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The Estimation of Complete Almost Ideal Demand System from Czech Household Budget Survey Data

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Abstract:

The aim of this paper is to provide a reliable set of income, own-price, and cross-price elasticities of demand for the consumer goods, foods and alcohol beverages based on Almost Ideal Demand System model applied to the most relevant Czech data set of Household Budget Statistics. While we concentrate on the last stage of our complete demand system which is concerned with the demand for beverages, the estimates obtained in the first (all consumption goods) and second (food) stages of our model may be used for consumer demand analysis with respect to any consumption group considered in our model.

Keywords: Almost Ideal Demand System, consumption, the Czech Republic, elasticity, price, spirits, tax, wine, beer.

JEL: D12, L66, Q18

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1. INTRODUCTION

This study is dealing with an estimation of Czech consumer demand with particular attention to the demand for alcohol. The popularity and ability of alcohol to influence human behavior has earned it much attention of not only the consumers but also of the governing authorities and the academic research community. From the point of view of government, alcohol purchases are very easy and obvious target for imposition of excise taxes.

The alcohol taxation decisions of policymaking authorities in any particular country are obviously not fully free of outside restrictions. When deciding on the optimal tax, the policymakers take into account not only the demand parameters of domestic consumers but also the level of taxation in neighboring countries and other international trade aspects needed for finding optimal tax rate in an open economy. For European Union (EU) countries the national tax authority has to satisfy also the EU regulation and EU minimal excise tax rates. Important factor influencing alcohol tax decisions is also a strong lobby of wine producers. This lobby is especially enhanced by the coordinated pressure of major wine producing countries (Italy, France, Spain). Nevertheless, even taking into account these outside restrictions, we have to emphasize that discovering and quantifying the consumption patterns of domestic alcohol demand is a necessary condition for implementing any government policy dealing with alcohol consumption and taxation.

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

Unfortunately these Czech policy interventions in the final consumer price of alcohol are not supported by an adequate comprehensive cost-benefit analysis of 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 rigorous estimation of own and cross-price elasticities of alcoholic beverages based on well-established microeconomic demand model and using the most relevant Czech data set of Household Budget Statistics.

2. 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 individual (psychological and medical surveys) or on society as a whole (sociological approach). Extensive economic research has been undertaken, examining relationships between alcohol and many economic variables such as domestic product, productivity of labor, employment and tax revenues.

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

In Europe, recent research in this field is mostly connected with initiatives of European Committee related to common plans for regulation of adverse impact of alcohol consumption on the community. Current results of this effort include, among others, the report by the Institute of Alcohol Studies conducted by Anderson and

Baumberg (2006), which maps the problem on a pan-European scale based on data from the European 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.

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

Many relevant studies were also published in the Czech journal *Agricultural Economics*. Chladkova, Tomsik and Gurska (2009) discussed the development of main factors of the wine demand. Their paper was a part of a long-term research project dealing with Czech wine market (Chladkova, Posvar and Zufan (2004), Tomsik and Chladkova (2005), Pysny, Posvar and Gurska (2007), Kucerova and Zufan (2008)). David (2009) discussed the problems of commodity taxation on an example of cigarettes taxation. Alternative approaches to price elasticity estimation to our almost ideal demand system model were presented by Bielik and Sajbidorova (2009), Hupkova, Bielik and Turcekova (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 flexible function forms. This is a functional class into which our almost ideal demand system model belongs. These models based on Czech data were presented by Crawford, Laisney and Preston (2003), Brosig and Hartmann (2001), Janda, McCluskey and Rausser (2000), Brosig and Ratering (1999), Banse

and Brosig (1998), Janda and Volosin (1998), Janda (1997), Janda and Rausser (1997), Dubovicka, Janda and Volosin (1997), and Ratering (1995).

The major issue in government policies dealing with commodity taxation is an existence of multiple, sometimes contradictory, sometimes complementary, goals pursued by these policies. On one hand, there is a fight against the adverse consumption effects of the commodities like tobacco products and alcohol beverages (negative health and social effects) or mineral fuels (global warming and other environmental concerns). On the other hand there is a need to find financial resources for dealing with population aging (pension system reform) and long-term sustainability of public finances. Some of these concerns were raised in the context of Czech indirect taxation policies by Slavik (2004).

3. THEORY

The pioneering role in estimating demand system derived directly from consumer's preferences theory is usually ascribed to Stone (1954) who first used the Linear Expenditure Systems developed by Klein and Rubin (1947-48) to estimate a whole demand system. Since then, a large number of models concerning this topic have been proposed. Let us mention at least the most renowned ones: the Rotterdam model (see Theil, 1967 and Barten 1969) and the translog model (see Christensen, Jorgenson and Lau, 1975). Our analysis is based on another influential model - the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980). To be more specific, it is based on the multi-stage budgeting modification of this model which was provided by Edgerton et al. (1996).

3.1 BASIC AIDS MODEL SPECIFICATION

In their proposition of demand system, Deaton and Muellbauer use a specific class of preferences (known as PIGLOG¹⁾), which allows for an exact aggregation

¹⁾ For more details on PIGLOG preferences see Muellbauer (1975).

over consumers. These preferences are represented straight with expenditure function. The AIDS form of this expenditure function is:

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

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

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

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

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

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

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 budget share form

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

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

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 changes in prices and real expenditure respectively²⁾, P represents price index and thus x/P stands for “real” expenditure³⁾.

²⁾ 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.

³⁾ The price index P and real expenditure x/P become of particular interest when we include the time scope of our analysis later on.

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 expenditure is at subsistence level). Analogically we could find that α_0 denotes the logarithm of subsistence expenditure measured in base year prices.

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

$$\sum_{i=1}^n \alpha_i = 1 \quad (6) \quad \sum_{j=1}^n \beta_j = 0 \quad (7) \quad \sum_{k=1}^n \gamma_{kj} = 0 \quad (8) \quad \gamma_{kj} = \gamma_{jk} \quad (9)$$

The restriction (8) ensures homogeneity (of degree 0) of the demand function. The formula (9) expresses 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 Slutsky equation⁴⁾. Given the concavity of expenditure function, the matrix of its second derivatives $\partial^2 c(p, u) / \partial p_i \partial p_j = \partial h_i(p, u) / \partial p_j$, often referred as “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 the 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 the numerator simply cancels out and the formula is reduced to

⁴⁾ 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.

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

We have just derived the full form of static AIDS model applicable on individual (say household) level. In order to move from the individual level estimation to the estimation on aggregate level we would have to tackle the problem of aggregate demand. As described by Mas-Colell, Whinston, and Green (1995, p. 105), three questions with respect to aggregation should be asked when progressing from the analysis of individual demand to the analysis of aggregate demand. These questions are: “When can aggregate demand be expressed as a function of prices and aggregate wealth?” “When does aggregate demand satisfy the weak axiom (of revealed preferences)?” “When does aggregate demand have welfare significance?” Given the importance of these questions (and related questions of existence of positive and normative representative consumer), they are extensively dealt with in the literature on which our model is based. In particular they are addressed by Edgerton et. al (1996), which is a major source of our theoretical and econometrical model.

3.2 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 number of consumers. In the case the econometric estimation would be based on aggregate time series data on expenditures it might be difficult to find an appropriate measure of population size. Ideal calculation would reflect all demographic changes (such as size of age groups, immigration etc). However, this would per se lead to very complicated models. In time series, as proposed also by Edgerton et al. (1996), the rate of demographic change is rather slow; therefore we may use the total population or the total number of households as a suitable approximation. Fortunately, data used in our study are gathered from household-based survey. Our model will therefore work in terms of per household demand and expenditures, and therefore aggregation will not be needed and we will

not be faced with a difficult choice of appropriate measure of population size and other concerns which plague the demand analysis based on aggregate time series data.

3.3 SIMPLIFICATIONS TO AIDS

While estimating the model we face one obvious problem – the non-linearity of price index in (5). Although this would not mean a large problem for single equation estimation, for more complex system and long series the calculation could become quite time consuming. While looking for suitable approximations, Deaton and Muellbauer (1980) suggest replacing the last two terms in (5) with 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 so called Linear Almost Ideal Demand System (LAIDS), which is being extensively applied in literature⁵⁾ and which is obtained by substituting (14) into (4)

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

It is worth mentioning, that α_0 is usually not identified in the system as it is absorbed in constant term $\alpha_i^* = (\alpha_i - \beta_i \alpha_0)$. In fact, empirical identification of α_0 is usually very problematic. Deaton and Muellbauer therefore propose taking logarithm of an a priori chosen value for real subsistence expenditure.

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

⁵⁾ See Alston et al. (1994) or Edgerton (1996).

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

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

3.4 MULTI-STAGE BUDGETING

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

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

To put the problem more rigorously, let us consider a two-stage budgeting process (which can be readily extended to multi-stage process), where the first stage comprises of n groups of goods. In the second stage, r^{th} group ($r = 1, \dots, n$) consists of m goods. Let the demand for i^{th} ($i = 1, \dots, m$) 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

$$u = f[\nu(q_1); \nu(q_2); \dots; \nu(q_n)] \quad (18)$$

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

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

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

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

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 since we could not simply replace all prices by simply taking n price indices (one for each group). Deaton and Muellbauer (1980) show that demand for r^{th} group goods may be approximated, when we express it in real terms as.

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

where Q_r is real r^{th} group expenditure expressed in some base year prices and P_i are 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 standard Paasche or Laspeyres indices⁶⁾. The proper form of three-stage budgeting used in our model will be discussed in the following section.

⁶⁾ The true cost of living indices would be independent of utility level if and only if the preferences were homothetic. However, Wilks (1938) shows that the quality of our approximation increases with increasing number of commodities in the model.

4. BASIC CHARACTERISTIC OF THE DATASET

Empirical part of our study is based on Household Budget Statistics (HBS) provided by Czech Statistic Office. It is an annual survey on microeconomic behavior of Czech households which supplies information on their expenditure and structure of their consumption. In fact, it is also the only survey which is detailed enough to provide consistent information on Czech alcohol consumption on individual (household) level. The survey monitors over 3000 households chosen on specific quota-based system. The quota tries to mimic the real composition of Czech society, i.e. 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 Microcensus survey, which is a socio-demographic survey based on random sampling techniques. Given this structure, a representative sample is then chosen from the set of all respondents. For illustration of socio-demographic composition of the population sample see Table 1.

Table 1. Sample Composition of Household Budget Survey 2007

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

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

4.1 MULTI-STAGE BUDGETING IN HOUSEHOLD SURVEY

Czech household budget survey is well suitable for application of multi-stage budgeting models because it captures multiple aspects of household cash-flow, namely: income items, food expenditures (including physical volumes where applicable), manufacturing and other consumer goods (both durables and non-durables), services expenses, transfers and payments, even natural incomes and expenditures and gifts. In our analysis, a three stage method has been chosen. First, we evaluate the system concerning distribution of total expenses on food, industrial products and services. Then we focus on food part, examining the consumer choice between: drinks; animal 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 drinks⁷⁾.

The number of observations in particular stages varies because of technical restrictions of the model. First, HBS is not constructed as a fully balanced panel. The condition of reflecting demographic composition (taken from Microcensus survey) is superordinate to continuous tracking of an individual household. In fact, only 288 households were tracked for the whole period (2002-2007) which we use in our study, and 3832 households were observed only within a single year (and thus inapplicable for our purposes). Moreover, the logarithmic form of our model prevents us from using such observations in stage 3, which exhibit zero consumption of particular beverage (for first two stages, positivity is assured by aggregation of the data across multiple consumption items). Moreover, in order to assure at least partial homogeneity in observed beverage quality, we need to exclude such observations, which exhibit deviant values of the beverage price and which would potentially cause biases and

⁷⁾ For a full list of items in particular group see Appendix 1.

leverage effects. In case of beer, the limits (price greater than CZK 5 and less than CZK 100 per liter) do not exclude many observations. In case of wine, however, the lower bound of CZK 25 per liter (which is the lowest market price for junk wine) limits over 300 observations. The reason for this could be attributed to semi-barter wine purchases in some Moravian regions, where the actual price might be lowered by non-economic factors such as natural exchange or various interpersonal relationships. The restriction is even more important for spirit part of the estimation. Compared to the other two beverages, spirit group is the most diversified, with alcohol content raging from mere 20% for several liquors to 70% for absinth. To eliminate the disrupting effect of beverages with a low alcohol content, we need to set a price boundary to reflect the cheapest market price of normalized spirit. Given that cheapest rum with alcohol content of 40% could be purchased for about CZK 180 per liter and given the fact that excise tax on distilled products per se reaches CZK 103, we set the lower limit to CZK 160.

5. EMPIRICAL ANALYSIS OF MICROECONOMIC CONSUMPTION BEHAVIOR

For estimating the systems given in (15) on the data from Czech Budget Household Survey, a structured dated panel has been created for each stage. For 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 a 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 a stage 1, we exclude the services equation, at a stage 2 it is the cereals and other foods equation and at the last stage we exclude the non-alcoholic drinks segment.

The estimation has been done using one-way Seemingly Unrelated Regression technique as in papers by Akbay and Jones (2006) and Janda (1995). This approach seems to be suitable for our analysis as it is able to capture the efficiency due to correlation of the disturbances across equations. For detailed specification of the approach review Baltagi (2008). In case of our study, this approach is able to account for non-included factors such as hot weather, which might lead to increased beer consumption in a particular year. The basic AIDS model frequently suffers from autocorrelation problems, which is confirmed also in our study. System residual Portmanteau Tests basically rejects no-autocorrelation hypothesis for the first lag for all three beverages with Q-stats over four thousand. Alessie and Kapteyn (1991) and

Assarsson (1991) proposed Dynamic AIDS model, which could (at least partially) solve this problem by introducing a vector of lagged dependent variables into each equation of the system. This method, however, is not applicable for our data as the length of our panel series is too short and cannot withstand such loss of degrees of freedom⁸⁾. Concerning the heteroskedasticity tests, Verbon LM test, which is appropriate for our data, does not seem to report too large problems (with only minor exception for one equation at Stage 1).

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

In the text below, we present the estimated elasticity values for individual budgeting stages, given by (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 stage 1 estimation are in accord with a common economic observation. Industrial and manufactured goods exhibit features of luxury goods with income elasticity of 1.34 (42.30), services show almost unity value reaching 0.98 (-3.42*). Finally, our results show food as a necessity with elasticity of 0.60 (-58.19).

The second stage brings estimates for the food segment. Again, the income elasticities show expected pattern: Animal products, Vegetables and Cereals & Other Foods exhibit the features of slight within-group necessities, with group-expenditure elasticities of 0.95 (-11.82), 0.99 (-0.95) and 0.92 (-15.64*). Drinks group, on the other hand, behaves as a within-group luxury with group-expenditure elasticity of 1.22 (24.62). This means that total income elasticity of demand for drinks reaches 0.74, therefore drinks again count as necessity.

Finally, in the third stage, we are interested not only in the income elasticities but also in the own-price and cross-price relations. The within-group expenditure elasticities show following pattern. Whereas wine and spirits behave as necessities – with corresponding group-expenditure elasticities 0.76 (-24.44) and 0.47 (-69.52), beer and non-alcoholic drinks show a luxury pattern – with corresponding elasticities 1.33 (35.03) and 1.06 (12.06*). In terms of total income elasticities this means total elasticities of 0.98 for beer, 0.56 for wine,

⁸⁾ For some examined households, only 2-3 observations have been collected, therefore introduction of lag structure is virtually implausible.

0.35 for spirits and 0.78 for non-alcoholic beverages. This pattern might seem a little surprising at a first sight. However it might be readily explained by structural properties of particular beverage groups. Our dataset includes both consumption at home and consumption in restaurants. For wine and spirits, the volume share consumed at home reaches 90% and 92% respectively of total consumption. For beer and non-alcoholic drinks, on the other hand, these proportions reach only 75% and 39% respectively. The implication to income elasticities is straightforward – as a result of wealth change, consumers of beer and non-alcoholic drinks may tend to increase their consumption in restaurants in larger proportion than their consumption at home. Data from HBS do support this statement. For example the share of draught beer seems to increase by 1.27% per additional CZK 1000 in drinks expenditure. The general consumption trends from bottled beer towards draught beer, and from mild to lager beer types are also confirmed by Czech Beer and Malt Association (2007). The opposite trend is likely to take place in the spirit group, where the price level is to a large extent leveled by high excise taxes.

All alcoholic beverages show negative own-price elasticities, amounting to -0.97 (-4.45) for beer, -1.09 (-6.69) for wine and -1.21 (-12.85) for spirits. It is legitimate ask whether the beer elasticity should not be lower in real world. Again, the effect of price increase might result in transition from draught to bottled beer. This effectively reduces beer's group-expenditure share leaving real volumes virtually unchanged⁹⁾.

Concerning the cross-price elasticities, our results do not confirm the symmetry assumption. In fact, 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. Listed t-statistics represent values for estimates of appropriate β_i (for income) and γ_{ij} (for own and cross-price) coefficients.

⁹⁾ 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.

Table 2. Income elasticities

	Within group	t-stat. of related	Total income
Beverage	elasticity	coefficient	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 (-58.19) and drinks' elasticity (within food group) is 1.220 (24.62). For 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-stat. 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.

Having calculated the above estimates of microeconomic behavior, it is natural to seek for similar micro-level analyses to obtain comparison. Crawford, Laisney and Preston (2004), who also use Czech HBS data, utilizing the implicit price information given by its volume-

expenditure scope, is the best comparable paper with respect to Czech HBS data. Although their analysis does not concern alcohol beverages in particular, it gives us additional confirmation on empirical problems with symmetry of cross-price elasticities at a non-aggregated level.

6. CONCLUSIONS

Alcohol drinks have always been a heterogeneous group of commodities. Each of the major beverages (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 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 the total domestic alcohol consumption in 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 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 midpoint among the beverages' estimated elasticities. While the own-price elasticity seems to be slightly more than unity, the results show 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 wine segment. On the other hand, the high proportion of spirit price attributed to excise tax seems 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 a 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 exception of wine-beer relation) suggests that if the tax measure would be aimed towards reduction of social costs of alcohol consumption, it needs to cover (to some extent) each individual beverage in order not to lose efficiency due to consumer switching behavior.

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

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Appendix 1: List of items in 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)

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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.
- **Vegetabilia:** 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.

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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 $\gamma_{\text{beerW_wineP}}$ represents the AIDS coefficient representing the change in within-group budget share (w_b) of beer with respect to wine price (P_w)

Table 4. Regression results – Stage 3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_{beerW}	-0.43103	0.03585	-12.0214	0.0000
$\gamma_{\text{beerW_beerP}}$	0.02225	0.00499	4.45234	0.0000
$\gamma_{\text{beerW_wineP}}$	-0.01515	0.00381	-3.96911	0.0001
$\gamma_{\text{beerW_spiritP}}$	0.05454	0.00618	8.82193	0.0000
$\gamma_{\text{beerW_nonalcP}}$	0.04489	0.00531	8.44832	0.0000
β_{beerW}	0.07281	0.00207	35.02972	0.0000
α_{wineW}	0.04053	0.02315	1.75092	0.0800
$\gamma_{\text{wineW_beerP}}$	0.04101	0.00322	12.7112	0.0000
$\gamma_{\text{wineW_wineP}}$	-0.01650	0.00246	-6.69330	0.0000
$\gamma_{\text{wineW_spiritP}}$	0.02710	0.00399	6.79020	0.0000
$\gamma_{\text{wineW_nonalcP}}$	0.03033	0.00343	8.84118	0.0000
β_{wineW}	-0.03280	0.00134	-24.43921	0.0000
α_{spiritW}	0.67446	0.01737	38.81020	0.0000
$\gamma_{\text{spiritW_beerP}}$	-0.00309	0.00242	-1.27594	0.2020
$\gamma_{\text{spiritW_wineP}}$	-0.02378	0.00185	-12.8535	0.0839
$\gamma_{\text{spiritW_spiritP}}$	-0.00518	0.00299	-1.72861	0.0000
$\gamma_{\text{spiritW_nonalcP}}$	-0.01294	0.00257	-5.02494	0.0000
β_{spiritW}	-0.07004	0.00100	-69.51860	0.0000
Equation: BEER				
R-squared	0.108440	Mean dependent var		0.219606
Adjusted R-squared	0.108029	S.D. dependent var		0.168076
S.E. of regression	0.158738	Sum squared resid		273.3949
Prob(F-statistic)	1.038239	Portmonteau Q-stat 1 st lag		5313
		Verbon LM het. test		0.2877
Equation: WINE				
R-squared	0.107079	Mean dependent var		0.136557
Adjusted R-squared	0.106667	S.D. dependent var		0.108444
S.E. of regression	0.102497	Sum squared resid		113.9857
Prob(F-statistic)	1.164769	Portmonteau Q-stat 1 st lag		4018
		Verbon LM het. test		0.7849
Equation: SPIRIT				
R-squared	0.313310	Mean dependent var		0.131777
Adjusted R-squared	0.312994	S.D. dependent var		0.092824
S.E. of regression	0.076938	Sum squared resid		64.22603
Prob(F-statistic)	1.321314	Portmonteau Q-stat 1 st lag		4619
		Verbon LM het. test		0.4556

Table 5. Regression results – Stage 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α drinksW	-0.3286	0.0207	-15.8464	0.0000
γ drinksW drinksP	0.0604	0.0018	32.6843	0.0000
γ drinksW animalP	0.0080	0.0033	2.3999	0.0164
γ drinksW vegetP	0.0195	0.0024	8.1572	0.0000
γ drinksW otherP	-0.0050	0.0023	-2.1334	0.0329
β drinksW	0.0440	0.0018	24.6150	0.0000
α animalW	0.9181	0.0192	47.9341	0.0000
γ animalW drinksP	-0.0190	0.0017	-11.1445	0.0000
γ animalW vegetP	-0.0482	0.0031	-15.5824	0.0000
γ animalW otherP	0.0001	0.0022	0.0248	0.9802
γ foodW servP	-0.0346	0.0021	-16.1057	0.0000
β animalW	-0.0195	0.0017	-11.8203	0.0000
α vegetW	0.0702	0.0133	5.2620	0.0000
γ vegetW drinksP	-0.0028	0.0012	-2.3920	0.0168
γ vegetW animalP	0.0216	0.0022	10.0429	0.0000
γ vegetW servP	-0.0291	0.0015	-18.9076	0.0000
γ vegetW otherP	0.0222	0.0015	14.8352	0.0000
β vegetW	-0.0011	0.0011	-0.9451	0.3446
Equation: DRINKS				
R-squared	0.1261	Mean dependent var		0.1981
Adjusted R-squared	0.1257	S.D. dependent var		0.0764
S.E. of regression	0.0714	Sum squared resid		57.2574
Prob(F-statistic)	1.1365	Portmonteau Q-stat 1 st lag		3995
		Verbon LM het. test		0.8832
Equation: ANIMAL PRODUCTS				
R-squared	0.1000	Mean dependent var		0.3758
Adjusted R-squared	0.0996	S.D. dependent var		0.0695
S.E. of regression	0.0660	Sum squared resid		48.8583
Prob(F-statistic)	1.1716	Portmonteau Q-stat 1 st lag		4877
		Verbon LM het. test		0.3881
Equation: VEGETABLE PRODUCTS				
R-squared	0.0524	Mean dependent var		0.1498
Adjusted R-squared	0.0520	S.D. dependent var		0.0472
S.E. of regression	0.0459	Sum squared resid		23.6991
Prob(F-statistic)	1.1458	Portmonteau Q-stat 1 st lag		4234
		Verbon LM het. test		0.5696

Table 6. Regression results – Stage 1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_{foodW}	3.66580	4.29781	0.85294	0.3937
$\gamma_{\text{foodW foodP}}$	-0.04196	0.20302	-0.20669	0.8363
$\gamma_{\text{foodW industP}}$	-0.32639	0.75623	-0.43160	0.6660
$\gamma_{\text{foodW servP}}$	-0.20507	0.37373	-0.54870	0.5832
β_{foodW}	-0.10787	0.00185	-58.1872	0.0000
α_{industW}	-6.98323	6.40998	-1.08943	0.2760
$\gamma_{\text{industW foodP}}$	-0.05694	0.30279	-0.18803	0.8509
$\gamma_{\text{industW industP}}$	1.04864	1.12788	0.92974	0.3525
$\gamma_{\text{industW servP}}$	0.42190	0.55740	0.75690	0.4491
β_{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	Portmanteau Q-stat 1 st lag		4380
		Verbon LM test		1.3822
Equation: INDUSTRIAL PRODUCTS				
R-squared	0.138213	Mean dependent var		0.346437
Adjusted R-squared	0.137906	S.D. dependent var		0.126217
S.E. of regression	0.117191	Sum squared resid		154.2844
Prob(F-statistic)	1.451514	Portmanteau Q-stat 1 st lag		2118
		Verbon LM test		0.9160

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