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Analysis of demand for on-trade and off-trade alcoholic beverages in the Czech Republic

Bachelor's thesis

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Abstract

The majority of the previous research examined the demand for alcohol consumed off-trade. However, some consumers might prefer to consume on-trade alcohol or switch between on-trade and off-trade consumption as a reaction to price or income change. Therefore, we constructed a behavioral model which considers beer, wine, and spirits consumed at home and away from home as six separate goods. Firstly, we derived unit prices calculated as a ratio of expenditure and quantity consumed, imputed unit prices for non-consumers and then adjusted them for the quality. Secondly, we estimated probit regressions explaining consumption probabilities following Heien and Wessels's approach to deal with the censoring in our data. Lastly, we estimated the Quadratic Almost Ideal Demand System to derive own-price, cross-price, and income elasticities. Consumption of beer was found to be the most responsive to income changes, whilst spirits are the least responsive, and on-trade income elasticities are always higher than their off-trade counterparts. Our results suggest that compensated own-price elasticities of demand range between -0.90 and -0.40 at the off-trade and between -1.36 and -0.53 at the on-trade alcohol market. On-trade alcoholic beverages were found to be mutual complements, implying that increase in the price of one results in a decrease in overall demand for alcohol consumed away from home. Lastly, off-trade beer's unique place in the Czech alcohol market has been supported by its positive cross-price elasticities with respect to all remaining beverages consumed at home or away from home, implying that consumers mostly react to increases in prices of alcohol by switching to at-home beer consumption. Data used in our analysis originate from the Czech Household Budget Survey.

JEL Classification	D10, D11, D12
Keywords	demand, QUAIDS, consumption, alcohol

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Abstrakt

Väčšina výskumu zameraná na alcohol, skúma dopyt po alkohole konzumovanom doma. Niektorí spotrebitelia však môžu uprednostňovať konzumáciu alkoholu v reštauráciách, baroch alebo podobných miestach alebo striedať konzumáciu doma a mimo domova ako reakciu na zmeny cien alebo príjmu. Z toho dôvodu sme vytvorili behaviorálny model, ktorý považuje pivo, víno a liehoviny konzumované doma a mimo domova za šesť samostatných produktov. Najprv sme odvodili jednotkové ceny vypočítané ako pomer výdajov a spotrebovaného množstva a nasledne ich upravili o kvalitu. Ďalej boli odhadnuté probitové regresie vysvetľujúce pravdepodobnosti spotreby jednotlivých alkoholických nápojov, ktoré boli neskôr použité pri korekcii nulových pozorovaní (Heien and Wessels, 1990). V poslednom kroku bol odhadnutý kvadratický dopytový systém (QUAIDS). Zistilo sa, že pivo má najvyššiu príjmovú elasticitu, liehoviny najnižšiu, a príjmové elasticity alkoholických nápojov konzumovaných v podnikoch, sú vždy vyššie ako u nápojov konzumovaných doma. Naše výsledky naznačujú, že kompenzované elasticity dopytu vlastných cien pre alkohol konzumovaný doma, sa pohybujú medzi -0.90 a -0.40, a medzi -1.36 a -0.53 pre alkohol konzumovaný mimo domova. Ďalej sa zistilo, že alkoholické nápoje konzumované mimo domova sú vzájomné komplementy, z čoho vyplýva, že zvýšenie ceny jedného z nich má za následok zníženie celkového dopytu po alkohole konzumovanom v podnikoch. Nakoniec, osobitné miesto piva na českom trhu s alkoholom bolo podporené výsledkom, že spotrebitelia reagujú na zvýšenie cien akéhokoľvek typu alkoholu konzumovaného doma alebo v podnikoch, prechodom na domácu konzumáciu piva. Data použité v analýze pochádzajú z Štatistiky rodinných účtov ČR.

Klasifikácia JEL	D10, D11, D12
Kľúčové slová	dopyt, QUAIDS, spotreba, alkohol
Názov práce	Analýza dopytu po alkoholických nápojoch konzumovaných doma a mimo domova v Českej Republike

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Contents

List of Tables

List of Figures

Acronyms

AIDS Almost Ideal Demand System

COICOP Classification of Individual Consumption by Purpose

CPI Consumer Price Index

CSO Czech Statistical Office

CZK Czech crowns

HBS Household Budget Survey

LES Linear Expenditure System

OLS Ordinary Least Squares

PIGLOG Price Invariant Generalized Logarithmic

QES Quadratic Expenditure System

QUAIDS Quadratic Almost Ideal Demand System

SILC Statistics of Incomes and Living Conditions

VAT Value-Added Tax

WHO World Health Organization

Chapter 1

Introduction

Alcohol and its consumption have a long-lived special position on the market, especially in the Czech Republic, which ranks among the countries with the highest alcohol consumption per capita in the world (WHO, 2018). Alcoholic beverages are often associated with recreation, socializing and specific events. However, their consumption is also often linked to certain diseases, abuse, and higher mortality (Wood et al., 2018). For this reason, it is not surprising that alcohol is nowadays a widely discussed topic. The motivation of the research community to uncover behavioral patterns of alcohol drinkers is high and results in extensive literature on alcohol demand.

Alcoholic beverages can be consumed either at home (off-trade) or at restaurants, bars, and other similar places (on-trade). In general, consumption at home might be sometimes associated with alcoholism, whereas consumption away from home is often linked to recreation and specific events. The consumer usually does not pay only for the beverage itself but also for the experience.

For this reason, reactions to changes in prices at these two markets might be different. Even though the research in this field is constantly evolving, most of the prior research considered alcoholic beverages consumed at on-trade and off-trade as one good or investigated off-trade alcohol in isolation, without allowing for the possibility of substituting for alcohol consumed away from home. This might be primarily due to the way in which Household Budget Surveys are designed; the expenditures on alcohol are either recorded only for at-home alcohol consumption, or the expenditures on alcohol consumed at home and away from home are aggregated. Being provided with a detailed Czech Household Budget Survey, which records expenditures for on-trade and off-trade alcohol separately, we aim to fill this gap in the literature and look

at these two markets separately since, for the reasons explained above, the behavior of consumers at each of them might be different.

The main focus of this thesis is given on the demand for beer, wine, and spirits at the on-trade and off-trade markets. Specifically, we investigate whether these two markets are different in the way in which consumers react to changes in income, own price, and prices of other alcoholic beverages. Moreover, we examine the relationship between alcoholic beverages consumed at these two markets, i.e., whether consumers are more likely to switch between different beverages but remain consuming either at home or away from home; or instead of changing to consumption of another type of beverage, shift their consumption between on-trade and off-trade.

The rest of the thesis is structured as follows. The second chapter provides an overview of the findings of previous authors and zooms in on the most commonly used methods of alcohol demand analysis. The third chapter describes the methodology. The fourth chapter is devoted to a description of the data. The fifth chapter aims to present and discuss the econometric results, and the sixth chapter points out the limitations of the analysis. Lastly, the seventh chapter summarizes our findings.

Chapter 2

Review of literature

2.1 Theory of demand modelling

The elasticity of demand represents the change of quantity demanded in response to the change of prices or income. When the elasticity of demand in absolute value is higher than one, we say that demand is elastic; when it is lower than one, demand is considered inelastic. The microeconomic theory distinguishes between own-price, cross-price, and income elasticity of demand.

Own-price elasticity measures responsiveness of quantity demanded, given change in the own-price. The sign of own-price elasticity is usually assumed to be negative. However, in very rare cases, the sign might be positive. These goods are called giffen goods.

Cross-price elasticity measures responsiveness of quantity demanded, given change in the price of another good. The theory distinguishes between substitutes; with positive cross-price elasticity and complements; with negative cross-price elasticity. When two goods are substitutes, an increase in the price of one, simultaneously increases demand for the other good. On the contrary, when two goods are complements, an increase in the price of one increases demand for the other since consumption of one good goes hand in hand with consumption of the other.

Income elasticity represents the change in demand as a reaction to a change in income. A good for which demand decreases with the increase of income is called an inferior good. When demand simultaneously increases with the increase of income, good is considered normal. Normal goods are further divided into luxuries, with income elasticity larger than one, and necessities, with positive income elasticity lower than one (Varian, 2014).

2.1.1 Single equation versus demand system

In general, there are two types of models used for the elasticity of demand estimation; single-equation and demand system models. First estimates of the elasticity of demand were obtained using single-equation models. Because equations are estimated independently, these models are simple and easy to estimate. However, considering commodities in isolation was criticized for not taking into account all necessary information and not being consistent with the microeconomic theory (Syrovatka, 2007; Dlaskova, 2016). For this reason, there was a need to derive a more sophisticated method that would account for consumer behavior.

On the contrary, demand systems are more coherent, complex, and they are derived from neoclassical demand theory. They capture the whole consumer's basket and account for consumer behavior such as substitution between commodities (Syrovatka, 2007; Dlaskova, 2016). These models are made of a system of equations that are tied together by specific restrictions; additivity, homogeneity, and symmetry of the substitution matrix.

Additivity implies that the sum of expenditures on each commodity equals the total expenditures of the consumer. The homogeneity rule ensures that the sum of all price elasticities and total expenditure elasticity is equal to zero. Lastly, symmetry of the substitution matrix or the Slutsky condition implies that the effect of demand has to be symmetric (Stone, 1954; Smutná, 2016).

The most popular demand systems include; Linear expenditure system (LES), Quadratic expenditure system (QES), Rotterdam model, Translog demand system, Almost ideal demand system (AIDS), and Quadratic almost ideal demand system (QUAIDS).

Almost Ideal Demand System- Deaton and Muellbauer (1980)

In 1980 Deaton and Muellbauer derived a new demand model called Almost Ideal Demand System (AIDS). The cost function from which AIDS is derived represents PIGLOG class preferences introduced by Muellbauer (1975, 1976) and defines the minimum expenditure necessary to reach a certain level of utility at given prices.

Advantages of this model include perfect aggregation over consumers, consistency with the widely used household budget data, and easy estimation. Axioms of choice are completely fulfilled, and conditions of homogeneity and symmetry can be easily tested. The majority of the properties possessed by

AIDS are possessed by other demand systems; however, no demand system possesses all of them at the same time. (Deaton and Muellbauer, 1980)

AIDS does not directly assume Engel curves that are linear, only monotonic in utility. In cases when Engel curves are assumed to be linear, authors have suggested using a Stone's price index instead of the ordinary price index.

On the contrary, once the Engel curves are not assumed to be monotonic in utility; and therefore, in total expenditures, we can't use AIDS. This might be the case of clothes and alcohol (Banks et al., 1997). For this reason, AIDS was later extended by Banks et al. (1997), into so called Quadratic Almost Ideal Demand System (QUAIDS), which allows for quadratic Engel curves.

2.1.2 The Almost Ideal Demand System estimation in the Czech Republic

Janda et al. (2000) were the first to estimate the Almost Ideal Demand System in the Czech Republic, focusing on Czech import demand in the 90's. The hypothesis that import prices are exogenously set outside the Czech economy was not rejected. Elasticities were estimated for various groups of food imported to the Czech republic. Results agree with previous findings. All estimated expenditure elasticities were positive, meaning that all goods are normal. Imported goods were usually found to be Hickian substitutes.

The problem of missing prices in household budget surveys was explored by Crawford et al. (2003). Based on the Almost Ideal Demand System, they proposed a methodology using unit prices, which are calculated as a ratio of expenditure and quantity purchased. The paper focuses on a sub-sample of married couples present in the Czech Household Budget survey between 1991 and 1992 and provides estimates for eight commodity groups. Furthermore, authors stress the importance of deriving unit prices instead of obtaining price data from other data sources.

Brůha and Ščasný (2006), among other things, point out that one limitation of AIDS is linearity of Engel curves. Firstly, they use simple linear regression, as well as non-parametrical estimation, and test whether linearity assumption holds. Then, they estimate two AIDS models, first for transport-related services and second for energy, to simulate the effects of different environmental policy scenarios. Heat and fuel taxation was found to have the highest effect on the increase of public revenues; however, the burden of heat taxation has to be compensated for; otherwise, it might have adverse social effects.

In a study conducted in 2009, Janda et al. used three-stage AIDS to investigate demand for a wide variety of items consumed by Czech households. In the first stage, they determine three categories; food, services, and industrial products. Food is further divided into vegetables and fruits, animal products, beverages, and other food. The beverage group, concretely alcoholic beverages, is later investigated more deeply by Janda et al. (2010). Data used in the study come from the Household budget survey collected in the period 2002 - 2007.

In his Master's thesis, Mikolasek (2009) provides own-price and cross-price elasticity estimates for beer, wine, and spirits, which were estimated using AIDS. Beer was found to have almost unit elastic demand, followed by wine and spirits, which were found to be elastic. Firstly, he assumes equal own-price elasticity for all consumers. Then, he takes a step further and divides consumers into abusers and non-abusers, artificially modifying elasticities by setting the own-price elasticity of abusers to one-half of estimated values. Apart from providing price and income elasticities estimates, the author proposes general policy implications for tax modeling. He implies that the proportion of abusers and non-abusers, and relative elasticity proportions of individual beverages, might be more important than elasticities in absolute terms.

Dybczak et al. (2010) were the first ones to use the quadratic specification of Almost Ideal Demand System (QUAIDS) on Czech data. They provide price and income elasticities for eight commodity bundles; food, clothing and shoes, energy, furniture and home electronics, health and body care, education and leisure, transportation and communication, and other goods. For the period between 2001 and 2004, they compensate for missing price data of individual commodities by deriving unit prices. For the period between 2005 and 2008, they rely solely on price data provided by the Czech Statistical Office. All estimations of own-price elasticities are negative. Food, energy, health, and body were found to be necessities, clothing and shoes, transportation and communication, leisure were classified as luxury goods. However, after examining income elasticities for low and high-income households separately, for low-income households, food was found to be a luxury. In contrast, the transportation and communication group was classified as a necessity.

Focusing on Value-added tax reforms in the Czech Republic, Janský (2014) was the second to estimate QUAIDS on Czech Household Budget Survey data. He deals with missing price data by including prices from the consumer price index, provided by Czech Statistical Office. Derivation of unit prices was not feasible since information about the quantity consumed was missing in the case

of some commodities. Estimated elasticities were used to simulate the impacts of various recently proposed VAT reforms on Czech households and government revenues. Janský points out that one of the limitations of microeconomic static models is that they do not take into account consumer behavior, such as the possibility to substitute goods as a response to the price change, and that the application of improper methods might lead to higher tax revenue estimations. The extension of this study focuses on the effects of impacts of excise duties on Czech households' demand (Janský, 2016).

2.2 Demand for alcoholic beverages

Most of the previous research on alcohol demand has focused on consumer behavior and optimal taxation. More than half of the literature comes from the USA, UK, Canada, Australia, and New Zealand, followed by Scandinavian countries and Russia (Boško 2020). There is little evidence that alcohol demand differs across countries; however, more inelastic demand was associated with higher consumption (Fogarty, 2006; 2010).

The majority of prior research has divided alcohol into three groups; beer, wine, and spirits. Literature provides a wide range of elasticity estimates, and findings vary according to time and estimation method; however, own-price elasticities are usually negative (Cook and Moore, 2000). Many authors have recognized beer to be the most inelastic among all types of alcohol, whereas wine and spirits are considered to be more similar (Gallet, 2007). Nevertheless, consumption trends are changing, and drinking preferences are not stable over time. The popularity of beer is gradually descending, and its own-price elasticity is increasing (Boško, 2020).

The elasticity of income was found to be higher in the case of wine and spirits, with beer being the most income inelastic beverage (Gallet, 2007).

Despite the interest in alcohol demand, few studies have focused on socio-demographic characteristics. Several authors suggest that elasticities differ across different socio-demographic groups. For instance, men and young people were found to have more inelastic demand (Gallet, 2007)

Since literature is extensive, the research has shifted to meta-regression analyses over the years. The first ones were conducted by Fogarty in 2006 and Gallet in 2007. Gallet focused on the elasticity of price, income, and advertising, Fogarty investigated only own-price elasticities. Their approach was later criticized, primarily because of lack of precision and presence of het-

eroskedasticity, which they did not sufficiently treat. Another meta-analysis by Wagenaar (2009) aimed to avoid these shortcomings. A few years later, Fogarty (2010) conducted another meta-analysis, adding new studies and including income elasticities. His dataset was extended by Fanta (2014) and later by Boško (2020). Latter two meta-analyses focused only on own-price elasticities of demand.

2.2.1 Alcohol demand estimation

Several methods are used in the literature to estimate price and income elasticities of alcohol demand. Nonetheless, elasticities were found to differ across different data types, demand specifications, and estimation methods. Early works in this area used mostly a utility-free single-equation approach. The most widely used functional forms are double-log and log-linear specifications. However, single-equation estimates were found to be significantly different from estimates reported by studies using demand system models. Among demand systems, the most widely used are AIDS and Rotterdam model (Fogarty, 2010).

The majority of the studies use cross-sectional data and time-series data. Individual cross-sectional data are usually obtained from surveys that are conducted on a sample of households in a given country; such as Household budget survey (Czech Republic), Household Food Consumption Survey (US), Swiss Household Expenditure Survey (Switzerland), Chinese Household Survey (China), Expenditure and Food survey (UK), Spanish Household National Survey (Spain).

As mentioned above, alcoholic beverages are usually divided into three groups; beer, wine, and spirits. Statistically different estimates imply that the behavior of consumers regarding these three types of alcohol tends to differ. What is important is that no matter the approach, elasticities obtained by estimating more sophisticated methods tend to be similar (Fogarty, 2010).

Heien and Pompelli (1989) investigated the elasticity of demand for alcohol consumed at home, including non-alcoholic beverages, coffee, tea, soft drinks, distilled spirits, juice, and milk, in the model as well. At the same time, they were first to include socio-demographic characteristics in the Almost ideal demand system. They argue that socio-demographic characteristics play an important role in demand analysis and stress the necessity to use a coherent demand system when explaining the behavior of consumers. They claim that the ordinary least squares single-equation approach yields biased

and inconsistent estimates. Authors calculated prices as a ratio of expenditure and quantity consumed. Since estimating a coherent demand system requires information about prices of all households, prices of non-consuming households were estimated using regression of consuming households' prices on regional dummies, seasonal dummies, and income. Results of this study imply that marital status and household size are important factors explaining alcohol demand. All own-price elasticities of three alcoholic beverages were shown to be inelastic. Surprisingly, wine and spirits were found to be less elastic than beer. Own-price elasticities were estimated to be -0,84; -0,55; -0,50; for beer, wine, and spirits, respectively. All three beverages were found to be mutual imperfect substitutes. Income elasticities are negative but small. This result might be contra-intuitive; however, with increasing income, households might switch to eating out and consume more alcohol away from home; switching from off trade to on-trade alcohol consumption. Results were further analyzed in order to provide tax policy implications.

In a cross-sectional study, Pan et al. (2006) examined the alcohol demand of Chinese consumers. Data used in this study were obtained from the Chinese household survey for the period between 1993 and 1998. Authors grouped alcoholic beverages into wine, wine cooler, and beer. To deal with zero expenditures, they followed Shonkwiler and Yen's (1999) two-step estimation procedure for a system of censored equations. In the second step, they applied LA/AIDS and obtained price and income elasticities. Results show that more educated households and households with a man as the head of the house are more likely to drink beer and wine. Households whose members have full-time or part-time jobs are more likely to drink beer. Wine cooler and beer were found to be necessities, and wine was shown to be a luxury. Reported the own-price elasticities of wine and wine cooler are higher than the own-price elasticity of beer.

Aepli (2014) estimated two-stage QUAIDS, using the Swiss Household Expenditure Survey for the period 2000 - 2009. In the first stage, he divided all commodities into food, beverages, and other goods and services. In the second stage, beverages were divided into beer, wine, spirits, and non-alcoholic beverages. He dealt with zero expenditures by applying Shonkwiller and Yen (1999) approach and corrected for heteroskedasticity by applying parametric bootstrap. Furthermore, missing prices were replaced by estimated quality-adjusted prices. Aepli assumes that elasticities across different segments vary. For this purpose, he divided households into light, moderate and heavy drinking, and

besides estimating elasticities for the whole sample, he estimated elasticities for each segment separately. Results yield positive income elasticity estimates; wine is a luxury, whereas beer is a necessity, and the elasticity of spirits is close to unity. On the contrary, for heavy drinking households, spirits are a necessity, beer and wine are luxuries. Own-price elasticities of all household segments are negative. For light drinking households, wine and beer are inelastic. However, heavy drinking households seem to have elastic demand for beer. For all households, non-alcoholic beverages were shown to be substitutes to wine and beer.

Macedo et al. (2021) investigated beer, wine, and spirits demand from a world perspective, using a sample of 44 countries monitored between the years 2010 and 2015. The model is constructed such that alcohol consumption per capita is explained by its own average price, the average price of substitutes, and gross domestic product per capita in a given country in a given year. First, they estimate a single-equation model, then the Almost Ideal Demand System. All of the estimated coefficients of the AIDS model were significant. Wine was found to be the most elastic, with own-price elasticity of -0,96, followed by spirits and beer with estimated elasticities of -0,50 and -0,38, respectively. Results indicate that wine and spirits are substitutes to beer, whereas wine and spirits are complements. GDP per capita has a positive and statistically significant effect on the consumption of all three beverages.

To estimate own- price, cross-price, income elasticities of demand, and effect of socio-demographic characteristics, multiple authors used the single-equation method; Yen (1994) in the United States, Angulo et al. (2001) in Spain, Chonviharnpan and Lewis (2015) in Thailand and Collis et al. (2010) in the United Kingdom.

A Rotterdam model was used by Selvanathan (1991), who investigated demand in nine countries; Australia, Canada, Finland, Japan, New Zealand, Norway, Sweden, the UK, and the US. Dynamic Almost Ideal Demand System was used by Andrikopoulos et al. (1997) in Canada and by Eakins and Gallagher (2003) in Ireland. Applying AIDS to cross-sectional data Nguyen (2020) studied alcohol demand in Vietnam.

2.2.2 On-trade and off-trade alcohol substitution

Household budget surveys are usually designed in a way that they only contain information about alcohol consumption at home (off-trade) or aggregated

consumption at home and away from home. However, away from home (on-trade) drinking is considered to be a social affair and leisure activity. Therefore some people might prefer to consume alcohol in pubs or bars (Vinopal, 2007). This implies that the behavior of consumers on off-trade markets and on-trade markets might be different. Estimating demand using only aggregated alcohol consumption might not yield precise estimates. By investigating only off-trade consumption, we disregard the information about possible substitution for on-trade beverages, which might lead to an incomplete model.

The majority of the research implies that on-trade and off-trade alcohol are substitutes (Ogwang and Cho, 2009). However, given that a rich dataset is necessary for such research, the literature on this topic is scarce.

Most of the studies dealing with alcohol at home and away from home substitution were conducted on data from the United Kingdom. The majority of these studies claim that these are substitutes, with the exception of Collis (2010), whose results obtained from the Tobit model suggest complementarity between certain types of on-trade and off-trade alcohol. Tomlison and Branson (2014) found that consumers are highly responsive to price changes in any of the two markets and are quickly willing to change their behavior.

As far as we are concerned, the only study using Czech data was conducted by Grosova et al. (2017), investigating on-trade and off-trade substitution of beer. In her research, she used annual aggregated time series data on consumption per capita provided by CSO for the period 1994 - 2014. In some parts of this period, CSO does not divide beer consumption into on-trade and off-trade; therefore, she assumes beer consumed away from home comes in kegs and tangs, whereas away from home beer consumption is recorded in consumption of bottled and canned beer. For the fact that literature suggests non-alcoholic beverages are substitutes to alcoholic beverages, Grosova et al. included mineral water consumption in the model as well. The model was estimated using the ordinary least squares method. Results of this study suggest that off-trade beer is a substitute for on-trade beer and vice-versa. Precisely, a 1% rise in off-trade average annual beer price increases on-trade consumption by 0,493%, and a 1% rise in on-trade price increases off-trade consumption by 0.986%.

2.2.3 Alcohol demand estimation in the Czech republic

Literature concerned with alcohol in the Czech Republic is relatively extensive. The Czech Republic is one of the countries with the highest annual per capita alcohol consumption; therefore, alcohol demand, consumer behavior, and optimal taxation appear to be important research topics. Many studies conducted on Czech data have detected an increasing trend in alcohol consumption. Despite the popularity of beer in the Czech Republic, the majority of the studies are concerned with wine demand.

Average consumption per capita in the Czech Republic is higher than the upper recommended limit (Wood et al., 2018). This was stressed out by Pyšný et al. (2008), remarking that a decrease in alcohol consumption would lead to increased welfare in the Czech Republic. The study focuses on Czech and European countries' demand for wine and its development between the years 1991 and 2005, using data on annual per capita consumption for wine. Authors conclude that consumers' disposable income and access to substitutes are the most important factors explaining the gross demand for wine in the Czech Republic. Results also reveal a negative relationship between beer and wine consumption in Europe. Pyšný et al. predicted that annual consumption per capita in 2010 will be 17.4 l.

Wine demand was further investigated by Chládková et al. (2009), who aimed to uncover factors influencing wine demand, using data from 143 owners or employees of wine shops and wine departments in supermarkets. According to the opinions of interviewed specialists, demand for domestic wine and domestic production of wine will grow. Growth in demand for domestic wines might be caused by the increasing quality of produced wine and low prices. Among interviewees, beer was usually considered to be a substitute for wine. This is consistent with findings provided by Pyšný et al. (2008).

The first study that used the Almost Ideal Demand System to estimate demand for alcohol on Czech data was conducted by Janda et al. (2010). The beverage group defined in the previous study by Janda et al. (2009) was further divided into four groups; beer, wine, spirits, and non-alcoholic drinks; aggregating on-trade and off-trade consumption. Results reveal own-price elasticities of –0,97; –1,09; and –1,21; for beer, wine, and spirits, respectively. Evidence shows that wine and beer are substitutes, whereas spirits are complements to both; wine and beer. Beer was shown to be the most within-group income elastic (1.33), followed by wine (0.76) and spirits (0.47).

Advertising and past consumption might have an effect on demand. This was investigated by Castiglione et al. (2011). He used monthly data between the years 2006 and 2008 to analyze panel data on 19 brands of spirits and 19 brands of beer. He estimates two models; a two-stage least squares model and a seemingly unrelated regression model. Both contain price, income, past consumption, and advertising expenditure as explanatory variables. When we account for the possibility of substituting beer for spirits, the own-price elasticity of beer is low (approximately -0,2) and consistent with previous studies; however, the single-equation model yields more elastic estimates (between –2.4 and –3.8). Spirit advertising has a low effect on beer demand. Interestingly, past consumption increases current consumption, implying that beer and spirits are associated with addictive behavior.

Kučerová (2018) studied the following factors; level of incomes in-country, consumer price, unemployment, development of beer consumption, and whether these had an effect on current wine demand and its development between the years 1994 and 2003. Effect on consumption was analyzed in four countries; the Czech Republic, Slovak Republic, Germany, and Austria. However, for the Czech Republic, Kučerova did not find any linkage between the factors stated above and current consumption. One possible explanation for the growing trend might be the quality of Czech domestic wine, which is steadily increasing; however, this relationship was not the subject of the study.

Since most Czech wine exports go to Slovakia, Kučerová (2014) zoomed in on wine trading between the Czech Republic and Slovakia, intending to uncover why the Slovak market is so attractive to Czech exporters of domestic wine and to predict future development of alcohol exports to Slovakia. However, she did not find the relationship between wine exports and evaluated factors, such as market size, expected market growth, stability of demand, industry structure, competitive structure, the industry's profitability, legislation, the purchasing power of the customers. According to Kučerová, one possible factor might be the entrance of the Czech and Slovak republic to the European Union.

Syrovátka et al. (2014) investigated the effect of changes in own-price and price of substitutes on the consumption of wine between years 1991 and 2012. Aggregated data provided by the Czech Statistical Office were used to estimate three single-equation models. All three regressions explain wine consumption; first by its own price, second by the price of beer, and third by the price of rum. Results imply that the own-price elasticity of wine in the monitored period is negative and inelastic. Negative cross-price elasticities show that beer

and spirits are both complements to wine. Income or expenditures were not included in the model.

A study focusing on wine supply was conducted by Syrovátka and Chladkova (2014), who analyzed the link between sales of Czech producers of bottled red quality wine and its market price. The study is based on monthly data taken from Czech Statistical Office and State Agricultural Intervention Fund (SAIF) in the period 2004 - 2012. Producers' reactions to the market price were investigated in the short term and the long term. Results suggest that a 1 CZK increase in the price of quality red bottled wine increases sales volume by 1203.84 hl in the long term. The immediate effect of 1 CZK increase results in approximately 1030.62 hl increase in sales volume.

Despite the fact that numerous studies have already accessed this topic before, Syrovátka et al. (2016) shed more light on the understanding of beer and wine gross demand in the Czech Republic, using updated data on annual consumption per capita in the period from 1991 to 2013. In order to estimate the own-price, cross-price, and income elasticity of gross demand for beer and wine, the authors estimated two independent dynamic log-linear models. In contrast with their previous work, results show no significant relationship between wine and beer annual per capita consumption and no linkage between per capita consumption of wine and average households' income. Own-price elasticity of demand for wine was estimated to be -0,2048; therefore, a 1% increase in prices of wine results in a 0,2048% decrease in annual wine consumption per capita. Income does not have a significant effect on wine consumption. Beer consumption does not seem to be influenced by fluctuations in its price. The income elasticity of beer is 0,02; implying that a 1% increase in average household income results in a 0,02% increase in consumption of beer in the Czech republic. Past consumption appears to have an effect on the current consumption of wine but not on the consumption of beer.

Janský (2016) looks at how much Czech households pay in excise duties and estimates the potential impacts of various hypothetical scenarios. Commodities included in the study are mineral oils (motor fuels, petrol, and diesel), tobacco products, and alcoholic beverages; all being subject to excise duties. Alcohol products are further divided into two groups; beer and other alcohol, excluding still wine since it was not subject to excise duty. Specifically, he analyzed the effects of changes in excise duties on Czech households; hypothetical 10% increase in current excise duties, the impact of proposed changes, and unsuccessful proposal to levy excise duty on wine. Excise duties were found to be

progressive for all goods; high-income (or expenditure) households pay a higher share of their income (or expenditures) on excise duties. This result contrasts with some previous studies (Crawford et al., 2010; Brůha and Ščasný, 2006), who found taxes for certain goods to be slightly regressive. The hypothetical effect of the unsuccessful attempt to levy tax on wine by the Czech government in 2012 would put the most considerable burden on third and fourth income quantiles. Another study that forecasted alcohol consumption was conducted by Slovačková et al. (2016) using the ARIMA model. The main aim of the study was to predict aggregated consumption of alcohol and consumption of individual types of drinks; wine, beer, and spirits in the Czech Republic for the next ten years. Results of the study did not indicate the growth of alcohol consumption in the future.

Janda et al. (2019) estimated a general equilibrium theoretical framework for optimal alcohol tax in the Czech republic. He builds on previous elasticity estimates (Janda et al., 2010) for beer, wine, and spirits. Optimal tax estimates differed in the case of all three types of alcohol. Therefore, according to Janda et al., policymakers should take into account different characteristics of alcoholic beverages. Final results imply that optimal tax on beer should be between 8 CZK and 15,6 CZK per liter of beer, 20,5 CZK and 37,4 CZK per liter of wine, and 65,9 CZK and 142 CZK per liter of spirits.

Chapter 3

Methodology

3.1 Prices

The following part focuses on the methodology that was used to obtain final elasticity estimates. Special attention had to be paid to prices that were imputed in the demand system. Cross-sectional data used in our analysis contain information about expenditures [1] and quantities consumed by each household. This allows us to calculate unit prices, which are specific for each household in our sample. However, it has to be taken into account that unit prices hold information not only about spatial and time-specific variations but also about households' quality preferences.

This means that unit prices have to be adjusted for quality effects before they are implemented in the demand analysis (Black, 1952; Cramer, 1973); otherwise, final estimates might be biased (Polinsky, 1977). According to Prais and Houthakker (1956), spatial and time variation is mainly due to price discrimination, region, time, and services purchased together with the commodity. On the other hand, quality effects might be reflected in household-specific characteristics. The authors of this paper also recommend dropping observations with unit prices that are more than five standard deviations away from the average unit price observed in our sample. We followed this recommendation in order to deal with any unwanted outliers.

In our analysis, we used a method that was introduced in 1986 by Cox and Wolgenhard. Their procedure captures the quality effects and adequately adjusts the implicit unit prices.

[1] All expenditures used in our analysis were adjusted for CPI.

We assume that a household's decision consists of two steps; the household first decides on commodity quality, then on the quantity it will purchase.

The hedonic price function used for the estimation of the quality effects is defined as follows:

$$ln\, UP_i = \alpha_i + \boldsymbol{X}_i \gamma_i + e_i$$

where UP_i is the per liter unit price, α_i is regional-time mean price per liter of the ith alcoholic beverage and $\alpha_i = (\alpha_{i0} + \alpha_i^{TIME} + \alpha_i^{REGION})$, where α_i^{TIME} and α_i^{REGION} are time and region specific dummies, respectively. Vector $\boldsymbol{X}_i$ represents household characteristics that reflect household's quality preferences, and the last (stochastic) term e_i is residual. Household-specific characteristics are reflected in variables such as the household size, age of the head of the household, and income. Quality-adjusted price of hth household is then defined as the sum of regional-time mean price α_i and predicted residuals e_i. The equation above is estimated using ordinary least squares.

Another issue that arises in the analysis is the absence of unit price data for the households that did not consume a commodity in the given period. Zero consumption might have multiple reasons. Firstly, a household might not be interested in the consumption of the given commodity due to health or taste reasons; implying zero utility from alcohol consumption. Secondly, the frequency in which the household purchases the item might be longer than the period throughout which the household's consumption is tracked. A third reason might be that at the time of the survey, households found the commodity's substitutes more appealing, (Smutná, 2016) or the current level of income and prices make alcohol purchase not desirable (Angulo and Gil, 2000).

However, in order to estimate a complete demand system, price information has to be available for all households. Literature provides multiple procedures by which missing prices can be estimated. Cox and Wolgenhard describe two methods; zero and first-order method. The zero-other method assumes that households in the same region simultaneously face the same price. This method is computationally easier as missing prices are simply replaced by regional-time price means. The first-order method consists of two steps; firstly, an ordinary least squares regression of unit price is run on regional, time, and socio-demographic variables. These regressions are then used to predict missing prices for the households with zero expenditure and quantity consumed. This approach was used, for example, by Heien and Pompelli (1989). However, the censoring of our data is more severe than in most previous studies. Therefore,

relying solely on regional, time, and socio-demographic variables might not be sufficient. For this reason, we also implemented available unit prices of other alcoholic beverages as predictors.

3.2 Censoring

Inadequate treatment of the censoring might cause the final estimates to be biased. This problem was first described by Tobin (1958), who demonstrated the bias and inconsistency of the OLS model with the censored dependent variable and proposed a procedure that minimalizes this bias.[2]

This is likely a problem of the alcohol demand analysis. In our sample, between about 13% and 22% of households did not consume off-trade alcohol. However, the share of non-consuming households in higher at the on-trade market, where 56% of households did not consume wine and 73% did not consume on-trade spirits (Section 4.2).

Heien and Wessels (1990) extended Tobin's treatment, originally suggested for a single equation demand model, to the system of censored equations. This method can be used on any demand system, and the whole procedure is computationally simple. For each commodity in the analysis, households in the sample can be divided into two categories; those that consume (whose expenditures on a given commodity are larger than zero) and those that do not consume (their expenditures on a given commodity are zero). A new binary variable is defined as an indicator variable that holds information about the decision of the household whether to consume or not. This latent variable attains a value of one for those households that consume the given commodity and zero for non-consuming households. First step of the procedure is estimation of the „participation equation". The probability that the household consumes the commodity is determined by probit regression, which is specified as follows:

$$Y_i = f(p_1, ..., p_n, m, d_1, ..., d_s),$$

where Y_i attains value 1 for consuming households and 0 for non-consuming households if the ith commodity, p_i represents price of the ith commodity, m is income or expenditure, and d_k is kth socio-demografic characteristic. In the next step, this regression is used to compute the Inverse Mills Ratio for hth

[2]For comparision of the selectivity treatments for the single-equation demand model, see Smutná and Sčasny (2017).

household. Inverse Mills Ratio for consuming households is specified as:

$$IMR_i = \phi(\mathbf{p},\ \mathbf{d}, m)/\Phi(\mathbf{p},\ \mathbf{d}, m)$$

where ϕ is density function, Φ is cumulative-probability function, p is vector of prices and d is vector of socio-demographic variables. For those households that did not consume, the Inverse Mills Ratio is specified as:

$$IMR_i = \phi(\mathbf{p},\ \mathbf{d}, m)/(1 - \Phi(\mathbf{p},\ \mathbf{d}, m))$$

where all variables are as defined previously.

Inverse Mills Ratio is then added to the final system of equations as an instrument. When the procedure is applied to the Almost Ideal demand system, the ith equation is defined as follows:

$$w_i = \alpha_i + \sum_j \gamma_{ij}\, ln\, p_j + \beta_i\, ln\, \{m/P\} + \gamma_i\, IMR_i$$

where m is total expenditure, w_i is budget share of ith commodity, p_j is price of the jth commodity, P is a price index and IMR_i is the Inverse Mills Ratio computed in the previous step.

In order for the adding-up property to be satisfied, it would be required that $\sum_{i=1}^{n} \gamma_i IMR_i = 0$ holds. Instead of imposing this restriction, Heien and Wessells propose to define the nth (omitted) equation the following way:

$$w_i = \alpha_i + \sum_j \gamma_{ij}\, ln\, p_j + \beta_i\, ln\, \{m/P\} - \sum_{j=1}^{n-1} \gamma_i\, IMR_i$$

Another approach used in the literature is a two-step estimation procedure for a system of censored equations proposed by Shonkwiler and Yen (1999). The authors of the paper have shown that their method might yield more precise estimates than Heien and Wessells's approach. However, the procedure is computationally more demanding. The errors are, by definition, heteroskedastic; therefore, additional steps have to be implemented to deal with the issue. The equations for the computation of the income and price elasticities after estimation of the Almost Ideal Demand system are different from those in the original paper by Deaton and Muellbauer (1980).

3.3 Quadratic Almost Ideal Demand System

The last step of our analysis is to estimate a demand system (see Dlaskova 2017 for a review). In our analysis, we rely on the Almost Ideal Demand System (Deaton and Muellbauer, 1980) that is most frequent demand system applied in the literature. Based on the recommendation of Banks et al. (1997), suggesting that the Engel curves of alcohol follow a quadratic, rather than a linear shape, and also supported by our data, we estimate Quadratic Almost Ideal Demand System (QUAIDS).

Following the notation from the paper, QUAIDS is derived from the following indirect utility function:

$$ln\, V = \left\{ \left[\frac{ln\, m - ln\, a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1}$$

where $[\, ln\, m - ln\, a(p)\,]/b(p)$ is the indirect utility function of PIGLOG demand system, $a(p)$ is price index, $b(p)$ is Cobb-Douglas price aggregator and $\lambda(p)$ is differentiable, homogeneous function of degree zero of prices, defined as follows:

$$ln\, a(p) = \alpha_0 + \sum_i \alpha_i\, ln\, p_i + \frac{1}{2} \sum_j \sum_i \gamma_{ij}\, ln\, p_i\, ln\, p_j$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i}$$

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i\, ln\, p_i$$

By applying Roy's identity to indirect utility function, we obtain QUAIDS demand functions in budget share form:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij}\, ln\, p_j + \beta_i\, ln \left[\frac{m}{a(p)} \right] + \frac{\lambda_i}{b(p)} \left\{ ln \left[\frac{m}{a(p)} \right] \right\}^2$$

where $a(p)$ and $b(p)$ are as defined previously, w_i is budget share of the ith commodity, p_j is price of the jth commodity and m is total expenditure on the commodities in the system. In our model specification p_j is the quality-adjusted price of the jth alcohol product, i.e., $(\alpha_{i0} + \alpha_i^{TIME} + \alpha_i^{REGION} + e_i)$.

To satisfy additivity, homogeneity and symmetry conditions, QUAIDS de-

mand functions in budget share require the following restrictions:

$$\sum_i \alpha_i = 1,\ \sum_i \gamma_{ij} = 0,\ \sum_i \beta_i = 0,\ \sum_j \lambda_i = 0$$

$$\sum_j \gamma_{ij} = 0$$

$$\gamma_{ij} = \gamma_{ji}$$

Both AIDS and QUAIDS can be augmented by incorporating socio-demographic characteristics in the model (Heien and Pompelli, 1989; Aepli, 2014). The augmented model can be defined as demand function in budget share form for the ith commodity, by modifying the intercept into linear function of socio-demographic variables:

$$\alpha_i = \rho_{i0} + \sum_{k=1}^{s} \rho_{ik}\, d_k$$

where ρ_{i0}, ρ_{ik} are parameters, d_k represent s different socio-demographic variables and the following restrictions have to be imposed:

$$\sum_i \rho_{i0} = 0,\ \sum_i \rho_{ik} = 0$$

The system of equations was estimated by MLE in STATA.

Final elasticities are estimated using the delta-method, at sample means (Banks et al., 1997; Heien and Wessells, 1990):

$$\mu_i \equiv \frac{\partial\, w_i}{\partial\, ln\, m} = \beta_i + \frac{2\lambda_i}{b(p)} \left\{ ln \left[\frac{m}{a(p)} \right] \right\}$$

$$\mu_{ij} \equiv \frac{\partial\, w_i}{\partial\, ln\, p_j} = \gamma_{ij} - \mu_i \left(\alpha_j + \sum_k \gamma_{jk} lnP_k \right) - \frac{\lambda_i \beta_j}{b(p)} \left\{ ln \left[\frac{m}{a(p)} \right] \right\}^2$$

Within the group income elasticities: $e_i = \mu_i / w_i + 1$

Uncompensated price elasticities: $e^u_{ij} = \mu_{ij}/w_i - \delta_{ij}$ where δ_{ij} is Kronecker delta.

Compensated price elasticites: $e^c_{ij} = e^u_{ij} + e_i w_j$

Chapter 4

Data

4.1 Czech Household Budget Survey

Data used in the empirical part of this work are provided by the Czech Statistical Office (CSO).[1] The unit, the data are gathered within the Czech Household budget survey (HBS), is a household that records detailed information about its expenditures, and for some consumption categories also quantities consumed, throughout the whole year. In the Czech Republic, it is the only source of this type of microdata.[2]

Every year, CSO collects data from about 3000 households, which are selected by quota selection, in order for the final sample to be representative of all households in the Czech Republic. Quota sampling is applied using households' attributes such as level of income, the structure of the household, or the economic activity of members. In order to make the dataset representative of the whole Czech population, each household has an assigned population weight. These weights are taken into account in each part of our analysis.

CSO collects detailed information about households' expenditures on goods classified by COICOP (Classification of Individual Consumption by Purpose). COICOP is divided into 12 categories, which represent different types of consumption. For some goods, mainly recorded in COICOP 01 (Food and non-

[1]Data from the Family Budget Survey are provided by the Czech Statistical Office. Analysis using the individual data was performed under a supervision of Dr. Milan Scasny in a compliance with the Contract on the provision of confidential statistical data for the purposes of scientific research No. S-0045-CEN-20 signed between Czech Statistical Office and the Charles University Environment Center.

[2]SILC (Statistics on Incomes and Living Conditions) annually records households' incomes from all sources and expenditures on (energy) utilities and housing. ENERGO survey monitors energy and motor fuel consumption. This survey is conducted irregularly (1997, 2004, 2015, and 2021).

alcoholic beverages), COICOP 02 (Alcoholic beverages, tobacco, and narcotics), and COICOP 03 (Clothing and footwear), CSO collected not only information about expenditures but also the quantity consumed. This allows us to calculate implicit unit prices, which can be further adjusted and used in the demand analysis.

Table 4.1: Classification of Individual Consumption by Purpose

Code	COICOP group
01	Food and non-alcoholic beverages
02	Alcoholic beverages and tobacco
03	Clothing and footwear
04	Housing, water, electricity, gas and other fuels
05	Furnishings, household equipment and routine household maintenance
06	Health
07	Transport
08	Communication
09	Recreation, sport and culture
10	Education
11	Restaurants and accommodation services
12	Other goods and services

Source: Data CSO

A household records its expenditures on non-food items, food consumed away from home, alcoholic beverages, and tobacco throughout the whole year. Then, only for two months, the household records detailed information about various food items consumed at home. Expenditures on these items are later recalculated by Consumer Price Indices to represent consumption throughout the whole year accordingly. Moreover, information on the household structure, size, owned equipment, income, and other socio-demographic characteristics is present in the final dataset as well.

Table 4.2: Composition of Czech HBS sample

1. Households managed by economically active member:
- Employees with lower education
- Employees with higher education
- Self employed
- Unemployed
2. Households managed by economically inactive member:
- Households with economically active members
- Households with no economically active members - managed by retired person
- Households with no economically active members - managed by other person

2016 is the last year when data also includes information about the quantity consumed. Data from 2017 were collected using a different methodology, and the final dataset contains information only about expenditures on individual goods classified by COICOP.

For the purpose of our analysis, we use the household-level data for the period 2011-2016. Our dataset contains in total of 15879 observations.[3] All variables expressed in monetary terms are recalculated into the 2016 price level using CPI.

Table 4.3: Descriptive statistics of Czech HBS sample (2011 - 2016)

Total number of households:				15879
	Mean	Std. Dev.	Min.	Max.
Per household:				
Members	2.24	1.13	1	7
Economically active	0.99	0.84	0	4.17
Children	0.55	0.85	0	5
0 - 5 years	0.14	0.41	0	3
6 - 9 years	0.10	0.34	0	3
10 - 14 years	0.12	0.36	0	3
15 years and more	0.20	0.49	0	3.5
Retirees	0.54	0.73	0	3
Consuming units (OECD)	1.80	0.70	1	4.8
Food and beverages budget share	0.26	0.08	0.01	0.82
Internet connection	0.64	0.48	0	1
Income (CZK, per capita)	165672	72485	2216	1167851
Expenditure (CZK, per capita)	146283	87657	10097	2631737

Source: Data CSO, own calculations

Table 4.3 describes the structure of our sample. The average number of members in a Czech household was 2.24. Households were usually formed of economically active members, followed by retirees and children. Households, on average, dedicated 26% of their expenses to food and beverages (including alcoholic beverages). The average yearly income per capita was 165672 CZK, and the average expenditure of a Czech household was 146283 CZK.

[3]Number of observations in our final sample is 2863, 2865, 2868, 2848, 2880, 1555, for years 2011, 2012, 2013, 2014, 2015, and 2016, respectively.

4.2 Alcoholic beverages in the Czech HBS

Expenditures on alcoholic beverages are recorded throughout the whole period. This means that when the household is present in the survey for the whole year, then the final expenditure on alcoholic beverages is expenditure for the period of twelve months.

What allows us to analyze on-trade and off-trade substitution is the segmentation of the alcoholic beverages among those consumed at home and those consumed at restaurants, bars, or similar places. Both on-trade and off-trade expenditures are further divided into multiple subcategories of alcohol, such as beer, wine, and spirits.

Table 4.4: Categories of alcoholic beverages in the Czech HBS, years 2011-2014

Off-trade	
Beer	Beer
Wine	Wine from grapes and other fruits
	Other types of wine
Spirits	Spirits
On-trade	
Beer	Beer consumed at restaurants
	Beer consumed in cafeterias, bars and similar places
Wine	Wine consumed at restaurants
	Wine consumed in cafeterias, bars and similar places
Spirits	Other alcoholic beverages consumed at restaurants
	Other alcoholic beverages consumed in cafeterias, bars and similar places

Source: Data CSO

In 2015 and 2016, CSO divided alcoholic beverages into even more categories, such as lagers, fortified wine, wine drinks, or beverages with low alcohol content. For the purpose of this work and consistency with the years 2011 to 2014, we have decided to aggregate similar goods into beer, wine, and spirits.

What allows us to perform detailed demand analysis is the presence of information on the quantity consumed (for the alcohol category aggregate). The unit in which quantity is recorded is a liter of a given alcoholic beverage.

On average, in the period between 2011 and 2016, Czech households spent 6153 CZK [4] per year on alcoholic beverages, with 3300 CZK on beer, 1730 CZK on wine, and 1123 CZK on spirits.

[4] Prices are reported in the 2016 price level.

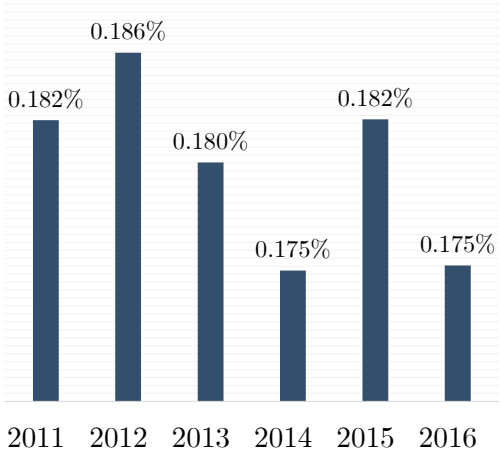


Figure 4.1: Average share of expenditures on alcohol (2011 - 2016) -all households

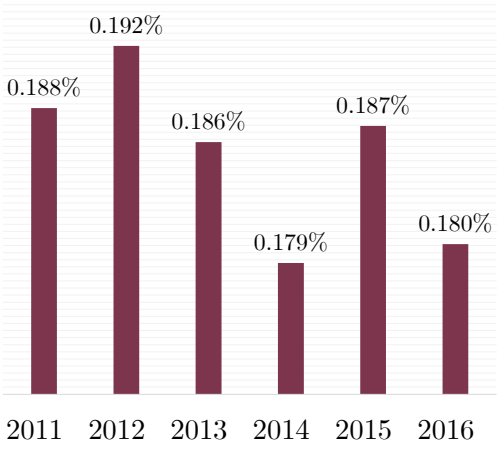
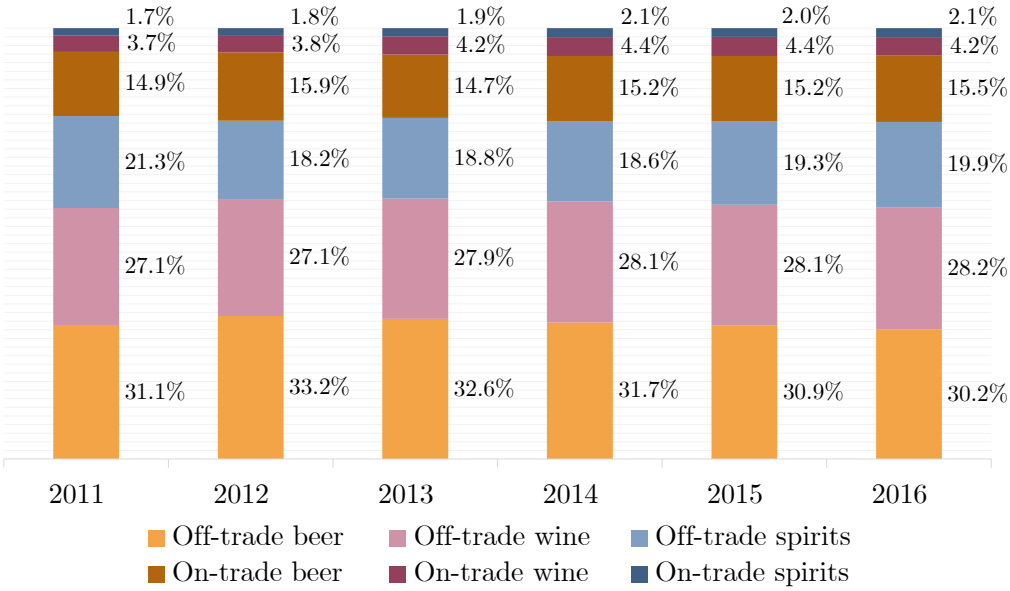


Figure 4.2: Average share of expenditures on alcohol (2011 - 2016) -consuming households

Source: Data CSO, own calculations

Expenditures on alcohol represented on average 0.18% of total household expenditures. The share of on-trade was 0.05%, while off-trade expenditures contributed by 0.13%. Figures 4.1 and 4.2 show the average share of expenditures on alcohol for all households and for alcohol consuming households only.

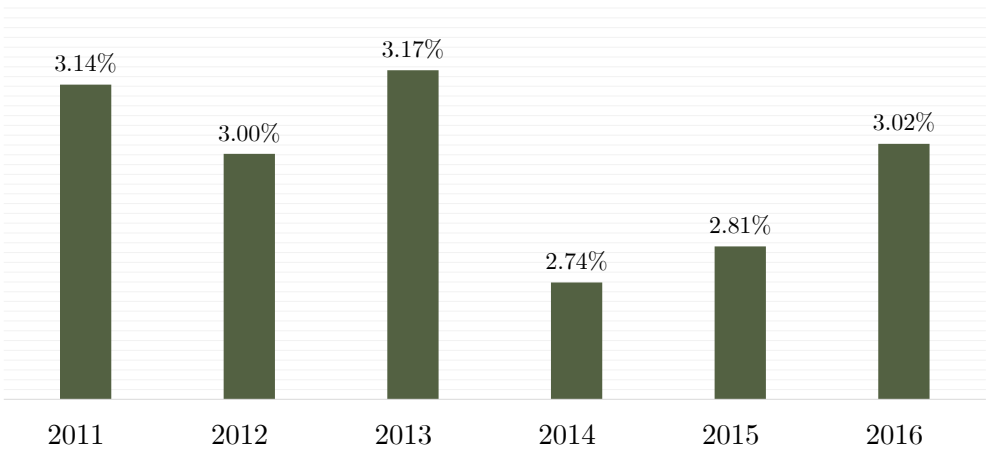
Figure 4.3: Structure of alcohol expenditures (2011 - 2016)



Source: Data CSO, own calculations

Households who consumed alcohol spent on average 22.29% of alcohol expenditures on alcoholic beverages consumed away from home. However, the on-trade share varied across the three categories, with 33.05%, 14.10%, and 11.32% for beer, wine, and spirits, respectively. Figure 4.3 visualizes the average structure of alcohol expenditures for households that reported non-zero expenditures on at least one type of beverage.

Figure 4.4: Percentage of alcohol non-consuming households (2011 - 2016)



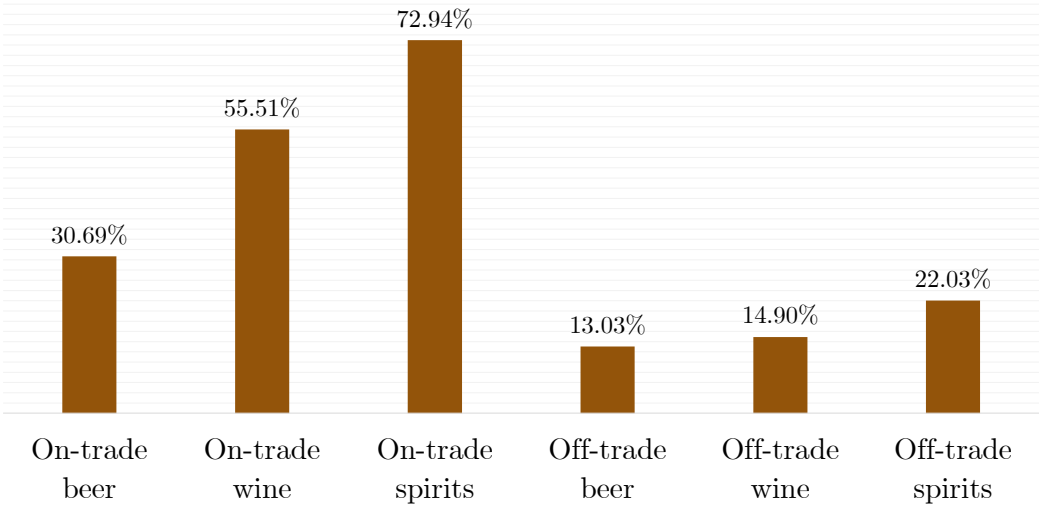
Source: Data CSO, own calculations

There was still a significant number of households that did not consume alcohol. Considering all alcoholic beverages, between 2011 and 2016, there was 2.98% of such households. Figure 4.4 describes the percentage of households that reported zero expenditures on alcoholic beverages during the monitored period.

Looking closely at individual alcohol items, 31% of households did not consume on-trade beer, and 56% and 73% of households did not consume wine and spirits, respectively. Looking at the off-trade, 13%, 15%, and 22% did not consume beer, wine, and spirits, respectively; see Figure 4.5.

We pay special attention to the high share of non-consumers in our modeling; see censoring (Chapter 3.2).

Figure 4.5: Percentages of zero consumption in our sample (2011 - 2016)



Source: Data CSO, own calculations

For the households with non-zero consumption, we derived a unit price for each type of alcoholic beverage as a ratio of expenditures and quantity. Table 4.5 presents summary statistics for consuming households' unit prices. Lastly, Table 4.6 describes remaining variables used in our analysis.

Table 4.5: Summary statistics of unit prices

Unit price per liter	Mean	Std. Dev.
Beer (off-trade)	26.93	9.05
Wine (off-trade)	104.97	44.58
Spirits (off-trade)	268.65	89.67
Beer (on-trade)	56.99	12.38
Wine (on-trade)	185.07	64.57
Spirits (on-trade)	533.33	309.76

Source: Data CSO, own calculations

Table 4.6: Description of variables used in the analysis

	Consumption related variables
PbeerOFF	quality-adjusted price of off-trade beer, CPI adjusted, (analogously defined for other beverages)
UPbeerOFF	unit price of off-trade beer, calculated as a ratio of expenditure and quantity consumed, CPI adjusted; imputed based on regression for non-consuming households (analogously defined for other beverages)
mUPbeerOFF	1 if information on the unit price of off-trade beer is missing, i.e., the household did not consume off-trade beer, (analogously defined for other beverages)
YbeerOFF	1 if household reported positive expenditures and quantity consumed of off-trade beer (analogously defined for other beverages)
PMES	length of the period during which household's consumption was being tracked (in months)

	Regional variables	Mean	Std. Dev.
URBAN	1 if household lives in urban area	0.30	0.46
SUBURBAN	1 if household lives in suburban area	0.38	0.48
RURAL	1 if household lives in rural area	0.33	0.47
VILLAGE	1 if household lives in a village with less than 2000 inhabitants	0.24	0.43

	Household specific characteristics	Mean	Std. Dev.
INCOME	household's monthly income in Czech crowns (divided by 10000)	2.86	1.48

CONS_UNITS	number of consuming units of the household (defined by OECD); sum for all members depends on the structure of the household: 1,0 - head of the household; 0,5 - each child between the age of 0 and 13; 0,7 - other members of the household)	1.80	0.70
AGE	age of the head of the household	54.43	15.50
EDUCATION	1 for households of members with higher education	0.27	0.44
SELF_EMPLOY	1 for households with self-employed members	0.12	0.33
WOMAN	1 if head of the household is a woman	0.32	0.47
CHILD	1 if at least one child lives in the household	0.35	0.48
SMALL_KIDS	number of children which are five years old, or younger	0.14	0.41
RETIREE	1 if at least one retiree lives in the household	0.40	0.49
SINGLE_MALE	1 for households with one member, which is male	0.07	0.25
COUPLE	1 for households with two members; couple without children	0.31	0.46
INTERNET	1 if household has access to the internet	0.64	0.48
HOMEMADE	1 if household produces their own alcohol	0.40	0.49
LUXURY	1 if household's budget share on clothes and luxury items is higher than the average budget share on clothes and luxury items of the whole sample	0.42	0.49
MODERN	1 if household owns a computer	0.72	0.45

HIGH_SOC	1 if head is a member of higher society, i.e. politician, lawyer, civil servant, official, or manager	0.02	0.12
HOMEFOOD	share of food budget spent on food consumed at home, calculated as a ratio of expenditures on food and beverages consumed at home and total expenditures on food and beverages (at home and away from home)	0.85	0.12

Chapter 5

Results

5.1 Missing prices

If a household did not consume a particular alcoholic beverage during the survey period, its unit price was predicted relying on regressions of unit price of consuming households on their socio-demographic, regional, and time variables. We assume, following the standard practice, that unit prices of alcoholic beverages that a household consumes are good predictors of the price at which a household would purchase alcoholic beverages for which the price information is missing. As highlighted in the literature, these unit prices might hold additional information about the quality preferences of households or changing supply conditions. For this reason, after imputing unit prices for the missing ones, we then adjust unit prices for the product quality.

Results show that unit prices of off-trade alcoholic beverages are associated with household's unit prices of other off-trade alcohol as well as with their on-trade equivalent. As an example, by an on-trade equivalent to beer purchased at off-trade market, we refer to beer purchased at restaurants, pubs, and similar places.

Because of the issue of high censoring, our special attention was paid to the prediction of missing prices of on-trade alcohol, specifically on-trade wine and spirits. Employing solely the variables used in the models for missing prices of off-trade alcohol and on-trade beer would not be sufficient. Since the explanatory power of these models was low, the models for on-trade wine and spirits were adjusted and augmented by more explanatory variables. Both available and predicted unit prices were later adjusted for quality in the same way as unit prices of the remaining four beverages.

Highly significant predictors of a household's unit price of on-trade wine were unit prices of wine and spirits consumed at home, unit price of on-trade beer, education, number of small children in the household, age of the head, income, and a dummy variable for households of self-employed members. All of the variables listed above were found to have a positive effect on unit price. Controlling for the effect of increasing income, the effect of an increasing number of consuming units in the household has a negative effect on unit price of on-trade wine. Quadratic specification of unit price of on-trade beer, unit price of off-trade spirits, and income is significant and has a negative coefficient, implying the diminishing effect of an increase in any of these three variables.

In the case of spirits consumed away from home, unit prices can be well approximated by unit price of off-trade spirits and wine. Income, number of small children in the household, and age of the reference person were found to have a positive effect. Interestingly, results indicate that households of members with higher education buy less expensive on-trade spirits. However, this result is only marginally significant at a 10% level. Similarly to the model for on-trade wine, the effect of increasing the number of consuming units is negative.

Moreover, keeping the effect of income constant, households where the head is a member of higher society (politician, lawyer, civil servant, official, or manager), were found to buy 25% more expensive on-trade spirits. One of the reasons these members of society could be tempted to avoid buying cheap alcohol might be increased social pressure. Lastly, we have included a dummy variable for households owning a computer, which might serve as a proxy for a modern household. This variable was found to have a positive effect.

Breusch–Pagan test detected heteroskedasticity in our models. For this reason, in regressions for missing prices, robust standard errors were applied. Regression results for the estimation of missing prices can be found in Appendix A.

5.2 Quality-adjusted prices

Results show that with increasing income, households decide to purchase more expensive alcohol. However, the negative coefficient next to the quadratic term implies that the effect is lower for higher-earning households. Education was found to have a positive effect on unit price of all types of alcoholic beverages except for on-trade spirits, where the effect is negative. Education's positive

Table 5.1: Regressions for quality adjustment of unit prices - off-trade

	*ln*UPbeerOFF	*ln*UPwineOFF	*ln*UPspiritsOFF
INCOME	0.0381***	0.0579***	0.0631***
	(5.82)	(6.40)	(10.55)
INCOME_SQ	-0.0026***	-0.0029**	-0.0039***
	(-3.72)	(-2.85)	(-5.78)
EDUCATION	0.0469***	0.0334***	0.0462***
	(8.11)	(4.21)	(8.41)
SINGLE_MALE	0.0235	0.0128	0.0112
	(1.53)	(0.62)	(0.83)
COUPLE	-0.0247**	-0.0120	-0.0192*
	(-2.87)	(-1.05)	(-2.43)
WOMAN	0.0715***	0.00133	-0.0288**
	(6.57)	(0.09)	(-2.87)
CONS_UNITS	-0.0691***	-0.0886***	-0.0678***
	(-10.50)	(-10.22)	(-11.33)
AGE	-0.00326***	-0.000459	-0.00167***
	(-16.74)	(-1.85)	(-9.71)
SELF_EMPLOY	0.0725***	0.0704***	0.0486***
	(10.56)	(7.77)	(7.55)
LUXURY	0.0420***	0.0878***	0.0329***
	(8.57)	(13.27)	(7.23)
URBAN	-0.0233***	-0.0108	-0.0130*
	(-3.50)	(-1.15)	(-2.20)
RURAL	-0.0243***	0.00372	-0.0147**
	(-4.49)	(0.50)	(-3.08)
Region			
Prague; A[1]	0.111***	0.104*	0.0714*
	(3.69)	(2.44)	(2.17)
Prague; B[2]	0.0525*	0.132***	0.00596
	(2.52)	(4.61)	(0.31)
Prague; C[3]	-0.0773***	0.0752***	-0.0281*
	(-5.63)	(4.20)	(-2.35)
Prague; D[4]	-0.00569	0.0909***	0.00661
	(-0.44)	(5.62)	(0.58)

[1] Hradčany, Josefov, Malá Strana, Nové Město, Staré Město

[2] Vinohrady, Vyšehrad, Holešovice, Trója, Karlín, Žižkov, Břevnov, Bubeneč, Dejvice, Střešovice

[3] Braník, Hodkovičky, Krč, Lhotka, Michle, Nusle, Podolí, Hlubočepy, Jinonice, Košíře, Motol, Radlice, Smíchov, Bohnice, Čimice, Ďáblice, Kobylisy, Letňany, Prosek, Střížkov, Hrdlořezy, Libeň, Vysočany

[4] Malešice, Strašnice, Vršovice, Záběhlice, Háje, Kbely, Hloubětín, Černý Most and other

Středočeský	-0.0974***	0.0291*	-0.0914***
	(-10.21)	(2.49)	(-11.02)
Jihočeský	-0.0929***	-0.0311*	-0.110***
	(-8.48)	(-2.24)	(-11.55)
Plzeňský	-0.0497***	0.0306*	-0.0621***
	(-4.51)	(1.98)	(-6.14)
Karlovarský	-0.0589***	-0.0162	-0.0628***
	(-4.10)	(-0.90)	(-5.21)
Ústecký	-0.0674***	-0.0776***	-0.0699***
	(-6.58)	(-5.39)	(-7.25)
Liberecký	-0.0526***	0.0125	-0.0553***
	(-3.93)	(0.68)	(-4.65)
Královéhradecký	-0.0532***	-0.0331*	-0.0859***
	(-4.63)	(-2.08)	(-8.59)
Pardubický	-0.0522***	-0.0239	-0.0763***
	(-4.24)	(-1.48)	(-7.72)
Vysočina	-0.0502***	-0.0530***	-0.115***
	(-4.21)	(-3.37)	(-11.74)
Jihomoravský	-0.0265**	-0.0890***	-0.0878***
	(-2.90)	(-6.66)	(-10.36)
Olomoucký	-0.111***	-0.0671***	-0.0551***
	(-10.35)	(-4.80)	(-5.74)
Zlínský	-0.0878***	-0.0810***	-0.0297**
	(-7.92)	(-5.01)	(-2.85)
Year		*(Ref.: Moravskoslezský)*	
2012	-0.00343	-0.00208	-0.00993
	(-0.47)	(-0.20)	(-1.54)
2013	-0.00995	0.0424***	-0.0159*
	(-1.35)	(4.09)	(-2.44)
2014	-0.0366***	0.0243*	-0.0537***
	(-4.81)	(2.35)	(-8.24)
2015	-0.0413***	0.0242*	-0.0649***
	(-5.56)	(2.32)	(-9.75)
2016	-0.0959***	-0.00726	-0.119***
	(-10.75)	(-0.60)	(-14.82)
			(Ref.: 2011)
Intercept	3.497***	4.565***	5.693***
	(141.87)	(142.78)	(251.15)
N	15879	15879	15879
R^2	0.129	0.0690	0.116
Adj. R^2	0.127	0.0670	0.114
Root MSE	0.270	0.363	0.244

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.2: Regressions for quality adjustment of unit prices - on-trade

	*ln*UPbeerON	*ln*lUPwineON	*ln*UPspiritsON
INCOME	0.0262***	0.0418***	0.147***
	(6.97)	(7.76)	(19.68)
INCOME_SQ	-0.0009*	-1.80e-11**	-0.0018***
	(-2.13)	(-2.95)	(-10.75)
EDUCATION	0.0366***	0.0428***	-0.0172*
	(10.07)	(8.72)	(-2.35)
SINGLE_MALE	-0.0326***	-0.0142	0.218***
	(-3.79)	(-1.24)	(13.12)
CONS_UNITS	-0.0483***	-0.0407***	-0.0874***
	(-12.76)	(-7.84)	(-11.55)
COUPLE	-0.0178***	-0.00205	-0.0267**
	(-3.42)	(-0.29)	(-2.62)
WOMAN	0.0219***	0.000682	-0.0324*
	(3.44)	(0.08)	(-2.53)
AGE	0.000432***	0.00137***	0.000000691
	(3.92)	(9.85)	(0.00)
SELF_EMPLOY	0.0369***	0.0527***	0.0201*
	(8.83)	(9.44)	(2.39)
LUXURY	0.0234***	0.0277***	-0.0428***
	(7.80)	(7.02)	(-7.54)
URBAN	0.0474***	0.0382***	0.0242**
	(11.57)	(6.84)	(2.99)
RURAL	-0.0216***	-0.0218***	-0.0258***
	(-6.33)	(-4.99)	(-4.18)
Region			
Prague; A[1]	0.0831***	0.0640**	-0.0613
	(4.61)	(2.62)	(-1.68)
Prague; B[2]	0.109***	0.0934***	-0.00316
	(8.44)	(6.45)	(-0.14)
Prague; C[3]	-0.00124	0.104***	-0.0663***
	(-0.16)	(10.06)	(-4.39)
Prague; D[4]	0.0581***	0.118***	0.00832
	(8.68)	(12.10)	(0.60)

[1] Hradčany, Josefov, Malá Strana, Nové Město, Staré Město

[2] Vinohrady, Vyšehrad, Holešovice, Trója, Karlín, Žižkov, Břevnov, Bubeneč, Dejvice, Střešovice

[3] Braník, Hodkovičky, Krč, Lhotka, Michle, Nusle, Podolí, Hlubočepy, Jinonice, Košíře, Motol, Radlice, Smíchov, Bohnice, Čimice, Ďáblice, Kobylisy, Letňany, Prosek, Střížkov, Hrdlořezy, Libeň, Vysočany

[4] Malešice, Strašnice, Vršovice, Záběhlice, Háje, Kbely, Hloubětín, Černý Most and other

Středočeský	-0.0287***	0.0466***	-0.136***
	(-4.97)	(6.23)	(-13.70)
Jihočeský	0.0130	0.0445***	-0.231***
	(1.89)	(5.13)	(-19.80)
Plzeňský	-0.0485***	0.00149	-0.232***
	(-6.57)	(0.17)	(-20.88)
Karlovarský	0.0137	0.0303**	0.00965
	(1.68)	(2.88)	(0.54)
Ústecký	-0.0364***	-0.0334***	-0.0890***
	(-5.53)	(-4.03)	(-8.24)
Liberecký	0.00453	0.0131	-0.118***
	(0.56)	(1.05)	(-6.38)
Královéhradecký	-0.0188*	-0.0727***	-0.280***
	(-2.57)	(-8.14)	(-22.08)
Pardubický	-0.0220**	-0.0300**	-0.137***
	(-2.95)	(-3.00)	(-8.65)
Vysočina	-0.0519***	-0.0118	-0.0771***
	(-7.28)	(-1.19)	(-5.27)
Jihomoravský	-0.00564	-0.00175	-0.169***
	(-0.99)	(-0.22)	(-15.09)
Olomoucký	-0.0537***	-0.0874***	-0.0733***
	(-8.62)	(-10.12)	(-5.54)
Zlínský	-0.0152*	-0.0358***	-0.0153
	(-2.53)	(-3.51)	(-1.12)
Year		*(Ref.: Moravskoslezský)*	
2012	0.000255	-0.0410***	0.00746
	(0.06)	(-7.05)	(0.90)
2013	-0.00125	-0.0132*	-0.00284
	(-0.28)	(-2.20)	(-0.33)
2014	0.00234	-0.0157**	0.0328***
	(0.51)	(-2.65)	(3.81)
2015	0.0102*	-0.0155**	0.0394***
	(2.29)	(-2.59)	(4.66)
2016	0.0283***	-0.0000431	0.0297**
	(5.50)	(-0.01)	(2.96)
			(Ref.: 2011)
Intercept	3.987***	5.032***	5.992***
	(279.81)	(263.43)	(212.02)
N	15879	15879	15879
R^2	0.156	0.142	0.168
Adj. R^2	0.155	0.140	0.166
Root MSE	0.165	0.218	0.320

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

effect is the most significant for on-trade beer, followed by on-trade wine, off-trade spirits, off-trade beer, and off-trade wine.

In the case of the age of the head of the household, results differ for on-trade and off-trade alcohol. Interestingly, households with an older head of the household buy higher quality on-trade beer and wine; however, lower quality off-trade alcohol. This result is the most significant for off-trade beer.

Households with woman as a reference person were found to purchase cheaper spirits by approximately 3%, but more expensive beer (by 7.1% at home and 2.2% at restaurants, pubs, and similar places).

At pubs, bars, and restaurants, males that live alone purchase 21.8% more expensive spirits but 3.26% less expensive beer. Interestingly, couples who live alone and without children tend to choose less expensive beer and spirits.

A number of consuming units in the household was found to have a negative effect on unit price of all beverages.

Households of self-employed members and members with higher education were buying higher quality alcohol. The effect of education was found to be the most significant in the case of on-trade beer, followed by on-trade wine, off-trade spirits, and off-trade beer.

What might be a helpful indicator of the quality of purchased alcohol are households' tastes and the importance of purchasing luxury goods. Therefore, by not including this in our model, we would be omitting an important variable. Unfortunately, our dataset does not provide us with this information. For this reason, we have defined a proxy variable for luxurious goods preferences, derived from the information about expenditures on clothes and luxury goods. The effect of this dummy variable is positive and highly significant in the case of off-trade wine, followed by off-trade and on-trade beer, off-trade spirits, and on-trade wine.

Next, we have controlled for the effect of the region-time variables. Prices in different regions at different times were found to differ. Once we keep the quality and time effects constant, all types of alcohol seem to be the most expensive in the Prague region.

Time variables in our model imply that the price off-trade spirits has been decreasing since 2013. The price of off-trade beer began to lower in 2014. On the other hand, the price of off-trade wine was increasing between 2013 and 2015. In the case of on-trade alcohol, prices of on-trade spirits began slightly rising in 2014, followed by an increase in the price of on-trade beer in 2015.

The price of on-trade wine was gradually decreasing; however, the change in price from 2015 to 2016 was not significant.

Similarly to prior case of missing prices, Breusch–Pagan test detected heteroskedasticity in our models. For this reason, in regressions for quality-adjusted prices, robust standard errors were applied.

The following table displays summary statistics of prices adjusted for quality effects.

Table 5.3: Summary statistics of quality-adjusted prices

Price per liter	Mean	Std. Dev.
Beer (off-trade)	31.23	9.28
Wine (off-trade)	102.66	39.66
Spirits (off-trade)	276.15	77.50
Beer (on-trade)	54.80	9.89
Wine (on-trade)	156.85	38.40
Spirits (on-trade)	387.28	142.33

5.3 Probit regressions explaining consumption probabilities

The procedure applied in the next step was used to deal with the issue of censoring. There might be multiple reasons why households do not consume certain alcoholic beverages. Firstly, usually due to health concerns, households might completely abstain from drinking alcohol. Secondly, members might not enjoy the taste of alcohol or prefer the taste of one alcoholic beverage over another. The decision whether to consume alcohol at restaurants, pubs, and other similar places, might be influenced by the frequency and importance of social interactions with friends or family since drinking alcohol away from home alone might be less common. On the contrary, alcoholism could be connected to the consumption of alcohol at home. Lastly, a household might not consume, because at the period of the survey, the price of a given alcoholic beverage was high. In this case scenario, we expect the household to purchase less of a given good or not consume at all.

Another reason also discussed in the literature is called infrequency of purchase. Our dataset monitors expenditures on alcoholic beverages throughout the whole year; therefore, we assume that this problem should not arise. However, some households did not remain in the survey throughout the whole

Table 5.4: Results of probit regressions - off-trade

	YbeerOFF	YwineOFF	YspiritsOFF
INCOME	0.0489**	0.0795***	0.0437**
	(2.62)	(4.63)	(3.09)
CONS_UNITS	-0.0329	0.0345	0.0507
	(-0.61)	(0.66)	(1.14)
AGE	0.00445**	0.000739	0.0136***
	(2.88)	(0.51)	(10.62)
WOMAN	-0.756***	0.115	-0.120
	(-10.40)	(1.58)	(-1.93)
HOMEMADE	0.141***	0.255***	0.114***
	(4.19)	(8.25)	(4.30)
CHILD	-0.0402	-0.0158	-0.0320
	(-0.65)	(-0.26)	(-0.61)
URBAN	0.0147	0.0238	-0.238***
	(0.41)	(0.70)	(-8.08)
INTERNET	0.0471	0.0362	0.159***
	(1.31)	(1.10)	(5.36)
RETIREE	0.240***	-0.0443	-0.0128
	(4.71)	(-0.95)	(-0.31)
EDUCATION	-0.0496	0.0444	0.0319
	(-1.15)	(1.07)	(0.90)
HOMEFOOD	-0.268	2.446**	2.473**
	(-0.28)	(2.69)	(2.99)
LUXURY	-0.0654	0.123***	0.100***
	(-1.95)	(3.91)	(3.65)
SELF_EMPLOY	-0.0912	0.161**	-0.0842*
	(-1.76)	(3.20)	(-2.04)
COUPLE	0.0665	0.0499	0.123*
	(1.02)	(0.84)	(2.36)
SINGLE_MALE	-0.363***	0.0166	-0.289***
	(-3.84)	(0.18)	(-3.67)
VILLAGE	0.0848*	-0.0269	0.0276
	(2.09)	(-0.76)	(0.87)
PMES	0.0187	0.0719***	0.0976***
	(1.01)	(4.19)	(6.27)

Prices of other beverages			
*ln*PbeerOFF	0.215***	-0.228***	-0.200***
	(3.61)	(-4.28)	(-4.31)
*ln*PwineOFF	-0.428***	0.0446	-0.151***
	(-9.35)	(1.03)	(-4.17)
*ln*PspiritsOFF	-0.0857	0.142*	0.000772
	(-1.31)	(2.26)	(0.01)
*ln*PbeerON	-1.143***	0.604***	0.217**
	(-11.07)	(6.55)	(2.72)
*ln*PwineON	0.236**	-0.835***	0.365***
	(2.80)	(-10.13)	(5.67)
*ln*PspiritsON	0.101	0.0771	0.0382
	(1.82)	(1.47)	(0.87)
Consumption of other beverages			
YbeerON	0.672***	0.143***	0.255***
	(19.00)	(4.35)	(8.51)
YwineON	0.0208	0.510***	0.0977**
	(0.54)	(14.19)	(3.25)
YspiritsON	0.114*	0.124**	0.388***
	(2.49)	(2.93)	(11.04)
YbeerOFF		0.582***	0.495***
		(15.49)	(13.95)
YwineOFF	0.593***		0.783***
	(16.02)		(24.34)
YspiritsOFF	0.476***	0.741***	
	(14.23)	(24.17)	
Intercept	4.165***	-0.628	-4.450***
	(6.09)	(-0.97)	(-8.01)
N	15879	15879	15879
Pseudo R^2	0.283	0.222	0.192
Log-likelihood	-4410.3	-5206.8	-6772.5
χ^2	3480.0	2967.4	3213.9
p-value	0.000	0.000	0.000
AUC	0.859	0.820	0.788

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.5: Results of probit regressions - on-trade

	YbeerON	YwineON	YspiritsON
INCOME	0.0963***	0.0526***	0.0937***
	(6.43)	(4.24)	(7.49)
CONS_UNITS	-0.193***	-0.121**	-0.0416
	(-4.17)	(-2.87)	(-0.95)
AGE	-0.00202	0.00295*	-0.0127***
	(-1.49)	(2.35)	(-9.45)
WOMAN	-0.474***	0.0886	0.126*
	(-7.32)	(1.46)	(1.99)
HOMEMADE	0.178***	0.256***	0.259***
	(6.67)	(10.90)	(10.32)
CHILD	-0.0249	-0.157**	0.0165
	(-0.45)	(-3.13)	(0.31)
URBAN	0.101**	0.00782	0.123***
	(3.28)	(0.28)	(4.14)
INTERNET	0.112***	0.0843**	0.154***
	(3.80)	(3.03)	(4.99)
RETIREE	0.0862*	0.00264	-0.00428
	(2.06)	(0.07)	(-0.10)
EDUCATION	0.0455	0.120***	-0.0164
	(1.22)	(3.69)	(-0.48)
HOMEFOOD	-15.34***	-13.27***	-19.49***
	(-14.56)	(-12.96)	(-15.96)
LUXURY	0.0641*	0.248***	0.0332
	(2.29)	(9.88)	(1.23)
SELF_EMPLOY	0.0207	0.144***	-0.0511
	(0.48)	(3.79)	(-1.28)
COUPLE	-0.0878	0.0116	0.219***
	(-1.64)	(0.23)	(4.08)
SINGLE_MALE	-0.0205	-0.516***	0.161
	(-0.24)	(-6.47)	(1.89)
VILLAGE	-0.0620*	-0.0610*	-0.0506
	(-1.98)	(-2.11)	(-1.60)
PMES	-0.207***	-0.175***	-0.231***
	(-11.41)	(-10.43)	(-12.67)

Prices of other beverages			
*ln*PbeerOFF	-0.214***	0.107*	0.219***
	(-4.57)	(2.45)	(4.66)
*ln*PwineOFF	0.0574	-0.200***	-0.105**
	(1.57)	(-6.12)	(-2.94)
*ln*PspiritsOFF	0.202***	0.0922	0.156**
	(3.75)	(1.95)	(3.17)
*ln*PbeerON	0.366***	0.457***	-0.151*
	(4.51)	(6.79)	(-2.12)
*ln*PwineON	-1.087***	-0.0630	-0.0380
	(-14.10)	(-1.21)	(-0.75)
*ln*PspiritsON	0.208***	-0.0642	-0.00521
	(3.90)	(-1.82)	(-0.17)
Consumption of other beverages			
YbeerON		0.993***	0.729***
		(32.60)	(18.22)
YwineON	0.990***		0.722***
	(32.82)		(26.59)
YspiritsON	0.749***	0.753***	
	(18.30)	(27.25)	
YbeerOFF	0.714***	-0.0136	0.0516
	(18.94)	(-0.33)	(1.04)
YwineOFF	0.137***	0.538***	0.138**
	(3.91)	(13.67)	(2.95)
YspiritsOFF	0.270***	0.104**	0.399***
	(8.74)	(3.28)	(10.65)
Intercept	5.013***	-0.0283	1.799***
	(8.29)	(-0.06)	(3.40)
N	15879	15879	15879
Pseudo R^2	0.317	0.265	0.263
Log-likelihood	-6688.9	-8021.1	-6837.5
χ^2	6218.4	5794.4	4881.9
p-value	0.000	0.000	0.000
AUC	0.864	0.829	0.836

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

period. We control for the length of the monitored period by variable PMES, which indicates the number of months a household participated in the survey.

Our probit regressions aim to capture the majority of the effects described above. Information about whether household members abstain from alcohol could be drawn from dummy variables that indicate whether the household consumes other types of alcohol. Availability of substitutes is controlled for by logarithmic prices, and the infrequency of purchase should be captured by information about the length of the monitored period. Moreover, we included household-specific characteristics that we assumed might explain participation in the market.

Results show that income increases the probability that a household consumes any of the alcoholic beverages. The household size was found to have a significant negative effect only in the case of on-trade beer and wine. This might be connected to one of the reasons why people consume alcohol away from home, which is socializing. Members of households of one or two people might feel a lack of social interaction more often than larger households and therefore, seek social contact at bars or pubs.

As might be expected, with the increasing age of the reference person, households tend to switch from spirits consumed at pubs and bars to wine consumed away from home and off-trade spirits and beer. A significant difference was found between households where the reference person is male and where the reference person is female. Results reveal that the probability that a household consumes beer at home or away from home is lower when the head of the household is a woman. On the contrary, these households were more likely to consume on-trade spirits. Whereas this result was not significant for wine and off-trade beer, households in urban areas are more likely to consume on-trade spirits and beer and less likely to consume spirits at home. On the other hand, households located in small villages are more likely to consume off-trade beer and, on the contrary, less likely to consume beer and wine away from home.

Interestingly, the probability of consuming any type of alcohol is higher for households producing their own wine or spirits. This might be counterintuitive as one might expect that those who produce their own beverages would have zero consumption. On the other hand, homemade alcohol might be an indicator of a heavy drinking household.

Lastly, we have included a variable that indicates whether the household has access to the internet. There might be various interpretations of this variable. One of the interpretations could be that households that decide to introduce the

internet to their home seek more connection with other people and the outer world. Not surprisingly, this variable has a positive effect on the consumption of all types of alcohol away from home and off-trade spirits.

Results were used to calculate Inverse Mills Ratios, which were used as an explanatory variable in the next step.

5.4 Estimation of Quadratic Almost Ideal Demand system

The last step of our analysis consisted of estimating the whole demand system. Six equations entering the system represent three beverages; beer, wine, and spirits, consumed at home and away from home. After estimation, we have performed a Wald test, which supports the hypothesis that Engel curves of alcohol are not linear, but rather quadratic. We conclude that QUAIDS is the preferred model over AIDS based on this result. Moreover, our model was augmented by household-specific and regional characteristics. Specifically, we controlled for the number of consuming units in the household, the age of the head of the household, a dummy variable for a woman being the head of the household, and a dummy variable for a household located in the urban area. Results suggest that the size of the household and the age of the reference person are negatively correlated with the consumption of alcohol in restaurants, pubs, and bars. In contrast, households located in urban areas were found to have higher on-trade alcohol consumption. Results for beverages consumed at home differ among three types of alcohol. Results can be found in Appendix B.

5.4.1 Alcohol consumed at home

Estimated within-group income elasticities were found to be positive for all three beverages, implying that off-trade alcohol is a normal good. Beer was found to be almost unit elastic, with an income elasticity of 1.04, followed by wine and spirits, with income elasticities of 0.86 and 0.35, respectively. The income elasticity of beer might be slightly contradictory with the findings of other authors, which, in general, suggest that beer is the least income elastic alcoholic beverage. However, the result is in line with the study conducted by Janda et al. (2010), who also analyzed alcohol demand using Czech House-

hold Budget Survey. Moreover, it has been previously found that high alcohol consumption is linked to the low price elasticity of beverages with high alcohol content (Aepli, 2014). Considering that the Czech Republic ranks among the countries with the highest alcohol consumption per capita (WHO, 2018), high-income elasticity of beer seems reasonable.

Table 5.6: Income elasticities - off-trade alcohol

Beverage	Within group elasticity	z stat.
Beer (off-trade)	1.04***	57.10
Wine (off-trade)	0.86***	40.37
Spirits (off-trade)	0.35***	14.67

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Compensated own-price elasticity was found to be the highest for off-trade beer (-0.90), followed by wine (-0.77) and spirits (-0.40), indicating that all alcoholic beverages consumed at home are price inelastic. As in the latter case of income elasticity, the Czech consumer was found to be the most responsive to price changes in off-trade beer. Uncompensated own-price elasticities range between -1.23 and -0.46.

Looking at the cross-price elasticities of beverages consumed at home, wine seems to be a gross substitute for beer and vice versa. On the other hand, beer was found to be a weak complement to spirits consumed at home.

Table 5.7: Price elasticities - off-trade alcohol

		Compensated		Uncompensated	
Beverage j	Beverage i	price elasticity	z stat.	price elasticity	z stat.
Beer	Beer	-0.90***	-42.05	-1.23***	-55.46
	Wine	0.40***	24.15	0.12***	6.96
	Spirits	0.15***	7.56	0.04*	1.98
Wine	Beer	0.35***	24.35	0.06***	3.98
	Wine	-0.77***	-38.99	-1.01***	-49.65
	Spirits	0.16***	8.87	0.06**	3.31
Spirits	Beer	0.11***	7.57	-0.09***	-6.11
	Wine	0.07***	4.54	-0.10***	-6.77
	Spirits	-0.40***	-14.91	-0.46***	-17.42

Estimated percentage change in consumption of beverage i as a reaction to 1% increase in price of beverage j

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.4.2 Alcohol consumed at restaurants, bars and similar places

Within-group income elasticities of alcoholic beverages consumed at restaurants, bars, and pubs were found to be higher than in the case of alcohol consumed at home. The estimated income elasticity of beer is the highest (1.85), followed by wine (1.46) and spirits (1.28). These numbers indicate that when it comes to the consumption of alcohol away from home, Czech consumers are highly responsive to income changes. The result that on-trade alcohol is a luxury is not surprising since the consumer pays not only for the alcohol itself but also for the experience, atmosphere, and employees responsible for the guests' well-being.

Table 5.8: Income elasticities - on-trade alcohol

Beverage	Within group elasticity	z stat.
Beer (on-trade)	1.85^{***}	61.59
Wine (on-trade)	1.46^{***}	27.43
Spirits (on-trade)	1.28^{***}	17.75

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The resulting compensated own-price elasticities at the on-trade market are -1.36, -0.65, and -0.53 for beer, wine, and spirits, respectively. These estimates suggest that beer and spirits are more price elastic in the on-trade market than in the off-trade market, whereas the opposite seems to be true for wine. Although, lower own-price elasticity of wine consumed away from home might result from wine's special role on the market and its connection to recreation or specific events (Kučerová, 2012). Uncompensated own-price elasticities range between -1.64 and -0.55.

Interestingly, all beverages consumed away from home were found to be weak complements. Therefore, an increase in the price of any on-trade beverage results in a decrease in its own consumption as well as a slight decrease in consumption of the other on-trade beverages. An exception is the cross-price elasticity of spirits and beer. With an increase in the price of beer, consumers seem to decrease their consumption of spirits; however, an increase in the price of spirits was not found to have a statistically significant effect on the consumption of on-trade beer.

Table 5.9: Price elasticities - on-trade alcohol

Beverage j	Beverage i	Compensated price elasticity	z stat.	Uncompensated price elasticity	z stat.
Beer	Beer	-1.36***	-32.07	-1.64***	-38.11
	Wine	0.04	0.56	-0.18*	-2.23
	Spirits	-0.12	-1.14	-0.31**	-3.01
Wine	Beer	0.02	0.81	-0.06**	-3.06
	Wine	-0.65***	-8.66	-0.71***	-9.45
	Spirits	-0.12	-1.62	-0.17*	-2.33
Spirits	Beer	0.01	1.06	-0.02	-1.90
	Wine	-0.04	-1.21	-0.07*	-2.01
	Spirits	-0.53***	-7.76	-0.55***	-8.11

Estimated percentage change in consumption of beverage i as a reaction to 1% increase in price of beverage j

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.4.3 Relationship between on-trade and off-trade alcohol

Lastly, we investigated substitution between alcoholic beverages consumed at home and away from home.

Looking at the cross-price elasticities of the same alcoholic beverages consumed in different environments, i.e. at home and away from home, the on-trade beverage always seems to complement its off-trade equivalent, and vice versa. For example, on-trade wine being a complement to off-trade wine, and the other way around. Although, the only beverage that does not appear to follow this pattern is beer. It seems like with an increase in the price of beer, either on-trade or off-trade, instead of substituting for another beverage, i.e., wine or spirits, Czech consumer keeps consuming beer but switches to a different environment, i.e., on-trade or off-trade. Nevertheless, the most statistically significant effect was increased at-home beer consumption due to the increased price of beer consumed in restaurants, pubs, and bars.

Regarding the remaining cross-price elasticities, off-trade beer seems to be a substitute for all on-trade beverages and vice versa. Both wine and spirits consumed away from home were found to be complements to off-trade wine and spirits, and off-trade wine and spirits appear to be complements to wine and spirits consumed away from home. Moreover, results suggest that with an increase in the price of on-trade beer, apart from switching to off-trade beer, consumers also switch to at-home consumption of wine and spirits (for spirits, the magnitude of the effect on consumption is lower). Although, on-trade beer

seems to go hand in hand with the consumption of off-trade wine and spirits, where an increase in the price of any of these two off-trade beverages decreases demand for on-trade beer. In other words, our analysis suggests, that beer consumed away from home is a complement to off-trade wine and spirits.

Table 5.10: Uncompensated price elasticities - substitution between on-trade and off-trade alcohol

Beverage j	Beverage i	Uncompensated price elasticity	z stat.
Beer (on-trade)	Beer (off-trade)	0.16***	10.36
	Wine (off-trade)	0.16***	10.14
	Spirits (off-trade)	0.08***	3.60
Wine (on-trade)	Beer (off-trade)	0.04***	5.59
	Wine (off-trade)	-0.02**	-3.00
	Spirits (off-trade)	-0.04**	-3.02
Spirits (on-trade)	Beer (off-trade)	0.02***	3.71
	Wine (off-trade)	-0.01	-1.88
	Spirits (off-trade)	-0.03***	-3.70
Beer (off-trade)	Beer (on-trade)	0.12***	3.55
	Wine (on-trade)	0.22**	3.48
	Spirits (on-trade)	0.21*	2.52
Wine (off-trade)	Beer (on-trade)	-0.07**	-2.62
	Wine (on-trade)	-0.35***	-6.99
	Spirits (on-trade)	-0.20**	-3.00
Spirits (off-trade)	Beer (on-trade)	-0.18***	-6.22
	Wine (on-trade)	-0.37***	-5.73
	Spirits (on-trade)	-0.26**	-2.91

Estimated percentage change in consumption of beverage i as a reaction to 1% increase in price of beverage j

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.11: Compensated price elasticities - substitution between on-trade and off-trade alcohol

Beverage j	Beverage i	Compensated Price elasticity	z stat.
Beer (on-trade)	Beer (off-trade)	0.32***	21.09
	Wine (off-trade)	0.29***	19.77
	Spirits (off-trade)	0.13***	6.24
Wine (on-trade)	Beer (off-trade)	0.09***	11.13
	Wine (off-trade)	0.01	1.77
	Spirits (off-trade)	-0.02	-1.85
Spirits (on-trade)	Beer (off-trade)	0.04***	7.74
	Wine (off-trade)	0.01	1.67
	Spirits (off-trade)	-0.02	-0.08
Beer (off-trade)	Beer (on-trade)	0.71***	21.64
	Wine (on-trade)	0.68***	11.10
	Spirits (on-trade)	0.62***	7.52
Wine (off-trade)	Beer (on-trade)	0.44***	17.52
	Wine (on-trade)	0.05	1.01
	Spirits (on-trade)	0.15*	2.29
Spirits (off-trade)	Beer (on-trade)	0.18***	6.17
	Wine (on-trade)	-0.08	-1.33
	Spirits (on-trade)	-0.01	-0.08

Estimated percentage change in consumption of beverage i as a reaction to 1% increase in price of beverage j

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 6

Limitations

The most important limitation lies in the high censoring of wine and spirits consumed away from home, which is higher than 50%. It implies that we had to rely on the information from approximately 30% of households that reported positive expenditures on on-trade spirits when imputing unit price for non-consumers. Even though our sample has a high number of observations, the analysis may not identify all consumer behavior patterns.

A question for discussion might be whether 70% is the real percentage of alcohol non-consuming households due to the frequently observed fact that alcohol consumption used to be underreported and suffering from large measurement errors in self-reported data. Compared to wine or beer, spirits consumed away from home are specific because they are often consumed at clubs or bars, and it might be more difficult to keep track of expenditures and quantity of spirits consumed at these places, especially when the amount of alcohol consumed is high. Moreover, a sample that reports prices may not be random. A high level of on-trade spirits censoring could be due to misreporting issues in the case of certain groups, such as teenagers or other people who want to keep their expenditures on alcohol a secret from other family members.

Furthermore, the volume content in different types of alcoholic beverages in the spirits group might vary and affect their price. Therefore, to build a more precise model for missing prices, we would have to include information about alcohol content, which we, unfortunately, do not have. Therefore, the precision of the final on-trade spirits elasticity estimates might not be as accurate as in the case of other beverages.

Another limitation worth discussing is the monitored period of the survey. CSO collects information about households' expenditures for the period

of twelve months; however, the expenditures are not provided for individual months but for the whole year as a single value. Therefore, the information about monthly price volatility could not be included in the analysis.

Consumption of alcohol might be likely affected by consumption of other goods, as shown, for instance, by Janda et al. (2010). Estimation of a more complex demand model, including a nested structure of alcohol demand, remains for future research.

Chapter 7

Conclusion

This thesis focuses on the behavior of Czech households at the on-trade and off-trade alcohol markets. This segmentation of consumption was mainly motivated by the enormous amount of previous research, which considers alcohol consumed at home and away from home as a single good or examines only the demand for alcohol purchased at the off-trade market. However, non of these two approaches consider the possibility of substituting on-trade and off-trade alcohol. Our main aim was to create a more detailed, complete model of alcohol consumption and investigate whether the behavior of consumers differs among these two segments.

In this thesis, alcohol is divided into beer, wine, and spirits, consumed at home and away from home. The basis for this analysis was Household Budget Survey data provided by the Czech Statistical Office, which provided us with detailed information about household characteristics, expenditures, and quantities consumed.

Since prices are one of the main components of the demand analysis, special attention had to be paid to their correct adjustment. Although the adjustment of the prices that were later imputed in the demand system was the main purpose of adjusting prices for quality effects, we also obtained information about which household characteristics affect the decision to purchase more expensive alcohol. Not surprisingly, income, education, number of consuming units, and household structure were the most significant regressors.

Another issue that comes hand in hand with alcohol demand analysis is censoring, i.e., the presence of households that report zero expenditures. In order to deal with this issue, we applied a censored regression approach introduced by Heien and Wessels. The first step consisted of estimation of probit

regressions, which explained the decision whether to purchase a certain beverage or not. What was found to have a significant effect was income, age of the reference person, the structure of the household, and prices of other beverages. However, most of the variation could be explained by the household's interest in the consumption of other alcoholic beverages. Interestingly, education was not found to be a good predictor. These regressions served as a basis for estimating the Inverse Mills Ratios, which were included as regressors in the final demand system.

The last step of our analysis was the estimation of the Quadratic Almost Ideal Demand System. Engel curves of the alcohol in the Czech Republic were found most likely to have a quadratic form. Our estimated income elasticity ranges between 0.34 and 1.03 for off-trade alcohol and between 0.34 and 1.03 at the on-trade market, with beer being the most income elastic, followed by wine and spirits, respectively. These results imply that alcohol consumed at home is a necessity, whereas consumption of alcoholic beverages at restaurants, pubs, or bars classifies as a luxury good.

Own price elasticities of demand reveal that the Czech consumer is the most responsive to changes in the price of beer and least sensitive to changes in the price of spirits. This result holds for off-trade as well as the on-trade market. However, whereas the own-price elasticity of beer and spirits is higher at the on-trade market, the opposite holds for wine, where households were found to be less responsive to changes in the price of wine consumed at restaurants, bars, and pubs.

Regarding the cross-price elasticities of demand, an increase in the price of beer consumed at home results in an increase in consumption at the off-trade as well as the on-trade market. Similarly, off-trade beer was found to be a substitute for all beverages consumed at home or away from home, except off-trade spirits, which increase in price was found to decrease consumption of off-trade beer. Wine and spirits consumed either at home or away from home were all found to be mutual complements. As in the previous example, the latter does not hold for spirits consumed at home, which were, as in the case of off-trade beer, found to be a substitute for off-trade wine. Lastly, beer consumed in restaurants, bars and pubs appears to complement all beverages except for beer consumed at home.

Not surprisingly, the most significant relationship was found between on-trade and off-trade beer. This result might be specific to the Czech Republic since beer consumption has its special tradition.

As far as we are concerned, despite the enormous amount of literature on alcohol demand, on-trade and off-trade alcohol substitution have not been given much attention yet. From the results, we can see that the final estimates are slightly different once these two segments are investigated separately. However, previous meta-analyses on alcohol demand have demonstrated that results may differ based on different time settings, data, and methodology. Therefore, as an implication for future research, we propose a further examination of consumer behavior regarding alcohol consumption but recommend taking into account the difference between these two market sectors.

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Appendix A

Appendix A

Table A.1: OLS models for missing unit prices

	*ln*UPbeerOFF	*ln*UPwineOFF	*ln*UPotherOFF	*ln*UPbeerON
INCOME	-0.00297	0.0741***	0.054***	0.00949*
	(-0.46)	(7.96)	(8.01)	(1.97)
INCOME_SQ	0.0002	-0.0048***	-0.0037***	0.0002
	(0.26)	(-4.61)	(-4.97)	(0.37)
EDUCATION	0.0371***	0.00261	0.0228***	0.0269***
	(6.22)	(0.33)	(3.58)	(6.18)
CONS_UNITS	-0.0532***	-0.0543***	-0.0344***	-0.0297***
	(-10.41)	(-7.74)	(-6.41)	(-7.77)
AGE	-0.00389***	-0.000171	-0.00159***	0.000313
	(-18.97)	(-0.62)	(-7.42)	(1.95)
URBAN	-0.0300***	-0.0114	-0.0170*	0.0472***
	(-3.97)	(-1.03)	(-2.19)	(8.11)
RURAL	-0.0242***	0.0126	-0.0107	-0.0191***
	(-4.00)	(1.51)	(-1.85)	(-3.95)
UPbeerON	0.00310***	0.00212***	0.00124***	
	(11.50)	(6.19)	(4.95)	
UPwineON	-0.0000364	0.000874***	0.000284***	0.000457***
	(-0.66)	(11.61)	(4.74)	(11.13)
UPspiritsON	-0.0000159	0.0000292	0.0000702***	0.0000169
	(-1.15)	(1.66)	(4.91)	(1.83)
UPbeerOFF		0.00784***	0.00369***	0.00312***
		(18.56)	(10.71)	(12.56)

UPwineOFF	0.00124***		0.000870***	0.000317***
	(18.98)		(12.08)	(6.21)
UPspiritsOFF	0.000389***	0.000580***		0.000123***
	(11.03)	(12.47)		(5.14)
mUPbeerON	0.198***	0.123***	0.0540***	
	(12.23)	(5.62)	(3.48)	
mUPwineON	-0.0365**	0.193***	0.0382**	0.0558***
	(-3.13)	(12.30)	(3.13)	(6.49)
mUPspiritsON	-0.0375***	0.0250*	0.0168	0.0193**
	(-3.90)	(2.05)	(1.80)	(2.94)
mUPbeerOFF		0.307***	0.109***	0.135***
		(15.92)	(7.43)	(10.97)
mUPwineOFF	0.151***		0.0869***	0.0131
	(12.77)		(6.68)	(1.32)
mUPspiritsOFF	0.130***	0.169***		0.0161
	(10.58)	(10.33)		(1.78)
Region				
Prague; A[1]	0.0977*	0.0530	0.0559	0.0686**
	(2.13)	(1.12)	(1.11)	(3.01)
Prague; B[2]	0.0189	0.0964**	-0.0220	0.0955***
	(0.79)	(3.16)	(-0.83)	(5.92)
Prague; C[3]	-0.0741***	0.0740***	-0.0213	0.00312
	(-4.85)	(3.66)	(-1.38)	(0.29)
Prague; D[4]	-0.0153	0.0731***	0.00346	0.0550***
	(-1.06)	(4.01)	(0.24)	(5.92)
Středočeský	-0.0870***	0.0581***	-0.0773***	-0.0189*
	(-8.23)	(4.49)	(-7.87)	(-2.32)
Jihočeský	-0.0850***	-0.00104	-0.0946***	0.0238*
	(-6.94)	(-0.06)	(-8.11)	(2.53)
Plzeňský	-0.0479***	0.0542**	-0.0487***	-0.0435***
	(-3.81)	(2.91)	(-3.72)	(-4.16)
Karlovarský	-0.0516**	-0.00720	-0.0566***	0.0184
	(-3.19)	(-0.36)	(-3.90)	(1.63)
Ústecký	-0.0576***	-0.0630***	-0.0539***	-0.0287**
	(-4.89)	(-3.88)	(-4.60)	(-2.91)

Liberecký	-0.0581***	0.0250	-0.0514***	0.00303
	(-3.81)	(1.22)	(-3.72)	(0.27)
Královéhradecký	-0.0476***	-0.00398	-0.0694***	-0.0119
	(-3.68)	(-0.22)	(-5.59)	(-1.19)
Pardubický	-0.0441**	0.00754	-0.0627***	-0.0123
	(-3.24)	(0.41)	(-5.27)	(-1.18)
Vysočina	-0.0365**	-0.0179	-0.100***	-0.0432***
	(-2.83)	(-1.03)	(-8.45)	(-4.37)
Jihomoravský	-0.0153	-0.0735***	-0.0711***	0.00605
	(-1.46)	(-4.69)	(-6.51)	(0.71)
Olomoucký	-0.0933***	-0.00347	-0.0304*	-0.0379***
	(-7.87)	(-0.23)	(-2.57)	(-4.82)
Zlínský	-0.0728***	-0.0424*	-0.0112	-0.000182
	(-6.19)	(-2.42)	(-0.90)	(-0.02)
				(Ref.: Moravskoslezský)
Year				
2012	-0.00147	0.00605	-0.00711	0.00551
	(-0.18)	(0.50)	(-0.88)	(0.88)
2013	-0.0115	0.0522***	-0.0160*	0.00168
	(-1.39)	(4.43)	(-1.97)	(0.27)
2014	-0.0325***	0.0420***	-0.0511***	0.00892
	(-3.80)	(3.57)	(-6.35)	(1.38)
2015	-0.0354***	0.0433***	-0.0615***	0.0170**
	(-4.21)	(3.68)	(-7.49)	(2.70)
2016	-0.0838***	0.0220	-0.110***	0.0400***
	(-8.30)	(1.58)	(-10.89)	(5.44)
				(Ref.: 2011)
Intercept	3.259***	3.777***	5.330***	3.767***
	(112.54)	(97.27)	(182.26)	(189.12)
N	13786	13612	12361	11238
R^2	0.152	0.116	0.130	0.158
Adj. R^2	0.150	0.114	0.127	0.155
Root MSE	0.282	0.380	0.270	0.193

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.2: OLS model for missing unit prices of on-trade wine

	*ln*UPwineON	
INCOME	0.0388***	(3.48)
INCOME_SQ	-0.0022	(-1.90)
SMALL_KIDS	0.0195*	(2.12)
EDUCATION	0.0298**	(3.13)
CONS_UNITS	-0.0216*	(-2.55)
COUPLE	0.0105	(1.03)
AGE	0.00146***	(4.56)
SELF_EMPLOY	0.0348**	(3.18)
LUXURY	0.0135	(1.68)
URBAN	0.0323**	(2.78)
RURAL	-0.0172	(-1.83)
UPbeerON	0.00999***	(4.52)
UPbeerON_SQ	-0.0000411*	(-2.51)
UPwineOFF	0.00121***	(10.95)
UPspiritsOFF	0.000752***	(3.58)
UPspiritsOFF_SQ	-0.000000787**	(-2.69)
mUPbeerON	0.470***	(6.33)
mUPwineOFF	0.166***	(7.07)
mUPspirtsOFF	0.113**	(3.10)
Region		
Prague; A[1]	0.0340	(0.78)
Prague; B[2]	0.0517*	(2.11)
Prague; C[3]	0.0921***	(4.18)
Prague; D[4]	0.0901***	(4.41)
Středočeský	0.0495**	(3.05)
Jihočeský	0.0461**	(2.58)
Plzeňský	0.00644	(0.32)
Karlovarský	0.0304	(1.29)
Ústecký	-0.0212	(-1.15)
Liberecký	0.00918	(0.39)
Královéhradecký	-0.0633***	(-3.44)
Pardubický	-0.0219	(-0.99)
Vysočina	0.00612	(0.31)
Jihomoravský	0.00427	(0.23)

Olomoucký	-0.0576***	(-3.68)
Zlínský	-0.0224	(-1.08)
Year	*(Ref.: Moravskoslezský; 2011)*	
2012	-0.0372**	(-3.00)
2013	-0.0136	(-1.08)
2014	-0.0114	(-0.93)
2015	-0.0131	(-1.03)
2016	0.00586	(0.40)
Intercept	4.299***	(51.28)
N	7307	
R^2	0.145	
Adj. R^2	0.140	
Root MSE	0.306	

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.3: OLS model for missing unit prices of on-trade spirits

	*ln*UPspiritsON	
INCOME	0.116***	(5.24)
INCOME_SQ	-0.0069**	(-3.26)
HIGH_SOC	0.250***	(4.88)
SMALL_KIDS	0.0955***	(4.54)
MODERN	0.128***	(3.92)
EDUCATION	-0.0375	(-1.89)
SINGLE_MALE	0.237***	(5.50)
CONS_UNITS	-0.0815***	(-4.44)
AGE	0.00207*	(2.45)
LUXURY	-0.0553**	(-2.79)
URBAN	0.0254	(0.91)
RURAL	-0.0164	(-0.71)
UPwineOFF	0.000512*	(2.30)
UPspiritsOFF	0.00165***	(3.43)
UPspiritsOFF_SQ	-0.00000151*	(-2.37)
mUPwineOFF	0.0593	(1.12)
mUPspiritsOFF	0.312***	(3.55)
Region		

Prague; A[1]	-0.0377	(-0.33)
Prague; B[2]	-0.00656	(-0.11)
Prague; C[3]	-0.0565	(-1.09)
Prague; D[4]	0.00733	(0.16)
Středočeský	-0.119**	(-3.10)
Jihočeský	-0.214***	(-4.66)
Plzeňský	-0.212***	(-3.99)
Karlovarský	0.0181	(0.29)
Ústecký	-0.0732	(-1.86)
Liberecký	-0.123	(-1.94)
Královéhradecký	-0.264***	(-6.06)
Pardubický	-0.122*	(-2.41)
Vysočina	-0.0597	(-1.31)
Jihomoravský	-0.151***	(-3.92)
Olomoucký	-0.0607	(-1.49)
Zlínský	-0.00708	(-0.17)
Year	*(Ref.: Moravskoslezský; 2011)*	
2012	0.00799	(0.27)
2013	-0.00809	(-0.27)
2014	0.0336	(1.13)
2015	0.0397	(1.31)
2016	0.0392	(1.01)
Intercept	5.432***	(48.51)
N	4626	
R^2	0.073	
Adj. R^2	0.065	
Root MSE	0.594	

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[1] Hradčany, Josefov, Malá Strana, Nové Město, Staré Město

[2] Vinohrady, Vyšehrad, Holešovice, Trója, Karlín, Žižkov, Břevnov, Bubeneč, Dejvice, Střešovice

[3] Braník, Hodkovičky, Krč, Lhotka, Michle, Nusle, Podolí, Hlubočepy, Jinonice, Košíře, Motol, Radlice, Smíchov, Bohnice, Čimice, Ďáblice, Kobylisy, Letňany, Prosek, Střížkov, Hrdlořezy, Libeň, Vysočany

[4] Malešice, Strašnice, Vršovice, Záběhlice, Háje, Kbely, Hloubětín, Černý Most and other

Appendix B

Appendix B

Table B.1: Income elasticities

(i)	Coef.	Std. Err.	z	P>z
beerON	1.8524	0.0301	61.5800	0.0000
beerOFF	1.0360	0.0181	57.1000	0.0000
wineON	1.4584	0.0532	27.4300	0.0000
wineOFF	0.8583	0.0213	40.3700	0.0000
spiritsON	1.2841	0.0723	17.7500	0.0000
spiritsOFF	0.3462	0.0236	14.6700	0.0000

Table B.2: Uncompensated price elasticities

(i)-(j)	Coef.	Std. Err.	z	P>z
beerON-beerON	-1.6401	0.0430	-38.1100	0.0000
beerON-beerOFF	0.1200	0.0338	3.5500	0.0000
beerON-spiritsON	-0.0229	0.0120	-1.9000	0.0570
beerON-spiritsOFF	-0.1799	0.0289	-6.2200	0.0000
beerON-wineON	-0.0604	0.0198	-3.0600	0.0020
beerON-wineOFF	-0.0692	0.0264	-2.6200	0.0090
beerOFF-beerON	0.1641	0.0158	10.3600	0.0000
beerOFF-beerOFF	-1.2323	0.0222	-55.4600	0.0000
beerOFF-spiritsON	0.0182	0.0049	3.7100	0.0000
beerOFF-spiritsOFF	-0.0895	0.0147	-6.1100	0.0000
beerOFF-wineON	0.0436	0.0078	5.5900	0.0000
beerOFF-wineOFF	0.0600	0.0151	3.9800	0.0000

spiritsON-beerON	-0.3128	0.1041	-3.0100	0.0030
spiritsON-beerOFF	0.2143	0.0849	2.5200	0.0120
spiritsON-spiritsON	-0.5532	0.0682	-8.1100	0.0000
spiritsON-spiritsOFF	-0.2551	0.0877	-2.9100	0.0040
spiritsON-wineON	-0.1734	0.0746	-2.3300	0.0200
spiritsON-wineOFF	-0.2040	0.0681	-3.0000	0.0030
spiritsOFF-beerON	0.0790	0.0219	3.6000	0.0000
spiritsOFF-beerOFF	0.0426	0.0215	1.9800	0.0480
spiritsOFF-spiritsON	-0.0289	0.0078	-3.7000	0.0000
spiritsOFF-spiritsOFF	-0.4643	0.0267	-17.4200	0.0000
spiritsOFF-wineON	-0.0366	0.0121	-3.0200	0.0030
spiritsOFF-wineOFF	0.0620	0.0187	3.3100	0.0010
wineON-beerON	-0.1779	0.0797	-2.2300	0.0260
wineON-beerOFF	0.2200	0.0632	3.4800	0.0010
wineON-spiritsON	-0.0699	0.0348	-2.0100	0.0440
wineON-spiritsOFF	-0.3654	0.0638	-5.7300	0.0000
wineON-wineON	-0.7105	0.0752	-9.4500	0.0000
wineON-wineOFF	-0.3547	0.0507	-6.9900	0.0000
wineOFF-beerON	0.1566	0.0154	10.1400	0.0000
wineOFF-beerOFF	0.1227	0.0176	6.9600	0.0000
wineOFF-spiritsON	-0.0087	0.0046	-1.8800	0.0600
wineOFF-spiritsOFF	-0.0996	0.0147	-6.7700	0.0000
wineOFF-wineON	-0.0224	0.0075	-3.0000	0.0030
wineOFF-wineOFF	-1.0069	0.0203	-49.6500	0.0000

Table B.3: Compensated price elasticities

(i)-(j)	Coef.	Std. Err.	z	P>z
beerON-beerON	-1.3583	0.0424	-32.0700	0.0000
beerON-beerOFF	0.7077	0.0327	21.6400	0.0000
beerON-spiritsON	0.0127	0.0120	1.0600	0.2900
beerON-spiritsOFF	0.1776	0.0288	6.1700	0.0000
beerON-wineON	0.0160	0.0197	0.8100	0.4180
beerON-wineOFF	0.4443	0.0254	17.5200	0.0000
beerOFF-beerON	0.3217	0.0153	21.0900	0.0000
beerOFF-beerOFF	-0.9036	0.0215	-42.0500	0.0000
beerOFF-spiritsON	0.0381	0.0049	7.7400	0.0000

beerOFF-spiritsOFF	0.1104	0.0146	7.5700	0.0000
beerOFF-wineON	0.0864	0.0078	11.1300	0.0000
beerOFF-wineOFF	0.3472	0.0143	24.3500	0.0000
spiritsON-beerON	-0.1174	0.1030	-1.1400	0.2540
spiritsON-beerOFF	0.6217	0.0827	7.5200	0.0000
spiritsON-spiritsON	-0.5285	0.0681	-7.7600	0.0000
spiritsON-spiritsOFF	-0.0073	0.0869	-0.0800	0.9330
spiritsON-wineON	-0.1204	0.0745	-1.6200	0.1060
spiritsON-wineOFF	0.1519	0.0662	2.2900	0.0220
spiritsOFF-beerON	0.1316	0.0211	6.2400	0.0000
spiritsOFF-beerOFF	0.1525	0.0202	7.5600	0.0000
spiritsOFF-spiritsON	-0.0222	0.0078	-2.8400	0.0050
spiritsOFF-spiritsOFF	-0.3975	0.0267	-14.9100	0.0000
spiritsOFF-wineON	-0.0223	0.0121	-1.8500	0.0650
spiritsOFF-wineOFF	0.1580	0.0178	8.8700	0.0000
wineON-beerON	0.0439	0.0789	0.5600	0.5780
wineON-beerOFF	0.6827	0.0615	11.1000	0.0000
wineON-spiritsON	-0.0419	0.0348	-1.2100	0.2280
wineON-spiritsOFF	-0.0840	0.0631	-1.3300	0.1830
wineON-wineON	-0.6504	0.0751	-8.6600	0.0000
wineON-wineOFF	0.0496	0.0493	1.0100	0.3140
wineOFF-beerON	0.2872	0.0145	19.7700	0.0000
wineOFF-beerOFF	0.3950	0.0164	24.1500	0.0000
wineOFF-spiritsON	0.0078	0.0047	1.6700	0.0950
wineOFF-spiritsOFF	0.0660	0.0145	4.5400	0.0000
wineOFF-wineON	0.0130	0.0074	1.7700	0.0770
wineOFF-wineOFF	-0.7690	0.0197	-38.9900	0.0000

Table B.4: Estimated parameters of the QUAIDS model

	Coef.	Std. Err.	z	P>z
ρ_{10}	0.6751	0.0170	39.6300	0.0000
ρ_{20}	0.2270	0.0216	10.5300	0.0000
ρ_{30}	0.0380	0.0059	6.3900	0.0000
ρ_{40}	-0.2536	0.0169	-15.0100	0.0000
ρ_{50}	0.1181	0.0090	13.1800	0.0000
ρ_{60}	0.1954	0.0204	9.6000	0.0000

β_1	0.1319	0.0047	28.3100	0.0000
β_2	0.0122	0.0059	2.0800	0.0380
β_3	0.0056	0.0014	3.9700	0.0000
β_4	-0.1282	0.0046	-27.6700	0.0000
β_5	0.0192	0.0022	8.6100	0.0000
β_6	-0.0408	0.0060	-6.7900	0.0000
γ_{11}	-0.0328	0.0071	-4.5900	0.0000
γ_{12}	0.0577	0.0050	11.5100	0.0000
γ_{22}	-0.0702	0.0069	-10.1800	0.0000
γ_{13}	-0.0033	0.0020	-1.6400	0.1000
γ_{23}	0.0058	0.0016	3.6700	0.0000
γ_{33}	0.0086	0.0013	6.6100	0.0000
γ_{14}	-0.0476	0.0049	-9.6500	0.0000
γ_{24}	-0.0302	0.0049	-6.1300	0.0000
γ_{34}	-0.0058	0.0017	-3.3400	0.0010
γ_{44}	0.1231	0.0064	19.3200	0.0000
γ_{15}	0.0021	0.0033	0.6400	0.5230
γ_{25}	0.0148	0.0025	5.9400	0.0000
γ_{35}	-0.0029	0.0014	-2.0100	0.0440
γ_{45}	-0.0180	0.0027	-6.6700	0.0000
γ_{55}	0.0136	0.0031	4.4200	0.0000
γ_{16}	0.0238	0.0042	5.6900	0.0000
γ_{26}	0.0221	0.0046	4.8200	0.0000
γ_{36}	-0.0025	0.0013	-1.9600	0.0500
γ_{46}	-0.0215	0.0042	-5.0900	0.0000
γ_{56}	-0.0096	0.0020	-4.7700	0.0000
γ_{66}	-0.0123	0.0055	-2.2500	0.0250
λ_1	0.0116	0.0005	24.9800	0.0000
λ_2	0.0038	0.0006	6.5800	0.0000
λ_3	0.0009	0.0001	5.9300	0.0000
λ_4	-0.0105	0.0004	-24.2400	0.0000
λ_5	0.0017	0.0002	7.3900	0.0000
λ_6	-0.0074	0.0006	-12.4300	0.0000
IMR_1	-0.0338	0.0034	-9.8900	0.0000
IMR_2	-0.0979	0.0046	-21.2300	0.0000
IMR_3	0.0470	0.0011	41.3700	0.0000
IMR_4	-0.0866	0.0034	-25.4900	0.0000

IMR_5	0.0308	0.0017	17.9800	0.0000
IMR_{1_5}	0.1406	0.0067	21.0000	0.0000
ρ_{11}	-0.0223	0.0029	-7.8100	0.0000
ρ_{12}	-0.0021	0.0001	-19.5100	0.0000
ρ_{13}	-0.0372	0.0043	-8.6500	0.0000
ρ_{14}	0.0440	0.0033	13.2200	0.0000
ρ_{21}	-0.0084	0.0037	-2.2600	0.0240
ρ_{22}	0.0027	0.0001	19.3000	0.0000
ρ_{23}	-0.1641	0.0057	-28.9300	0.0000
ρ_{24}	-0.0421	0.0043	-9.7100	0.0000
ρ_{31}	-0.0051	0.0009	-5.9000	0.0000
ρ_{32}	-0.0005	0.0000	-16.2700	0.0000
ρ_{33}	0.0021	0.0013	1.6500	0.0990
ρ_{34}	0.0055	0.0010	5.4800	0.0000
ρ_{41}	0.0031	0.0030	1.0400	0.2980
ρ_{42}	0.0009	0.0001	7.5100	0.0000
ρ_{43}	0.0470	0.0045	10.4400	0.0000
ρ_{44}	-0.0231	0.0035	-6.6600	0.0000
ρ_{51}	-0.0042	0.0014	-3.0700	0.0020
ρ_{52}	-0.0005	0.0001	-10.0800	0.0000
ρ_{53}	0.0252	0.0021	12.2100	0.0000
ρ_{54}	0.0146	0.0016	9.1800	0.0000
ρ_{61}	0.0368	0.0037	9.9700	0.0000
ρ_{62}	-0.0004	0.0001	-2.9100	0.0040
ρ_{63}	0.1270	0.0057	22.4500	0.0000
ρ_{64}	0.0011	0.0043	0.2700	0.7900

Parameters ρ_{x1}, ρ_{x2} , ρ_{x3}, ρ_{x4} are parameters of household specific characteristics CONS_UNITS, AGE, WOMAN and URBAN, respectively.

Table B.5: Wald test for the quadratic term in QUAIDS

Test	Null hypothesis	χ^2 value	p-value	Result
Wald test of QUAIDS model	The coefficients λ_i are not jointly significant	1529.56	0.0000	Reject

Table B.6: Goodness-of-fit statistics for the QUAIDS model

Equation	RMSE	R^2
1 Beer (on-trade)	0.1867	0.4516*
2 Beer (off-trade)	0.2442	0.6527*
3 Spirits (on-trade)	0.0558	0.2288*
4 Spirits (off-trade)	0.1956	0.5296*
5 Wine (on-trade)	0.0885	0.2163*
6 Wine (off-trade)	Omitted	

*Uncentered R^2