EUR millions)

DIRECT EFFECTS	Costs	Benefits	INDIRECT EFFECTS	Costs	Benefits
Health care	9.85	4.24	Mortality[1]	142.27–246.82	8.35–14.18
Police	14.48		Incarceration	3.13	
Courts	0.91		Disability (temp)	10.54	3.13
Prosecution	1.70		Disability (perm)	30.26	4.76
BFM	0.33		Workplace productivity	13.52	
Prisons	5.19				
Rescue	2.27				
Property	16.14				
NET COSTS	**46.63**		**NET COSTS**	**183.48–282.20**	
TOTAL NET COSTS 230.11 – 328.83 (in millions of euros)					
PERCENTAGE OF GDP 1.72% – 2.46%					

Source: Author's calculations

Notes: [1] Discount rate 10%–4%, GDP growth rate 2%–5%; temp is temporary, perm is permanent.

Examining the cost structure related to the mortality issue, more than 75% of this was associated with males. In addition, approximately half of the costs were derived from external causes, despite the fact that there were substantially more deaths caused by diseases. By way of explanation, it must be noted that there were large variations in the value of lives, depending on gender and age of death. To be more specific, young person's obviously have many more years to lose than older ones. Thus, their lives were more highly valued. Applying different employment rates by sex and age group also caused substantial variations. For example, in the case of conservative assumptions (discount rate of 10% and real GDP growth rate of 2%) the value of life of males aged 25–29 was estimated as EUR 229,000, while the value of life of females aged 70–73 was valued as EUR 4,000, representing the highest and the lowest value of human life. In the case of less conservative assumptions, the respective values were

EUR 589,000 and EUR 4,000. Thus – although female mortality was almost three times lower than that of males, this was not the only reason for the low proportion of costs associated with females. The lives of females as such were given a lower value (up to 34%, depending on age group) because of the lower employment rate among women (this does not apply to age group 41–50 because shorter life-expectancy of males decreased their productive value even smaller than females'). In addition, since males and young people are more frequently associated with accidents and assaults, the proportion of costs related to males and external causes was relatively large.

Most of the costs resulting from mortality were associated with persons aged 40–59. There were 546 male and 181 female alcohol-related deaths in this age group (see Table 9, where the number of deaths per 100,000 is shown for purposes of international comparison), representing more than 60% of the costs from mortality. Another 30% of deaths were caused by traffic fatalities. Other important cost components were medical problems that are directly caused by alcohol consumption, like accidental poisoning and exposure to alcohol (representing 15% of costs caused by premature mortality), alcoholic cardiomyopathy (11%) and alcoholic liver disease (11%). Since consumption of alcohol decreases the prevalence of some diseases, it was estimated that there were also benefits of EUR 8.4–14.2 million associated with lower mortality, of which 85% arose from lessened incidence of ischaemic heart disease, 11% from hypertensive diseases and 4% from cholelithiasis.

Table 9. Premature mortality attributed to alcohol in Estonia in 2006

	Alcohol-related deaths by different age groups							
	0–19	20–29	30–39	40–49	50–59	60–74	Total	Per 100,000
Males	18	41	74	208	338	373	1052	177
External cause	18	39	52	90	103	62	364	61
Disease	0	2	22	118	235	311	688	116
Females	7	8	18	51	130	205	421	64
External cause	7	6	7	19	30	26	96	15
Disease	0	2	11	32	100	179	325	49

Source: Statistics Estonia (2007a; 2007e), author's calculations

In addition to premature mortality, indirect costs are comprised of four cost components. First, it was estimated that alcohol misuse caused a loss of EUR 13.5 million due to lower productivity in the workplace. Since the prevalence of alcohol misusers (1.84% of the work force) among males was four times higher than among females (0.46%) and it was assumed that male productivity was curbed by 10%, while in the case of females the assumed rate was 5%, almost

90% of lower labour productivity is attributable to alcohol misuse by males. Secondly, net costs of temporary disability of persons who could not work during periods of illness amounted to EUR 7.8 million, representing 3% of indirect costs. The total costs of temporary disability were significantly higher – EUR 10.9 million. The difference between total and net costs takes into account benefits of EUR 3.1 million accruing from alcohol consumption that helped to avoid potential disability caused by cholelithiasis (39% of benefits), hypertensive diseases (37%), and ischaemic heart disease (24%). The four main cost components of temporary disability were falls (18% of disability costs), hypertensive diseases (17%), mental and behavioural disorder due to use of alcohol (13%) and traffic accidents (8%). Thirdly, while the net costs of permanent disability were estimated to be EUR 25.5 million, total costs were higher by EUR 4.6 million due to benefits of alcohol arising almost equally from hypertensive diseases and ischaemic heart diseases. Costs of permanent disability were mainly caused by mental and behavioural disorder due to use of alcohol (14% of total costs), degeneration of nervous system due to alcohol (13%) and alcoholic polyneuropathy (9%). Fourthly, incarceration costs amounted to EUR 3.1 million and were mainly associated with prisoners who had been imprisoned for offences against persons (75% of incarceration costs) and traffic crimes (21%).

Table 10. Criminal offences and misdemeanors attributed to alcohol in Estonia in 2006

Criminal offences and misdemeanors	Number registered	Attributed to alcohol
All criminal offences and misdemeanors	254,830	57,112
Criminal offences against persons	4,402	1,288
Criminal offences and misdemeanors against property	36,476	1,240
Criminal offences and disturbances of the peace	13,718	2,058
Driving motor vehicle or tram under influence of alcohol or refusing alcohol intoxication tests	17,109	17,109
Misdemeanor violations of Alcohol Act	35,417	35,417

Source: Author's calculations

Half of the direct costs were carried by the criminal justice system, including the police, the BFM, the courts, the Prosecutor's Office and prisons, which bore costs of EUR 22.6 million due to alcohol misuse. Two thirds of these costs were borne by the police system. Of the more than a quarter of a million criminal offences and misdemeanors committed in 2006 57,112 were attributed to alcohol (see Table 10). Most of the cost (62%) to the police system was related to misdemeanor violations of the Alcohol Act (Alkoholiseadus), mainly associated with the drinking of alcohol in public places, appearance in public places under the influence of alcohol, and drinking by under-aged persons. Prosecutor and prison costs amounted to EUR 1.7 and EUR 5.2 million, respectively. Both sets of costs were incurred primarily in regard to offences against

persons (65% of prosecutor costs and 75% of prison costs) and traffic crimes (16% and 21%, respectively). The two main cost components borne by courts were offences against the Alcohol Act (25% of court costs) and driving under the influence of alcohol (42%). Costs to the BFM were associated with alcoholic liver diseases (22% of BFM costs), traffic accidents (22%), other external causes like homicides, suicides, falls, etc. (38%), and assessments of blood alcohol concentration (9%).

Total costs to the health care system were EUR 10.1 million, but since benefits that arose from prevention of ischaemic heart disease (51% of benefits), cholelithiasis (36%) and hypertensive diseases (12%) amounted to EUR 4.2 million, net costs to the health care system were EUR 5.9 million, amounting to 13% of net direct costs. Most of the health care costs were caused by ischaemic heart diseases (22% of total health care costs), falls (15%), cancers (14%), mental and behavioural disorder due to use of alcohol (8%) and hypertensive diseases (8%). In total, 29% of health care costs related to alcohol were caused by external causes and 71% by diseases.

Although only 2% of health care costs were caused by the treatment of consequences of smoke, fire and flames, more than 80% of the alcohol-related costs to the rescue system are caused by fires, since over half of all calls received by Rescue Board are related to fires. Most of the other costs borne by the rescue system are associated with traffic accidents. A substantial part of direct costs arose from property damage related to traffic accidents – 35%.

2.2.5. Discussion

Comparison with prior estimates

Estimates about the social costs of alcohol misuse in Estonia have not been compiled, so the results of this study were compared with COI surveys undertaken in other countries. There are two main aspects that are comparable across studies – the structure and the level (ratio to GDP) of costs. Beginning with the latter, variability between different studies is relatively large. This may result from methodological differences, where lower costs in some studies were caused by very conservative estimates and the exclusion of some cost components because of lack of data, difficulties in monetizing several consequences of alcohol misuse, and problems finding the correct AAF. However, since a standard framework has been followed in most of the studies, the results can be compared to a certain extent. In this study, the most conservative estimate produced a figure of 1.6% of GDP. In the context of results presented in Table 1 in preceding chapter Estonia can be classified as a country with relatively high social costs of alcohol use, especially when considering the least conservative estimate of over 2%. Considering the high level of alcohol consumption (WHO 2011a) and very high rates of mortality related to alcohol use (WHO, 2011b) in Estonia, this was an expected outcome.

Although the structure of social costs of alcohol varies considerably, there is one similarity that is apparent across the studies – the large share of indirect costs. Even then, the share of indirect costs in Estonia was estimated to be higher than in most of the other studies presented in Table 1, reaching over 75% of total costs. In addition to methodological differences like using GDP per labourer as a value for lost life years instead of earnings by gender and age groups or GDP *per capita*, one obvious explanation for the very large share of indirect costs in Estonia may lie in the relatively low direct costs that arise from the small public sector. General government output accounted for only 17.1% of GDP in 2006, which is low compared to most of the developed countries, and also to the EU average of 19.1% in 2005 (Eurostat, 2007). A low level of total expenditure on health as a percentage of GDP (e.g., 5.3% compared with 15.4% in the USA and 9.8% in Portugal in 2004) also helps to explain the results (WHO, 2007). Another reason may lie in a very high mortality rate that has lessened costs for the health care system, but also has increased indirect costs.

Tax policy implications

Cost levels have often been compared with the level of tax receipts (Cook and Moore 1999, Cook and Moore 2002). In efficient economies, tax receipts from taxes on alcohol should be at least as large as external costs associated with alcohol consumption (Barker 2002). If marginal external costs are increasing, tax receipts should even exceed total external costs (Barker 2002, Ironfield et al. 1999). Assuming that consumers do not have complete information about the consequences of alcohol misuse such as premature mortality or health effects, and ignoring the share of direct cost that is borne by alcohol misusers themselves, total social costs may be interpreted as external costs. Considering that in Estonia tax receipts on alcohol amounted to EUR 134 million in 2006 (Statistics Estonia 2007f), economic inefficiency definitely exists with respect to the alcohol market, since social costs exceeded tax receipts by EUR 70 million. This implies a need for public intervention, especially when considering that there were several cost components that were excluded. For instance, although direct costs from criminal offences against persons accounted to only 2% of total alcohol-attributed costs to the police system, the influence of such crime on society was substantial, because of the suffering, fear and pain that were experienced by victims and their close relatives and friends.

There is an important caveat concerning comparison between costs and revenues. Specifically, there is no consensus as to whether all productivity losses may be regarded as external costs. The argument of efficiency dictates that nothing justifies public intervention if costs are internal and consumers are rational. As regards traffic costs, that is representing 30% of mortality costs and 8% of disability costs, preceding subchapter about traffic mortality suggested

that 32.1% of these costs can be considered as external[36]. This represents only 8% of total productivity costs. Remaining indirect costs like mortality or disability from alcohol-related internal diseases, lost time due to incarceration or lower on-job-productivity due to alcohol abuse, are probably mainly borne by drinkers themselves and their families through foregone earnings.

Another rationale to tax alcohol arises due to un-internalized, internal costs. In the COI framework, it is assumed that consumers are not capable of taking into account any consequences of alcohol misuse except for the price they pay when buying alcohol. Under this assumption, a tax raise in Estonia would be warranted as was discussed above. However, this may be a too extreme approach and is probably an inappropriate assumption when designing taxation policy. Therefore, due to information failures, i.e. drinkers' inability to take into account all the risks drinking poses on them, it is reasonable to consider a certain proportion of indirect costs as un-internalized, internal costs. Obviously, the choice of this proportion considerably affects the optimal level of taxation. For example, according to the conservative estimate of this study, the proportion of external costs of losses applying to total productivity should be over 50% in order to outweigh tax receipts, which would then indicate a need for public intervention in Estonia.

In addition to some ambiguity of cost division into internal and external, comparison of tax revenues and alcohol costs fails to take into account drinkers' heterogeneity. To overcome this problem, formula (1.6) that was derived in the previous chapter could be used to carry out an exercise in order to obtain an optimal tax rate for Estonia. Nine alternative estimates are obtained to deal with the uncertainty of parameter values. At first, there are middle, low and high estimates. Under the middle estimates it is assumed that abusive drinkers drink 50% of the total alcohol (i.e. parameter in the optimal tax formula takes the value of $\frac{Z^n}{Z^a} \cdot \frac{Q^n}{Q^a} = 1$), and the price responsiveness of abusive drinkers is somewhat lower than moderate drinkers ($\frac{\eta^n}{\eta^a} = \frac{-0.7}{-0.4} = 1.75$). As regards to the first parameter, under low and high estimates abusive drinkers were assumed to drink one third and two thirds of the total alcohol, respectively (i.e. $\frac{Z^n}{Z^a} \cdot \frac{Q^n}{Q^a} = 2$ and $\frac{Z^n}{Z^a} \cdot \frac{Q^n}{Q^a} = 0.5$). Price responsiveness was assumed to lie in the range from –0.4 to –1.0. Specifically, under low estimates $\eta^n = -1.0$ and $\eta^a = -0.4$ while under high estimates elasticities were assumed to be vice versa. In addition, variation in cost estimates is also allowed in order to show results under different assumptions regarding the division of indirect costs into internal and external.

[36] It was suggested that 13.5% of all traffic fatalities are alcohol externalities. As in the current subchapter it was assumed that 42% of traffic accidents are attributed to alcohol, accordingly 32.1% of these are considered as external (i.e. 0.420/0.135 = 0.321).

The results are presented in Table 11. At first, it is seen that the optimal level of alcohol taxation ranges under alternative scenarios from EUR 1.6 to EUR 9.9 per unit of pure alcohol. While the prevailing average tax rate in 2006 was EUR 7.0, it means that it lies in the upper range of optimal levels revealed here[37]. It appears that the division of costs into external and internal becomes extremely important. For example, all three estimates obtained under the assumption that individuals fail to internalize only one third of traffic-related productivity losses, are substantially lower than prevailing rate. Being little bit less conservative in this respect gives considerably higher estimates under all scenarios.

Table 11. Partial equilibrium Pigouvian tax estimates

The share of indirect costs considered as un-internalized	Average external cost per liter of pure alcohol	Pigouvian tax (EUR per liter of pure alcohol)		
		Low	Mid	High
32.1% of traffic costs 0% of other than traffic costs	3.2	1.6	2.3	4.0
50% of traffic costs 25% of other than traffic costs	5.4	2.7	3.9	6.8
75% of traffic costs 50% of other than traffic costs	7.9	4.0	5.7	9.9
Prevailing rate in 2006		7.0		

Source: Author's calculations

Differences between low, mid and high estimates arise mainly due to different sensitivity of the optimal tax towards changes in price elasticities among moderate and abusive drinkers. As long as price elasticities are identical, meaning that $\frac{\eta^n}{\eta^a} = 1$, optimal tax rate would exactly equal to average external costs presented in the left column and the optimal level of taxation can easily be obtained by dividing the total external costs by total consumption. When there is reason to believe that abusive drinkers are not as responsive as moderate drinkers are, the optimal level of average alcohol tax stays lower than the prevailing rate even under non-conservative assumptions regarding the cost division between internal and external. The results of this exercise suggest that the raise in prevailing taxes in 2006 is warranted only under the assumptions that moderate drinkers are less responsive to price than abusive drinkers and more than half of indirect costs are external.

[37] To obtain prevailing average tax rate, alcohol excise revenues (Statistics Estonia, 2010b) were divided by total amount of alcohol (in liters of pure alcohol) purchased in 2006 (Orro et al., 2010).

Final comments

This subchapter has contributed to alcohol taxation research by disclosing the economic cost of alcohol in Estonia. This enables the ability to derive empirical values for several cost parameters required in order to estimate the optimal level of alcohol taxation. A simple exercise was carried out to apply the results to the optimal tax formula derived in a partial equilibrium framework. Somewhat surprisingly, it appeared that in 2006, the prevailing tax on alcohol was rather too high. However, it should be noticed that while this study has followed a conservative approach and gives the lower bound to most of the cost parameters, it has also excluded some important alcohol consequences due to lack of data.

As regards to the optimal tax rates obtained here, a partial equilibrium solution completely ignores fiscal rationale of alcohol taxation as was discussed in the first chapter. As follows, the third chapter develops the model to meet this requirement.

3. OPTIMAL ALCOHOL TAXATION IN GENERAL EQUILIBRIUM FRAMEWORK: SIMULATION RESULTS FOR ESTONIA

From the first two chapters, the following points have arisen. At first, as regards to the Estonian context, while there have been several changes in alcohol taxes during the last years, there is no a single study that would have addressed the issue regarding optimal tax policy in Estonia. Secondly, although international literature has recognized alcohol taxation as one of the most effective policy tools for controlling alcohol-related harm, only a few studies have addressed the optimal alcohol taxation problem and even less can be found in which other than externality rationale has been the concern. As the Estonian government has recently used alcohol taxes for fiscal purposes mainly, the latter is of high importance.

Of these scarce studies, it was shown that the main empirics needed for estimation of optimal alcohol taxes concern external costs of alcohol as well as several elasticities. While the present thesis obtains elasticities from international literature, the second chapter was designed to provide external cost estimates. Specifically, while consisting of two separate empirical studies, mainly two findings deserve special attention. The first study confirmed the presence of alcohol in traffic-related harm as well as its high prevalence in accidents in which pedestrians have been killed. The second study, which presented the social costs estimate for Estonia, revealed that productivity losses due to premature mortality represent the largest share of economic costs of alcohol. While the division of productivity losses into internal and external costs remains somewhat ambiguous, direct costs, which can all be categorized as external, were estimated to arise through the criminal justice system and the health care system as well from traffic-related property damage.

The aim of this chapter is to go further and say something more concrete about taxation policy currently implemented in Estonia, by using the result revealed in previous chapters. To accomplish that goal, following the brief introduction below, a theoretical model is developed, which is parameterized in the following section. More specifically, the chapter is structured as follows: section 3.2 presents the model and derives an optimal alcohol policy formula, while section 3.3 estimates parameter values and simulates the formula. Section 3.4 discusses the results and draws conclusions. Both the theoretical model and simulation results presented in this chapter have been published previously (Saar, 2011) meaning that on a large scale the reasoning and the structure of these two papers are identical. However, compared with the published paper, this thesis applies a somewhat different parameterization strategy and several parameter values have been re-estimated, which produces somewhat different results. In addition, this thesis has used much more space for describing the model as well as discussing the overall results and their policy implications.

3.1. Introduction

This chapter is the first attempt to arrive at empirical estimates for an optimal level of alcohol taxation in Estonia. For this purpose, the Parry et al. (2009) general-equilibrium model is used. As was discussed in the first chapter, the model integrates the principles of externality-correcting Pigouvian taxation and revenue-raising Ramsey taxation. This kind of approach has been widely used in the environmental taxation literature. The essential idea is to use revenues from externality-correcting taxation to reduce pre-existing distortionary taxes. This approach suggests that under certain conditions, the optimal tax rate may differ considerably from the Pigouvian tax on fiscal grounds. In specific regard to alcohol, Parry et al. (2009) used this framework to obtain optimal alcohol policies for the United States. The simplified version of this model was also laid out in the first chapter. This chapter, however, while following closely more sophisticated version presented by Parry et al., also expands the model upon to adjust it for Estonian context.

Compared with analysis conducted by Parry et al. (2009), while specific taxes on individual beverages nor optimal levels of drunk driving penalties are not estimated, there are primarily four extensions. Firstly, alcohol purchases by tourists represent a considerable proportion of total alcohol sales in Estonia. Unlike tax revenues from local taxpayers, which are simply transfers within a society, tax revenues from tourists could be treated as benefits, because they reflect an additional "windfall" contribution to the welfare of the community. These revenues can be used to provide public goods without the locals having to incur any costs. Consequently, it is reasonable to decompose this effect in the optimal tax formula as well. Although – in addition to the alcohol market – tourists could also have a considerable effect on other sectors like food services, accommodation, and transportation, this paper only considers excise tax revenue from alcohol purchases made by tourists.

Secondly, it is assumed that raising tax on alcohol increases resource costs to government. Parry et al. (2009) only considered this kind of cost when a penalty rate is charged. Tax raises may however require even greater increases in administrative costs, since the black market tends to expand as price levels go up on the legal market. Therefore, deriving the optimal tax on alcohol, it is assumed that government can use more resources to deal with the possible expansion of the illegal alcohol market.

Thirdly, the model applied here allows public spending to interact with labor supply[38]. For example, using alcohol tax revenue to increase public medical expenditures may raise the quality of health care services and as a result, labor supply incentives for individuals could go up. For this reason, an efficiency gain under the described scenario may be derived from two sources. First is the

[38] Although this aspect was not raised in subchapter 1.3 as the key point to solve for Estonia, this assumption is expected to provide some interesting insights to the optimal taxation problem.

potential efficiency gain that comes from the public spending itself. This arises when households place more value on public good than on the money used to provide it. Secondly, if the supply of labor increases, deadweight loss in the labor market caused by labor taxes is reduced. This thesis takes into account both of these effects. To consider tax policy involving the adjustment of public spending could also have higher policy relevance, because reduction in labor taxes may be politically unfeasible. In Estonia, for instance, this would mean a change in the overall system of social security funding, since part of the revenue from labor taxes is earmarked for social security expenditures.

The fourth expansion arises from estimates presented in the second chapter of this thesis, where it was indicated that public drinking misdemeanors and criminal offenses against persons account for more than half of the alcohol-related costs borne by the criminal justice system in Estonia. Consequently, in addition to drunk driving also public drinking and offenses against persons are incorporated into the model as externalities. As regards public drinking, this paper considers three different kinds of activity penalized in Estonia. Firstly, the Alcohol Act (Alkoholiseadus) allows drinking alcohol in public only if permitted by the local government, or in places where retail sale for public consumption takes place. Secondly, the same law prohibits being under the influence of alcohol in a public place if this offends human dignity or the sense of morality. Thirdly, the Traffic Act (Liiklusseadus) applies more stringent penalty for the breaking of traffic regulations by pedestrians who are under the influence of alcohol, compared with sober pedestrians. In this paper, the public drinking variable that involves all of these acts is included for two reasons. To begin with, prosecuting public drinking misdemeanors or treating non-fatal traffic injuries caused by pedestrians places a substantial economic burden on the criminal justice system as well as on the health care system. In addition, although health effects caused by pedestrians are usually borne pedestrians themselves, different kinds of spillover effects may arise affecting also other parties. Injured pedestrians may be less productive at workplace, for instance. Although Estonian laws don't prohibit drunken pedestrians being in traffic (Liiklusseadus), this paper assumes that the risk of causing traffic accidents is the main negative externality of public drinking.

3.2. Derivation of optimal policy formula

3.2.1. The model

In this section, a static one-period general-equilibrium model with a representative consumer is laid out. The structure of the model and variable notations closely follow Parry et al. (2009). However – since there are several important extensions, some new variables are included that are more specifically discussed below. The basic assumptions in the model are listed as follows:

- the representative consumer represents an aggregation of all households which means that the behavior of different types of alcohol drinkers are all represented in the behavior of represented consumer[39];
- the representative consumer is rational, meaning that she or he is able to internalize all drinking consequences such as alcohol-related illnesses and injuries, including the future costs of addiction;
- in addition to consumption of alcohol, leisure and other commodities, the agent receives utility also from committing different unlawful acts, and disutility from bearing non-pecuniary penalties and facing health risks;
- there is perfect competition in the production side of the economy which means that firms earn only normal profits and alcohol tax is totally shifted on to consumer, by raising the market price by exactly the amount of the tax;
- the fiscal system is financed only through labor tax, alcohol tax and pecuniary penalties that are used to finance health care system, criminal justice system and government transfers;
- efficiency alone determines the optimality of policy, meaning that this is the only concern of government and no attention is paid to distributional effects of alcohol taxation;
- by maximizing agent's utility, government takes into account only the utility of local agents and ignores citizens of other countries[40].

Based on these assumptions, continuous and quasi-concave utility function, for representative consumer is defined:

$$U = U(A^D, C, l, D, N, P, \tau_D D, \tau_P P, H) \tag{3.1a}$$

$$H = f(A^D, D, N, P, \overline{D}, \overline{N}, \overline{P}, r^M) \tag{3.1b}$$

In utility function (3.1), all variables are expressed as per capita, and a bar denotes variables exogenous to the agent. The agent's utility is an increasing function in all variables except $\tau_D D$, $\tau_P P$ and H. The latter is an increasing function in all its arguments except r^M.

The agent can freely choose the level of legal alcohol consumption A^D, consumption of non-alcoholic goods C, leisure l, drunk driving D, public drinking N and offenses P. Alcohol consumption here denotes drinking pure alcohol contained in any alcoholic beverages. It means that alcohol consumed for some other purposes, such as medicine in health care sector, is not included. In addition, alcohol consumption is assumed to be complementary commodity to all three unlawful acts as well as to leisure. In the context of alcohol taxation

[39] This may seem a highly troubling assumption at first sight, but as was discussed in the first chapter, the heterogeneity of consumers can be at least partly taken into account during the parameterization.

[40] This assumption means that the Estonian government, being the member of the EU, does not care about citizens in other member states.

this means that taxing alcohol does not reduce only drinking but it also curbs the demand for leisure, misdemeanors and crimes. The agent's choice to take a number of drunk driving trips or commit offenses against persons entails expected penalties equal to $\tau_D D$ and $\tau_P P$, respectively. Both, τ_D and τ_P denote non-pecuniary penalties per unlawful act. These penalties can be interpreted as the product of probability of being convicted per act and penalty per act.

Health risks H capture the risk of taking ill, as well as the risk of getting injured, disabled or killed. It is a quasi-concave function of crimes and misdemeanors committed by agents themselves and by others (variables with bar). Health risks are also affected by alcohol drinking directly, by causing internal illnesses. Although it is known that in moderate quantities alcohol consumption could also have positive impact on people's health, here this possibility is ignored. This basically means that when alcohol taxation reduces alcohol consumption, reduction in the prevalence of alcohol-related illnesses occurs as well. Considering one of the world highest drinking level in Estonia this seems reasonable assumption. It should be also noted that in this model there is no need to consider how different alcoholic beverages have different roles in causing negative effects because the aim of the thesis is to evaluate average level of optimal alcohol taxation. In practice, obviously, some beverages probably have more important role and even the alcohol content is not always decisive. Therefore, although finding optimal level of tax rate for each beverage separately is certainly an important issue it stays above the scope of the thesis.

Finally, health risks depends on the level of government expenditure per one medical case, denoted as r^M. The latter is assumed to determine the quality of medical services, which are assumed to be free for individuals. Therefore the higher quality of medical services improves chances for recovery and alleviates health risks[41].

[41] One probably notices that the level of medical expenditure is the only type of public spending that directly (through health risks) affects the utility of representative consumer. As is shown below, the government is assumed to finance spending on safety through the criminal justice system and public transfers. Thus, at first sight it may seem peculiar that consumer's utility is unaffected by these expenditures. However, it should be noticed that public transfers affect consumer's utility through the consumer's budget. As concerns public spending on safety, it is assumed that the level of this spending is held constant. Therefore, even if spending on safety would be included in the utility function, their role for optimal alcohol taxation policy would be null. However, relaxing this constancy assumption would probably produce similar effects as changes in medical expenditures. Specifically, the higher level of spending on safety would probably raise the safety in a country just as if higher medical spending would raise the quality of public medical services. Latter can be interpreted as some type of safety as well – more safe to get injured for instance. However, changes in medical expenditure probably have stronger effect on consumer's behavior (current thesis assumes that medical spending also affects consumer's labor supply decisions through raising the quality of medical services) than changes in spending on safety. For that reason, only the former is an allowed changed by the government. However, to author's knowledge

There are no pure profits in the production side of the economy. Producer prices are fixed and firms pay a gross wage of w that is equal to the value marginal product of labor. The effective labor supply W is the product of labor supply L and w. Changes in H are assumed to affect labor productivity so that $\frac{\partial W}{\partial H} < 0$. In addition, auto insurance companies charge households the lump-sum premium K to cover the costs of auto repair c_D and c_N. The auto repair costs are expressed per one drunk driving trip and per one public drinking incident, respectively. To earn zero profit, companies adjust K so that $K = c_D D + c_N N$.

Maximizing the utility agent faces the following budget and time constraints:

$$(1 - t_L)wL + G^T = (p_A + t_A)A^D + p_C C + t_N N + t_D D + K \quad (3.2)$$

$$T(H) = L + l \quad (3.3)$$

In (2) t_A is tax rate on alcohol, t_L is tax rate on labor, t_D and t_N are pecuniary penalties on drunk driving and public drinking, while p_A is a producer price of alcohol and G^T is government transfer payment. It should be noted that as producer price p_A is assumed to be fixed, this automatically means that alcohol tax t_A is completely shifted on to consumers in terms of higher tax-inclusive market price $p_A + t_A$. This assumption is related to the perfect competition assumption in general, as under this kind of market form long run supply is completely elastic with respect to price (i.e. supply curve is horizontal) and the burden of taxation is borne by consumers[42]. In addition, T in (3.3) is time endowment, divided between labor and leisure, and is a decreasing function in health risks. The latter means that as alcohol-related health risks are higher, the time available to agents shortens due to being disabled or dying prematurely.

As it is see from (3.2), the model does not incorporate value added tax (VAT). This certainly requires some clarification. At first sight it could be said that the inclusion of value added tax is not essentially necessary as by designing optimal level of alcohol taxation the key issue concerns relative prices of alcohol. VAT in Estonia imposes uniform ad valorem rate 20% on most goods, including alcoholic beverages, which means that identical tax wedges are created for most commodities. No distortions arises across most of the commodities and value added tax can be ignored in this respect. However, there is one important issue that must be dealt with. Specifically, since according to the Value Added Tax Act (Käibemaksuseadus) in Estonia the tax base for VAT includes excise tax, it follows that VAT basically taxes excise tax[43]. What it

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there is no reliable evidence on how public spending interacts with labor supply. Therefore, the main idea is just to capture these interactions in this model and the type of spending is not the most important issue here.

[42] This assumption was discussed in the subchapter 1.2.

[43] For example, if the producer price without taxes is 10 EUR and excise tax is 2 EUR, which raises the price to 12 EUR, then VAT according to rate prevailing in Estonia (20%) will be 2.4 EUR. The final price therefore would be 14.4 EUR. VAT for the same

means is that when excise tax increases, the final price increases even more, given the assumption of 100% tax shifting on to prices. Specifically, raising excise rate by 5 EUR per liter of pure alcohol, for instance, alcohol prices in Estonia will rise by 6.0 EUR. This 6.0 EUR is divided between excise tax (5.0 EUR) and VAT (1.0 EUR). Therefore, variable t_A rather reflects the latter than the former. Specifically, t_A consists of excise tax and the proportion of VAT arising from taxing the excise tax. Although in the theoretical model there is no variable reflecting the VAT, it can and is taken into account when policy implications from the empirical simulations are drawn.

The consumer's maximization problem yields the following first-order conditions:

$$\frac{U_A}{\lambda} = p_A + t_A + mpc \cdot H_A\ ,\ \frac{U_D}{\lambda} = t_D + \tau_D + mpc \cdot H_D \qquad (3.4a)$$

$$\frac{U_N}{\lambda} = t_N + mpc \cdot H_N,\ \frac{U_P}{\lambda} = mpc \cdot H_P + \tau_P,\ \frac{l}{\lambda} = (1 - t_L)w$$

$$mpc = -\left[\frac{U_H}{\lambda} + (1 - t_L)(wT_H + W_H)\right] \qquad (3.4b)$$

In (4) it is normalized, so that $-\frac{U_{\tau_P P}}{\lambda} = -\frac{U_{\tau_D D}}{\lambda} = 1$. In addition, λ is marginal utility of income and mpc denotes the marginal private cost of health risks. The latter consists of direct disutility from suffering $\frac{U_H}{\lambda}$, the value of reduced life expectancy $(1 - t_L)wT_H$, and lost wages from lower productivity $(1 - \mathrm{t_L})\mathrm{W_H}$. It is seen from (3.4) that the agent increases alcohol consumption to the point where the marginal benefit received from the last drinking unit is equal to the tax-inclusive alcohol price and marginal private health cost. Similarly, misdemeanors and criminal offenses are committed until expected marginal benefit equals expected government penalties and marginal private health cost. Individuals also equate marginal benefit from leisure with net wage. (3.4a) and (3.4b) practically show that agent is assumed to be rational and possesses perfect information regarding drinking consequences. It means that in addition to tax-inclusive market price she or he pays for alcohol, agent also internalizes expected penalties as well as internal morbidity and mortality costs arising from alcohol consumption, drunk driving, public drinking and offences. As a result these variables do not appear in the optimal tax formula below that includes only external effects borne by agent.

The government faces the following budget constraint:

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commodity without excise taxation would be 2.0 EUR and the final price would be 12.0 EUR. Therefore, additional tax burden arises equal to 20% of excise tax (in this example 0.40 EUR).

$$r^M M + (r^D - t_D)D + (r^N - t_N)N + r^P P + G^T = (t_A - r^A)(A^D + A^F) + t_L W \quad (3.5a)$$

$$M = f(A^D, P, D, N) \quad (3.5b)$$

The right side of the equation (3.5) indicates that government receives revenues from two different sources. The government first gets revenues from alcohol taxation, less administrative cost per liter of pure alcohol. Legal alcohol purchases are divided between consumption by local drinkers A^D and purchases by tourists A^F. The government also collects labor taxes. In addition to transfer payments, total revenue is used for three purposes. First, government finances public medical expenditures $r^M M$, where M is the number of medical cases, i.e. it is the number of medical conditions that an agent has, including only such conditions that government finances treatment of. Medical cases are defined by the function that increases in all its arguments. Secondly, government finances the criminal justice system, which includes costs of proceedings in cases of drunk driving $r^D D$ and public drinking $r^N N$, less pecuniary penalties, as well as proceeding costs in cases involving offenses against persons $r^P P$. It means that all costs in government budget except transfers are expressed as the product of average cost per incident and the number of incidents. In optimizing alcohol policy, externalities borne by foreign agents are ignored, while possible losses or gains to local agents arising from public use of tax revenues derived from alcohol purchases by tourists is taken into account.

In the model described above, increasing the alcohol tax brings several welfare effects. Before the optimal level of alcohol tax is obtained formally, the effects of alcohol taxation are followed intuitively in Figure 11. It is shown that increasing the tax reduces alcohol consumption, which in turn curbs drunk driving, public drinking, and offenses against persons. Accordingly, these effects improve the health of individuals by preventing a number of injuries and fatalities. A decrease in excessive alcohol consumption also has a direct effect on the health of individuals by lessening the incidence of internal illnesses. Negative health effects which would have been caused to other people by drinkers and are prevented due to increased taxes, termed as reduced health externalities in Figure 11, are regarded as the efficiency gain from reduced external costs. It must be also noted that resulting cost savings to the fiscal and auto insurance systems are included into the total efficiency gain, denoted as reduced fiscal and insurance externalities in Figure 11.

A second type of welfare gain arises from reduced preexisting tax distortions in the labor market. Specifically, reduction in drinking is expected to decrease leisure demand and consequently increase labor supply. In addition, preexisting tax distortions in the labor market are also reduced through the fiscal system. This arises due to the assumption that the government keeps its budget balanced by adjusting either labor taxes or public spending. Specifically, an increase in tax revenues from alcohol tax and cost savings to the health care and criminal

justice systems allows reduction of labor taxes, increasing labor supply even more. The arrow running from the labor market to the fiscal system reflects the fact that any change in labor supply affects revenues from labor taxes and also affects the public budget.

Alternatively, if – instead of cutting labor taxes – the improved budget position is used to increase public spending, efficiency gains may arise from such spending. This efficiency gain could be amplified if public spending interacts with labor supply choices by increasing labor supply. There is of course the possibility that these revenues might be used in a wasteful way, in which case efficiency gain would fail to arise from this channel.

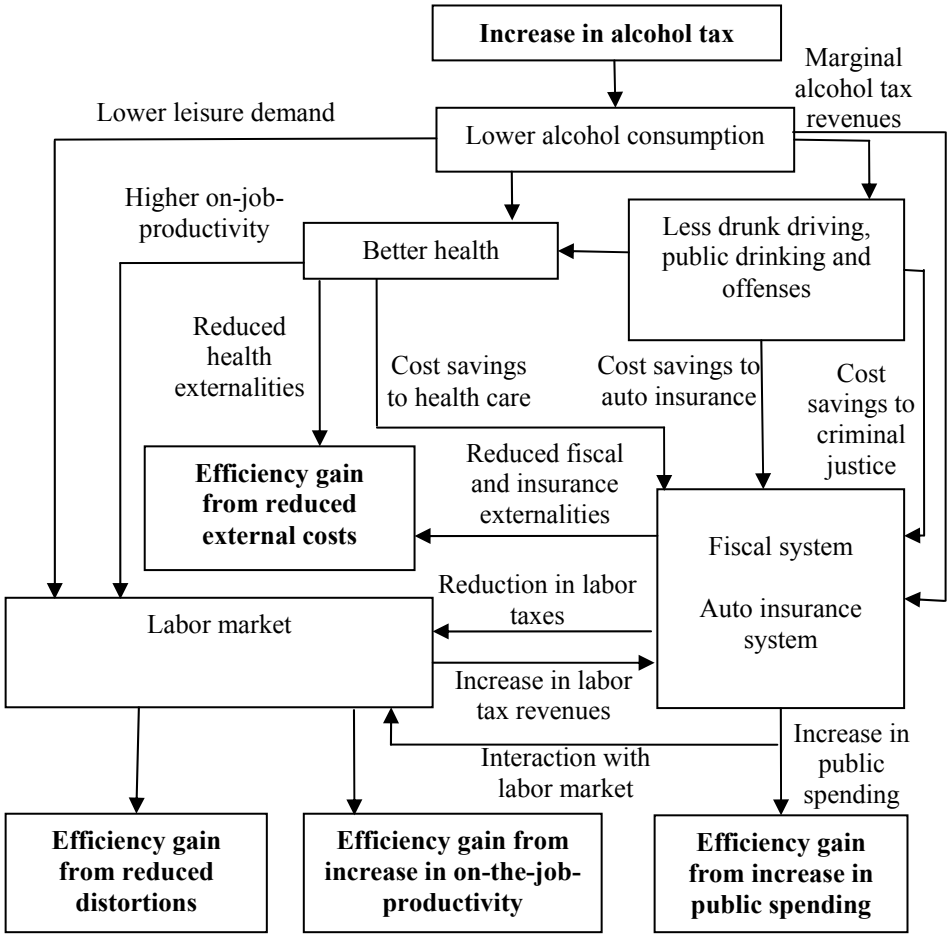

Figure 11. Welfare effects of alcohol taxation
Source: Compiled by the author

Finally, there is an arrow running from "better health" to "labor market". This denotes the fact that people's better health increases their productivity. As a consequence, their wage as well as the time they are available for work increases, resulting in an additional efficiency gain, identified as on-the-job-productivity.

3.2.2. Optimal tax policy

This section derives optimal alcohol policy formulas. Throughout the optimization, it is assumed that government aims to maximize the utility of the agent by finding the optimal level of t_A, given the level of t_D, t_N, τ_D and τ_P. At the same time, the government must keep its budget balanced. To do that, it can change the tax rate on labor t_L or resource cost per medical case r^M. Optimal policy formulas for both alternatives are derived.

Differentiating the indirect utility function with respect to t_A, allowing changes in t_L or r^M to keep the government budget balanced, equating the resulting equation with zero and solving for t_A, gives the following optimal tax formula (see derivation in Appendix 7):

$$t_A^* = PV + RR + FB - TI + PR \tag{3.6a}$$

where

$$PV = g^A + \frac{D\eta_{DA}}{A\eta_{AA}}(c_D + mpc \cdot H_{\bar{D}}) + \frac{N\eta_{NA}}{A\eta_{AA}}(c_N + mpc \cdot H_{\bar{N}}) + \frac{P\eta_{PA}}{A\eta_{AA}} mpc \cdot H_{\bar{P}} + r_{t_A}^A \frac{p_A + t_A}{\eta_{AA}}, \tag{3.6b}$$

$$RR = [(1 + \mu_i\alpha)(\mu_i + MEG_i) - \mu_i]\left[\left(1 - r_{t_A}^A\right)\frac{p_A + t_A}{(-\eta_{AA})} - t_A + g^A\right],$$

$$FB = (1 + \mu_i\alpha)(1 + MEG_i)\left[\left(1 - r_{t_A}^A\right)\frac{A^F}{A^D}\frac{p_A + t_A}{(-\eta_{AA})} - (t_A - r^A)\frac{A^F}{A^D}\frac{\eta_{FA}}{\eta_{AA}}\right],$$

$$TI = (1 + \mu_i\alpha)(1 + MEG_i)\frac{t_L(p_A + t_A)(\eta_{Al}^c + \eta_{LI})}{(1 - t_L)(-\eta_{AA})},$$

$$PR = (1 + \mu_i\alpha)(1 + MEG_i)t_L\left(-W_H H_{A^D}\right), \ (i = t_L, r^M)$$

It is seen from (3.6a) that the optimal tax on alcohol contains five components. PV is the Pigouvian tax that captures the externalities that alcohol abusers impose on others, less marginal resource costs required to administer alcohol taxes. More specifically, there are marginal external costs g^A borne by third parties through the fiscal system. These costs are divided into three different categories. First are costs to the health care system due to alcohol consumption, drunk driving and public drinking, expressed as resource cost per medical case

r^M, multiplied by marginal medical case of alcohol consumption, marginal case of drunk driving or marginal case of public drinking, respectively. Second are costs to the criminal justice system expressed as resource cost per incident of drunk driving r^D, public drinking r^N and offense r^P, less pecuniary penalty. Third are costs that have to be borne by the government in order to collect alcohol tax r^A, expressed per liter of pure alcohol.

The Pigouvian component also includes the marginal private health cost $mpc \cdot H_{\bar{D}}$, $mpc \cdot H_{\bar{P}}$ and $mpc \cdot H_{\bar{N}}$, that individuals must face due to others' drunk driving, others' offenses and others' public drinking, respectively. Property damage due to traffic accidents c_D and c_N are expressed per drunk driving trip and per public drinking incident, respectively. This shows up in the agent's budget in terms of higher insurance premiums, charged by auto insurance companies.

Almost each term in PV is multiplied by either $\frac{D\eta_{DA}}{A\eta_{AA}}$, $\frac{N\eta_{NA}}{A\eta_{AA}}$ or $\frac{P\eta_{PA}}{A\eta_{AA}}$ in order to express them in terms of per unit reduction in alcohol consumption. Only marginal medical cost of alcohol consumption and administrative costs per liter of pure alcohol are expressed simply as $r^M M_A$ and r^A, since both are already in the appropriate form. On the other hand, this kind of representation reflects that the responsiveness of alcohol-related harm with respect to alcohol price is expressed as relative responsiveness compared to responsiveness of alcohol consumption. As was discussed in subchapter 1.3, regardless of the employment of representative agent model, heterogeneity of drinkers can be taken into account. For instance, assuming that only moderate drinkers are responsive to price, meaning that $\eta_{DA} = \eta_{PA} = \eta_{NA} = 0$, corresponding terms in the Pigouvian component turn out to be zero. As a result, the rationale to tax alcohol on externality basis almost disappears because the taxation would only cause deadweight loss without correcting external costs of alcohol.

It should be also noticed that $\eta_{AA} < 0$, otherwise optimal policy formula would not make a sense as the denominator of any fraction cannot have the value zero. This is only natural assumption because when $\eta_{AA} \geq 0$ then intuitively it follows that optimal alcohol tax would be practically infinity since tax revenues could be increased without any limit.

Quantities of drinking, drunk driving and public drinking in optimal tax formula are given as follows:

$$k = k^0 \left(\frac{p_A + t_A}{p_A + t_A^0}\right)^{\eta_{kA}} \tag{3.7}$$

where $k = \{A^D, A^F, P, D, N\}$. It means that constant elasticity with respect to alcohol price is assumed. The superscript zero denotes the initial quantities for k^0 and initial tax rate for t_A^0.

There is one very important issue concerning Pigouvian component in (3.6). It is well known that in partial equilibrium approach this is usually the only rationale to tax alcohol. So, all terms of Pigouvian tax in (3.6), except the last

one, are the components of the classical Pigouvian tax, reflecting marginal external costs of alcohol, and could have been captured also by traditional partial equilibrium model. The last term $r_{t_A}^{A}\frac{p_A+t_A}{\eta_{AA}}$, however, extends the concept of Pigouvian tax in this thesis. It captures the increase in resources required by government for administering the raise in excise rates. The additional administrative burden is expected to arise mainly due to monitoring and hindering activities undertaken by taxpayers to reduce illegally the tax burden. It is easy to see that this term is negative as it is assumed that $\eta_{AA} < 0$. It means that under very high marginal administrative costs of alcohol tax Pigouvian component could also become negative because this last term may exceed rest of the terms in Pigouvian tax.

The second component of optimal tax is the revenue-recycling effect, denoted as RR. It captures changes in both tax revenues and alcohol-related public expenditures, induced by alcohol tax. To be more specific, the first two terms of this component reflect marginal tax revenue, net of marginal administrative costs, and expressed per unit reduction in alcohol consumption (by domestic agents). The third term reflects savings in expenditures by the criminal justice system and health care system. As regards the role of price responsiveness of locals' alcohol consumption: the lower it is, the greater the tax revenue from alcohol taxation as well as overall revenue-recycling effects.

The third component TI is the tax-interaction effect that – together with revenue-recycling effect – forms the fiscal component[44]. It arises from change in the labor supply, induced by raising the alcohol price relative to leisure. It is important to understand here that this change in labor supply due to higher alcohol prices can arise only among drinkers. The strongest effect could be expected to occur among frequent drinkers. While rare drinkers are not strongly affected, abstainers do not buy alcohol at all and are not therefore affected. When alcohol and leisure are complements or weak substitutes for drinkers, the alcohol tax increases the labor supply, and the tax-interaction effect is positive. Under weak substitutability, labor supply increases, because the income effect that is also caused by the rise in alcohol tax more than offsets the substitution effect. Income effect increases labor supply as leisure is assumed to be a normal good, which means that $\eta_{LI} < 0$. Formally, labor supply increases as long as $\eta_{Al}^{c} < 0$ or $0 < \eta_{Al}^{c} < |\eta_{LI}|$. If alcohol and leisure were strong substitutes, raising the alcohol tax would decrease alcohol consumption as well labor supply and labor tax revenue. In this case, the tax interaction component would obviously be negative.

[44] It should be noted that the foreign benefit component, described below, arises purely through fiscal system as well. Therefore it basically provides an additional fiscal rationale to tax alcohol. However, to bring out the role of tourists more clearly, this thesis defines the fiscal component as the sum of revenue-recycling and tax-interaction components.

Fourth is the productivity effect PR, expressed per unit reduction in alcohol consumption. This arises since taxing alcohol reduces drinking overall, to include public drinking, drunk driving and alcohol-related crimes. As a result, consequences of these activities such as internal diseases and external harm inflicted on others are also decreased. This means that individuals have better health and longer life spans. Both have a positive effect on effective labor supply.

Finally, there is the additional component reflecting changes in tax revenues from alcohol purchases by tourists, termed as foreign benefit effect FB. It is expressed per unit change in alcohol consumption by local drinkers, net of administrative costs. Although the foreign benefit effect has characteristics similar to the revenue-recycling effect, since in both cases revenues are recycled either to reduce labor tax or increase public spending, there is one important difference. While marginal tax revenue from drinking by locals does not improve efficiency per se, marginal tax revenue from tourists does. More specifically, the former simply shifts resources within society from households to government, while the latter directly reflects an addition to the community's welfare that is complemented by a possible efficiency gain from the use of these revenues.

Multipliers in front of each component except Pigouvian tax account for efficiency gain achieved either by reducing labor taxes or increasing medical expenditures. It should be noted that μ_i in (3.6) is the dummy variable that integrates tax policies with labor tax and public spending adjustments into one equation. For this purpose, $\mu_{r^M} = 1$ and $\mu_{t_L} = 0$. In case of $i = t_L$ the multiplier in front of the revenue-recycling component simplifies to MEG_{t_L}. The multipliers of the following components simplify to $1 + MEG_{t_L}$.MEG_{t_L} is marginal efficiency gain from reducing labor tax, defined as the marginal deadweight loss of labor tax per marginal tax revenue (defined formally in Appendix 7). Deadweight loss is expressed as the product of the wedge between the gross wage and net wage t_L and reduction in labor supply $\frac{\partial L}{\partial t_L}$. Therefore: when alcohol policy enables a reduction of labor tax, efficiency gain can be achieved in terms of reduced deadweight loss.

In the case of $i = r^M$, tax policy with a public spending adjustment is implemented, meaning that marginal tax revenue and savings in alcohol-related public expenditures are used to increase r^M. As a result, the revenue-recycling effect comprises the multiplier $\left[(1+\alpha)\left(1+MEG_{r^M}\right)-1\right]$, and tax-interaction, productivity and foreign benefit components comprise $(1+\alpha)\left(1+MEG_{r^M}\right)$. MEG_{r^M} is the marginal efficiency gain from marginal medical expenditures, and α is the multiplier effect of government medical expenditures (both defined formally in Appendix 7). The former reflects the value of one additional euro to the agent, spent on medical services, per medical case, minus one euro. This effect arises from changes in the labor supply caused by change in medical expenditures. As regards the latter, the numerator of the first term in

α expresses increase in government medical expenditure due to marginal increase in r^M. This is obtained by differentiating $r^M M$ with respect to r^M. The same term is included into the denominator, except that an additional term, denoted by $wt_L \frac{\partial L}{\partial r^M}$ is added. The latter, while reflecting marginal labor tax revenue, arises from change in labor supply as labor supply decisions are affected by changes in the level of r^M. Therefore, α basically indicates that raising r^M by one euro requires resources of less than one euro. The reason is that this kind of spending policy returns part of the resources through an increase in labor tax revenue after it has increased labor supply. It should be also noted that as it is reasonable to assume that $M > wt_L \frac{\partial L}{\partial r^M} > 0$, it is also obtained that $0 < \alpha < 1$.

Following the optimal policy formula derived above guarantees that the utility of representative agent is maximized. However, another related question concerns changes in overall welfare if current tax were adjusted to attain optimal level. The formula for overall welfare gain was obtained by combining optimal tax formula and marginal welfare effects of alcohol tax, and integrating over the entire tax increase (see Appendix 7):

$$\Delta W = (1 + \mu_i \alpha)(1 + MEG_i) \int_{v=t_A^0}^{t_A} A \frac{\eta_{AA}}{p_A + v} (v - t_A^*) dt_A \qquad (3.8)$$

In (3.8) it is seen that welfare gain consists of the difference between optimal and prevailing tax rate, multiplied by tax induced change in alcohol.

3.3. Empirical simulation

3.3.1. Parameterization of the model

Baseline principles and procedures

In this section, parameter values and their derivation is described. All values were estimated for 2009 if not stated otherwise. At first, the most plausible numerical values were assigned to all parameters in order to obtain mid-range estimates for optimal tax. Acknowledging uncertainty in several parameter values both extreme case and variable-by-variable sensitivity analysis was carried out. In case of variable-by-variable sensitivity analysis, the effect of change in a certain parameter was separately examined. This concerns variables such as price elasticity of alcohol demand, marginal administrative cost of alcohol tax, efficiency gain from public spending and a parameter reflecting interaction between public spending and the labor market. Although difficult to quantify, all these parameters are of special interest in this thesis. While estimates obtained under the most plausible parameter values were labeled as the mid estimates, in the extreme case sensitivity analysis also low and high values were applied to obtain a lower and upper bound on optimal policy. Low parameter values are interpreted here as parameter values that – compared with

the mid value – decrease optimal tax. In contrast, computations based on high values reflect the upper limit of tax rates. To find upper and lower limit, a ±30% variation is allowed for the majority of variables, so that parameters values under mid-range estimates were multiplied by 1.3 and 0.7, respectively (precise values under all three scenarios can be found in Appendices 4 and 5).

As regards to all price elasticities other than the elasticity of tourists' demand (see Appendix 6), a somewhat different logic was followed. Specifically, while the range was chosen based on evidence in the literature, high price responsiveness was assumed in order to obtain low estimates for optimal policy and vice versa, regardless of their influence on optimal level of taxation. Although higher price responsiveness of violence, for instance, contrary to higher alcohol demand elasticity suggests higher tax on alcohol, it is reasonable to assume that under high alcohol demand responsiveness, the same applies to crime and misdemeanors as well. Therefore, under low optimal tax estimates elasticities are assumed to be at the upper bound. In case of tourists, however, under the low estimates scenario low elasticity and under high estimates scenario high elasticity was applied. This is reasonable as due to a high level of optimal taxation obtained under high parameter values, tourists are obviously more responsive to prices compared with optimal policy obtained under low parameter values.

In addition to the mid, low and high estimates, one additional scenario was applied, labeled as the black market, border trade and home production scenario or the BH scenario. Specifically, although allowing administrative costs per liter of pure alcohol to increase, improves the ability of the government to deal with the potential expansion of the illegal alcohol market, in practice the latter cannot be eradicated completely. Secondly, just like Finns purchasing alcohol in Estonia, Estonians may buy more alcohol abroad. This applies especially to people living in the northeastern and southern region, bordered by Russia and Latvia, respectively. And thirdly, there is a great chance that the tax increase induces people to produce alcohol beverages in their own households. For example, according to Hein et al. (2010), 6–12% of drinkers in Estonia produce alcoholic beverages such as wine and beer at home. All these potential occurrences pose a question of whether and how the results would change under these circumstances.

In principle, a few adjustments must be made for the BH scenario compared with parameter values applied to the mid scenario. First, as there would be a good substitute commodity available in terms of tax-free illegal alcohol, cheaper foreign alcohol or own-produced alcohol, price elasticity of legal alcohol demand on the part of locals would be higher. Second, under this kind of substitution, there would be no decrease in total alcohol consumption as we observe in the local legal alcohol market. Therefore, the government could find it difficult to achieve savings in respect to alcohol-related costs (denoted by g^A in optimal tax formula) because misdemeanors, felonies and health effects would now partially be caused by consumption of alcohol acquired from other sources. The same applies to the on-the-job-productivity, cost savings in the auto insurance system

and external private health costs included in Pigouvian component. Therefore, under the BH scenario lower values for corresponding parameters should be applied. Third, if reduction in total alcohol consumption were hindered, it would probably have the same effect on labor supply incentives. This means that the tax-interaction effect would be smaller. This can be captured by employing lower value for alcohol/leisure cross-price elasticity η_{Al}^{c}.

All these adjustment are made in order to obtain estimates for optimal level of alcohol taxation under the BH scenario. Specifically, regardless of great reduction in alcohol consumption it is designed to indicate that approximately half of reduced consumption comes back in terms of illegal, imported or home-produced alcohol (for specific parameter values see Appendices 4, 5 and 6). It should be noticed that the low estimate accounts for these possibilities as well – compared with the mid scenario, the low scenario applies higher alcohol demand elasticities of locals, 30% lower values for cost parameters and marginal effects of alcohol consumption, and assumes that alcohol and leisure are substitutes. The main difference, however, compared with the BH scenario concerns lower tourists' alcohol elasticity and non-zero marginal administrative cost of alcohol tax[45]. Therefore, while the low estimates simply give the lower boundary for optimal taxation level, which could arise also from illegal and border trade or from home production, the BH scenario is specifically designed to illustrate the sensitivity of optimal taxation level to considerable expansion in these activities.

All the calculations were carried out in a computer spreadsheet program. As it appears in (3.6), the optimal tax formula is an implicit equation, which means that the optimal tax rate is affected by its own value. In other words, alcohol tax is also in the right hand of the optimal tax formula. Therefore, it was not possible to solve the model by just inserting estimated parameter values into the formula. In general, the estimation procedures consisted of three steps. At first, the formula (3.6) was inserted in the spreadsheet. Secondly, parameter values, including a randomly chosen value for alcohol tax, were inserted into the respective cells. In order to obtain the desired value for alcohol tax, the randomly chosen parameter value of alcohol tax was changed until its value was equal to the value of the right hand side of the optimal tax formula. As follows, the derivation method and sources of each parameter value is described.

The alcohol market and labor tax

The current tax rate $t_A = 9.4$ EUR was estimated by dividing revenue from the alcohol tax (Statistics Estonia, 2010a) by the quantity of alcohol sales (measured in liters of pure alcohol). Producer price of alcohol $p_A = 24.5$ EUR is the tax-exclusive market price per one liter of pure alcohol. The tax-inclusive market price is the weighted average price of beer, wine and spirit, the weights being the quantities of different alcoholic beverages sold in liters of

[45] Specifically, the BH scenario assumes that government does not employ additional resources to deal with the illegal trade, i.e. $r_{t_A}^{A} = 0$.

corresponding beverage[46]. Initial alcohol consumption $A^D = 9.6$ measures total consumption of pure alcohol (excluding illegal alcohol) expressed in liters of pure alcohol per Estonian. Data pertaining to the alcohol market were obtained from the Estonian Institute of Economic Research (Orro et al., 2010) which compiles regular alcohol market overviews in Estonia.

In 2008, the implicit tax rate on labor was 33.7% in Estonia (Eurostat 2010a). During the recession in 2009, when real GDP decreased by more than one tenth, the government carried out some policy changes concerning income tax and employment insurance tax to achieve its fiscal goals. As a result, the tax rate on labor was probably somewhat higher than in the preceding year. Therefore, in this paper $t_L = 0.35$ is applied. This is still highly conservative, as VAT, which can also be considered a tax on labor[47], is not taken into account in order to follow conservative strategy. Therefore, the efficiency gain obtained from reducing labor tax is rather underestimated than overestimated.

Tourism sector

During the last decade, the Estonian Institute of Economic Research has regularly estimated quantities of alcohol bought or consumed by tourists in Estonia, using mainly methods such as observations of alcohol shops and questioning managers of these shops. Accordingly, it has been estimated that tourists have bought 4.4 million liters of pure alcohol in 2009, of which 3.52 liters was exported and 0.85 liters were consumed in Estonia (Orro et al., 2010). This value was also given to parameter that reflects tourists alcohol purchases in Estonia – $A^F = 4.4$. This represents approximately one fourth of total sales in Estonian alcohol markets. As regards to price elasticity of alcohol demand by tourists, the range from –0.4 to –1.0 was applied. However, in sensitivity analysis the range from –0.4 to –2 was examined.

There is considerable degree of uncertainty in regard with to the price responsiveness of tourists. In fact, there is no single empirical estimation conducted in order to provide some empirical basis. Therefore, some reasoning follows in regard with the choice of relatively low elasticity under alternative estimates. At first, it must be noted that in 2009 there were more than 4 million border crossings in Estonia performed by foreigners, of whom almost 60% were Finnish. This means

[46] Compared with the published paper where $p_A = 7.8$ was assumed (Saar, 2011), the resulting value of producer price here is more than three times higher. This difference arises from different estimation methods. Specifically, in order to obtain the value of producer price in the published paper, the retail turnover of the alcohol market was divided by the total quantity of pure alcohol sold in Estonia, from which $t_A = 9.4$ was subtracted. The level of turnover, however, was most likely underestimated by Statistics Estonia. Therefore, this thesis uses an alternative strategy. As a result, the optimal taxation level is considerably higher when compared to the results presented in the preceding paper. However, this difference in price levels only affects the optimal level of taxation but does not change the overall patterns of the results.

[47] Similarly, to labor tax, VAT reduces the price of leisure relative to other commodities since it reduces the real wage.

that Finnish responsiveness towards alcohol prices is the most relevant to understand. Other active visitors were Latvians, Lithuanians, Swedes and Russians, representing approximately 30% of the border crossings. Visitors from the Baltic States and from Russia, however, are not relevant as in these countries alcohol prices are even lower than in Estonia. In Finland, on the other hand, prices of alcoholic beverages are more than two times higher than in Estonia (see Figure 12).

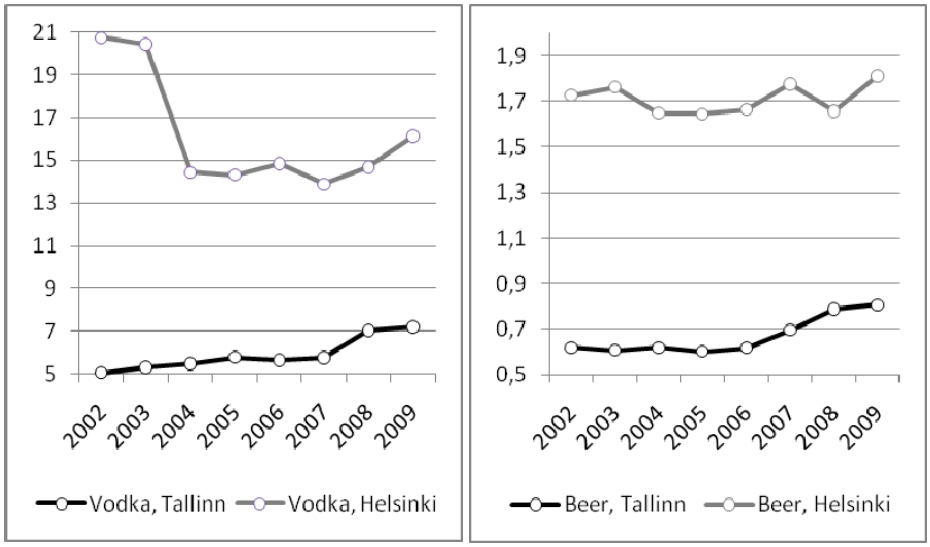

Figure 12. Prices of alcoholic beverages in Tallinn and Helsinki
Source: Orro et al. (2010), compiled by the author

In addition, since Estonia's accession to the EU in 2004, people in northern countries face an opportunity to bring relatively large quantities of alcoholic beverages to their home country without paying additional excise taxes. Due to great differences in price levels, this new opportunity is rather attractive. This is also supported by empirics. Specifically, although in 2004 the Finnish government reduced tax rates on alcohol approximately by one third, tourists' alcohol purchases in Estonia grew considerably. According to estimates by the Estonian Institute of Economic Research (Orro et al., 2010), compared with 2003, quantities of alcohol exported by tourists increased by two times from 1.9 to 4.0 million liters of pure alcohol. In subsequent years this figure has somewhat decreased, being at minimum level in 2008 when 3.1 million liters were sold to tourists. There may be several reasons for this trend including the rise in general price level in Estonia due to the economic boom experienced in these years, but also more expensive transport can play some role due to the rise in the price of ferry tickets.

Although in 2008 and 2010 alcohol taxes were raised in Estonia, similar policy changes were carried out in Finland in 2008 and 2009 (Hämäläinen et al., 2010). As a result, regardless of tax changes in both countries during the last five years, price

differences have not decreased as is shown in Figure 12. In fact, alcohol export by tourists increased in 2009 compared with the preceding year by more than one tenth. Therefore, it is reasonable to assume that unless alcohol prices rise considerably more than 50%, in which case the price difference would decrease to less than 50%, tourists' price responsiveness remains low. However, the critical level of this difference is unknown. It is also important to notice that price difference depends not only on policy implemented in Estonia. Even if the Estonian government would increase taxes appreciably, as long as the price difference remains large due to tax policy carried out by the Finnish government, tourists probably find their way to Estonia. Surely, there are many other factors, such as transportation issues, that may affect tourists' intentions as well, these considerations, however, stay beyond the scope of this thesis. Even then, future research should definitely pay more attention to revealing clearly tourists' behavior in order to provide more arguments concerning fiscal revenues from alcohol purchases as well as from other spending made by tourists.

Misdemeanors and serious crimes

Data about registered misdemeanors were drawn from the Estonian Police and Border Guard Board (2010), and data about registered crimes were drawn from the Ministry of Justice of Estonia (2010) through personal communication. Deriving empirical estimates about the total number of alcohol-related misdemeanors, it was assumed that 5% of all misdemeanors are registered. In the case of crime, a detection rate of 90% was applied. This means that $D = 191{,}520$ and that $N = 306{,}460$ was obtained by multiplying the registered number of drunk driving and public drinking incidents by 20, and $P = 1{,}856$ was obtained by multiplying the registered number of crimes by 1.11.

It was estimated that $t_D = 28.8$ EUR and $t_N = 9.6$ EUR. Both represent half of the maximum penalty rate that can be charged in Estonia on the basis of the Traffic Act (Liiklusseadus) and Alcohol Act (Alkoholiseadus), adjusted to reflect penalty per committed act. To be more specific, t_D is the penalty rate per drunk driving trip and t_N is the penalty rate per public drinking incident.

Cost parameters regarding auto repair due to drunk driving $c_D = 47.1$ EUR and public drinking $c_N = 23.6$ EUR were estimated based on data from Statistics Estonia (2011b). More specifically, alcohol-related motor third party liability insurance gross claims, attributed equally to drunk drivers and public drinkers, were divided by the number of drunk driving trips and public drinking incidents, respectively. Association with alcohol was created through an alcohol attributed fraction that is equal to 0.42, the same that was used in chapter 2 for social cost estimates.

Marginal effects

Appendix 4 comprises values for parameters that reflect marginal effects of drinking, drunk driving, public drinking and offenses. To obtain figures for marginal medical cases, medical cases attributed to alcohol were first found, using the total number of medical cases registered by the Estonian Health

Insurance Fund (2010) and attributable fractions in Appendices 1 and 2. Secondly, alcohol-related medical cases were divided into four categories – traffic injuries caused by drunk drivers, traffic injuries caused by pedestrians, injuries related to offenses, and by diseases. In the case of traffic accidents, it was assumed that three fourth of alcohol-related traffic injuries were caused by drunk drivers and one fourth by pedestrians. Medical cases in the fourth category were considered to be the consequence of drinking of alcohol. The third step was to subtract the number of medical cases that will be canceled out due to premature mortality. Data obtained from Estonian Health Insurance Fund (2011) showed that in 2009 there were 2.6 medical cases per inhabitant in Estonia. Therefore, each death practically reduces the burden to health care sector by saving costs of treating these 2.6 medical cases. It means that the final number of medical cases in each category is expected to reflect the number of medical cases attributed to alcohol, net of medical cases prevented by alcohol. The fourth step was to divide the number of alcohol related medical cases in each category by the total number of respective alcohol-related acts. For example, in case of M_A the number of medical cases in the fourth category was divided by the amount of alcohol consumed by Estonians in 2009, including alcohol bought from the black market (0.6 liters of pure alcohol per capita). Therefore, the estimated value for $M_A = 0.0066$ applies to both legal and illegal alcohol, as it is assumed that there is no difference between legal and illegal alcohol regarding the generation of externalities. To estimate M_D, M_N, M_P, the number of alcohol-related medical cases of drunk driving, public drinking and offenses were divided by the total number of drunk driving trips, incidents of public drinking, and offenses, respectively.

In essence, this kind of derivation method to derive marginal medical cases means that marginal and average values are assumed to be equal. However: it is reasonable to assume in practice that as alcohol consumption, drunk driving or the number of crimes committed increase, marginal alcohol-related externality also increases. In such a case, this assumption underestimates marginal effects and yields conservative estimates for Pigouvian as well revenue-recycling components.

There is another block of parameters in Appendix 4 comprising marginal on-the-job-productivity costs and marginal private costs, both borne by individuals through marginal health risks. Based on 2006 data, in chapter 2 productivity costs due to the lower state of health of alcohol abusers were estimated to be EUR 13.52 million, and productivity costs due to disability costs that arise from both permanent and temporary disability attributed to alcohol to be EUR 32.91 million. Accordingly, total workplace productivity cost is estimated as EUR 46.43 million and productivity costs per liter of pure alcohol $W_H H_A = 3.61$ EUR.

As defined hereinbefore, marginal private costs mpc that enter the Pigouvian component comprise direct disutility from suffering, the value of reduced life-expectancy and lost wages from lower productivity. All three components must be estimated in order to obtain $mpc \cdot H_{\bar{D}}$, $mpc \cdot H_{\bar{N}}$ and $mpc \cdot H_{\bar{P}}$, and separately for all three parameters. Starting with the latter component, it was estimated in chapter 2 that offenses against persons and traffic accidents

account for 4.6% and 7.4% of disability costs[48], respectively. According to these proportions, total workplace productivity costs due to the agent's drunk driving is estimated to be EUR 2.44 million and EUR 1.51 million due to offenses. In case of the latter, all costs were considered as external. In case of the former, however, applying the same proportions as was derived for traffic fatalities in the chapter 2, it was assumed that three fourth of traffic-related external health costs attributed to alcohol have been caused by motor-vehicle drivers of which 43% are assumed to be external[49]. Although one fourth of traffic-related health costs were assumed to be caused by pedestrians, all of them were considered as internal (meaning that $W_H H_{\bar{N}} = 0$). Dividing total productivity costs by the number of drunk driving trips and offenses committed, values for $W_H H_{\bar{D}}$ and $W_H H_{\bar{P}}$, respectively, were obtained.

While disutility from suffering was excluded, the monetary value of reduced life expectancy was obtained from Saar (2009). He has estimated that productivity losses due to alcohol-related premature mortality ranged from EUR 142 million to EUR 247 million in 2006. Dividing the lower value by alcohol-related deaths in the same year produces a figure of EUR 0.56 million. This was chosen to reflect the value of life. To find the reduced value of life expectancy due to offenses, the value of lost life was multiplied by the number of alcohol-related homicides, and the resulting value was divided by the total number of alcohol-related assaults. Finally, to obtain $mpc \cdot H_{\bar{P}} = 1\,872$ EUR, the sum of monetary values of reduced life expectancy and lost wages per alcohol-related assault was multiplied by $(1 - t_L)$.

$mpc \cdot H_{\bar{D}}$ was derived analogously, with the caveat that just as in case of on-job-productivity only 43% of fatalities were considered as externalities. This means that 57% of alcohol-related traffic accidents caused by drivers were assumed to have been caused by the victims themselves. For example, a drunk driver may have driven off the road or crashed into a tree. It is assumed that all accidents caused by pedestrians only pedestrians themselves are injured or killed, so that $mpc \cdot H_{\bar{N}} = 0$.

Government resource costs

Appendix 5 is comprised of variables indicating resource costs to government. As regards to costs to the criminal justice and health care systems, estimates were derived analogously to estimates presented in chapter two, applying the same alcohol-attributable fractions by updating the results for 2009. Only those costs, which were needed for optimal policy formula application, have been updated. Total costs attributed to alcohol by different categories are presented in

[48] These proportions are derived based on temporary disability costs but are applied also to permanent disability costs here. No data was available about permanent disability by type of external causes.

[49] The value of 43% is obtained by combining the following figures: 32.1% of fatalities attributed to alcohol are external (see note 34), three fourth of alcohol-related deaths caused by drivers (i.e. 0.32/0.75 = 0.43).

Table 12. In order to obtain values for parameters in Appendix 5, total costs were divided by the total number of respective cases. In the case of the criminal justice system, costs to the Police and Border Guard Board, the Courts of the first and second instance and the Prosecutor's Office and Prisons were included. In short, operating costs per alcohol-related activity (expressed as initiated proceedings or registered crime etc.) engaged in by these institutions was computed in order to estimate resource costs attributed to alcohol. It was also assumed that in Police and Border Guard Board proceedings, one misdemeanor requires 20% more resources than processing a criminal offense.

To obtain court costs, initiated proceedings were weighted by the duration of different types of proceedings to differentiate between misdemeanors and criminal offenses. Otherwise, it was assumed that all activities entail proportionally equal costs within an institution. The data for the year 2009 was obtained from the Ministry of Justice of Estonia (2010) and from the Estonian Police and Border Guard Board (2010). Average cost to the health care system per medical case was estimated based on data about total costs by different alcohol-related diseases. Data was obtained from the Estonian Health Insurance Fund (2010) through personal communication.

Table 12. Alcohol-related fiscal costs updated for 2009

Drinking consequences	Costs (mln EUR)
Health care system	
Offence injuries	0.41
Transport injuries	0.69
Other diseases	10.10
Criminal justice system	
Proceeded offences against persons	7.71
Proceeded drunk driving incidences	4.91
Proceeded public drinking incidences	5.90

Source: Author's calculations

Resource costs for the Tax and Customs Board in respect to alcohol taxation were found by taking the share of total operating costs of the Tax Board proportional to the ratio of alcohol tax revenues to total tax revenue, and dividing this by alcohol sales in liters of pure alcohol. In the last row, marginal costs due to the increase in tax rate are presented. Although administrative costs of alcohol taxation were estimated to represent only 0.9% of alcohol tax revenue, a marginal cost figure ten times higher $r_{t_A}^{A} = 0.1$ was applied as the mid estimate. This means that by increasing the tax rate by one euro, the Tax Board increases its expenditures by 10 cents per each liter of pure alcohol sold on the market. This highly conservative value was applied to take into account the possible expansion of the black market, because as the tax rate goes up, the more resources the government may require for monitoring.

Elasticities

Elasticities used to derive the optimal tax level are presented in Appendix 6. Although there are no studies conducted in Estonia in order to estimate alcohol demand elasticities, there are rather convincing evidence from international literature implying that alcohol consumption elasticity with respect to alcohol price lies between –0.4 and –1.0 (see chapter 1). This range was also chosen for the present study, and was applied to drinking by locals as well as to alcohol purchases by tourists. Only for black market and border trade scenario demand elasticities of both tourists and local drinkers was assumed to be –1.5. Based on evidence in literature[50] there is no reason to believe that price responsiveness would vary considerably across nations. Obviously, cultural, social and economical factors affect people's responsiveness to price but it is assumed here that this variance stays within the chosen range. For tourists the main issue concerns the difference between prices in Estonia and their home country. This point will be paid special attention in sensitivity analysis as well as in the discussion section.

There is empirical evidence that the quantity of criminal offenses or misdemeanors committed is responsive to higher alcohol price (Elder et al. 2010, Wagenaar et al., 2010). In this paper, the elasticity of both misdemeanors and criminal offenses is suggested to lie within the same range as alcohol consumption. Elasticity of drinking with respect to price of leisure was drawn from West and Parry (2009) who indicated an interval from –0.12 to 0.08. In this study, the interval is widened somewhat and $\eta^{c}_{Al} = -0.1$ is used as the mid estimate.

There is a vast body of literature estimating labor supply elasticity. The majority of these reports have found it to be inelastic (Evers, et al. 2008). Recently, Staehr (2008) applied Estonian data to estimate labor participation elasticity and arrives at 0.6. In addition, Staehr's (2008) estimates did not reveal any significant effect of after-tax wage on working hours of individuals already working. As stated by Evers et al. (2008) it has been a typical finding in the literature that participating elasticity is higher than elasticity of hours worked. Considering this evidence, the present study applies 0.2 to get conservative estimates for optimal alcohol tax. The latter gives an outcome of $MEG_{t_L} = 0.12$. There is no scientific evidence that would help to estimate α and MEG_{r^M}. 0.1 was suggested as the mid estimate. However, a wider range is examined under sensitivity analysis.

The value of income elasticity of labor supply $\eta_{LI} = -0.1$ is applied for three grounds. At first, leisure is assumed as a normal good meaning that elasticity coefficient must be negative. Secondly, while it is a quite frequent result in literature that labor supply is inelastic with respect to wage rate, there is much more ambiguity as to whether this is due to low or high substitution and income effects[51] (e.g. see Kimball and Shapiro, 2008). In order to take a neutral

[50] See subchapter 1.1.3.

[51] Specifically, with an inelastic labor supply, substitution and income effects must completely or almost, cancel each other out. Therefore, they can both be very low or even zero, but also very high.

view, it is reasonable to assume $\eta_{LI} = -0.1$ which means that the income effect is assumed to be neither zero or very large. It should be noticed that in regard with optimal taxation, this is a conservative choice because the larger the absolute value of this elasticity becomes, the higher will be the optimal level of taxation due to a greater increase in the labor supply induced by the increase in alcohol tax. Third reason to apply this value stems from the fact that the income elasticity of the labor supply in this study must reflect labor supply responses of drinkers among whom the proportion of women is probably lower than among the entire population. This, however, makes a difference due to the well-known results from literature that compared with males, the labor supply of females is more elastic (Evers, 2008; Kimmel and Kniesner, 1998; Rizzo and Blumenthal, 1994; Renaud and Siegers, 1984). Relatively high elasticity of women has been confirmed with Estonian data as well (Alloja, 2005; Siliverstovs and Koulikov, 2002). Therefore, the application of a rather low value of income elasticity in this model is justified. Finally, one should notice that although the value of this elasticity is held constant under all alternative scenarios, η_{Al}^{c} is varied which has the same effect as varying η_{LI}[52].

3.3.2. Simulation results

Optimal tax policy

Table 13 presents simulation results. As shown, the mid estimate suggests that the optimal tax rate per liter of pure alcohol is EUR 27.9 with a labor tax adjustment and EUR 35.2 with the public spending adjustment. Both patently exceed the current tax rate. However, the optimal policy is rather sensitive to changes in parameter values. Low estimates represent more than 150% and high estimates more than 700% of the current tax rate. Nevertheless, even under border trade, black market and home production scenario optimal level is more than 50% higher than actual rate.

It may be surprising to find that the Pigouvian component is negative under all estimates. The reason is that under all scenarios, a relatively low elasticity of alcohol demand was applied that considerably increased the marginal administrative cost, with the latter expressed per unit of decreased consumption of alcohol. In other words, at the same time that the amount of traffic in alcohol monitored by the Tax and Customs Board, doesn't change appreciably, administrative costs per liter of pure alcohol increase. The consequence is that the marginal increase in administrative costs exceeds marginal external costs, producing a negative Pigouvian effect. Examining the structure of the Pigouvian component, it appears that regardless of the scenario, more than half of it is attributable to property damage due to traffic accidents and external costs borne by the fiscal system.

[52] This can be easily traced from tax-interaction component of the optimal tax in (3.6b).

Table 13. Optimal alcohol tax in 2009 (EUR per liter of pure alcohol)

Components of optimal alcohol tax	With labor tax adjustment				With public spending adjustment			
	BH	Low	Mid	High	BH	Low	Mid	High
PV	2.5	–1.2	–2.6	–11.3	2.7	–1.8	–3.7	–16.9
RR	1.5	2.6	5.0	14.3	2.2	4.4	9.1	30.7
TI	1.6	0.0	9.0	32.9	3.9	0.0	11.1	46.5
PR	0.7	1.0	1.4	1.8	0.8	1.1	1.5	2.0
FB	8.2	12.2	15.1	10.5	10.4	14.9	17.1	8.4
Total	14.6	14.5	27.9	48.2	20.0	18.5	35.2	70.7
Actual in 2009	9.36							
Actual in 2010	9.73							

Source: Author's calculations

It is easy to see that the great variability in the optimal tax under the alternative scenarios is mostly caused by the high level of sensitivity of fiscal and foreign components. The variability is caused mainly by differences in price elasticities of alcohol demand on the part of locals (from –0.4 to –1) applied to derive low, mid and high estimates. This causes tax revenues from alcohol purchases by locals to vary, also causing variation in the revenue-recycling component. It should be noted here that alcohol-related cost savings represent only 2% to 10% of the revenue-recycling component under alternative scenarios, while the remaining part is formed by alcohol tax revenues.

As regards to the tax-interaction component, it disappears completely under the low estimate. The reason for this is that under the given parameter values, the substitution effect between alcohol and leisure that decreases the labor supply is offset by the income effect from the higher alcohol price that, to the contrary, increases labor supply. Under high estimates, the tax-interaction effect is inflated, so that it alone represents more than half of the total optimal tax rate, and together with the revenue-recycling effect, they represent more than 75% of it. Tax revenues from alcohol purchases by tourists captured by the foreign benefit component play an important role under all three scenarios. Although variation in the price responsiveness of the locals and in the overall level of the tax rate causes the level of foreign benefit component to vary as well, it is rather stable ranging from EUR 8.2 to EUR 17.1 under low, mid and high estimates. This stability arises from applying high demand elasticity of tourists under high estimates and low elasticity under low estimates.

Whether an improved budget position is used to reduce labor tax or to increase public spending makes a substantial difference only for high estimates (see Table 13). As the only difference between these two policies concerns marginal efficiency gain parameters, this result was expected. In this paper, marginal efficiency gain was suggested to be higher with labor supply adjustment (0.12), and a marginal efficiency gain from public spending (0.1) was assumed amplified by interactions with labor supply. As a result, a higher optimal tax was obtained under this policy. This multiplier effect was especially

large under high parameter values, resulting in an optimal tax approximately 50% higher than would have been the case under labor tax adjustments (EUR 48.2 and EUR 70.7, respectively).

Effects of optimal tax policy

Following tax policy proposals presented above, the welfare of people is expected to improve. Although this improvement can be expressed in monetary terms, which have been quantified below, there are many other related effects. As follows, these effects, which arise from moving current tax to its socially optimal level, are more closely examined. More specifically, five different tax rates were chosen to cover the whole range presented in Table 14. There is no rationale to differentiate here between labor tax and public spending adjustments as this make a difference only as regards the welfare gain.

Table 14. Non-monetary effects from changes in alcohol tax

	Raising to EUR 14.6 (BH)	Raising to EUR 14.5 (low)	Raising to EUR 27.9 (mid)	Raising to EUR 35.2 (mid)	Raising to EUR 70.7 (high)
Alcohol cons.					
Locals (th.)	–2,473.6	–1,679.4	–3,376.3	–4,203.1	–4,349.8
Tourists (th.)	–414.8	–237.9	–1,146.6	–1,427.4	–2,810.0
Cr. and misd.					
Pub. dr. (th.)	–36.3	–49.9	–100.4	–125.0	–129.3
Off. ag. per.	–176	–242	–487	–606	–628
Dr. driv. (th.)	–18.2	–25.0	–50.3	–62.6	–64.7
Med. cas. (th.)	–9.4	–13.0	–26.0	–32.4	–33.6
Deaths	–44	–136	–273	–339	–352
Ext. cs.	–5	–7	–13	–16	–17
Int. cs.	–95	–129	–260	–323	–335

Source: Author's calculations

Notes: Alcohol cons. is Alohol consumption, th. is thousands, Cr. and misd. is Crimes and misdemeanors, Pub. dr. is Public drinking, Off. ag. per. is Offenses against person, Dr. driv. is Drunk driving, Med. cas. is Medical cases, Ext. cs. is External causes, Int. cs, is Internal causes.

From Table 14 it is shown that following the optimal tax policy under the mid estimates, legal alcohol consumption (excluding alcohol acquired via border trade or home production) is expected to decrease by approximately 3300–4200 thousands liters of pure alcohol, that is 2.5–3.1 liters of pure alcohol per capita. Raising tax to 70.7 that turned out to be optimal under high estimate with public spending adjustment, alcohol consumption would decrease by the same magnitude due to lower elasticity applied under this scenario. Tourists' alcohol purchases are expected to decrease by somewhat more than one fourth under the mid estimate and by almost three fourth under the high estimate. As concerns

alcohol-related deaths, increasing tax to EUR 70.7 saves only 17 lives that otherwise would have been lost due to external effects borne by victims. However, this result reflects the highly conservative approach as less than one fifth of traffic fatalities and all the deaths related to internal illnesses were considered internal. The effect on total mortality is much wider – even a tax increase from the current EUR 9.4 to EUR 14.5 would save 136 lives.

Table 15 presents simulations of the fiscal effects from changes in alcohol taxation. It should be noted that only alcohol-related revenues and costs are observed. Any improvement or deterioration in the budget position is offset by simultaneous change in labor taxes or public spending to keep the budget balanced. The effects of the latter have not been considered in Table 15. As it is seen, while a rise in the alcohol tax increases tax revenues and administrative costs it also reduces revenues from pecuniary penalties and costs to health care and criminal justice. Specifically, increasing the current tax to EUR 14.5 under the low parameter values, the budget is mainly affected by changes in tax revenues.

Table 15. Fiscal and welfare effects associated with changes in alcohol tax (EUR mln)

	Raising to EUR 14.6 (BH)	Raising to EUR 14.5 (low)	Raising to EUR 27.9 (mid)	Raising to EUR 35.2 (mid)	Raising to EUR 70.7 (high)
REVENUES		58.8	191.0	243.2	546.7
Alcohol tax					
Locals	30.7	41.2	143.7	183.8	480.9
Tourists	16.7	18.8	48.8	62.4	68.9
Pec. pen.					
Dr. driv.	–0.5	–0.7	–0.9	–1.8	–1.9
Pub. dr.	–0.3	–0.5	–0.6	–1.2	–1.2
COSTS		5.5	14.8	19.1	45.9
Crim. justice	–1.9	–1.4	–5.4	–6.7	–9.0
Med. costs	–1.0	–0.7	–2.9	–3.6	–6.2
Tax administ.	0	7.6	23.1	29.4	61.1
NET REVEN.	43.7	53.3	176.2	224.1	500.8
WELF. GAIN	7.8	5.2	45.3	91.9	290.7

Source: Author's calculations

Notes: Pec. pen. is Pecuniary penalties, Dr. driv. is Drunk driving, Pub. dr. is Public drinking, Crim. justice is Criminal justice, Tax administ. is Tax administration, Net reven. is Net revenues, Med. costs is Medical costs, Welf. gain is Welfare gain; the welfare gain arising from the tax increase to EUR 27.9 was estimated under the labor tax adjustment and the welfare gain arising from the tax increase above EUR 27.9 was estimated under the public spending adjustment.

When tax rate is increased further, however, changes in administrative costs become larger and larger due to an assumption that tax administration becomes more and more complex and more expensive per liter of pure alcohol. Complexity is assumed to arise mainly from possible expansion of the black

market. Therefore, while under high parameter values the optimal tax on alcohol were estimated to be EUR 70.7, this result was obtained by allowing government to increase its spending on enforcement activities by EUR 61.1 million. This means that based on the budget size in 2009, the Tax and Customs Board could more than double its budget to deal with illegal alcohol.

The BH scenario deserves a special attention in order to understand expected effects of illegal or border trade as well as home production. It shows that legal alcohol consumption, consisting of alcohol acquired only legally from the local market, decreases by 2,473.6 thousands of liters of pure alcohol (see Table 14), representing 20% of total consumption before the tax increase. However, under this scenario alcohol acquired from non-taxable sources partially offsets the positive effect arising from reduction in the consumption of taxable alcohol. For example, if the tax under the mid scenario were raised to EUR 14.6 per liter of pure alcohol, as suggested by the BH estimate, locals would reduce their alcohol purchases at the local legal market by 1,221.3 thousands of liters, which is roughly two times lower figure than proposed by the BH estimate. As a result, instead of collecting tax revenues as much as EUR 30.7 million, this figure under the mid scenario with tax increase to EUR 14.6 would be EUR 49.0 million. Accordingly, the reduction in drinking consequences under the BH scenario is roughly two times smaller as well. This is why the optimal taxation level is EUR 27.9 per liter of pure alcohol under the mid estimate, instead of being EUR 14.6, which turned out to be optimal under the BH scenario.

Regardless of the scenario, an increase in alcohol taxes is expected to improve the fiscal budget. Although it could be questioned whether it is realistic to gather additional EUR 500 million revenues from alcohol taxation as is suggested by the high estimates, it should be noted that this result was obtained under low price elasticity. Whether this could be a realistic assumption in the Estonian context should be addressed in future research. In addition, it is interesting to note that while net revenues from an increase in alcohol tax differs about ten times under alternative scenarios (i.e. EUR 53.3 and EUR 500.8), corresponding variation of welfare gain is more than fifty times (i.e. EUR 5.2 and EUR 290.7). However, it is only natural that the larger the difference between actual and optimal taxation level, relatively more welfare gain there is to achieve. These figures also clearly point out that total fiscal effect is much larger than welfare gain. This is due to the fact that, tax revenues or cost savings becoming efficiency gain assumes their efficient employment.

Sensitivity analysis

In Figure 13, changes in the optimal tax under mid estimates with respect to different elasticities are more closely observed. In the panel on the left, optimal tax is decomposed into two parts. The first is the Pigouvian tax and the second is the sum of revenue recycling, tax-interaction, foreign benefit and productivity effects. As was already inferred above, under inelastic demand, Pigouvian tax represents only a marginal part of the tax rate. Similarly to the estimates presented in Table 13, it is negative when price elasticity is lower than –1.0.

However, the remaining part more than offsets this negativity and almost sextuples the tax, compared with the current tax rate. Although the role of other than Pigouvian rationale for alcohol taxation is sharply diminished under elastic alcohol demand, it still stays greater than the Pigouvian tax.

The range from –0.5 to –2.0 was chosen to illustrate the sensitivity of alcohol tax with respect to changes in the price elasticity of tourists' alcohol demand (see the right panel of Figure 13). Under inelastic demand, the foreign benefit rationale for alcohol taxes alone, amount to the current rate and represent more than half of the simulated optimal tax rate. It is also interesting to note that under the mid estimate, tourist price elasticity must be more than –2.0 for the foreign benefit component to become negative. Cancelling out the foreign benefit effect, however, would bring the optimal level below the currently prevailing rate.

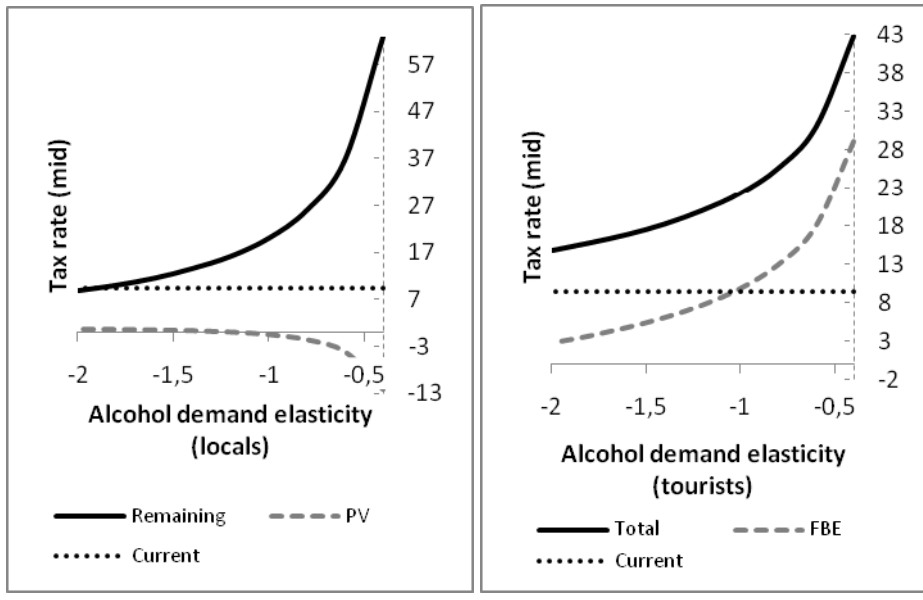

Figure 13. Sensitivity with respect to elasticities
Source: Compiled by the author
Notes: PV is Pigouvian component, Remaining is optimal tax less Pigouvian component, Current is prevailing average tax rate in 2009, FBE is foreign benefit component, and Total denotes optimal tax including all components.

One additional test was conducted in order to explore the sensitivity of optimal tax with respect to other elasticities, which show the responsiveness of unlawful acts with respect to the alcohol price. It appeared that variation in their values does not have very large impact. For example, under mid estimations, where all elasticities were assumed to take the value of –0.7, increasing the drunken driving, offense and public drinking elasticities with respect to alcohol price all

to –0.4, optimal taxation level would be reduced less than 10%. Similarly, under low estimates, in case of which all elasticities except tourists' alcohol demand elasticity were assumed –1.0, increasing the same elasticities to –0.4 reduces optimal tax only by less than 15%. It means that under the assumption of unresponsive harmful and illegal activity the results are not overruled.

Sensitivity of the optimal tax rate with respect to marginal administrative cost can be followed in the left-hand panel of Figure 14. It illustrates that just as was described above; the optimal tax rate is especially sensitive under low elasticity of alcohol demand. More precisely, it becomes more than ten times higher when the increase in the tax rate does not require additional resources for tax administration, compared with the case when a one unit increase in the tax rate requires an additional 40 cents per one liter of pure alcohol (i.e. $r_{t_A}^A = 0.4$). As regards to the optimal tax rate under higher demand elasticity, the variation is much smaller. The overall level of optimal tax, however, tends to be lower than the current rate from the point where a one-unit increase in the tax rate requires an additional 25 cents per one liter of pure alcohol for tax administration.

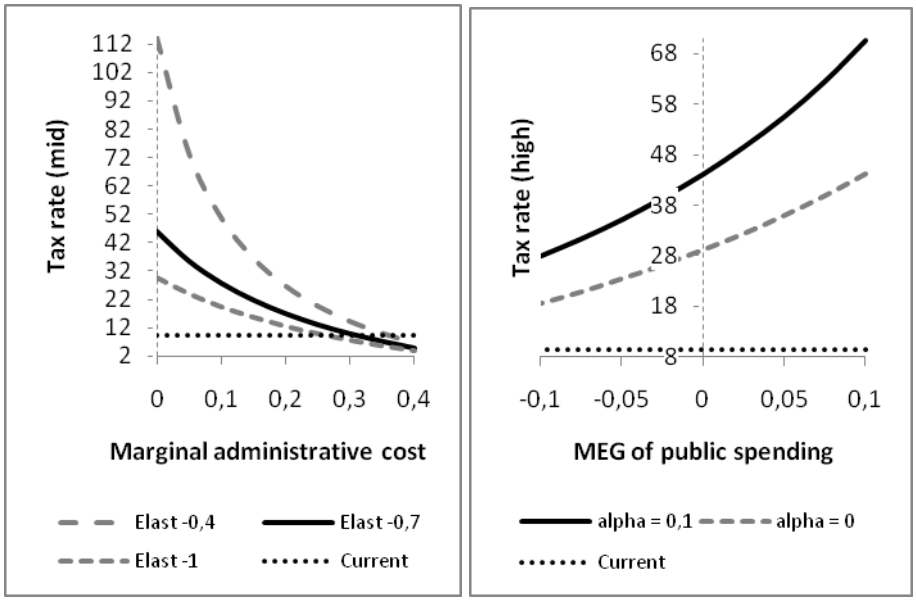

Figure 14. Sensitivity with respect to cost parameters
Source: Compiled by the author
Notes: Elast is price elasticity of locals' alcohol demand, Current is prevailing average tax rate in 2009, alpha denotes multiplier effect arising from interaction of public spending with labor market.

Finally, it appears that the role of elasticity disappears under high marginal administrative cost, as in this case, simulated optimal taxes are almost equal under all three elasticities. In any event, the main point here is that the optimal policy is strongly affected by government capability to operate the tax system effectively when the tax rate is raised. As Figure 14 suggests, with zero costs, optimal policy would involve raising the current tax rate even under unit-elastic alcohol demand. In contrast, with high costs, this is not true even under inelastic demand.

A solid basis of information was not available for estimating the values of MEG_{r^M} and α. They do however play a decisive role in inflating the tax rate to an extremely high level under high parameter values. As is shown in the right-hand panel of Figure 14, if public medical spending affects the labor supply incentive so that $\alpha = 0.1$, efficiency gains from alcohol tax are substantially amplified and as a consequence, the optimal tax rate rises above EUR 60. Even without experiencing the multiplier effect ($\alpha = 0$), an increase in MEG_{r^M} may cause a considerable increase in the optimal level. It was also revealed that under high and mid parameter values, even an inefficient spending program under which households obtain less utility than the program costs them ($MEG_{r^M} < 0$), does not eliminate the rationale to increase the current tax rate. Further analysis showed that this does not apply under low estimates. For example, if $MEG_{r^M} = -0.05$ (meaning that the revenue-recycling effect is negative) and $\alpha = 0$, optimal tax is estimated to equal EUR 7.3.

Table 16. Optimal alcohol taxes under Pigouvian penalties (EUR)

Alternative scenarios	Pigouvian penalties	Optimal tax rates on alcohol	
		Labor tax adjustment	Public spending adjustment
BH			
Public drinking	27.7	14.1	19.5
Drive drinking	140.1	13.1	18.4
Both	–	12.6	17.9
Low			
Public drinking	23.9	13.9	17.7
Drive drinking	97.6	13.0	16.7
Both	–	12.3	15.9
Mid			
Public drinking	27.7	27.2	34.4
Drive drinking	140.1	25.6	32.6
Both	–	24.9	31.8
High			
Public drinking	36.1	47.1	69.1
Drive drinking	183.1	44.9	66.1
Both	–	43.8	64.6

Source: Author's calculations

Alcohol externalities are partially internalized through drunk driving and public drinking penalties, which were estimated in this thesis as EUR 28.8 and EUR 9.6 per incident, respectively. In Table 16, the average external cost per incident has been presented for both types of incidents. These costs denote optimal level of penalties (i.e. Pigouvian penalties) in a partial equilibrium framework according to which the optimal penalty is equal to the marginal external cost of the corresponding unlawful act. It shows that there is much room for a penalty rise – even under the low average external cost estimates. Current rates represent less than half of the Pigouvian level.

In addition, it is shown how the optimal level of alcohol taxation is affected when penalties were raised to the Pigouvian level. It can be seen that raising both penalties to the Pigouvian level, the optimal tax rate is reduced approximately by 10–15% under all scenarios. For example, under mid estimate with labor tax adjustment, optimal alcohol tax is EUR 24.9 compared with EUR 27.9 under current prevailing penalty rates as was reported in Table 13 above. Raising only one penalty, keeping other one at its current level, entails somewhat smaller effects on optimal tax policy. However, even then, optimal tax is approximately 5% lower.

3.4. Discussion

Comparison with prior estimates

To author's best knowledge there are no empirical studies carried out previously concerning optimal alcohol taxation in general equilibrium framework except the one conducted in the US that was extended upon in this thesis. Therefore, the results of both studies regarding optimal taxation with labor tax adjustment are compared in Figure 15. Although acknowledging enormous differences between these two countries regarding social, cultural and economic circumstances as well as population size, comparing the results somewhat complements the sensitivity analysis giving a better picture of how the model behaves under different conditions and empirics

Regardless of fluctuations in the exchange rate between the euro and the dollar, it can be said that the overall optimal tax in the US has been estimated to be higher than in Estonia. In reality, however, the Estonian tax rate is more than twice as high as the rate implemented in the US (EUR 9.4 and EUR 4.5, respectively). More specifically, Parry et al. (2009) have estimated that the optimal tax on alcohol with labor tax adjustment ranges from EUR 18 to EUR 161 per liter of alcohol under alternative scenarios (using an exchange rate of 1 USD = 0.76 EUR, i.e. from USD 88 to USD 803 per gallon of alcohol), while the prevailing rate in practice is EUR 4.5. The US estimates depicted in Figure 15 – named here arbitrarily as mid-range – assume that the own-price elasticity of alcohol demand is –0.7, alcohol/leisure cross-price elasticity is zero, and productivity effect is calculated on the basis of the most conservative estimates. For Estonia, optimal tax is estimated to range from 15 EUR to EUR 71 under

low and high parameter values, while the mid estimate is depicted in Figure 15. It is important to note, however, that in order to make both estimates more comparable, compared with the mid estimates presented in Table 13 above alcohol/leisure cross-price elasticity is similarly to the US case assumed to be zero. This is the reason why it is lower than standard result of the thesis under mid estimates. Specifically, although fiscal, foreign benefit and productivity components together amount to EUR 25, final level is EUR 22.9 due to negative Pigouvian tax.

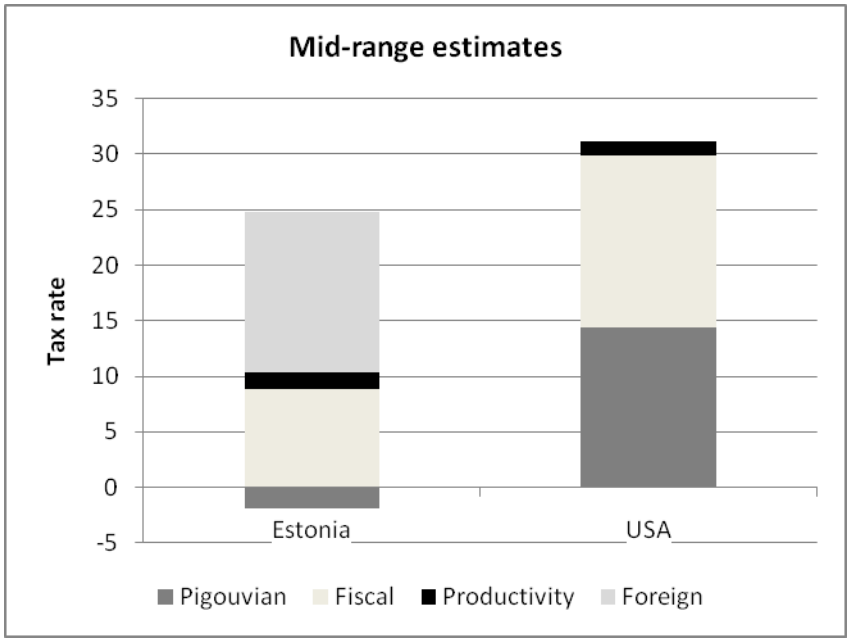

Figure 15. Estimated optimal alcohol taxes in Estonia and the USA
Source: Parry et al. (2009), compiled by the author

As concerns the structures of optimal tax rates under mid-range simulation results in both countries, it appears that in contrast to the Estonian case, the total tax rate in the US is formed almost equally by Pigouvian and fiscal components. Although, unlike the model used for the USA, the Pigouvian component in the Estonian case also includes effects from public drinking and offenses against persons, it is still negative due to administrative costs that were ignored by Parry et al. (2009). In addition to differences in core data that is determined by the extent of alcohol externalities in both countries, as well as by methods used to monetize these externalities, one obvious reason behind this result arises from the considerable gap between income levels in the two countries. Estonian GDP per capita represents less than half of US GDP per capita (Eurostat 2010b). This means that in absolute terms, the cost of alcohol-related public

spending apportioned to the criminal justice system, for instance, is substantially higher in the US. The same applies to most of the other monetary variables. For instance, value of life – an input-providing Pigouvian component – was assumed to be EUR 0.56 million in this paper. Parry et al. (2009) used a much higher value of EUR 3.04 million (or USD 4 million).

Productivity effects that are probably underestimated in both cases only play a marginal role in affecting the overall level of alcohol tax. For example, Parry et al. (2009) also obtained a considerably higher value for this component, amounting to EUR 16. In the Estonian case, estimates regarding productivity losses due to alcohol misuse presented by Saar (2009) were used as input data. This, however, only includes the decrease in the wage rate of alcoholics and the monetary value of lost workdays due to alcohol-related illnesses, and not some other factors. For instance, due to a lack of data, unemployment caused by alcohol misuse was not included.

Both papers have shown that the fiscal component exceeds Pigouvian rates under a number of plausible parameter combinations. This holds true under mid-range estimates as well. Figure 15 also demonstrates the substantial difference in absolute levels of fiscal components between the two countries. Obviously, with the higher Pigouvian tax, there are more revenues that can be used to reduce labor taxes. In addition, the higher tax rate affects labor supply more intensely, increasing the tax-interaction component in the US, when compared with Estonia. In other words, due to interdependencies between different components in optimal tax formula, higher Pigouvian tax practically amplifies the other effects as well. One additional reason why the fiscal effect is much greater in the US arises due to lower alcohol prices in Estonia. More specifically, under different price levels, while assuming identical price elasticities of demand, a one-unit increase in alcohol price reduces alcohol consumption more in the country with lower prices. Therefore, as the fiscal component of optimal alcohol tax is expressed as per unit reduction in alcohol consumption, the tax rate proves to be lower in the country with low prices. Another reason for the difference concerns the level of pre-existing labor taxes. The higher these are, the more welfare gain there is to receive when taxes are reduced. In this paper, the pre-existing tax rate on labor was assumed to be 0.35 compared with 0.4 applied by Parry et al. (2009), which causes an additional divergence between the results.

Implications

This study has revealed a set of empirical estimates for alcohol policy in Estonia, considering both externalities as well as fiscal aspects. Simulation results convincingly support the view that policy as currently implemented is not restrictive enough. Specifically, under several alternative combinations of parameter values, the socially optimal tax rate on alcohol patently exceeds the rate implemented in practice. Following the mid estimates at least 200% increase in alcohol taxes are suggested. In addition, under tax policy with adjustments for public spending, the optimal alcohol tax could be substantially

inflated, due to the amplifying effect of interaction between public spending and labor supply, amounting to more than 1000% of currently prevailing rate.

In interpreting the numerical results, it must be kept in mind that the suggested increase in alcohol taxes includes both, excise tax and the proportion of VAT arising from taxing excise tax. Therefore, somewhat lower increase in excise rates is warranted compared with the result shown in Table 13. Specifically, in order to achieve an increase in alcohol taxes by 27.9 EUR and 35.2 EUR, as proposed under the mid estimates, average excise rates on alcohol must be raised by 23.3 EUR and 29.3 EUR, respectively. This is because in Estonia, VAT taxes excise tax as well and adds to the final market price an additional 20% of excise tax. Therefore, excise rates should be raised by approximately 150%. Naturally, this train of thoughts is true only under the assumption of 100% tax shifting and given 20% of VAT rate.

Similarly, to Parry et al. (2009), the simulations results showed that accounting for fiscal considerations strongly affects the optimal level of alcohol taxation. Compared with earlier papers, which applied partial equilibrium approach and captured only the Pigouvian component, the range within which optimal tax could lie becomes much wider. For instance, Pogue and Sgontz's (1989) partial equilibrium estimates regarding average optimal tax rate ranged from USD 20 to USD 314 per gallon of pure alcohol. In their analysis, arriving at the precise value of the tax depended on the making of an assumption concerning the share of internal cost that drinkers fail to internalize. Parry et al., while holding the Pigouvian component constant at USD 72 per gallon of alcohol, disclosed the range from USD 90 to USD 799, regardless of the fact that actual average tax on alcohol was estimated to remain below USD 25 in both papers. The strength of the fiscal rationale over Pigouvian one just implies that it would be more efficient to gather somewhat more revenue from alcohol taxation and less revenue from labor taxation, given the revenue neutral scenario under which the main result were obtained[53].

Compared with Parry et al., this paper has extended the role of fiscal consideration mainly in two ways. At first, it was demonstrated that considering alcohol as a commodity heavily consumed by tourists further strengthens revenue-raising rationale for an excise tax on alcohol. Secondly, optimal taxation level could also be reduced if tax increases require more administrative costs. In fact, given the assumptions in regard with marginal administration costs of alcohol tax made in this thesis, Pigouvian component was completely washed out. Fiscal effects can therefore move the optimal tax in both directions, resulting in additional uncertainty regarding appropriate alcohol policy. This also means that under high marginal administration costs, social benefits from following only Pigouvian rule may stay below the additional resources required to administer this policy. However, accounting also fiscal rationales, the

[53] Although the taxation policy with public spending adjustment was also simulated, due to a relatively weak empirical ground the value of the results obtained under this scenario is rather theoretical than empirical.

simulation results confirmed that rise in prevailing tax rates is warranted even when it is complemented with increase in tax administrative costs. This increase could be required due to potential expansion of the black market that is often considered as the main credible counterargument for tax raises in any country. Therefore, following the mid estimate with labor tax adjustment, under which 200% increase in current taxation level is proposed, the Tax and Customs Board is allowed to increase its budget approximately by 50% or more than 20 million EUR. Although the most effective utilization of these additional resources requires further analysis, it is reasonable to assume that resources of this magnitude should be enough in order to prevent the large-scale increase in prevalence of illegal alcohol.

In addition, an optimal policy was shown to be rather sensitive towards demand elasticity of tourists' alcohol demand. As under low elasticity, the optimal level of taxation was considerably higher than under elastic demand, when planning a tax raise, government should account for differences in alcohol prices in Estonia and Finland. At the current state, the difference is more than twofold which means that a considerable raise can be carried out without changing incentives for tourists' to purchase alcoholic beverages from Estonia. For example, raising the tax rate by 200%, suggested by mid estimates with labor tax adjustment, brings along approximately 50%–55% rise in average alcohol prices, assuming that taxes are completely shifted onto consumers. As a result, alcohol prices in Estonia could still represent only approximately four fifth of price level in Finland. Therefore, this thesis proposes to take advantage of current situation to improve the welfare of Estonian citizens. It should be stressed, though, that optimal policy solution critically depends on tax policy implemented by Finnish government and other factors affecting tourists' incentives to visit Estonia. Changes in these factors should be examined before the policy is put into practice. Therefore, a considerable rise in excise taxes should be carried out in a longer period as to observe how markets or neighboring countries react.

In case of the BH scenario, under which administrative burden of alcohol tax was held constant and both illegal and border trade as well as home production, are assumed to become more massive, approximately 50% increase in the level of alcohol taxation gathers additional revenue somewhat more than EUR 40–50 million. The short-term effects of recent tax changes imply that this is highly realistic scenario. Specifically, during 2008–2010 the taxation level was increased more than 40% and as a result government managed to collect excise tax revenues EUR 165.2 million in 2010, compared with EUR 147.9 million in 2007. Considering also the value added tax, this tax increase has gathered additional EUR 21 million. It is noteworthy that this occurred during the worldwide economic recession when there was a sharp reduction in total consumption expenditures. Moreover, alcohol excise revenues in the first three month in 2011 exceeded the revenue collected in the same period in 2010 by more than EUR 6 million, implying that the effects of the recent tax increase are much greater than experienced in 2010.

There is no particular reason to believe that the rest of the scenarios predicting even greater revenue growth could be unrealistic. It must be noticed that these scenarios assume positive marginal administrative burden of alcohol taxation due to the employment of additional measures to deal with the potential expansion of illegal market. One can only speculate how the introduction of such measures could work in practice. Obviously, the outcome depends heavily on their quality. However, it would be extremely pessimistic to assume that nothing can be done to prevent massive illegal trade. Probably much more important concerns are border trade and home production. However, as concerns the border trade, it is important to note that the corresponding regulations in the EU allowing duty-free importation of alcohol in relatively large quantities was shown to create the main rationale to tax alcohol. This rationale to apply assumes that Finns still find the way to Estonia to purchase alcohol and Estonians only moderately replace the alcohol sold in the local market with alcohol imported via border trade. Considering huge differences in alcohol prices between Finland and Estonia, and the fact that during the last decade the relative purchasing power of alcoholic beverages has risen about two times in Estonia (see Figure 5 in chapter 1), this assumption should be reasonable at least under the tax increase to a certain level. Whether that level exceeds prevailing average tax rate more than 50%, 100% or 200%, must be confirmed in the future empirical research.

Nevertheless, following the policy recommendation under the mid estimates to raise excise taxes, given the assumed demand elasticity, considerable reduction in alcohol consumption is expected, amounting to 3 liters of pure alcohol per capita. This would mean that Estonia could lose its almost "leading" position in world drinking ranking and the level of alcohol consumption would decrease to the level of approximately 7 liters of pure alcohol per capita. This level can be probably considered as socially desirable as well. For example, people in countries such as Sweden, Norway and Japan consume nearly the same amount of alcohol. These countries also experience much lower rates of alcohol-related injuries, mortality and illnesses (WHO, 2011a). The current thesis suggests that considerable reduction in alcohol-related mortality, medical cases, crimes and misdemeanors could also follow the tax raise. As it can be seen from Table 14, under the mid estimate more than 250 lives would be saved and nearly 500 people less would experience an offense from another person in one year. Obviously, these effects would not follow the tax raise immediately. For example, most alcohol-related illnesses will develop after long-term abuse of alcohol. Therefore, benefits from preventing these illnesses will arise in the future as well. By the same token, even sharp reduction in heavy drinking cannot promptly eliminate the harm it has already caused. The same applies to the fiscal burden associated with these effects. Therefore, it must be realized

that the optimal level of alcohol taxation obtained in this thesis accounts for both immediate and future effects[54].

It would be naïve to expect solving all the problems with taxation policy. It must be noticed that these results are obtained under certain assumptions regarding price elasticities and the dynamics of associations between drinking and its consequences. However, given the high level of alcohol consumption in Estonia it is reasonable to assume that well prepared taxation policy accompanied by more intense monitoring activities of corresponding public institutions could have substantial benefits, maybe even greater than these figures show.

It must be acknowledged that policy proposals in this thesis are rather intriguing in the context of EU harmonization policy. It is suggested that citizens in one EU member state should try to attract citizens from other member states to visit their country for alcohol purchasing purposes. Moreover, the damaging effects of alcohol consumption on citizens from other states are completely ignored. Therefore, the welfare maximizing alcohol policy implemented by one individual member state may actually deteriorate the welfare of other countries or the welfare of the EU as a whole. For example, in the model applied in this thesis, the optimal taxation level is considerably reduced under high elasticity of tourists' alcohol demand. From the perspective of Finland, however, this reduction in the level of taxation could cause substantial social harm, as the Finn's would have access to cheap alcohol. However, this is the current EU legislation, which allows border trade in relatively large quantities of alcohol. As shown by the analysis in this chapter, this kind of policy creates strong incentives for governments to raise tax revenues from border trade. Therefore, the results are directly related to the policy implemented in the EU.

The same applies to minimum excise rates all member states must follow. Although these rates are currently very low, their rise may strongly affect optimal level of taxation. Considering the results of the study here, for Estonia a certain rise in minimum rates would certainly be beneficial. This would make it much easier to carry out welfare increasing changes in excise rates as proposed by this thesis without worrying much about countries with extremely low levels of taxation. Otherwise, Estonians could find a way for these countries to purchase alcohol from there. On the other hand, too sharp increase in minimum rates could eliminate the price differences between Estonia and Finland, abolishing also the rationale to tax alcohol for tourism purposes. The latter could mean substantially lower optimal level of taxation as well.

Finally yet importantly, government should seriously consider raising penalties on drunk driving and public drinking as in the current state penalties, the charges are much lower than marginal external damage caused by these

[54] Thereby, the optimal taxation level revealed in this thesis is practically a long-run equilibrium level. Nevertheless, the appropriate pathways to achieve that level as well as other dynamic issues stay above the scope of this paper.

unlawful acts. Both types of acts were assumed to generate negative effects through traffic as well as through fiscal system. Therefore, a rise in penalties would enable the internalization of these alcohol externalities from the people responsible for these externalities. This would reduce the optimal level of alcohol taxation as well. For example, under mid estimates revealed in this thesis, the optimal level of alcohol tax could be reduced by 5–15% when both types of penalties would be simultaneously increased to the Pigouvian level. However, it should be noted that this thesis has not directly addressed the optimal penalty problem. Specifically, just like in case of tax policy, optimal penalty formulas could be obtained in a general equilibrium framework under which optimal penalty rates may differ from the Pigouvian level.

Limitations

There are a number of limitations worth notice. The validity of assumptions concerning perfect competition and rational addiction as well as application of a representative agent framework has been discussed in the first chapter (see subchapter 1.3). An additional important limitation of the study concerns obtaining only average rate of excise on pure alcohol. In practice, however, there are different types of alcoholic beverages such as wines, vodkas, beers, ciders etc., with different alcohol content. These beverages may be consumed in very different manners and consequently their external costs must not be necessarily related to alcohol content. In addition, the demand elasticities across these beverages probably vary considerably. As was shown in the first chapter, beer price responsiveness has been often shown to be much lower than vodka's, implying that alcohol unit in beer should be taxed more heavily than vodka's on fiscal purposes. In practice, this is exactly the other way around in most countries. In Estonia, excise rate on vodka based on alcohol content is approximately two times higher than beers or wines[55]. As a result, alcohol tax represents more than half of vodka's market price and less than 20% of beers and wines. Correspondingly, it probably would not be reasonable to raise excises uniformly for all beverages. For example, assuming 100% tax shifting, 200% uniform increase in excise rates would cause only about 30% increase the beer market prices but more than 100% increase in vodka's market prices. Therefore, it would be wise to somewhat smooth this difference. This, however, requires clarification by the future research.

In interpreting the results of this paper, one must be aware that the model considers only indirectly or ignores completely several relevant effects that could substantially affect optimal level of alcohol taxation. At first, there are both legal and illegal channels that can be used to avoid the paying of higher

[55] Specifically, while half liter vodka with 40% alcohol content is taxed by EUR 2.8, half liter beer with 4.5% alcohol content is taxed by EUR 0.1 (Alkoholi-, tubaka-, kütuse- ja elektriaktsiisi seadus, authors calculations). Therefore, while there is approximately 10 times more pure alcohol in a vodka bottle compared with beer, the tax amount is more than 20 times higher.

taxes. Illegal alcohol consumption, home production as well as acquiring alcohol via border trade were considered in the model parameterization. Specifically, one scenario was particularly designed to account for these aspects. However, this was purely indirect way to tackle the problem. For example, as concerns the potential border trade, for people living in the northern area, a trip to the other country just to buy alcohol may not be reasonable. It is also well known that northeastern and southern regions are the least developed areas in Estonia where a relatively small part of the population lives. Therefore, more sophisticated analysis, including transportation costs considerations, is needed to address this problem. In addition, massive changes in home production would probably also affect individuals' labor supply decisions as home production requires labor as an input. Therefore, the interactions of alcohol and labor markets induced by tax policy, which has played a central role in this thesis, could be strongly affected (see Aronsson and Sjögren, 2010). In addition, although the analysis is based on a general equilibrium model comprising the alcohol market, labor market, auto-insurance sector as well as the public sector; it excludes some relevant economic sectors, which could have considerable impact on the optimal policy. Essentially the whole tourism sector may shrink due to high alcohol prices. However, due to lower criminal activity and fewer drunken people on the streets, there may be positive effects on tourism as well. The net effect stays ambiguous, though.

In addition to potential substitution between alternative purchasing sources, there may be also substitution between alcohol and other substances. This possibility was not considered in the model simulated in this thesis. Therefore, one could argue that the taxation level suggested by the simulations results could generate incentives for drinkers to switch to some different types of drugs such as heroin for instance. That could probably pose a much more serious harm to society than alcohol. Although acknowledging the problem, it was disclosed in the first chapter that often alcohol and alternative drugs are rather complements than substitutes. Therefore, the immediate substitution effect is not very likely. In addition, it should be stressed here that the results obtained in this thesis assume considerable increase in resources available for government to support this policy. Although it was assumed that these resources are employed to control the expansion of an illegal alcohol market, these could be also distributed to finance any other supportive activities, including hindering a potential increase in illegal substance use. Therefore, the success of an alcohol taxation policy depends directly on the implementation capability of public institutions and their ability to use resources effectively to control potential negative side effects.

It must also be acknowledged that several alcohol-related cost categories have not been included. For instance, estimating economic costs of alcohol future research should attempt to include alcohol-attributed costs from fires, absenteeism, unemployment and transfer payments such as disability pensions. In addition, tax rates obtained in this paper are based on tangible costs only. In other words, intangible costs such as pain or psychological suffering have not

been considered. For instance, when one drives drunk and causes a traffic accident in which a victim is injured, only fiscal health care costs and productivity losses due to temporary disability were considered, in order to derive optimal tax. Psychological stress, as well as its impact on the relatives of the victims, was not considered. Alcohol-related domestic violence is also a well-known social problem, which often remains hidden and is therefore difficult to capture. What this means is that increases in alcohol taxes certainly entail substantial social benefits that are difficult to estimate in monetary terms.

To conclude, it must be stressed that the results of this paper should be treated cautiously, as many empirically estimated parameters are based on very rough approximations or have rather weak scientific foundations. This especially concerns variables such as marginal administrative cost of alcohol tax, tourists' alcohol demand elasticity, marginal efficiency gain from public spending and drunk driving, public drinking and offense elasticities with respect to alcohol price. In addition, the value of alcohol demand elasticity in respect to which the optimal taxation level was very sensitive is drawn from international literature. Although there is no reason to believe that this could be completely different in Estonia, its central role in the model requires its estimate with Estonian data.

CONCLUSIONS

Excessive alcohol consumption is often considered to lay an enormous socio-economic burden overall on society by causing several illnesses, injuries, fatalities and criminal behavior. The present thesis has addressed this problem from the perspective of taxation policy, which has been shown in prior literature to be one of the most effective as well as cost effective policy measures to control drinking consequences. Specifically, optimal average excise rate on alcohol was evaluated in order to correct alcohol externalities and raise revenues for government in Estonia. To accomplish this aim, four research questions were raised concerning the definition of optimality criterion, building the appropriate model to assess this optimality, and the implications for alcohol taxation in general as well as specifically for Estonia.

At first it was analyzed how the optimality with respect to these two goals could be defined. As prior literature on optimal alcohol taxation is rare, the optimality definition was borrowed from environmental policy literature. The approach applied there nicely delivers the solution required to accomplish the aim of the thesis. Specifically, well-known principles of externality correcting Pigouvian taxation, which in its simplest form equates a tax rate with marginal external cost and revenue-raising Ramsey taxation, which taxes more heavily leisure complements, have been integrated. Applying a static, general-equilibrium model with a representative consumer, the optimal tax is defined as the one, which maximizes the sum of efficiency gain obtained from both sources. To the author's knowledge only Parry et al. (2009) have applied this approach to alcohol in the US. They showed empirically that fiscal rationales might be far stronger than an external one in determining the optimal level of alcohol taxation.

In order to apply this approach to Estonia at first two empirical studies were carried out, as there are only few narrowly targeted studies concerning alcohol externalities in Estonia. Both studies are presented in the second chapter. The first one concerns alcohol-related traffic mortality and the second one estimated the level and the structure of economic costs of alcohol in Estonia. Three main findings from these studies are worth stressing. At first, the prevalence of a high degree of alcohol intoxication among pedestrians was disclosed implying that policy analysis concentrating only on drunk driving, which has been the common approach, also in the alcohol taxation literature, is incomplete. Second, while the economic costs to society resulting from alcohol misuse in Estonia in 2006 amounted to EUR 230–329 million, over 75% of total costs were associated with the indirect burden of alcohol misuse, over 80% of which arose from premature mortality. Third, it was revealed that out of direct economic costs of alcohol, half of these were carried by the criminal justice system, one-tenth by health care system and one third had arisen from traffic-related property damage. Therefore, all these areas must be somehow be included into the optimal taxation analysis.

The third chapter uses the results from second chapter as input and extends the Parry et al. model, parameterizes it and simulates optimal alcohol taxes for 2009. As a result, the current thesis provides innovation to the optimal alcohol taxation literature in several ways. At first and most importantly, in addition to motives stemming from Pigouvian and Ramsey taxation principles, the third rationale for imposing higher taxes on alcoholic beverages compared with other commodities was suggested. Particularly, as alcohol is intensively consumed by tourists, some fiscal burden arising from production of public goods can be placed on tourists through alcohol taxation. This has been acknowledged in tourism taxation literature in general but has not been previously analyzed in the context of optimal alcohol taxation. Altogether, optimality of alcohol tax in this thesis is defined on an accounting efficiency basis for all three aspects. Compared with prior literature the model is extended also to account for offences against persons and public drinking incidences as externalities, implementation costs of tax policy arising from possible expansion of an illegal alcohol market and interactions between the quality of public medical services and labor supply.

Based on this model, the optimal tax formula was derived. Parameterization was carried out by using empirical results from both the second chapter and international literature but also existing international and Estonian-based databases. Simulations were carried out for two different scenarios. The first one assumed that the government budget was held balanced by changing labor tax rate; the second one adjusted the level of public medical spending. For both scenarios three estimates were obtained – the low, the mid and the high. The middle estimate was expected to be the most accurate as under this estimate the most plausible parameter values were applied. It was estimated under alternative scenarios that the average optimal tax rate ranges from EUR 14.5 to EUR 70.7 per liter of pure alcohol in 2009. More specifically, mid-range estimates were EUR 27.9 with labor tax adjustment and EUR 35.2 with public spending adjustment. In addition, raising the current tax rate to EUR 27.9 or EUR 35.2 would improve people's welfare by EUR 45.3 or EUR 91.9 million, respectively. Considering the fact that the prevailing average tax rate in 2009 was EUR 9.4 per liter of pure alcohol, a considerable raise is proposed (including both excise tax and VAT). The raise is warranted even under considerable growth of complexity in tax administration. For instance, when raising taxes by 200%, The Tax and Customs Board are assumed to increase its budget more than 50% or 23 million EUR to deal with increased activity in the illegal market.

Similarly to Parry et al. (2009), it was shown that fiscal concerns dominate over Pigouvian rule affecting considerably optimal level of alcohol taxation.
Compared with Parry et al., this paper has extended the role of fiscal consideration mainly in three ways. At first, it was demonstrated that considering alcohol as a commodity heavily consumed by tourists further strengthens revenue-raising rationale for an excise tax on alcohol. Therefore, existing intra-EU excise allowances, which favor border trade between

countries with considerable price differences, create strong incentives for individual governments to take advantage of this situation. Secondly, optimal taxation level could also be reduced if carrying out the tax raise requires more administrative costs. Fiscal effects can therefore move the optimal tax in both directions, resulting in additional uncertainty regarding appropriate alcohol policy. It is also noteworthy that in this setting the Pigouvian component was completely washed out, i.e. it turned out to be less than zero. Therefore, while alcohol taxation policies in practice have often utilized and warranted for harm controlling purposes, this thesis has shown that its revenue-raising ability could be also used as a strong argument. Thirdly, it was shown that the optimal level of taxation policy in certain circumstances could depend heavily on how tax revenues are spent. If they are spent efficiently, substantial welfare gain can be obtained from a raise in alcohol taxes. This obviously applies to any taxation policy in general as well.

The present thesis has several limitations. At first, the model design fails to take into account the dynamic nature of addiction. Secondly, the alcohol market is assumed to behave as perfectly competitive which is not probably the case in practice. In addition, although the general equilibrium model applied in the thesis notifies the possibility of expansion of an illegal alcohol market through acknowledging administrative costs of alcohol taxation, it does not directly address neither expansion of illegal alcohol market or the possibility of massive border trade or home production. The effects of these phenomenon on the optimal taxation level were explored only indirectly by adjusting corresponding parameter values. The possibility of drinkers switching to substitute substances such as cannabis was completely ignored. Finally, although the model decomposes taxation of tourists' alcohol purchases in the optimal policy formula, the effect of alcohol taxation overall on the tourism sector is not considered. Future research could contribute to these topics by addressing all or some of these limitations

In order to improve the applicability of this model to Estonia much more empirical research work is needed. Specifically, many parameter values in the present thesis are based on very rough approximations, have rather weak scientific foundations or are completely based on international literature. More solid empirical base would allow this model also to include much wider range of alcohol externalities, such as property damage and productivity losses attributable to alcohol-related fires as well as positive externalities which have probably unfairly earned much less attention. Accompanied by additional empirical research, the analysis could also be extended to estimate optimal taxes for individual alcoholic beverages as well as the optimal level for pecuniary and non-pecuniary penalties imposed on alcohol-related unlawful behavior.

APPENDICES

Appendix 1. Alcohol attributable fractions (internal causes)

Disease (ICD–10 code)	AAF
Malignant neoplasm of lip, oral cavity and pharynx (C00-C14)[3]	0.40
Malignant neoplasm of esophagus (C15)[1]	0.42
Malignant neoplasm of stomach (C16)[3]	0.20
Malignant neoplasm of colon (C18)[2]	0.12
Malignant neoplasm of rectum (C20)[2]	0.04
Malignant neoplasm of liver and intrahepatic bile ducts (C22)[1]	0.38
Malignant neoplasm of pancreas (C25)[2]	0.14
Malignant neoplasm of larynx (C32)[1]	0.51
Malignant neoplasm of breast (C50)[2]	0.18
Alcohol-induced pseudo-Cushing's syndrome (E24.4)	1.00
Mental and behavioural disorder due to use of alcohol (F10)	1.00
Degeneration of nervous system due to alcohol (G31.2)	1.00
Alcoholic polyneuropathy (G62.1)	1.00
Alcoholic myopathy (G72.1)	1.00
Hypertensive disease (I10-I15)[1]	0.11
Hypertensive disease (I10-I15)[1] – benefit	–0.07
Ischaemic heart disease (I 20–25)[1]	0.08
Ischaemic heart disease (I 20–25)[1] – benefit	–0.08
Cerebrovascular disease (I60-I69)[2]	0.11
Diseases of esophagus, stomach and duodenum (K20-K31)[3]	0.10
Alcoholic gastritis (K29.2)	1.00
Alcoholic liver disease (K70)	1.00
Cirrhosis (K74.3-K74.6)[3]	0.50
Cholelithiasis (K80)[1] – benefit	–0.50
Acute pancreatitis (K85)[1]	0.24
Alcohol-induced chronic pancreatitis (K86.0)	
Fetal alcohol syndrome (Q86.0), maternal care for (suspected) damage to fetus from alcohol (O35.4), fetus and newborn affected by maternal use of alcohol (P04.3)	1.00

Source: Compiled by author

Notes: [1]AAF drawn from Lai *et al.* (2005). [2]AAF drawn from Devlin *et al.* (1997). [3]AAF drawn from Harwood *et al.* (1998).

Appendix 2. Alcohol attributable fractions (external causes)

External cause (ICD–10 code)	AAF
Transport accidents (V01-V99)[1]	0.42
Falls (W00-W19)[1]	0.16
Accidental drowning and submersion (W65-W74)[1]	0.31
Exposure to smoke, fire and flames (X00-X09)[1]	0.44
Accidental poisoning by and exposure to noxious substances (X40-X49)[3]	0.10
Accidental poisoning by and exposure to alcohol (X45)	1.00
Intentional self-harm (X60-X84)[1]	0.23
Assault (X85-Y09)[1]	0.47

Source: Compiled by author

Notes: [1]AAF drawn from Harwood et al. (1998). [3]AAF drawn from Lai et al. (2005).

Appendix 3. Alcohol attributable fractions for costs to public institutions

Police, Courts, Prosecutors and Prisons	
Type of crime or misdemeanor	AAF
Against life[1]	0.3
Against health and freedom[1]	0.3
Sexual assaults[1]	0.225
Against property[1]	0.034
Disturbances of the peace [2]	0.15
Driving under influence of alcohol	1
Bureau of Forensic Medicine	
Cause of death	AAF
Homicide, assault[3]	0.47
Suicide[3]	0.23
Illness[3]	Same as finding health care costs
Traffic fatality[3]	0.42
Fall[3]	0.16
Other accidents[4]	0.1
Rescue Board	
Type of call	AAF
Traffic accident[3]	0.42
Fire, work and off-the-job accident, accident at body of water[4]	0.1

Source: Compiled by author

Notes: [1]AAF drawn from Harwood *et al.* (1998).[2]Two thirds of offences committed under influence of alcohol were attributed to alcohol misuse. [3]AAF drawn from Lai *et al.* (2005). [4]AAF drawn from Harwood *et al.* (1998), who used the same value for consequences of external causes.

Appendix 4. Estimates of marginal effects

Meaning and parameter notation in formula	BH	Low	Mid	High
Marginal medical case of alcohol consumption, M_A	0.0034	0.0046	0.0066	0.0089
Marginal medical case of an offence against persons, M_P	3.16	2.21	3.16	4.11
Marginal medical case of drunk driving, M_D	0.0222	0.0156	0.0222	0.0290
Marginal medical case of misdemeanors, M_N	0.0037	0.0026	0.0037	0.0048
Marginal on-the-job productivity of alcohol consumption (EUR), $W_H H_A$	1.80	2.53	3.61	4.69
Marginal private cost of· health risks per unit change in drunk driving (EUR), $mpc \cdot H_{\overline{D}}$	31.3	21.91	31.3	40.70
Marginal private cost of health risks per unit change in misdemeanors (EUR), $mpc \cdot H_{\overline{N}}$	0	0	0	0
Marginal private cost of health risks per unit change in offenses against persons (EUR), $mpc \cdot H_{\overline{P}}$	8,853.15	6,197.20	8,853.15	11,509.09

Source: Author's calculations

Appendix 5. Estimates of government resource costs

Parameters	BH	Low	Mid	High
Average costs to criminal justice system per offence against persons (in euros), r^P	4,166.59	2,916.61	4,166.59	5,416.57
Average costs to criminal justice system per drunk driving incident (in euros), r^D	35.72	25.01	35.72	46.44
Average costs to criminal justice system per violation of Alcohol Act (in euros), r^N	15.46	10.82	15.46	20.09
Average cost to Tax Board per liter of pure alcohol (in euros), r^A	0.08	0.06	0.08	0.10
Average cost to health care system per case (in euros), r^M	109.94	76.96	109.94	142.92
Marginal cost of tax rate on alcohol, $r^A_{t_A}$	0.0003	0.10	0.10	0.10

Source: Author's calculations

Appendix 6. Applied elasticities

Parameters	BH	Low	Mid	High
Drinking with respect to alcohol price, η_{AA}	–1.5	–1.0	–0.7	–0.4
Alcohol purchases by foreigners with respect to alcohol price, η_{FA}	–0.7	–0.4	–0.7	–1.0
Drunk driving, public drinking or offenses against persons with respect to alcohol price, η_{DA}, η_{NA} or η_{PA}	–0.7	–1.0	–0.7	–0.4
Drinking with respect to price of leisure (compensated), η^{c}_{Al}	0	0.1	–0.1	–0.2
Labor supply with respect to income, η_{LI}	–0.1	–0.1	–0.1	–0.1
Labor supply with respect to wage rate, η_{LL}	0.2	0.2	0.2	0.2

Source: Compiled by author

Appendix 7. Derivation of optimal policy formulas

Deriving equation (3.6) with $i = t_L$

From (1), (2) and (3) agents solve the following maximization problem:

$$V(t_A, t_L, r^M, \bar{D}, \bar{N}, \bar{P}, G^T) = Max\ U(.) + \lambda[(1 - \mathrm{t_L})\mathrm{w(H)(T(H)} - \mathrm{l}) + \mathrm{G^T} - K - (p_A + t_A)A^D - C - t_D D - t_N N] \quad \text{(A.1)}$$

Totally differentiating (A.1) with respect to t_A:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = -A^D - wL\frac{dt_L}{dt_A} + \left[\frac{U_H}{\lambda} + (1 - t_L)(wT_H + W_H)\right] H_{r^M}\frac{dr^M}{dt_A} + \left[\frac{U_H}{\lambda} + (1 - t_L)(wT_H + W_H)\right] H_{\bar{D}}\frac{d\bar{D}}{dt_A} + \left[\frac{U_H}{\lambda} + (1 - t_L)(wT_H + W_H)\right] H_{\bar{N}}\frac{d\bar{N}}{dt_A} + \left[\frac{U_H}{\lambda} + (1 - t_L)(wT_H + W_H)\right] H_{\bar{P}}\frac{d\bar{P}}{dt_A} + \frac{dG^T}{dt_A} - \frac{dK}{dt_A} \quad \text{(A.2)}$$

Totally differentiating government budget constraint (5) with respect to t_A:

$$r^M M_{A^D}\frac{dA^D}{dt_A} + M\frac{dr^M}{dt_A} + (r^M M_D + r^D - t_D)\frac{dD}{dt_A} + (r^M M_N + r^N - t_N)\frac{dN}{dt_A} + (r^M M_P + r^P)\frac{dP}{dt_A} + \frac{G^T}{dt_A} = A^D + t_A\frac{dA^D}{dt_A} + A^F + t_A\frac{dA^F}{dt_A} - r^A_{t_A}A^F - r^A\frac{dA^D}{dt_A} - r^A_{t_A}A^D - r^A\frac{dA^F}{dt_A} + \mathrm{t_L}\frac{dW}{dt_A} + \mathrm{W}\frac{dt_L}{dt_A} \quad \text{(A.3)}$$

Substituting (A.3) in (A.2), while assuming that $\frac{dK}{dt_A} = c_D\frac{dD}{dt_A} + c_N\frac{dN}{dt_A}$ due to zero profits of auto insurance companies, and denoting $mpc = -\left[\frac{U_H}{\lambda} + (1 - t_L)(wT_H + W_H)\right]$ and $MEG_{r^M} = -\frac{1}{M}mpc * H_{r^M} - 1$, in (A.2), gives:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = -r^M M_{A^D}\frac{dA^D}{dt_A} - (r^M M_D + r^D - t_D)\frac{dD}{dt_A} - (r^M M_N + r^N - t_N)\frac{dN}{dt_A} - (r^M M_P + r^P)\frac{dP}{dt_A} + t_A\frac{dA^D}{dt_A} + \left(1 - r_{t_A}^A\right)A^F + \left(\mathrm{t_A} - \mathrm{r^A}\right)\frac{dA^F}{dt_A} - r^A\frac{dA^D}{dt_A} - r_{t_A}^A A^D + \mathrm{t_L}\frac{dW}{dt_A} - (c_D + mpc \cdot H_{\bar{D}})\frac{dD}{dt_A} - (c_N + mpc \cdot H_{\bar{N}})\frac{dN}{dt_A} + mpc \cdot H_{\bar{P}}\frac{d\bar{P}}{dt_A} + MEG_{r^M M}\frac{dr^M}{dt_A} \quad \text{(A.4)}$$

Defining the following elasticities:

$$\eta_{AA} = \frac{\partial A^D}{\partial t_A}\frac{(p_A + t_A)}{A},\ \eta_{DA} = \frac{\partial D}{\partial t_A}\frac{(p_A + t_A)}{D} \quad \text{(A.5)}$$

Noting that $\frac{dD}{dt_A}\Big/\frac{dA^D}{dt_A} = D\eta_{DA}/A\eta_{AA}$, $\frac{dP}{dt_A}\Big/\frac{dA^D}{dt_A} = P\eta_{PA}/A\eta_{AA}$, $\frac{dN}{dt_A}\Big/\frac{dA^D}{dt_A} = N\eta_{NA}/A\eta_{AA}$, $A^D\Big/\frac{dA^D}{dt_A} = \frac{p_A + t_A}{\eta_{AA}}$, and denoting $PV = r^M M_{A^D} + (r^M M_D + r^D - t_D)\frac{D\eta_{DA}}{A\eta_{AA}} + (r^M M_N + r^N - t_N)\frac{N\eta_{NA}}{A\eta_{AA}} + (r^M M_P + r^P)\frac{P\eta_{PA}}{A\eta_{AA}} + r^A + (c_D + mpc \cdot H_{\bar{D}})\frac{D\eta_{DA}}{A\eta_{AA}} + (c_N + mpc \cdot H_{\bar{N}})\frac{N\eta_{NA}}{A\eta_{AA}} + mpc \cdot H_{\bar{P}}\frac{P\eta_{PA}}{A\eta_{AA}} + r_{t_A}^A\frac{p_A + t_A}{\eta_{AA}}$, (A.4) can be expressed as:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + MEG_{r^M M}\frac{dr^M}{dt_A} + \mathrm{t_L}\frac{dW}{dt_A} + \left(1 - r_{t_A}^A\right)A^F + \left(\mathrm{t_A} - \mathrm{r^A}\right)\frac{dA^F}{dt_A} \quad \text{(A.6)}$$

In order to obtain marginal labor supply effects $\frac{dW}{dt_A}$, induced by the increase in alcohol tax, at first labor supply function from (A.1) is defined as $L = f(t_L, r^M, \bar{D}, \bar{N}, \bar{P}, G^T)$. Noting that while consumer takes $\bar{D}$, $\bar{N}$ and $\bar{P}$ as given, equilibrium values of these variables are the private choices of consumer herself or himself. Therefore, equilibrium labor supply is a function of only exogenous variables, which means that $L = f(t_L, r^M, G^T)$. Differentiating this function with respect to alcohol tax, while assuming $\frac{dG^T}{dt_A} = 0$, it is obtained[56, 57]:

[56] The first component in (A.7) reflects the fact that alcohol tax reduces health risks and consequently increases on-the-job productivity (it arises from the assumption $\frac{\partial W}{\partial H} < 0$ made in section 3.2.1).

[57] In order to keep the public budget balanced, this thesis assumes that government only adjust r^M or t_L, while holding other variables, including G^T, fixed. In reality, the raise in alcohol tax would probably cause G^T to decrease because reduced level of alcohol misuse reduces alcohol-related transfers (e.g. disability pensions) as well, meaning that $\frac{dG^T}{dt_A} < 0$. However, this would not have any feedback effect on labor supply decisions

$$\frac{dW}{dt_A} = \frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A} + w\frac{\partial L}{\partial t_L}\frac{dt_L}{dt_A} + w\frac{\partial L}{\partial r^M}\frac{dr^M}{dt_A} \quad \text{(A.7)}$$

Differentiating government budget constraint (5) with respect to t_A, allowing t_L to vary while holding r^M fixed:

$$r^M M_{A^D}\frac{dA^D}{dt_A} + (r^D - t_D)\frac{dD}{dt_A} + (r^N - t_N)\frac{dN}{dt_A} + r^P\frac{dP}{dt_A} + \frac{G^T}{dt_A} = A^D + t_A\frac{dA^D}{dt_A} + A^F + t_A\frac{dA^F}{dt_A} - r^A_{t_A}A^D - r^A\frac{dA^D}{dt_A} - r^A_{t_A}A^D - r^A\frac{dA^F}{dt_A} + \mathrm{t_L}\frac{dW}{dt_A} + \mathrm{W}\frac{dt_L}{dt_A} \quad \text{(A.8)}$$

Substituting (A.7) in (A.8) and solving for $\frac{dt_L}{dt_A}$ (still holding r^M fixed), gives:

$$\frac{dt_L}{dt_A} = -\frac{\left(1-r^A_{t_A}\right)\left(A^D+A^F\right)+t_A\left(\frac{dA^D}{dt_A}+\frac{dA^F}{dt_A}\right)-r^A\frac{dA^F}{dt_A}-g^A\frac{dA}{dt_A}+t_L\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A}+w\frac{\partial L}{\partial t_A}\right)}{w\left(L+t_L\frac{\partial L}{\partial t_L}\right)} \quad \text{(A.9)}$$

where $g^A = r^M M_{A^D} + (r^M M_D + r^D - t_D)\frac{D\eta_{DA}}{A\eta_{AA}} + (r^M M_N + r^N - t_N)\frac{N\eta_{NA}}{A\eta_{AA}} + (r^M M_P + r^P)\frac{P\eta_{PA}}{A\eta_{AA}} + r^A$. Substituting (A.7) in (A.6):

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + MEG_{r^M}M\frac{dr^M}{dt_A} + \mathrm{t_L}\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A} + w\frac{\partial L}{\partial t_L}\frac{dt_L}{dt_A} + w\frac{\partial L}{\partial r^M}\frac{dr^M}{dt_A}\right) + \left(1 - r^A_{t_A}\right)A^F + \left(\mathrm{t_A} - \mathrm{r^A}\right)\frac{dA^F}{dt_A} \quad \text{(A.10)}$$

Substituting (A.9) into (A.10) and holding r^M fixed, gives:

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because the reduction in transfer payments rather reflects the fact that there are less injuries and illnesses than decrease in consumers' income level. Therefore it is reasonable to assume here that $\frac{dG^T}{dt_A} = 0$. One could wonder that if $\frac{dG^T}{dt_A} < 0$ then it should at least someway be the part of optimal tax formula. For Pigouvian component this is not the case as this term cancels out (see the derivation of A.4 above). In other words, it is pure transfer being represented in both consumer's and government budgets. It could be the part of revenue-recycling component, though. For example, when one assumes that $\frac{dG^T}{dt_A} = \frac{dG^T}{dA^D}\frac{dA^D}{dt_A} < 0$, alcohol-related transfers could be represented as $\frac{dG^T}{dA^D}$ in g^A. However, considering the results and discussion presented in subchapter 3.2 and 3.3, inclusion of the alcohol-related transfer would only strengthen the main arguments of the thesis to propose imposing higher taxes on alcohol mainly on fiscal purposes.

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + \mathrm{t_L}\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right) - \mathrm{t_L}w\frac{\partial L}{\partial t_L}\left\{\left[\left(1 - r_{t_A}^A\right)(A^D + A^F) + t_A\left(\frac{dA^D}{dt_A} + \frac{dA^F}{dt_A}\right) - r^A\frac{dA^F}{dt_A} - g^A\frac{dA}{dt_A} + t_L\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right)\right] / \left(wL + wt_L\frac{\partial L}{\partial t_L}\right)\right\} + \left(1 - r_{t_A}^A\right)A^F + \left(\mathrm{t_A} - \mathrm{r^A}\right)\frac{dA^F}{dt_A} \quad \text{(A.11)}$$

Defining the following elasticity:

$$\eta_{LL} = \frac{\partial L}{\partial[(1-t_L)w]}\frac{(1-t_L)w}{L} \quad \text{(A.12)}$$

Rearranging the terms in (A.11) and denoting $MEG_{t_L} = -\frac{t_L\frac{\partial L}{\partial t_L}}{L + t_L\frac{\partial L}{\partial t_L}} = \frac{\frac{t_L}{1-t_L}\eta_{LL}}{1 - \frac{t_L}{1-t_L}\eta_{LL}}$, gives:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + MEG_{t_L}\left(\left(1 - r_{t_A}^A\right)A^D + t_A\frac{dA^D}{dt_A} - g^A\frac{dA}{dt_A}\right) + \left(1 + MEG_{t_L}\right)\left[\left(1 - r_{t_A}^A\right)A^F + (t_A - r^A)\frac{dA^F}{dt_A}\right] + \left(1 + MEG_{t_L}\right)wt_L\frac{\partial L}{\partial t_A} + \left(1 + MEG_{t_L}\right)t_L\frac{\partial W}{\partial H}\frac{dH}{dt_A} \quad \text{(A.13)}$$

From Slutsky equations:

$$\frac{\partial L}{\partial t_A} = \frac{\partial L^c}{\partial t_A} - \frac{\partial L}{\partial I}A^D,\ \frac{\partial L}{\partial t_L} = -\frac{\partial L^c}{\partial(1-t_L)\mathrm{w}} - \frac{\partial L}{\partial I}wL \quad \text{(A.14)}$$

Slutsky symmetry property yields:

$$\frac{\partial L^c}{\partial t_A} = -\frac{\partial A^{Dc}}{\partial[(1-t_L)w]} \quad \text{(A.15)}$$

Substituting (A.14) and (A.15) into (A.13):

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + MEG_{t_L}\left(\left(1 - r_{t_A}^A\right)A^D + t_A\frac{dA^D}{dt_A} - g^A\frac{dA}{dt_A}\right) + \left(1 + MEG_{t_L}\right)\left[\left(1 - r_{t_A}^A\right)A^F + (t_A - r^A)\frac{dA^F}{dt_A}\right] + \left(1 + MEG_{t_L}\right)wt_L\left[-\frac{\partial A^{Dc}}{\partial[(1-t_L)w]} - \frac{\partial L}{\partial I}A^D\right] + \left(1 + MEG_{t_L}\right)t_L\frac{\partial W}{\partial H}\frac{dH}{dt_A} \quad \text{(A.16)}$$

Defining the following elasticities:

$$\eta_{AI}^c = \frac{\partial A^D}{\partial[(1-t_L)w]}\frac{(1-t_L)w}{A};\ \eta_{LI} = \frac{\partial L}{\partial I}\frac{(1-t_L)wL}{L} \quad \text{(A.17)}$$

Noting that $-\frac{\partial A^{Dc}}{\partial[(1-t_L)w]} = -\eta^c_{Al}\frac{A^D}{(1-t_L)w}$ and $-\frac{\partial L}{\partial I}A^D = -\eta_{LI}\frac{A^D}{(1-t_L)w}$, it is obtained:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + MEG_{t_L}\left(\left(1 - r^A_{t_A}\right)A^D + t_A\frac{dA^D}{dt_A} - g^A\frac{dA}{dt_A}\right) + \left(1 + MEG_{t_L}\right)\left[\left(1 - r^A_{t_A}\right)A^F + (t_A - r^A)\frac{dA^F}{dt_A}\right] - \left(1 + MEG_{t_L}\right)\frac{t_L A^D}{(1-t_L)}(\eta^c_{Al} + \eta_{LI}) + \left(1 + MEG_{t_L}\right)t_L\frac{\partial W}{\partial H}\frac{dH}{dt_A} \quad \text{(A.18)}$$

Equating (A.18) to zero and rearranging:

$$t_A\left(-\frac{dA^D}{dt_A}\right) = PV\left(-\frac{dA^D}{dt_A}\right) + MEG_{t_L}\left(\left(1 - r^A_{t_A}\right)A^D + t_A\frac{dA^D}{dt_A} - g^A\frac{dA^D}{dt_A}\right) + \left(1 + MEG_{t_L}\right)\left[\left(1 - r^A_{t_A}\right)A^F + (t_A - r^A)\frac{dA^F}{dt_A}\right] - \left(1 + MEG_{t_L}\right)\frac{t_L A^D}{(1-t_L)}(\eta^c_{Al} + \eta_{LI}) + \left(1 + MEG_{t_L}\right)t_L\frac{\partial W}{\partial H}\frac{dH}{dt_A} \quad \text{(A.19)}$$

Dividing both sides of the equation (A.19) by $\left(-\frac{dA^D}{dt_A}\right)$ yields optimal tax formula (6) with $i = t_L$.

Deriving equation (3.6) with $i = r^M$

Differentiating government budget constraint (5) with respect to t_A, holding t_L fixed and allowing r^M to vary:

$$r^M M_{A^D}\frac{dA^D}{dt_A} + M\frac{dr^M}{dt_A} + (r^M M_D + r^D - t_D)\frac{dD}{dt_A} + (r^M M_N + r^N - t_N)\frac{dN}{dt_A} + (r^M M_P + r^P)\frac{dP}{dt_A} + \frac{G^T}{dt_A} = A^D + t_A\frac{dA^D}{dt_A} + A^F + t_A\frac{dA^F}{dt_A} - r^A_{t_A}A^F - r^A\frac{dA^D}{dt_A} - r^A_{t_A}A^D - r^A\frac{dA^F}{dt_A} + \mathrm{t_L}\frac{dW}{dt_A} \quad \text{(A.20)}$$

Substituting (A.7) in (A.20) and solving for $\frac{dr^M}{dt_A}$ (still holding t_L fixed), gives:

$$\frac{dr^M}{dt_A} = -\frac{\left(1-r^A_{t_A}\right)(A^D+A^F) + t_A\left(\frac{dA^D}{dt_A}+\frac{dA^F}{dt_A}\right) - r^A\frac{dA^F}{dt_A} - g^A\frac{dA}{dt_A} + t_L\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right)}{M - wt_L\frac{\partial L}{\partial r^M}} \quad \text{(A.21)}$$

Substituting (A.21) into (A.10), holding t_L fixed, gives:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + MEG_{r^M} M\left\{\left[\left(1 - r_{t_A}^A\right)(A^D + A^F) + t_A\left(\frac{dA^D}{dt_A} + \frac{dA^F}{dt_A}\right) - r^A\frac{dA^F}{dt_A} - g^A\frac{dA}{dt_A} + t_L\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right)\right] / \left(M - wt_L\frac{\partial L}{\partial r^M}\right)\right\} + \mathrm{t_L}\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right) + \mathrm{t_L} w\frac{\partial L}{\partial r^M}\left\{\left[\left(1 - r_{t_A}^A\right)(A^D + A^F) + (t_A - r^A)\left(\frac{dA^D}{dt_A} + \frac{dA^F}{dt_A}\right) - g^A\frac{dA}{dt_A} + t_L\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right)\right] / \left(M - wt_L\frac{\partial L}{\partial r^M}\right)\right\} + \left(1 - r_{t_A}^A\right)A^F + \left(\mathrm{t_A} - \mathrm{r^A}\right)\frac{dA^F}{dt_A} \quad \text{(A.22)}$$

Denoting $\alpha = \frac{\mathrm{t_L} w\frac{\partial L}{\partial r^M}}{M - wt_L\frac{\partial L}{\partial r^M}} = \frac{M}{M - wt_L\frac{\partial L}{\partial r^M}} - 1$:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA^D}{dt_A}\right) + MEG_{r^M}(\alpha + 1)\left[\left(1 - r_{t_A}^A\right)(A^D + A^F) + t_A\left(\frac{dA^D}{dt_A} + \frac{dA^F}{dt_A}\right) - r^A\frac{dA^F}{dt_A} - g^A\frac{dA}{dt_A} + t_L\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right)\right] + \mathrm{t_L}\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right) + \alpha\left[\left(1 - r_{t_A}^A\right)(A^D + A^F) + (t_A - r^A)\left(\frac{dA^D}{dt_A} + \frac{dA^F}{dt_A}\right) - g^A\frac{dA}{dt_A} + t_L\left(\frac{\partial W}{\partial H}\frac{dH}{dt_A} + w\frac{\partial L}{\partial t_A}\right)\right] + \left(1 - r_{t_A}^A\right)A^F + \left(\mathrm{t_A} - \mathrm{r^A}\right)\frac{dA^F}{dt_A} \quad \text{(A.23)}$$

Noting that $MEG_{r^M}(1+\alpha) + \alpha = \left(1 + MEG_{r^M}\right)(1+\alpha)$ and $MEG_{r^M}(1+\alpha) + \alpha + 1 = (1+\alpha)\left(1 + MEG_{r^M}\right) - 1$, rearranging the terms, gives:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = (PV - t_A)\left(-\frac{dA}{dt_A}\right) + \left[\left(1 + MEG_{r^M}\right)(1+\alpha) - 1\right]\left[\left(1 - r_{t_A}^A\right)A^D + t_A\frac{dA^D}{dt_A} - g^A\frac{dA}{dt_A}\right] + \left(1 + MEG_{r^M}\right)(1+\alpha)\left[\left(1 - r_{t_A}^A\right)A^F + (t_A - r^A)\frac{dA^F}{dt_A} + wt_L\frac{\partial L}{\partial t_A} + t_L\frac{\partial W}{\partial H}\frac{dH}{dt_A}\right] \quad \text{(A.24)}$$

To obtain (6) with $i = r^M$, a derivation process identical to deriving (6) with $i = t_L$ is followed. Specifically, see equations from (A.14) to (A.18) above. The only difference concerns multipliers reflecting marginal efficiency gain.

Deriving equation (3.8)

Rearranging (A.6):

$$\frac{1}{\lambda}\frac{dV}{dt_A} = -PV\frac{dA^D}{dt_A} + \left(1 + MEG_{t_L}\right)t_A\frac{dA^D}{dt_A} + MEG_{t_L}\left(\left(1 - r_{t_A}^A\right)A^D - g^A\frac{dA}{dt_A}\right) + \left(1 + MEG_{t_L}\right)\left[\left(1 - r_{t_A}^A\right)A^F + (t_A - r^A)\frac{dA^F}{dt_A}\right] + \left(1 + MEG_{t_L}\right)wt_L\frac{\partial L}{\partial t_A} + \left(1 + MEG_{t_L}\right)t_L\frac{\partial W}{\partial H}\frac{dH}{dt_A} \quad \text{(A.25)}$$

Rearranging (A.19):

$$-PV\frac{dA^D}{dt_A} = -\left(1 + MEG_{t_L}\right)t_{\mathrm{A}}^{*}\frac{dA^D}{dt_A} - MEG_{t_L}\left[\left(1 - r_{t_A}^{A}\right)A^D - g^A\frac{dA}{dt_A}\right] - \left(1 + MEG_{t_L}\right)\left[\left(1 - r_{t_A}^{A}\right)A^F + \left(t_A - r^A\right)\frac{dA^F}{dt_A}\right] - \left(1 + MEG_{t_L}\right)wt_L\frac{\partial L}{\partial t_A} - \left(1 + MEG_{t_L}\right)t_L\frac{\partial W}{\partial H}\frac{dH}{dt_A} \quad \text{(A.26)}$$

When substituting (A.15) into (A.14), most of the terms cancel out and marginal welfare gain is expressed as follows:

$$\frac{1}{\lambda}\frac{dV}{dt_A} = \left(1 + MEG_{t_L}\right)\left(t_A - t_{\mathrm{A}}^{*}\right)\frac{dA^D}{dt_A} \quad \text{(A.27)}$$

Using definition of price elasticity of alcohol from (A.5) and integrating over the entire tax increase, gives (3.8).

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SUMMARY IN ESTONIAN – KOKKUVÕTE

Optimaalne alkoholi maksustamine Eestis

Motivatsioon

Alkohoolsete jookide tarvitamine on saanud avalikkuses väga palju negatiivset tähelepanu, kuna alkoholi loetakse üheks oluliseks riskiteguriks erinevate kahjulike tagajärgede tekkimisel. Sellest johtuvalt on väga paljud teadlased läbi viinud suurel hulgal erinevaid alkoholi mõjudega seotud analüüse. Valdavalt on leitud, et alkohol asetab ühiskonnale suure sotsiaalmajandusliku koormuse (Thavorncharoensap et al., 2009) ning valitsuse sekkumine teatud moel on põhjendatud. Ka Eesti pole selles suhtes erandlik. Mitmed autorid on näidanud alkoholi märkimisväärseid kahjulikke tagajärgi. Eesti uurijate peamine uurimisobjekt on olnud eelkõige alkoholiga seotud haigestumus ja suremus (Lai et al., 2003, Kaasik et al., 2004), aga ka liigtarbimise mõjud tervishoiusektorile (Reinap, 2009). Siiski, alkoholi väärkasutamise mõjud on palju laiaulatuslikumad, mõjutades ka teisi ühiskonna sfääre. Seega, üheks motivatsiooniks väitekirja kirjutamiseks oli täita see oluline lünk vastavas kirjanduses, et jõuda paremale arusaamisele antud probleemist ja võimalikest lahendustest Eesti jaoks.

Rahvusvahelises kirjanduses on tehtud teatavaid üldiseid alkoholipoliitilisi soovitusi. Erinevate autorite poolt on korduvalt ja üsna veenvalt näidatud, et teiste alkoholipoliitiliste alternatiivide hulgas on alkoholi maksustamine nii üks kõige efektiivsemaid kui ka kulu-efektiivsemaid (nt Ludbrook et al., 2002). Isegi Eestis on ühes uuringus jõutud sarnasele järeldusele (Lai et al., 2007). Sedalaadi uuringud näitavad aga üksnes erinevate meetmete mõjusid, suutmata välja pakkuda vastavate meetmete optimaalset taset. Viimane eeldab põhjaliku teoreetilise raamistiku kujundamist. Sellised uuringud on rahvusvahelises kirjanduses suhteliselt harvaesinevad ja puuduvad Eesti kontekstis täielikult, mis oli peamiseks motivatsiooniks väitekirja eesmärgi määratlemisel.

Nendest vähestest kirjanduses ilmunud optimaalse alkoholi maksustamise analüüsidest on enamik rakendanud osalise tasakaalu mudeleid, kus optimaalne maks kõige lihtsamas käsitluses on võrdne alkoholi tarvitamisega kaasneva marginaalse väliskuluga (Pogue ja Sgontz, 1989; Kenkel, 1996). Sedalaadi analüüsid ignoreerivad aga fiskaalseid aspekte, mis on Eesti kontekstis üliolulised. Näiteks moodustasid alkoholi aktsiisitulud 2009 aastal ligikaudu 4% riigieelarve kogutuludest. Väliskulude korrigeerimise ja fiskaalsetel eesmärkidel kehtestatud makse hakati koos ühe mudeli raames analüüsima eelmise sajandi keskpaigas. Eriti levinuks sai see keskkonnapoliitika-alases kirjanduses alles 1990ndatel. Autorile teadaolevalt on alkoholi maksustamist sedalaadi raamistikus analüüsinud üksnes Parry et al. (2009). Kuid ka nimetatud töös on mitmeid edasiarendamist vajavaid aspekte nii üldises plaanis kui ka eraldi Eesti jaoks. Näiteks pole seal arvestatud võimaliku salaturu osakaalu kasvuga aktsiisimaksude tõstmise tagajärjel ega ka võimalusega, et suure osa kohalikul turul müüdavast alkoholist ostavad turistid.

Seega, selleks et saaks anda mingit hinnangut hetkel rakendatava alkoholi aktsiisipoliitika kohta Eestis, on vaja täiendavalt analüüsida nii reaalset olukorda alkoholiturul kui ka välja arendada Eesti oludele kohandatud teoreetiline raamistik ühiskondlikult sobiva aktsiisipoliitika kujundamiseks. Järgnevalt selgitatakse täpsemalt, kuidas antud väitekirjas seda tehakse.

Töö eesmärk, uurimisülesanded ja ülesehitus

Töö eesmärk on hinnata alkoholile kehtestatud aktsiisimäärade optimaalset taset saavutamaks kahte avalikku eesmärki Eestis – korrigeerida välismõjusid ja koguda tulusid valitsusele. Eesmärgi saavutamiseks otsitakse vastuseid järgmistele uurimisküsimustele:

- Kuidas defineerida optimaalsust nende kahe eesmärgi suhtes?
- Kas ingliskeelses kirjanduses rakendatud mudeleid optimaalse alkoholi- ja keskkonnapoliitika hindamiseks saab kasutada ka Eesti jaoks?
- Kuidas peaks mudel olema formuleeritud Eesti jaoks?
- Millised on mudeli rakendamise tulemused üldises plaanis ja konkreetselt Eesti jaoks?

Uurimisküsimustele vastamiseks on püstitatud järgmised uurimisülesanded. *Esimene* nendest puudutab probleemist arusaamist: alkoholiga seotud probleemide sümptomite hindamine ja alternatiivsete sekkumismeetmete analüüs. *Teiseks uurimisülesandeks* on uurida kirjanduses optimaalse alkoholi maksustamise analüüsiks kasutatud mudeleid, et hinnata nende sobivust Eesti jaoks. Kuna antud väitekiri baseerub eksisteerival optimaalse maksustamise alasel kirjandusel, siis võetakse vaatluse alla üksnes selle uurimissuuna nii osalise kui ka üldise tasakaalu mudelid.

Kolmas uurimisülesanne on määratleda empiiriliselt liiklussuremuse ulatus ja selle seotus alkoholiga Eestis. Antud valdkonnale pööratakse väitekirjas erilist tähelepanu mitmel põhjusel. Esiteks, varasemates uuringutes on näidatud, et liiklusõnnetused, sh -suremus, moodustavad märkimisväärse osa alkoholi sotsiaalmajanduslikust koormusest (nt Varney ja Guest, 2002; Johansson et al., 2006). Teiseks, paljud autorid on näidanud, et alkoholi maksustamine on efektiivne meede liikluskahjude kontrollimiseks (Grossman ja Saffer, 1986; Wagenaar, 2010). Mõlemad viitavad sellele, et alkoholi maksude optimaalne tase sõltub otseselt olukorrast liikluses. Varasemates optimaalse alkoholi maksustamise kirjanduses ongi joobes juhtimist peetud üheks olulisemaks välismõjuks, mida maksupoliitika on kujundatud kontrollima (nt Kenkel, 1996; Parry et al., 2009). Lisaks nendele kahele põhjusele pöörab antud väitekiri liiklussurmadele erilist tähelepanu selleks, et tuua eraldi välja jalakäijate roll alkoholiga seotud liiklusõnnetuste põhjustamisel. Täpsemalt, kuigi empiiriliselt on sageli näidatud, et hukkunud jalakäijate hulgas on joobes isikuid isegi rohkem kui hukkunud sõidukijuhtide hulgas, pole sellele faktile varasemad poliitikauuringud erilist tähelepanu pööranud. Kuna antud töös seda tehakse, ongi

liikluses toimuv vaja võtta spetsiaalse vaatluse alla. Lõpetuseks, kuna liiklusõnnetused ja nende tagajärjed on olnud üheks olulisemaks ühiskondlikuks probleemiks Eestis terve viimase aastakümne jooksul, on liiklussurmade analüüs sobiv lähtekoht väitekirja empiiriliseks analüüsiks.

Neljandaks uurimisülesandeks on hinnata alkoholi sotsiaalsete kulude taset ja struktuuri Eestis. See on vajalik, kuna alkoholi väärkasutamise rahas väljendatud kuluhinnangud on peamised sisendid maksustamise optimaalse taseme hindamisel. Antud uurimisülesande raames hinnatakse alkoholi otseseid kulusid nii tervishoiusektorile, kriminaal-justiitssüsteemile, kindlustussektorile, aga ka kaudseid kulusid kaotatud produktiivsuse näol. *Viies uurimisülesanne* on välja arendada teoreetiline mudel, mille baasil tuletada valem optimaalse alkoholi maksutaseme hindamiseks Eestis. Selleks kasutatakse varasemalt kirjanduses rakendatud mudeleid, kuid kohandatakse neid Eesti tingimustele, võttes arvesse vastavaid eripärasid. *Kuuenda uurimisülesandena* parameteriseeritakse mudel ning simuleeritakse alkoholi maksustamise optimaalse taseme hinnangud. Olulise sisendina kasutatakse siinkohal antud väitekirjas läbiviidud empiirilisi uuringuid aga ka rahvusvahelisi empiirilisi uuringuid.

Väitekiri koosneb kolmest peatükist. Esimeses antakse ülevaade teoreetilisest ja empiirilisest tagapõhjast, täites kahte esimest uurimisülesannet. Teises peatükis viiakse läbi kaks empiirilist uuringut, mis on seotud kolmanda ja neljanda uurimisülesande täitmisega. Kaks viimast uurimisülesannet täidetakse kolmandas peatükis.

Teoreetiline ja empiiriline tagapõhi

Akadeemilises kirjanduses on alkohol saanud oluliseks uurimisobjektiks eelkõige seoses alkoholiga seotud negatiivsete tagajärgedega. Alkoholi optimaalse maksustamise kontekstis, eelkõige maksupoliitika mõjude hindamise aspektist, on vaja need mõjud kvantifitseerida ja hinnata nende rahalist väärtust. Tervisemõjude kvantifitseerimiseks kasutatakse kõige sagedamini meetodit, mille korral kombineeritakse hinnanguid alkoholi suhtelisest mõjust tervisele ehk relatiivset riski alkoholi tarbimiskogustega, et tuletada koefitsient, mis näitab osakaalu tagajärgedest, mida saab lugeda alkoholist tingituks (ing k *alcohol attributable fraction*) (nt English et al., 1995). Erinevate akuutsete tagajärgede, aga ka kriminaalse käitumisega seotud tagajärgede kvantifitseerimisel lähtutakse enamasti joobes isikute osakaalust ohvrite või ründajate hulgas. Tehakse ka kliinilisi uuringuid, selgitamaks kas hukkunul olid maksakahjustused, ja kvalitatiivseid uuringuid nagu intervjuud kuritegude sooritajatega.

Mõjudele rahalise väärtuse andmiseks on kõige sagedamini kasutatud haiguskulu (ing k *cost-of-illness,* edaspidi COI) lähenemist (vaata Single et al., 2003). Selle raames hinnatakse sotsiaalsest vaatenurgast lähtudes kulusid võrreldes hüpoteetilise olukorraga, kui maailmas poleks alkoholi. COI raamistikku rakendades on erinevates riikides läbiviidud uuringutega hinnatud, et alkoholiga seotud majanduslik koormus jääb suurusjärku, mis on võrreldav

1–2%-ga SKP-st (Thavorncharoensap et al., 2009). Eestis on varem hinnatud üksnes vigastussuremuse ja terviseriskidega seotud kulusid, mille ulatus jääb suurusjärku 1% SKP-st (Kaasik et al., 2004; Reinap, 2009). Lisaks on käesoleva väitekirja autori poolt läbiviidud uuring 2006. aasta kohta, mis on täiendatud kujul esitatud ka väitekirja teises peatükis (Saar, 2009). Kulude tasemeks hinnati seal 1,6–2,3% SKP-st.

Olulised negatiivsed mõjud on olnud piisavaks põhjenduseks valitsusel rakendada alkoholipoliitikat. Samas seisab valitsus silmitsi väga erinevate alternatiivsete sekkumismeetmetega alates kättesaadavuse piiramisest ja lõpetades meediakampaaniatega. Siiski, paljude uuringutega on üsna veenvalt tõestatud, et maksupoliitika on üks kõige efektiivsemaid ja ka kuluefektiivsemaid meetmeid alkoholi tarvitamise piiramiseks. Sellele vaatamata on Eestis kuni aastani 2008 rakendatud alkoholi aktsiisipoliitika olnud suhteliselt passiivne. Selle tagajärjel on alkohoolsete jookide ostujõud mõõdetuna keskmise palga ja alkohoolsete jookide keskmise hinna suhtena kasvanud perioodil1998–2008 rohkem kui kaks korda. Kuigi Eesti on Euroopa Liidu liige ja peab järgima Euroopa Komisjoni poolt kehtestatud alammäärasid, pole need mingit survet tekitanud, kuna aktsiiside tase Eestis ületab need pea et kahekordselt. Alates 2008. aastast on Eesti valitsus siiski tõstnud aktsiismäärasid kokku rohkem 50%, mis on peatanud ka inimeste alkohoolsete jookide ostujõu kasvu. Samas on ilmne, et valitsusel puudub põhjalikult läbikaalutud aktsiisipoliitika ja viimaste aastate maksutõusud on olnud rohkem seotud eelarvedefitsiidi vähendamisega kui mingi pikaajalise strateegia elluviimisega.

Empiirilised uuringud kinnitavad aga, et aktsiisipoliitika abil võib saavutada märkimisväärseid tulemusi alkoholi väärkasutamise kontrollimisel. On korduvalt hinnatud, et alkoholi nõudluse hinnaelastsuse koefitsient on väiksem kui null ja jääb vahemikku –0.3 kuni –1.5 (nt Elder et al., 2010). Ka alkoholi hinna ja alkoholi tarvitamisega seotud tagajärgede vahelist negatiivse seose kohta on kirjanduses piisavalt empiirilist tõendusmaterjali. Tagajärgede all on siinkohal mõeldud liiklusõnnetusi (Wagenaar et al., 2010), vägivalda (Wagenaar et al., 2010; Grossmann and Markowitz, 1999), tapmisi (Andreasson et al., 2006), isikuvastaseid ründeid, alkoholi sõltuvust (Farrell et al., 2003), maksatsirroos (Elder et al., 2010), alkoholist tingitud haigustega seotud suremust (Wagenaar et al., 2009).

Eelpool esitatud empiiriliste uuringute tulemuste baasil ei saa aga midagi järeldada optimaalse alkoholi aktsiisipoliitik kohta. Viimane eeldab teoreetilise mudeli väljaarendamist, mis võimaldaks defineerida optimaalsust. Majanduskirjanduses rakendatakse optimaalsuse kriteeriumina kõige sagedamini Pareto efektiivsuse kontseptsiooni, mis kehtib ka optimaalse alkoholi maksustamise kirjanduse kohta. Ökonomistid on näidanud, et teatud tingimustel suudab turumajandus sellele kriteeriumile ka vastata. See eeldab järgmist: (a) palju ostjaid ja müüjaid, nii et keegi ei avalda turuhinnale olulist mõju; (b) homogeensed kaubad, mistõttu kõik müüjad on hinnavõtjad; (c) madalad turule sisenemis- ja väljumisbarjäärid, mistõttu firmad teenivad üksnes normaalkasumeid; (d) turuosalistel on täielik info hindade ja toodete kohta; (e) puuduvad välismõjud.

Alkoholiturud ei vasta eelkõige kahele viimasele tingimusele. Täpsemalt, kuna alkoholi tarvitamisega tekitatakse teistele isikutele mitmeid negatiivseid mõjusid, mida alkoholi hind ei peegelda, osutub turumajanduse tingimustes alkoholi tarbimine ebaefektiivselt suureks. Sama juhtub mittetäieliku informatsiooni korral, kui tarbijad ei tea alkoholi tarvitamisega seotud riske. Näiteks ei pruugi neil olla infot selle kohta, millistesse haigustesse haigestumise riski alkoholi tarvitamine suurendab. Mõlemal juhul osutub turg ebaefektiivseks ja on põhjendatud valitsuse sekkumine turutõrgete korrigeerimiseks.

Pigou (1920) pakkus juba pea et sada aastat tagasi välja lahenduse välismõjude korrigeerimiseks, mis on kujunenud laialt aktsepteeritud põhimõtteks ka kaasaja majandusteaduses. Selle järgi on alkoholile kehtestatud optimaalne maksumäär võrdne alkoholi marginaalse väliskuluga. Sellega saavutatakse see, et alkoholi hind peegeldab alkoholi reaalset kulu ühiskonnale ning alkoholi tarbimine langeb efektiivsele tasemele, kus tema sotsiaalne piirkulu on võrdne sotsiaalse piirkasuga. Kui infotõrgete tõttu ei suuda inimesed arvesse võtta kõiki alkoholi tarbimisega seotud riske, siis tarbivad nad samuti liiga palju. Ka seda probleemi saab korrigeerida maksupoliitikaga – maksumäär peaks olema võrdne marginaalse väliskulu ja marginaalse intenaliseerimata sisemise kulu summaga.

Pigou reeglit on kirjanduses edasi arendatud arvestamaks ka moonutustega, mida maks tekitab mõõdukalt alkoholi tarbijate käitumises. Sellest lähtuvat on arendatud mudeleid, kus on vähemalt kahte tüüpi tarbijaid – mõõdukalt tarvitajad ja liigtarvitajad – ning optimaalne maksumäär maksimeerib väliskuludes langusest saadavate efektiivsuskasude ja tarbimismoonutustest tekkiva efektiivsuskulu vahe. Kirjeldatud raamistikku on optimaalsete maksude empiiriliseks hindamiseks kasutanud mitmed uurijad USA-s (nt Kenkel,1996; Pogue ja Sgontz, 1989). Kasutades sisendina alkoholi sotsiaalsete kulude hinnanguid, on näidatud, et kehtivad maksumäärad USA-s on märkimisväärselt madalamad Pigou tasemest.

Maksustamise põhieesmärgiks on tulude kogumine valitsusele, mis pakub täiendavaid aluseid ka alkoholi maksustamiseks. Nimelt, samuti klassikaliseks optimaalse maksustamise printsiibiks majanduskirjanduses on kujunenud Ramsey (1927) poolt pakutud reeglid kaupade maksustamisel. Nimelt näitasid Corlette ja Hague (1957) Ramsey (1927) analüüsile tuginedes, et võrreldes teiste kaupadega peaks vaba aja täiendkaupadele kehtestama kõrgemad maksumäärad. Loogika seisneb selles, et kui ühtlase määraga kaupade maksustamine tekitab moonutusi indiviidide valikutes vaba aja ja töötamise vahel, siis maksustades vaba aega läbi vabal ajal tarbitavate kaupade nagu alkohol, on võimalik seda moonutust korrigeerida.

Suhteliselt uus uurimissuund optimaalse maksustamise kirjanduses on turismi maksustamine. Kuna alkoholi tarbivad suures koguses ka turistid, eriti riikides, kus alkoholi hind on suhteliselt madal, on võimalik valitsusel osa maksutuludest koguda turistidelt. Turismi maksudel on üks väga oluline omadus võrreldes tavapäraste maksudega, mille kehtestamine tekitab üldjuhul alati teatud ulatuses moonutuskulusid – valitsus saab maksutulusid ilma

turumoonutusi tekitamata, sest maksustamisest tingitud turistide käitumise moonutused ei avalda oma riigi kodanike heaolule mingit negatiivset mõju.

Kuni 20. sajandi keskpaigani analüüsiti nii välismõjude maksustamist kui ka tulude eesmärgil tarbimise maksustamist eraldi. Samas praktikas eksisteerivad mõlemat tüüpi maksud üheaegselt. Lisaks tarbimismaksudele eksisteerivad ka veel teised maksud, näiteks erinevad tulumaksud. Esimestena andsid tõuke kahe uurimissuuna ühendamiseks Tullock (1967) ja Sandmo (1975). Kuid aktiivsem selleteemaline arutelu sai alguse alates 1980ndatest Nicholsi (1984), Terkla (1984), Lee ja Misioleki (1986) ja Pierce (1991) töödega keskkonnapoliitika alases kirjanduses. Põhiline väide nendes töödes seisnes selles, et kuna Pigou maksu rakendamisega kogutakse ka maksutulusid, mida autorid tõlgendasid lisakasuna välismõjude korrigeerimise kõrval, võimaldavad need vähendada teisi makse, eelkõige tööjõumakse, ja sel moel maksusüsteemi poolt tekitatud moonutuskulu vähendada. Sellest tulenevalt hakati seda lähenemist nimetama ka topeltdividendi teooriaks (ing k *double dividend theory*). Seega, optimaalne keskkonnamaks võib olla oluliselt kõrgem kui Pigou' reegel soovitab.

Hilisemates töödes näitasid aga Bovenberg ja Ploeg (1992), Bovenberg ja Mooji (1994) ja Bovenberg ja Goulder (1994) üldise tasakaaluga mudelites, et varasemas kirjanduses, kus kasuti osalise tasakaaluga mudeleid, vaadati mööda ühest olulisest aspektist. Täpsemalt, maksustades välismõjusid tekitavaid kaupu ning kui need kaubad on sisendiks ka teistele kaupadele (mis keskkonnamõjusid tekitavate kaupadega sageli nii on), siis tõstavad sellised maksud ka teiste tarbimiskaupade hinnataset ja vähendavad seeläbi tarbijate reaalpalka. See aga võimendab eelnevalt kehtestatud tööjõumaksude poolt tekitatud moonutusi indiviidide valikutes töö ja vaba aja vahel. Sellest tulenevalt võib optimaalne maks osutuda hoopis madalamaks kui Pigou' maks ehk marginaalne väliskulu.

Antud väitekirja kontekstis on oluline märkida, et Parry (1995) oli esimene, kes dekomponeeris varasemates töödes esitatud optimaalse maksu valemi eraldi kolmeks osaks – Pigou maks, tulu taas-ringluse komponent ja maksu vastastoime komponent. Esimene võrdub klassikalise Pigou maksumääraga ehk marginaalse välise piirkuluga. Teine näitab efektiivsuse kasvu, mis tuleneb kogutud maksutulude kasutamisest tulumaksu alandamiseks. Efektiivsuskasv tuleneb siin moonutuste vähenemisest tööjõuturul. Kolmas komponent näitab muutusi majanduslikus efektiivsuses tulenevalt sellest, kas maksustatav kaup on vaba aja täiend- või asenduskaup. Kui tegemist on täiendkaupadega, siis tööjõupakkumine maksustamise tagajärjel suureneb. Teisisõnu, keskkonnamaks vähendab moonutusi tööjõuturul, mida on põhjustanud eelnevalt kehtestatud tööjõumaks. Kui aga tegemist on asenduskaupadega, võivad tööturul eksisteerivad moonutused võimenduda, kuna tööjõupakkumine alaneb veelgi. Kui Pigou ja tulu-taasringluse komponendid leiti keskkonnapoliitika alases kirjanduses olevat positiivsed, siis maksu vastastoime komponent negatiivne ja absoluutväärtuselt suurem tulu-taasringluse komponendist (sest keskkonnamaksude maksubaas on kitsam kui tööjõumaksul). Seega, optimaalne maks osutub väiksemaks kui Pigou maks. Samas, sellisele tulemusele viis järgmine eeldus: kõik kaubad on võrdselt asendatavad vaba ajaga. On ilmne, et sellisel

eeldusel pole Ramsey printsiipidel ühe kauba kõrgem maksustamine otstarbekas.

Alkoholi puhul on põhjust arvata, et ta on vaba aja täiendkaup. Seda on empiiriliselt hiljuti näidanud ka West ja Parry (2009). Sellisel juhul võib kirjeldatud mudeli baasil hinnatud optimaalne maksutase osutuda oluliselt kõrgemaks Pigou maksust. Parry et al. (2009) seda USA-s ka näitasid. Autorid võtsid aluseks keskkonnapoliitika alases kirjanduses välja arendatud mudeli, kuid tegid sinna mõned olulised täiendused. Esiteks eeldati, et alkoholi maksustamine peaks tõstma alkoholi tarbijate produktiivsust töökohal, mis lisas optimaalse maksu valemisse täiendava komponendi – produktiivsuse komponendi. Teiseks, kuna alkoholi maksustamine vähendab lisaks tervishoiukuludele ka kriminaaljustiitssüsteemi kulusid, liiklusõnnetustega seotud varalist kahju, laiendati mudelis valitsuse eelarvet erinevate kulukomponentidega ning lisati ka kindlustussektor. Eeldades ka ratsionaalseid tarbijaid ja täielikku konkurentsi, hinnati, et samal ajal kui tegelik maksumäär USA-s on 24 dollarit ühe galloni puhta alkoholi kohta, jääb optimaalne maks erinevate stsenaariumite korral vahemikku 68 kuni 799 dollarit.

Kuigi Parry et al. (2009) poolt väljaarendatud mudelil on teatavad piirangud, sobib selle baaskuju rakendamiseks ka antud väitekirjas püstitatud eesmärgi saavutamiseks. Esiteks, optimaalsus on defineeritud üksnes efektiivsus-põhiselt ning baseerub turutõrgete kontseptsioonil. Lisaks võtab see erinevalt osalise tasakaalu mudelitest arvesse ka alkoholi maksu fiskaalseid efekte. Täpsemalt, optimaalsuse kriteeriumi võiks defineerida järgmiselt: optimaalne maksutase saavutatakse, kui maksimeeritakse tarbija kasulikkus, maksimeerides alkoholi välismõjude korrigeerimisest ning alkoholi maksu kehtestamisest tingitud tööturumoonutuste vähenemisest saavutatud efektiivsuse juurdekasv. Kuna Eesti majandus on turumajanduspõhine ning ka valitsus viib ellu maksumoonutusi minimeerivat maksupoliitikat, sobib see lähenemine nii Eesti majanduse üldise funktsioneerimise loogikast kui ka omab olulist poliitilist tähtsust. Mõnevõrra problemaatiline võib tunduda Parry et al. mudeli eeldus täieliku konkurentsi kohta, kuna alkoholi turg Eestis on suhteliselt kontsentreeritud. Samas on mitmeid põhjuseid, et uskuda konkurentsi toimimist olulises ulatuses ka Eesti alkoholisektoris. Täpsemalt, kuna Eesti on väike avatud majandus, pakuvad kohalikele suurtootjatele olulist konkuretsi importtootjad. Teiseks, Eestis on väga suur arv jaemüüjaid, mistõttu valitseb jaeturul tõenäoliselt täieliku konkurentsiga sarnane olukord. Kolmandaks, kuigi alkoholiturg meenutab pigem oligopoli, on teoreetilises kirjanduses näidatud, et ka selline turg võib teatud juhtudel sarnaneda täieliku konkurentsi turuga.

Empiirilised uuringud

Antud väitekirjas viidi läbi kaks empiirilist uuringut. Esimene nendest keskendus liiklussuremusele Eestis, et teha kindlaks surmade seos alkoholiga erinevate liiklejate lõikes ning tuletada see osa surmadest, mida saab lugeda välisteks – st ohver polnud ise õnnetuses süüdi. Andmed saadi Eesti Kohtuarstliku Ekspertiisibüroo lahanguaruannetest perioodi 2000–2002 kohta. Uuring hõlmas 512 hukkunu andmeid vanuses 15–64 aastat, mis moodustab 97% kõigist valitud vanusegrupi hukkunutest sellel perioodil. Analüüsimeetodina kasutati Student t-testi keskmiste ja hii-ruut testi proportsioonide erinevuste hindamiseks. Lisaks hinnati ka mitmeid binaarseid tingimuslikke logit mudeleid tuvastamaks tegureid, mis prognoosivad joobes seisundit hukkunute hulgas.

Tulemustest väärivad kindlasti esiletoomist järgmised aspektid. Esiteks, perioodil 2000–2002 64% liikluses hukkunutest olid joobes. Teiseks, jalakäijate hulgas oli joobes hukkunute osakaal selgelt kõrgem kui sõidukijuhtide hulgas. Erinevad logit mudelid paljastasid täiendavalt, et kui hukkunu oli mees, hukkunud maanteel toimunud õnnetuses ja ei viibinud õnnetuse hetkel mootorsõidukis, on selgelt tõenäolisem, et ta oli joobes. Kasutades väga spekulatiivset ja intuitiivset meetodit, hinnati antud empiirilises uuringus ilmnenud empiirika baasil, et 13,5% kõigist liiklussurmadest saab pidada alkoholi välismõjudeks.

Teises uuringus hinnati alkoholi liigtarvitamisest tingitud majanduslikku koormust ühiskonnale 2006 aastal. Selleks kasutati laialt aktsepteeritud niinimetatud haiguskulu (ing k *cost-of-illness*) lähenemist. See meetod baseerub alternatiivkulu kontseptsioonil – arvesse võetakse üksnes kulud, mis tekivad alkoholist tingitud ressursside kasutamisega, ignoreerides eri tüüpi alkoholiga seotud siirdeid ühiskonna sees. Lisaks, ka kulud, mida kompenseerivad alkoholi tarvitamisest saadavad kasud, jäävad arvestusest välja. Samas kulud, mis pole kasudega kompenseeritud, võetakse arvesse. Sellest põhimõttest lähtuvalt hinnatakse ka alkoholist tingitud suremuse kulusid, kuna eeldatakse, et isikud pole suutelised suremisriske arvesse võtma ja neid kasudega kõrvutama. Antud väitekirjas rakendatakse kulude hindamisel levimus-põhist metoodikat, võttes arvesse kõik 2006 aastal tekkinud kulud, sõltumata sellest millal vastava tagajärje põhjustanud alkoholi tarvitamine aset leidis. Mis puudutab osakaalusid, mis näitavad, kui suur osa erinevatest negatiivsetest tagajärgedest omistatakse alkoholile, rakendati väga konservatiivset strateegiat – varasemas Eesti ja rahvusvahelises kirjanduses erinevatele vanuserühmadele ja soole rakendatud erinevatest osakaaludest kasutati antud uuringus ühte ja kõige madalamat osakaalu. Lisaks, arvesse on võetud ainult rahas mõõdetavad mõjud, ignoreerides mittemateriaalseid mõjusid nagu valu ja kannatus. Hinnati seitset kulukomponenti: otsesed kulud tervishoiu- ja kriminaaljustiitssüsteemile ning liiklusõnnetustega seotud varaline kahju ja kaudsed kulud enneaegsest suremusest, vangistusest, ajutisest ja püsivast töövõimetusest ning madalamast tööjõu produktiivsusest töökohal. Kulude hindamisel võetu arvesse ka kasusid, mis tekivad seoses sellega, et alkoholi tarvitamine vähendab teatud haiguste levikut. Seega kulud on väljendatud netokuludena. Siiski tuleb tõdeda, et kuna

paljusid alkoholiga seotud kasusid on keeruline rahasse ümber arvutada, on antud uuring orienteeritud eelkõige kulude hindamisele.

Analüüsi käigus selgus, et majanduslik koormus alkoholi väärkasutamisest 2006 aastal ulatub 230–329 miljoni euroni, mis võrdluses SKP-ga ulatub 1,7–2,5%-ni SKP nominaalväärtusest. 75% nendest kuludest on kaudsed, millest omakorda 80% on seotud enneaegse suremusega. Mis puudutab otseseid kulusid, siis kriminaaljustiitssüsteem kannab nendest poole, tervishoiusüsteem kümnendiku ja kolmandik on seotud liiklusõnnetustest tingitud varalise kahjuga. Uuringu tulemusi kasutati ka selleks, et tuletada optimaalne alkoholi maksumäär rahvusvahelises kirjanduses rakendatud osalise tasakaalu mudeli baasil. Pogue ja Sgontzi (1989) mudelile sarnases analüüsiraamistikus hinnati, et Pigou maks alkoholile erinevate stsenaariumite korral jääb vahemikku 1,6 eurot kuni 9,9 eurot ühe liitri puhta alkoholi kohta 2006 aastal. Stsenaarium, mis antud töös eeldati olevat kõige täpsem, andis tulemuseks 3,9 eurot liitri puhta alkoholi kohta, võrreldes 2006. aastal kehtiva 7,0 euroga liitri kohta.

Teoreetiline mudel ja selle simulatsioon

Optimaalsete alkoholi maksu taseme hindamiseks üldise tasakaalu raamistikus arendati edasi Parry et al. (2009) mudelit, milles tehti peamiselt neli täiendust. Esiteks, eristatakse kohalike ja turistide alkoholi tarbimist, kuna turistide tarbimine moodustab ligikaudu veerandi Eestis müüdavast alkoholist. Teiseks eeldatakse, et alkoholi maksumäära tõusuga vajab Maksu- ja Tolliamet rohkem ressursse maksusüsteemi administreerimiseks seoses võimaliku salaturu mahu kasvuga. Kolmandaks eeldatakse, et kui valitsus suurendab avalikke tervishoiukulutusi, mõjutab see teatud määral indiviidide tööjõu pakkumise otsuseid. See võimaldab anda hinnangut aktsiisipoliitikale, mille korral täiendavate maksutuludega suurendatakse kulutusi, mitte ei alandata teisi makse. Neljandaks kaasatakse alkoholi välismõjudena mudelisse lisaks joobes juhtimisele ka avalik alkoholi tarvitamine ning isikuvastased ründed. Esimese puhul peetakse silmas nii Alkoholiseaduses kehtestatud alkoholi tarbimise keeldu avalikus kohas ja avalikku kohta ilmumist joobeseisundis inimväärikust solvaval viisil, aga ka Liiklusseaduses sätestatud liikluseeskirjade rikkumist joobes jalakäijate poolt. Mudelil on järgmised baaseeldused:

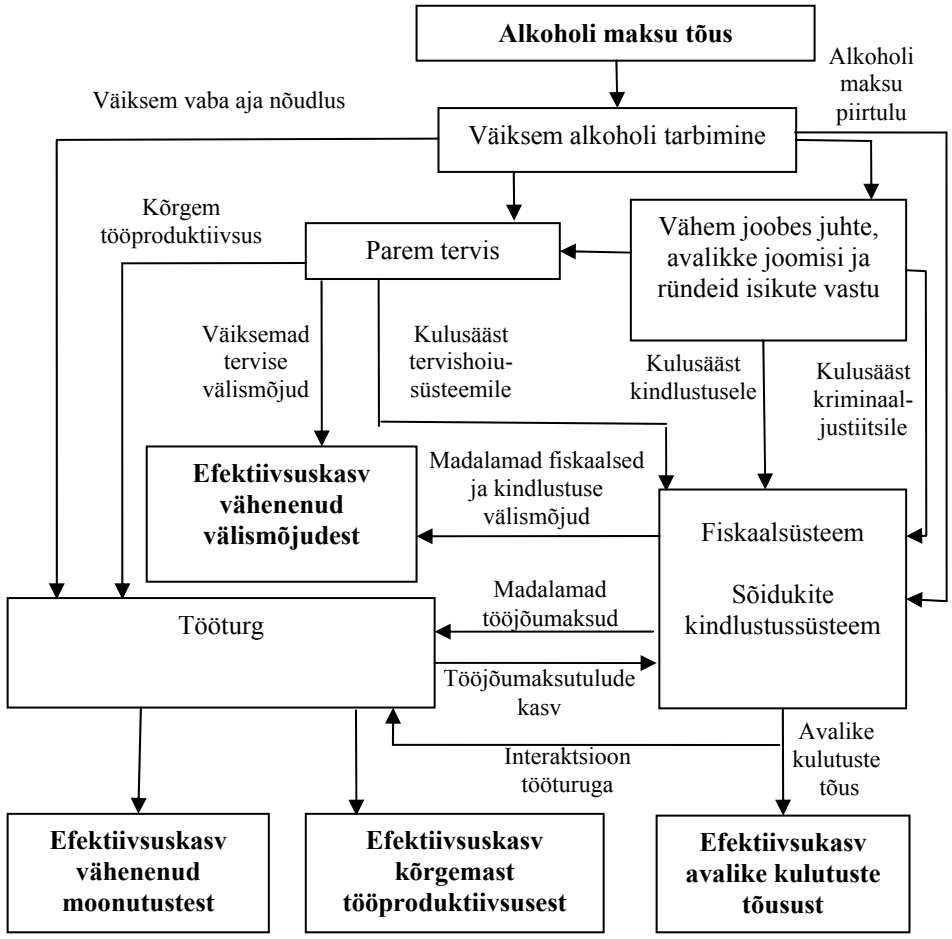
- representatiivne tarbija esindab agregatsiooni kõigist majapidamistest;
- tarbija on ratsionaalne, suutes muuhulgas arvesse võtta kõiki alkoholi tagajärgi (haigused, sõltuvus jne);
- lisaks alkoholi tarbimisele saab tarbija kasulikkust ka vabast ajast, erinevatest ebaseaduslikest tegevustest; tema heaolu vähendavad mitterahalised karistused ebaseaduslike tegevuste sooritamise eest ning erinevad terviseriskid (põhjustatud nii enda kui teiste alkoholi liigtarvitamisest);
- representatiivne tarbija saab tööjõutulusid ning rahalisi siirdeid valitsuselt, kulutused jagunevad viie kulukomponendi vahel – kulutused

alkoholile, teistele kaupadele, liikluskindlustusmaksetele, rahatrahvide maksmisele nii joobes mootorsõiduki juhtimise kui ka alkoholi avaliku tarbimise eest;
- majanduses valitseb täielik konkurents, mis tähendab, et firmad teenivad üksnes normaalkasumit ja alkoholi maksud kanduvad 100%-liselt edasi alkoholi hindadesse;
- fiskaalsüsteemi, läbi mille tehakse majapidamistele rahalisi siirdeid ning finantseeritakse tervishoiu- ja kriminaaljustiitssüsteeme, finantseeritakse läbi tööjõu maksu, alkoholi maksu ja rahaliste trahvide ning valitsus hoiab oma eelarvet tasakaalus;
- maksimeerides representatiivse tarbija kasulikkust, ignoreeritakse poliitika mõjusid väliskodanike (turistidele) heaolule.

Seega, valitsuse eesmärgiks on kehtestada alkoholile maks, mis maksimeeriks tarbija kasulikkuse, hoides samal ajal oma eelarve tasakaalus ning maksu kehtestamisest tingitud muutused eelarvetuludes ja –kuludes neutraliseeritakse kas tööjõumaksude või tervishoiukulutuste muutmise kaudu. Selliste eelduste korral on alkoholi maksul järgmised mõjud representatiivse tarbija heaolule (vt joonis 1). Esiteks, kuna alkoholi maksu tõus alandab alkoholi tarbimist, vähenevad nii alkoholiga seotud haigused kui ka ebaseaduslikud tegevused (joobes juhtimine, avalikud joomised, ründed). Seoses viimasega vähenevad ka alkoholi tarvitajate poolt teiste indiviidide tervisele põhjustatud negatiivsed välismõjud, mida käsitletakse efektiivsuse kasvuna. Teist tüüpi efektiivsuskasv tuleneb eelnevalt tööturul eksisteerivatest tööjõumaksude poolt põhjustatud maksumoonutustest, mis alkoholi maksu tõttu vähenevad. See juhtub, kuna alkoholi maks vähendab vaba aja nõudlust (eeldusel, et alkohol ja vaba aeg on täiendkaubad), aga ka seetõttu, et valitsus kasutab täiendavaid maksutulusid ja kulusääste tööjõumaksu alandamiseks. Kui valitsus kasutab paranenud eelarvepositsiooni avalike kulutuste suurendamiseks, siis paraneb efektiivsus selle kanali kaudu. Muidugi eksisteerib alati võimalus, et valitsus teeb kulutusi ebaefektiivselt ja majandusliku efektiivsuse kasv jääb saavutamata. Efektiivsuskasv kõrgemast tööproduktiivsusest tuleneb aga sellest, et kuna vähenenud alkoholi tarvitamine parandab inimeste tervislikku seisundit, siis on nad ka tööl efektiivsemad.

Matemaatiliselt lahendatakse kirjeldatud mudel kaudse kasulikkuse funktsiooni maksimeerimise teel, mis annab viiest komponendist koosneva optimaalse alkoholimaksu võrrandi. Esimene on Pigou maks, mis võrdub marginaalse väliskuluga. Osalisele tasakaalule tuginevad mudelid üksnes seda komponenti hindavadki. Teine on tulu taasringluse komponent, mis väljendab efektiivsuskasvu, mis tuleneb nii suurenenud maksutulude kui ka vähenenud alkoholiga seotud eelarvekulude kasutamisest kas tulumaksu langetamiseks või tervishoiukulutuste suurendamiseks. Kolmas on väliskasu komponent, mis peegeldab turistide ostudelt kogutud maksutulude kasutamisest saadavaid kasusid. Tulud turistidepoolsetelt ostudelt erinevad kohalike elanike poolt sooritatud ostudelt kogutud maksutuludest heaolukontekstis eelkõige selle poolest, et kui viimaste

puhul on tegemist lihtsalt tulusiiretega ühiskonna sees ja heaolu kasv tekib üksnes sellest, kui neid kasutatakse näiteks tööjõumaksude langetamiseks (mistõttu moonutused tööjõuturul vähenevad), siis turistidelt kogutud maksutulud ei koorma kohalikke elanikke absoluutselt ning suurendavad samas mahus ka kohalike elanike heaolu (kuna selle võrra peavad kohalikud elanikud vähem makse maksma või saavad tarbida rohkem avalikke kaupu).



Joonis 1. Alkoholi maksustamise heaoluefektid
Allikas: Autori koostatud

Neljas on maksu vastastoime komponent, mis tuleneb sellest, et kõrgem alkoholi hind vähendab nii alkoholi tarbimist kui ka vaba aja tarbimist, sest eeldatavalt on tegemist täiendkaupadega. Seega, tööjõu pakkumine kasvab ja tulumaksu poolt tekitatud moonutused tööturul vähenevad. Viies ja viimane komponent peegeldab maksu põhjustatud produktiivsuskasvu töökohal, kuna langenud alkoholi tarbimine vähendab terviseriske, tõstes agendi produktiivsust.

Optimaalse maksu võrrandi simuleerimiseks hinnati kõigepealt empiiriliselt erinevaid mudeli parameetreid. Selleks kasutati tulemusi antud väitekirja raames läbi viidud kahest empiirilisest uuringust, Eesti Konjunktuuriinstituudi poolt läbi viidud alkoholituru uuringuid, riigieelarve näitajaid (Rahandusministeerium), erinevaid statistilisi andmebaase (Statistikaamet, Eurostat) ja hinnanguid rahvusvahelisest kirjandusest (eelkõige erinevad elastsuskoefitsiendid). Lisaks tehti päringuid vastavatesse asutustesse (Justiitsministeerium, Politsei- ja Piirivalveamet, Haigekassa). Kuna mitmete parameetrite väärtused olid väga spekulatiivsed, anti kolm erinevat hinnangut – madal, keskmine ja kõrge. Keskmise hinnangu saamiseks rakendati väärtusi, mis hinnati kõige täpsemaks, madala ja kõrge hinnangu saamiseks korrutati eeldatavalt kõige täpsemat väärtust vastavalt kas 0,7 või 1,3-ga. Väärtuste andmisel erinevatele elastsustele lähtuti varasematest Eestis ja mujal läbiviidud empiirilistest uuringutest. Näiteks alkoholi nõudluse hinnaelastsuste puhul rakendati sõltuvalt stsenaariumist vahemikku –0,4 kuni –1,5. Eraldi tuletati hinnang, mis võtab arvesse võimalust, et eestlased hakkavad tooma teistest riikidest kaasa odavamaid alkohoolseid jooke, hakatakse oluliselt rohkem tarbima maksuvaba salaalkoholi või toodetakse rohkem alkoholi kodus. Selle stsenaariumi korral eeldati, et kui maksutõus langetab kodumaisel turul müüdava legaalse alkoholi tarbimist, siis sellest langusest ligikaudu pool asendatakse kas sala- või piiriülese kaubanduse kaudu hangitud või kodus toodetud alkoholi tarbimisega. Lisaks viidi mitmete parameetrite suhtes läbi ka tundlikkuse analüüs.

Tabel 1. Optimaalne alkoholi maks 2009 aastal (eurot liitri puhta alkoholi kohta)

Optimaalse alkoholi maksu komponendid	Tööjõu maksu kohandamisega				Avalike kulutuste kohandamisega			
	SK	Mad	Kes	Kõr	SK	Mad	Kes	Kõr
Pigou	2.5	–1.2	–2.6	–11.3	2.7	–1.8	–3.7	–16.9
Tulu taasringlus	1.5	2.6	5.0	14.3	2.2	4.4	9.1	30.7
Maksu vastastoime	1.6	0.0	9.0	32.9	3.9	0.0	11.1	46.5
Produktiivsus	0.7	1.0	1.4	1.8	0.8	1.1	1.5	2.0
Väline kasu	8.2	12.2	15.1	10.5	10.4	14.9	17.1	8.4
Kokku	**14.6**	**14.5**	**27.9**	**48.2**	**20.0**	**18.5**	**35.2**	**70.7**
Kehtiv 2009					9.36			
Kehtiv 2010					9.73			

Allikas: Autori arvutused

Märkused: SK tähistab salaturu, piiriülese kaubanduse ja kodus tootmise stsenaariumi, Mad on madal hinnang, Kes on keskmine hinnang, Kõr on kõrge hinnang.

Tulemused (vt tabel 1) näitasid, et optimaalne keskmine maksumäär alkoholile jääb erinevate hinnangute kohaselt vahemikku 14.5 kuni 70.7 eurot ühe liitri puhta alkoholi kohta. Keskmine hinnang andis tulemuseks 27.9 eurot neutraalse

eelarvepoliitika (st kui alandati tulumaksu) ja 35.2 eurot eelarvekulutusi suurendava eelarvepoliitika korral. Isegi kui eeldada ulatuslikku kasvu salaturult või piiriülese kaubanduse teel hangitud alkoholi tarbimises, kinnitavad tulemused, et optimaalne maksustamise tase on 14.6 eurot ühe liitri puhta alkoholi kohta. Optimaalse maksu struktuuris moodustavad suurima osa just erinevad fiskaalse iseloomuga komponendid, millest väga olulist rolli mängib just välise kasu komponent, moodustades keskmise hinnangu korral ligikaudu pool optimaalsest maksumäärast. Üllataval kombel on Pigou maks negatiivne. See tuleneb sellest, et optimaalse maksu võrrand sisaldab ka komponenti, mis peegeldab maksu tõusust tingitud administratiivkulude kasvu. Kuna nii madala, keskmise kui ka kõrge hinnangu korral on optimaalne määr suhteliselt kõrge, siis ületab alkoholi maksu marginaalne administratiivkulu marginaalse väliskulu ning Pigou komponent osutubki negatiivseks.

Optimaalse maksutaseme suur varieeruvus erinevate parameetrite suhtes tuleneb fiskaalsete komponentide tundlikkusest, seda eriti nõudluse hinna-elastsuse suhtes. Täpsemalt, mida elastsem on nõudlus, seda madalam on optimaalne maks, kuna sel juhul maksu tõus ei suurenda nii palju tulusid, mistõttu pole võimalik ka tulumaksu väga palju alandada või tervishoiukulutusi tõsta. Esile tuleb tuua ka seda, et tulemused on väga tundlikud selle suhtes, kui suurt täiendavat ressurssi vajab Maksu- ja Tolliamet maksude administreerimisel. Antud töös näidati, et võrreldes olukorda, kus täiendavaid ressursse üldse ei vajata, olukorraga, kus maksumäära tõstmisel ühiku võrra eraldatakse Maksu- ja Tolliametile täiendavalt 40 senti iga turul müüdava ühe liitri alkoholi kohta, siis optimaalne maksumäär varieerub märkimisväärselt (kuni 20 korda).

Poliitika implikatsioonid

Kuna 2009 aastal kehtiv keskmine maksumäär hinnati tasemele 9.4 eurot ühe liitri puhta alkoholi kohta, siis parameetrite keskmiste väärtuste baasil saadud analüüsitulemused viitavad, et otstarbekas oleks kaaluda 200%-list maksumäärade tõusu Eestis. Samas tuleb tähele panna, et alkoholimaks Eestis sisaldab ka käibemaksu, kuna alkoholi aktsiis on käibemaksu baasiks. Seega, kui soovida alkoholi maksustamise taset suurendada 200%, tähendaks see aktsiiside tõstmist ligikaudu 150%, eeldusel et kogu maksukoormus kandub 100% edasi hindadesse.

Sarnaselt Parry et al. (2009) uuringuga leidis kinnitust fakt, et fiskaalsete aspektidega arvestamine avaldab alkoholi maksu optimaalsele taseme märkimisväärset mõju. Kuna optimaalse maksutaseme hindamisel eeldati, et eelarve tasakaalus hoidmiseks muudetakse tööjõumakse[58], viitavad tulemused sisuliselt sellele, et valitsusel oleks efektiivsem mõnevõrra rohkem tulusid

[58] Kuigi osade stsenaariumite korral eeldati ka seda, et alkoholi maksustamisest tulenev positiivne mõju eelarvele kasutatakse meditsiinikulutuste suurendamiseks, on sellest tulenev efektiivsuskasv siiski empiiriliselt väga nõrgalt põhjendatud. Seetõttu nende stsenaariumite alusel tuletatud hinnangud on pigem teoreetilise kui empiirilise väärtusega.

koguda alkoholi maksustamisest ja vähem tööjõu maksustamisest. Võrreldes Parry et al. (2009) analüüsiga arendati antud väitekirjas fiskaalsete tegurite rolli edasi peamiselt kahel moel. Esiteks, kui arvestada eraldi ka turistide alkoholi oste, tugevneb fiskaalse iseloomuga komponentide osakaal optimaalse maksu struktuuris veelgi. Teiseks, optimaalne tase võib oluliselt alaneda, kui valitsus vajab suurel hulgal ressursse salaturu kasvu kontrollimiseks. Näiteks käeolevas analüüsis elimineerisid administratiivkulud Pigou komponendi sootuks, muutes selle negatiivseks. Seega fiskaalsed tegurid mõjutavad optimaalset taset mõlemas suunas.

Oluline on tähele panna, et arvulised tulemused antud väitekirjas olid väga tundlikud nii turistide kui ka kohalike elanike alkoholi nõudluse elastsuste suhtes. Mida suurem on elastsus, seda madalam on optimaalne tase. 2009. aastal oli keskmine alkohoolsete jookide hinnataseme erinevus Eesti ja Soome vahel ligikaudu kahekordne. Kui tõsta makse 200%, siis tähendaks see ligikaudu 55%-list hinnatõusu, eeldades 100%-list maksude edasikandumist. Selle tagajärjel moodustaksid hinnad Eestis endiselt ligikaudu neli viiendikku hindadest Soomes ja võiks eeldada, et soomlastel jääb motivatsioon Eestist alkoholi osta alles ja nende elastsus hinna suhtes võib küll olla märkimisväärne, kuid mitte ka ülisuur. Samas, 200% on hetkel ka ilmselt ülemine piir, millest suurem maksude tõus poleks reaalselt teostatav. Seega, antud väitekirjas läbiviidud analüüsi baasil saab öelda, et reaalselt rakendatav optimaalne alkoholi maksustamise tase on 50%–200% kõrgem hetkel kehtivast. Samas, viies ellu märkimisväärset maksutõusu, oleks seda mõistlik teha pikema perioodi vältel, et saaks jälgida, kuidas turud sellisele poliitikale reageerivad.

Käesolev väitekiri kinnitas ka seda, et Euroopa Liidus kehtivad regulatsioonid, mille kohaselt on võimalik ühest liikmesriigist teise viia oluline kogus alkoholi aktsiisimaksuvabalt, tekitavad madalama hinnatasemega riikide valitsustele olulise motivatsiooni seda olukorda enda kodanike hüvanguks ära kasutada. Tekib suhteliselt intrigeeriv olukord, kus ühe riigi valitsusel on motivatsioon meelitada teise riigi kodanikke alkoholi ostma. Kuigi selline maksupoliitika võib olla optimaalne ühe riigi seisukohast, ei pruugi see olla optimaalne Euroopa Liidu kui terviku jaoks, kuna paljudel riikidel võib alkoholi liigtarvitamise piiramine osutuda väga keeruliseks.

Piirangud ja edasiarendamise soovitused

Töös läbiviidud analüüsil on mitmed piirangud. Esiteks, analüüsi lihtsustamiseks on rakendatud mudelit representatiivse tarbijaga ning on eeldatud ideaalset konkurentsi. Reaalse majanduse imiteerimisel võivad need osutuda ebareaalseteks. Teiseks, kuigi käesolevas töös eeldati, et tarbijad suudavad internaliseerida ka potentsiaalselt väljaareneva sõltuvusega seotud kulud, on mudel oma olemuselt staatiline, samas kui alkoholi sõltuvusega seotud küsimusi on kohasem analüüsida dünaamilise mudeliga. Lisaks on väitekirjas hinnatud üksnes keskmist maksumäära ühe liitri puhta alkoholi kohta. Reaalselt

eksisteerib aga erinevaid alkohoolseid jooke, mille nõudluse elastsused ja alkoholisisaldused on erinevad. Eestis on hetkel näiteks viinas sisalduv alkohol oluliselt kõrgemalt maksustatud kui teistes jookides sisalduv alkohol, mistõttu ilmselt oleks praktikas otstarbekas edaspidi rohkem tõsta maksumäärasid lahjematele jookidele kui kangetele. Seda toetavad ka empiirilised uuringud, mis viitavad sellele, et viina nõudluse elastsus on kõrgem kui näiteks õllel. Samas, erinevate jookide maksustamine vajab eraldi analüüsi ja jääb käesoleva väitekirja analüüsist välja.

Töö tulemusi tõlgendades tuleb täiendavalt arvestada, et kasutatud teoreetiline mudel ei võta otseselt arvesse mitmeid olulisi efekte, mida alkoholi maksustamine võib kaasa tuua. Täpsemalt, kuigi mudelis oli arvestatud võimaliku salaturu laienemisega ja lubatud selle tõkestamiseks valitsusasutustel suurendada administratiivkulutusi, eeldati, et salaturu kasvu suudetakse sel moel vältida. Ilmselt praktikas võib osaline kasv siis aset leida. Lisaks pole mudelisse otseselt sisse kirjutatud võimalusi, et eestlased võivad maksutõusu tagajärjel hakata ostma odavamat alkoholi näiteks Venemaalt ja Lätist või isegi tootma alkohoolseid jooke kodumajapidamistes. Sellest tulenevalt võib valitsus kaotada suure osa maksutuludest ja alkoholi optimaalne tase osutub madalamaks. Välismaalt toodud alkoholi tarbimine tekitab ka mitmeid negatiivseid mõjusid, sh täiendava koormuse fiskaalsüsteemile. Kuigi mudeli parameteriseerimisel kohandati ühele neljast põhistsenaariumist parameetrite väärtuseid selliselt, et need peegeldaksid ka salaturu laienemise, piiriülese kaubanduse ja kodumajapidamistes alkoholi tootmise mõju optimaalse maksustamise tasemele, siis on tegemist siiski suhteliselt kaudse viisiga nimetatud ilmingute analüüsimiseks. Näiteks võib majapidamiste endi poolt alkoholi tootmine oluliselt mõjutada ka majapidamiste valikuid töö ja vaba aja vahel, mille implikatsioonid vajaksid eraldi analüüs. Lisaks tuleb arvestada võimalusega, et alkoholi maksutõus suurendab mitmete teiste illegaalsete narkootiliste ainete tarbimist, mida antud analüüsis sisuliselt ignoreeriti. Ka maksutõusu mõju turismisektorile tervikuna ei käsitletud, mudel võttis arvesse üksnes turistide alkoholi ostudest laekuvat maksutulu.

Tuleb ka tähele panna, et keskmine maksumäär on antud töös leitud sedalaadi alkoholi väliskulude baasil, mida on lihtne rahas väljendada. Arvesse pole võetud mitmeid teisi mõjusid nagu näiteks alkoholist tingitud koduvägivald või psühholoogilised mõjud alkoholi „ohvrite“ lähedastele. Samuti pole hinnatud mitmeid rahaliselt väljendatavaid kulusid (nt alkoholiga seotud tuleõnnetuste varalised tagajärjed või alkoholi liigtarvitamisega seotud töövõimetuspensionite maksmisest tekkiv fiskaalkoormus). Kuna eeldati tarbijate ratsionaalsust, siis ei arvestatud ka erinevaid sisemisi kulusid, nagu alkoholi tarvitamisest tingitud haigustega seotud suremus või isikute endi poolt põhjustatud liiklusõnnetustes saadud vigastused ja nende juhtumite tagajärjel kaotatud maksudejärgne sissetulek. Ka paljudele alkoholi tarvitamisest tõusetuvate kasudega, nagu näiteks stressi leevendus, pole arvestatud, kuna sedalaadi mõjude kvantifitseerimine on problemaatiline ja eeldaks eraldi uuringut. Kokkuvõttes tuleb analüüsi tulemustesse suhtuda teatud ettevaatlikkusega ka

seepärast, et mitmed parameetrite väärtused on kas väga kaudselt tuletatud või siis neil puudub üleüldse mingi teaduslik alus.

Edaspidised uuringud võiksidki panustada mõne eespool nimetatud puuduse kõrvaldamisse. Spetsiifiliselt Eesti kontekstis peaksid need eelkõige panustama erinevate parameetrite empiirilisse hindamisse, et suurendada antud töös kasutatud mudeli praktilist väärtust. See võimaldaks kaasata samasse analüüsiraamistikku täiendavaid alkoholi välismõjusid, aga rakendada seda mudelit ka nii erinevatele alkohoolsetele jookidele kehtestatud maksude kui ka õigusrikkumistele kehtestatud karistusmäärade optimaalse taseme hindamiseks.

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Peamised uurimisvaldkonnad

Optimaalne maksustamine, alkoholi majanduslikud mõjud, kulu-tulu analüüsi rakendused

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