Complete almost ideal demand system approach to the Czech alcohol demand

Analýza české poptávky po alkoholu pomocí metody úplného „téměř ideálního poptávkového systému“

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Abstract: Tax interventions into alcohol beverages market are an important and recently discussed tool of the Czech fiscal policy. The impact of any such measure would be strongly dependent on the microeconomic behavior of the consumers. The aim of this paper is to provide a reliable set of income, own-price, and cross-price elasticities of demand for the key alcohol beverages based on the Almost Ideal Demand System model applied on the most relevant Czech data set of the Household Budget Statistics.

Key words: Almost Ideal Demand System, alcohol, beer, brewing industry, consumption, the Czech Republic, elasticity, price, spirits, tax, wine

Abstrakt: Daňové zásahy do trhu s alkoholickými nápoji jsou pro českou fiskální politiku důležitým a v poslední době často skloňovaným nástrojem. Důsledky takových opatření však do značné míry závisí na mikroekonomickém chování spotřebitelů. Účelem této studie je vytvořit spolehlivý odhad (vlastních a křižových) cenových a důchodových elasticit poptávky po základních skupinách alkoholických nápojů. Tento odhad je založen na „téměř ideálním poptávkovém systému“ aplikovaném na nejrelevantnější data české statistiky rodinných účtů.

Klíčová slova: AIDS poptávkový systém, alkohol, cena, Česká republika, elasticita, destiláty, lihoviny, pivo, spotřeba, víno

Alcohol production and consumption are an important part of the Czech history and culture. The Czech Republic is globally famous for its beer, and well "equipped" with popular spirit brands. Despite not possessing optimal climate conditions, wine production of the country is almost capable of serving the domestic demand. The total Czech consumption of alcoholic beverages has doubled over the last five decades and since the 1990s, it has stabilized at an approximate annual value of 180 litres per head[1]. The dominant position among all alcoholic drinks in the Czech Republic belongs to beer, which accounts for more than 85% of the total volume consumed.

The popularity and ability of alcohol to influence human behaviour has earned it much attention of not only the consumers but also of the governing authorities and of course the scientific community. In the Czech Republic, alcohol taxes have recently been

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

the subject of political discussion. At the beginning of 2009, the Czech Ministry of Health proposed the adoption of the increased excise tax on alcohol in order to compensate the budget deficit from easing the health-service fees. However, the Ministry of Finance has blocked this initiative stating that the effect of the increased excise taxes on the budget revenues is dubious due to the decline in the spirit consumption, the threat of the black market re-emergence and the possibility of substitution between the beverages to those not taxed (such as non-sparkling wine). Nevertheless, recently (September 2009) the Lower Chamber of the Czech Parliament approved an increase in the alcohol excise taxes suggested by the Czech government as a part of the saving package designed to limit the size of the budget deficit. This situation is a more than eloquent illustration of the fact that the alcohol related policies is still regarded to be current affairs.

Unfortunately these Czech policy interventions in the final consumer price of alcohol are not supported by an adequate comprehensive cost-benefit analysis of the alternative tax changes. The major building block of any such analysis has to be a set of reliable price elasticities. Our study presents the first step towards a rigorous estimation of own and cross-price elasticities of alcoholic beverages based on the well-established microeconomic demand model and using the most relevant Czech data set of the Household Budget Statistics.

LITERATURE REVIEW

Research studies on alcohol include a large scale of disciplines, ranging from statistical and demographical surveys, through studies examining the impact of alcohol consumption on the individual (psychological and medical surveys) or on the society as a whole (sociological approach). An extensive economic research has been undertaken, examining the relationships between alcohol and many economic variables such as domestic product, productivity of labour, employment and tax revenues.

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

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

Czech literature is primarily concerned with the medical and psychological aspects of alcohol consumption, with the special focus on its impact on the youth population group. An extensive research on this field has been done by the Czech National Health Institute – see Csémy and Sovinová (2003). Among others, let us name at least the psychiatric studies by Karel Nešpor (see e.g. Nešpor 2003). The excessive alcohol consumption in the Czech Republic is generally perceived as an important phenomenon with a direct and adverse impact on a significant proportion of the population. This also implies a negative indirect impact on the rest of the society. Most of the studies also conclude that the alcohol consumption trends have been deteriorating recently, meaning an increasing rate of the alcohol abuse and especially the shifts in the underage drinking habits. A more complete discussion of the economic aspects of alcohol demand in the Czech Republic is provided in the forthcoming article by Janda and Mikolasek (2011).

Many relevant studies were also published in this Journal. Chladkova et al. (2009) discussed the development of the main factors of the wine demand. Their paper was a part of a long-term research project dealing with the Czech wine market (Chladkova et al. 2004; Tomsik and Chladkova 2005; Pysny et al. 2007; Kucerova and Zufan 2008). David (2009) discussed the problems of the commodity taxation on an example of the cigarettes taxation. Alternative approaches to the price elasticity estimation to our AIDS model were presented by Bielik and Sajbidorova (2009), Hupkova et al. (2009), Zentkova and Hoskova (2009) and Syrovatka (2006, 2007).

There also exists a sizeable literature dealing with the estimation of Czech food demand elasticities based on the flexible function forms. This is a functional class into which our AIDS model belongs. These models based on Czech data were presented by Ratinger (1995), Dubovicka et al. (1997), Janda (1997), Janda and Rausser (1997), Banse and Brosig (1998), Janda and Volosin (1998), Brosig and Ratinger (1999), Janda et al. (2000), Brosig and Hartmann (2001) and Crawford et al. (2003).

THEORY

The pioneering role in estimating the demand system derived directly form the consumer's preferences theory is usually ascribed to Stone (1954) who first used the Linear Expenditure Systems developed by Klein and Rubin (1947–1948) to estimate the whole demand system. Since then, a large number of models concerning the topic have been proposed. Let us mention at least the most renowned ones: the Rotterdam model (see Theil, 1967 and Barten 1969) and the translog model (see Christensen et al. 1975). Our analysis is based on another influential model - the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980). To be more specific, it is based on the multi-stage budgeting modification by Edgerton et al. (1996).

Basic aids model specification

In their proposition of the demand system, Deaton and Muellbauer use a specific class of preferences (known as PIGLOG[2], which allows for the exact aggregation over consumers. These preferences are represented straight with the expenditure function. Its AIDS form is:

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

where α_k, β_k and γ^*_{jk} are parameters of the model. Demand functions could be derived directly from (1) by applying the Sheppard's lemma. Multiplying both sides of the applied lemma by $p_i / c(p, u)$, we get

$$\frac{\partial \log c(p,u)}{\partial \log p_i} = \frac{p_i q_i}{c(p,u)} = w_i \tag{2}$$

where w_i denotes i^{th} commodity's budget share i.e. the weight of spending on i^{th} good on total expenditure. When we apply this on (1), we get

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i u \beta_0 \prod_{k=1}^{n} p_k^{\beta_k} \tag{3}$$

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

Generally, the expenditure function of a utility maximizing consumer, $x = c(p, u)$ could be inverted to obtain the indirect utility function $u = \omega(p, x)$. Applying this on (1) and substituting the result to (3), Deaton and Muellbauer get the desired AIDS demand functions in the budget share form

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P}\right) \tag{4}$$

$$\log P = \alpha_0 + \sum_{k=1}^{n} \alpha_k \log p_k + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \gamma_{kj} \log p_k \log p_j \tag{5}$$

where again w_i denotes i^{th} commodity budget share, γ_{ij} and β_i represent the changes in i^{th} good budget share caused by the changes in prices and the real expenditure respectively[3], P represents price index and thus x/P stands for the "real" expenditure[4]. Setting $p = 1$ and $u = 0$ in (3), we could see that α_i represents the subsistence budget share of i^{th} good (i.e. its budget share when the expenditure is at the subsistence level). Analogically, we could find that α_0 denotes the logarithm of subsistence expenditure measured in the base year prices.

In order to comply with the microeconomic theory, the demand system has to satisfy several restrictions:

$$\sum_{i=1}^{n} \alpha_i = 1 \tag{6}$$

$$\sum_{j=1}^{n} \beta_j = 0 \tag{7}$$

[2]For more details on PIGLOG preferences see Muellbauer (1975).

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

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

$$\sum_{j=1}^{n}\beta_j = 0 \quad (8)$$

$$\gamma_{kj} = \gamma_{jk} \quad (9)$$

Restriction (8) ensures homogeneity (of degree 0) of the demand function. Formula (9) expresses the Slutsky symmetry condition. Restrictions (6, 7, 8) taken together ensure that the system of demand functions adds up to the total expenditure (e.g. $\sum w = 1$). Another important condition arises from the properties of the Slutsky equation[5]. Given the concavity of the expenditure function, the matrix of its second derivatives $\partial^2 c(p, u)/ \partial p_i \partial p_j = \partial h_j(p, u)/\partial p_j$, often referred as the "substitution matrix", must be negative semi-definite. When applied to the AIDS functional form, we impose the negative semi-definiteness on elements

$$\frac{\partial^2 c(p,u)}{\partial p_i \partial p_j} = \gamma_{ij} + \beta_i\beta_j \log\left(\frac{x}{P}\right) - \delta_{ij} w_i + w_i w_j \quad (10)$$

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

However, it should not be forgotten that it is own and cross-price demand elasticities e_{ij}, which are of our primary interest. These uncompensated elasticities, together with expenditure elasticity E_i, could be easily obtained from (4) as

$$E_i = 1 + \frac{\beta_i}{w_i} \quad (11)$$

$$e_{ij} = \frac{\gamma_{ij} + \beta_i\left(\beta_j \log(x/P) - w_j - \frac{1}{2}\sum_{k=1}^{n}(\gamma_{kj} - \gamma_{jk})\log p_k\right)}{w_i} - \delta_{ij} \quad (12)$$

Given the symmetry assumption (9) the last term in numerator would simply cancel out and the formula is reduced to

$$e_{ij} = \frac{\gamma_{ij} + \beta_i\left(\beta_j \log(x/P) - w_j\right)}{w_i} - \delta_{ij} \quad (13)$$

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

AIDS on aggregate level

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

Simplifications to AIDS

While estimating the model, we face one obvious problem – the non-linearity of the price index in (5). Although this would not mean a large problem for the single equation estimation, for a more complex system and long series the calculation could become quite time consuming. While looking for suitable approximations, Deaton and Muellbauer (1980) suggest replacing the last two terms in (5) with the Stone's price index

$$P^* = \sum_{k=1}^{n} w_k \log p_k \quad (14)$$

This means replacing (5) with

$$\log P = \alpha_0 + \sum_{k=1}^{n} w_k \log p_k \quad (15)$$

which would be measured in every point in time. This leads to the so-called Linear Almost Ideal Demand System (LAIDS), which is being extensively applied in literature[6] and is obtained by substituting (14) into (4)

$$w_i = \left(\alpha_i^*\right) + \sum_{j=1}^{n}\gamma_{ij}\log p_j + \beta_i \log\left(\frac{x}{P^*}\right) \quad (16)$$

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

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

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

cation of α_0 is usually very problematic. Deaton and Muellbauer therefore propose taking the logarithm of an a priori chosen value for the real subsistence expenditure.

Moreover, Chalfant (1987) proposed an approximation formula for the calculation of elasticities. Its reliability has been (among others) confirmed by Edgerton et al. (1996). While the expenditure elasticity still remains given by (11), the uncompensated price elasticities (which we will use also in our study) become:

$$e_{ij} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} - \delta_{ij} \quad (17)$$

A further discussion about the use of the Linear Approximate AIDS is provided by Akbay and Jones (2006) and Sheng et al. (2008) who used the LAIDS to estimate the consumer demand system in the USA and Malaysia.

Multi-stage budgeting

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

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

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

$$u = f[\upsilon(q_1); \upsilon(q_2); \ldots; \upsilon(q_n)] \quad (18)$$

where $\upsilon(q_r)$ is a "sub-utility" which is maximized separately in the second stage. This maximization follows the usual rules of the demand theory, just with the overall expenditure replaced with the group expenditure

$$x_r = \sum_{i=1}^{m} p_{ri} q_{ri}$$

determined in the first stage. It takes the form of

$$q_{ri} = g_{ri}(p_1, \ldots, p_i, \ldots, p_m, x_r) \quad (19)$$

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

$$\frac{\partial\left(\frac{\partial u}{\partial q_{ri}} \Big/ \frac{\partial u}{\partial q_{rj}}\right)}{\partial q_{sk}} = 0 \quad (20)$$

Whereas the second stage of the model (maximizing the within-group utility) is quite straight-forward, for the first stage some more assumptions need to be taken as we could not simply replace all prices by simply taking n price indices (one for each group). Deaton and Muellbauer (1980) show that the demand for r^{th} group goods may be approximated, when we express it in the real terms as.

$$Q_r = g_r(P_1, \ldots, P_n, x) \quad (21)$$

where Q_r is real r^{th} group expenditure expressed in some base year prices and P_i are the true cost of living indices for a specific utility level u. If we assume that these indices do not vary heavily in u, we could approximate them by using the standard Paasche or Laspeyers indices[7]. The proper form of three-stage budgeting used in our model will be discussed in the following section.

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

BASIC CHARACTERISTIC OF THE DATASET

The empirical part of our study is based on the Household Budget Statistics (HBS) by the Czech Statistical Office. It is an annual survey on the microeconomic behaviour of Czech households which provides information on their expenditure and the structure of their consumption. In fact, it is also the only survey which is detailed enough to provide the consistent information on the Czech alcohol consumption on the individual (household) level. The survey monitors over 3 000 households chosen on the specific quota-based system. The quota tries to mimic the real composition of Czech society, i.e. the structure of all Czech households, as tightly as possible. The quota method follows an a priori chosen frequency of all combinations of certain attributes. Fundaments for this structure are derived from the Microcensus survey, which is a socio-demographic survey based on random sampling techniques. Given this structure, a representative sample is then chosen from the set of all respondents. For illustration of the socio-demographic composition of the population sample see Table 1.

The respondents contribute to the database on the daily basis, recording all revenues and expenditures summarized over all household members. Some budget items, such as certain industrial goods, food and alcoholic beverages, are reported also on the volume basis (e.g. in kilograms, litres or pieces). This is crucial for further calculation as it allows us to calculate the unit price for each household and allows us to examine the price differentiation across various demographic groups or geographic regions.

Table 1. Sample composition of household budget survey 2007

Social group	Number of households in the sample
Households managed by economically active member	2 335
Employees with lower education	843
Employees with higher education	870
Self employed	445
Unemployed	177
Households managed by economically inactive member	665
Households with ec. active members	149
Households with no ec. active members	516
– managed by retired person	467
– managed by other person	49
Total number of households	3 000

Multi-stage budgeting in household survey

Czech household budget survey is well suitable for the application of multi-stage budgeting models because it captures multiple aspects of the household cash-flow, namely: Income items, food expenditures (including physical volumes where applicable), manufacturing and other consumer goods (both durables and non-durables), services expenses, transfers and payments, even natural incomes and expenditures and gifts. In our analysis, a three stage method has been chosen. First, we evaluate the system concerning the distribution of the total expenses on food, industrial sector and services. Then we focus on the food part, examining the consumer choice between: drinks; animal and products; vegetables and fruit; cereal products and other food group. Finally, we target the drinks segment estimating the elasticities for: beer; wine; spirits; and non-alcoholic drinks[8].

The number of observations in the particular stages varies because of the technical restrictions of the model. First, the HBS is not constructed as a fully balanced panel. The condition of reflecting the demographic composition (taken from the Microcensus survey) is superordinate to the continuous tracking of an individual household. In fact, only 288 households are tracked for the whole period (2002–2007) which we use in our study, and 3832 households are observed only within a single year (and thus inapplicable for our purposes). Moreover, the logarithmic form of our model prevents us from using such observations in stage 3, which exhibit zero consumption of the particular beverage (for first two stages, positivity is assured by the aggregation of the data across the multiple consumption items). Moreover, in order to assure at least a partial homogeneity in the observed beverage quality, we need to exclude such observations, which exhibit the deviant values of the beverage price and which would potentially cause biases and leverage effects. In the case of beer, the limits (price greater than CZK 5 and less than CZK 100 per litre) do not exclude many observations. In the case of wine, however, the lower bound of CZK 25 per litre (which is the lowest market price for junk wine) limits over 300 observations. The reason for this could be attributed to the semi-barter wine purchases in some Moravian regions, where the actual price might be lowered by non-economic factors such as the natu-

[8]For a full list of items in particular group see Appendix 1.

ral exchange or various interpersonal relationships. The restriction is even more important for spirit part of the estimation. Compared to the other two beverages, the spirit group is the most diversified, with the alcohol content raging from mere 20% for several liquors to 70% for absinth. To eliminate the disrupting effect of beverages with the low alcohol content, we need to set a price boundary to reflect the cheapest market price of the normalized spirit. Given that cheapest rum with the alcohol content of 40% could be purchased for about CZK 180 per litre and given the fact that the excise tax on distilled products per se reaches CZK 103, we set the lower limit to CZK 160.

EMPIRICAL ANALYSIS OF MICROECONOMIC BEHAVIOR

For estimating the systems given in (15) on the data from the Czech Budget Household Survey, a structured dated panel has been created for each stage. For the reasons discussed in data section, the number of observations for each stage varies from 11 238 at stage 1 and 2 to only 10 856 observations at stage 3. Within each step, we estimate a system of N-1 equations where N is number of commodity groups. This is because of the adding-up condition, which ensures that the last equation is a linear combination of the former equations. At stage 1, we exclude the services equation, at stage 2 it is the cereals and other food equation and at the last stage, we exclude the non-alcoholic drinks part.

The estimation has been done using the one-way Seemingly Unrelated Regression technique as in papers by Janda (1995) and Akbay and Jones (2006). This approach seems to be suitable for our analysis as it is able to capture the efficiency due to the correlation of the disturbances across equations. For the detailed specification of the approach review Baltagi (2008). In case of our study, it is able to account for non-included factors such as hot weather, which might support beer consumption in a particular year. The basic AIDS model frequently suffers from autocorrelation problems, which is confirmed also in our study. The system of the residual Portmanteau Tests basically rejects the no-autocorrelation hypothesis for the first lag for all three beverages with the Q-stats over four thousand. Alessie and Kapteyn (1991) and Assarsson (1991) proposed the Dynamic AIDS model, which could (at least partially) solve this problem by introducing a vector of the lagged dependent variables into each equation of the system. This method, however, is not applicable for our data as the length of our panel series is too short and cannot withstand such loss of the degrees of freedom[9]. Concerning the hetoreskedasticity tests, the Verbon LM test, which is appropriate for our data, does not seem to report too large problems (with only a minor exception for one equation at the Stage 1).

Despite the strong significance of many individual coefficients (particularly at stage 3 estimations), the model in general shows a rather low explanatory power, with the R^2 reaching values lower than 0.3. However, for cross-sectional data and especially for the non-aggregated form of the model, these values could be treated as quite natural.

In the text below, we present the estimated elasticity values for the individual budgeting stages, given by (11) and (17). The number in brackets represents t-statistic of corresponding coefficient in the system (16), which is γ_{ij} for price elasticities and β_i for income elasticities. For the figures of the non-estimated equations, the unobserved t-statistic is taken from an auxiliary regression (with exclusion of the first equation from the system instead). These figures are denoted with "*". For a full list of regression outputs, see Appendix 2.

The results of the stage 1 estimation are in accord with the common economic observation. Industrial and manufactured goods exhibit the features of luxury goods with income elasticity of 1.34 (42.300), services show an almost unity value reaching 0.98 (–3.422*). Finally, the results show food as a necessity with the elasticity of 0.60 (–58.187).

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

Finally, in the third stage, we are interested not only in the income elasticities but also in the own-price and cross-price relations. The within-group expenditure elasticities show the following pattern: Whereas wine and spirits behave as necessities – with the corresponding group-expenditure elasticities 0.76

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

(–24.439) and 0.47 (–69.519), beer and non-alcoholic drinks show a luxury pattern – with the corresponding elasticities 1.33 (35.030) and 1.06 (12.056*). In terms of the total income elasticities, this means the total elasticities of 0.98 for beer, 0.56 for wine, 0.35 for spirits and 0.78 for non-alcoholic beverages. This pattern might seem a little surprising at the first sight. However, it might be readily explained by the structural properties of the particular beverage groups. Our dataset includes both consumption at home and consumption in restaurants. For wine and spirits, the volume share consumed at home reaches 90% and 92% respectively of the total consumption. For beer and non-alcoholic drinks, on the other hand, these proportions reach only 75% and 39% respectively. The implication to income elasticities is straightforward – as a result of the wealth change, consumers of beer and non-alcoholic drinks may tend to increase their consumption in restaurants in larger proportion than their consumption at home. The data from the HBS do support this statement. For example, the share of draught beer seems to increase by 1.27% per additional CZK 1 000 in drinks expenditure. The general consumption trends from bottled beer towards draught beer, and from mild to lager beer types are also confirmed by the Czech Beer and Malt Association (2007). The opposite trend is likely to take place in the spirit group, where the price level is to a large extent levelled by the high excise taxes.

Table 2. Income elasticities

Beverage	Within group elasticity	t-statistic of related coefficient	Total income elasticity
Beer	1.3316	35.0298	0.9829
Wine	0.7598	–24.4392	0.5609
Spirit	0.4685	–69.5186	0.3458

Source: Own calculation based on data from the Czech Budget Household Survey

Note: The total income elasticities of demand include results from the first two stages, where income elasticity of food is estimated to 0.6041 (–58.1872) and drinks' elasticity (within food group) is 1.220 (24.6150). For the full list of regression results see Appendix 2.

Table 3. Empirical analysis – the results

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

Source: Own calculation based on data from Czech Household Budget Survey

Note: For full list of regression results see Appendix 2

All alcoholic beverages show negative own-price elasticities, amounting to –0.97 (–4.452) for beer, –1.09 (–6.693) for wine and –1.21 (–12.853) for spirits. It is legitimate ask whether the beer elasticity should not be lower in the real world. Again, the effect of the price increase might result in the transition from draught to bottled beer. This effectively reduces the beer group-expenditure share leaving the real volumes virtually unchanged.

Concerning the cross-price elasticities, our results do not confirm the symmetry assumption. In fact, the Wald tests reject the hypothesis at any usual level of significance. The uncompensated non-symmetric demand elasticities for the alcoholic beverages are listed in Table 2 and 3. The listed t-statistics represent values for the estimates of appropriate β_i (for income) and γ_{ij} (for own and cross-price) coefficients.

Having calculated the above estimates of microeconomic behaviour, it is natural to seek for the similar micro-level analyses to obtain comparison. Crawford, Laisney and Preston (2004), who also use the Czech HSB data, utilizing the implicit price information given by its volume-expenditure scope, is the best comparable paper with respect to the Czech HBS data. Although their analysis does not concern alcohol beverages in particular, it gives us the additional confirmation on empirical problems with the symmetry of cross-price elasticities at the non-aggregated level.

CONCLUSIONS

Alcohol drinks have always been a heterogeneous group of commodities. Each of the major beverages

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

(beer, wine and spirit) is perceived by the consumers to possess its own and individual set of attributes which are likely to be different across countries, depending on the local culture and the production and consumption history.

In the Czech Republic, a dominant position among other beverages has always been attributed to beer, which consistently accounts for about half of the total domestic alcohol consumption in the terms of pure ethanol equivalent. The results of this paper indicate that this state is likely to be quite stable as beer shows the lowest own-price elasticity of demand among all three groups. This would also signify that, when perceived purely from the fiscal perspective, taxing beer could be relatively more efficient than the excise taxes levied on the other two beverages. The substitution between beer and spirits, also proposed by the results, is not likely to reverse this trend. The income elasticity of demand for beer, on the other hand, is relatively high. This result could be attributed to the large within-group heterogeneity of beer as the consumer is allowed to substitute between bottled and draught beer, while there is a severalfold price difference between these two beer sub-groups.

The wine segment represents a notional midpoint among the beverages' estimated elasticities. While the own-price elasticity seems to be slightly more than unity, the results show a much smaller response to income, compared to beer, but still significantly higher than for spirits. This difference could be again attributed to the within-group price diversity in the wine segment. On the other hand, the high proportion of spirit price attributed to the excise tax seems to (at least to a large extent) level the price pattern within the spirit group. The estimated cross-commodity effects, treating wine and beer as mild complements and wine and spirits as substitutes are again not likely to play a dominant role in the potential taxation strategy.

Generally, the economic policy implications of our results suggest that while designing the tax intervention and evaluating its impact, one must treat all three beverages separately and it is likely, that an optimal tax solution could be far from an overall tax harmonization. Moreover, the small but non-negligible substitution relationship between the drinks (perhaps with the exception of the wine-beer relation) suggests that if the tax measure is aimed towards the reduction of the social costs of alcohol consumption, it needs to cover (to some extent) each individual beverage in order not to lose efficiency due to the consumer switching behaviour.

The explanatory power of the model is not overwhelming, which is quite a natural consequence of examining the detailed microeconomic data instead of the aggregated series. Moreover, this analysis, along with the results by other papers based on the Czech budget household survey, does not find the statistical support for the symmetry of cross-price elasticities, required by the microeconomic theory. However, the results of the study are quite encouraging in terms of reasonability of estimated elasticity figures arising from the solid and exclusively Czech microeconomic data.

Appendix 1: List of items in the particular steps of multistage budgeting

Stage 3: Drinks

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

Stage 2: Food

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

Stage 1: All consumer goods

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

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

Appendix 2: Regression results

Note: For example γ_beerW_wineP represents the AIDS coefficient representing the change in within-group budget share (w_b) of beer with respect to wine price (P_w)

Regression results – Stage 3

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

Equation: BEER			
R-squared	0.108440	Mean dependent var	0.219606
Adjusted *R*-squared	0.108029	S.D. dependent var	0.168076
S.E. of regression	0.158738	Sum squared resid	273.3949
Prob (*F*-statistic)	1.038239	Portmanteau *Q*-stat 1st lag	5 313
		Verbon LM het. test	0.2877

Equation: WINE			
R-squared	0.107079	Mean dependent var	0.136557
Adjusted *R*-squared	0.106667	S.D. dependent var	0.108444
S.E. of regression	0.102497	Sum squared resid	113.9857
Prob (*F*-statistic)	1.164769	Portmanteau *Q*-stat 1st lag	4 018
		Verbon LM het. test	0.7849

Equation: SPIRIT			
R-squared	0.313310	Mean dependent var	0.131777
Adjusted *R*-squared	0.312994	S.D. dependent var	0.092824
S.E. of regression	0.076938	Sum squared resid	64.22603
Prob (*F*-statistic)	1.321314	Portmanteau *Q*-stat 1st lag	4 619
		Verbon LM het. test	0.4556

Regression results – Stage 2

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

Equation: DRINKS

R-squared	0.1261	Mean dependent var	0.1981
Adjusted *R*-squared	0.1257	S.D. dependent var	0.0764
S.E. of regression	0.0714	Sum squared resid	57.2574
Prob (*F*-statistic)	1.1365	Portmanteau *Q*-stat 1st lag	3 995
		Verbon LM het. test	0.8832

Equation: ANIMAL PRODUCTS

R-squared	0.1000	Mean dependent var	0.3758
Adjusted R-squared	0.0996	S.D. dependent var	0.0695
S.E. of regression	0.0660	Sum squared resid	48.8583
Prob (*F*-statistic)	1.1716	Portmanteau Q-stat 1st lag	4 877
		Verbon LM het. test	0.3881

Equation: VEGETABLE PRODUCTS

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

Regression results – Stage 1

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

Equation: FOOD

R-squared	0.240232	Mean dependent var	0.272437
Adjusted *R*-squared	0.239961	S.D. dependent var	0.090129
S.E. of regression	0.078575	Sum squared resid	69.35913
Prob (*F*-statistic)	1.359519	Portmonteau *Q*-stat 1st lag	4 380
		Verbon LM test	1.3822

Equation: INDUSTRIAL PRODUCTS

R-squared	0.138213	Mean dependent var	0.346437
Adjusted *R*-squared	0.137906	S.D. dependent var	0.126217
S.E. of regression	0.117191	Sum squared resid	154.2844
Prob (*F*-statistic)	1.451514	Portmonteau *Q*-stat 1st lag	2 118
		Verbon LM test	0.9160

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