DEMAND ELASTICITY FOR THE CZECH CONSUMER

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Abstract

The mission of economics in practical application can be described as an additional tool for the deeper understanding of the connection between market subjects. The price elasticity of demand is an extremely important value for the right pricing strategy. In many cases there are merely theoretical concepts, and concrete values for the actual situation are lacking. The objective of this paper is to evaluate methods for identifying demand elasticity. A longer time period will be used for the solution. The article will compare data from previous studies and discuss possible changes of the coefficients of elasticity for the Czech consumer. Two different procedures will be used for the solution. Reference values will be calculated by a standard approach of correlation and regression analysis. In the next section, these results will be compared with the second procedure, which is more focused on the possible variability of individual responses. The values determined are then compared with known values from the past and from the literature. The final part contains identification of changes in elasticity values for the previous 10 years in the Czech Republic.

Key words: Elasticity, Demand, Consumer Basket, Regression Analyses, Standard Deviation.

JEL Code: D12, D39, D49

Introduction

The choice of a suitable method of data collection is the primary objective of this research. The questionnaire method will be applied, because in our opinion it represents a reasonable compromise between miscellaneous approaches to data collection from individual respondents. It is possible that other methods (e.g. interviews) could enable easier affection and directing of the respondent so that his/her answers do not steer away from the context of the established facts, but questionnaire research is much more advantageous from the point of view of the length of time required. On the other hand, it must be pointed out that the importance of no type of public opinion research in the field of demand should be overestimated, because the absolutely perfect prediction of the demand of an individual is not,

in principle, possible, as it always represents an attempt to estimate the consumer's behaviour in reaction to certain price impulses, which, contrary to the "ceteris paribus" rule, are an integral part of a certain complex of decisions following not only from the buyer's effort to maximise his/her profit, but also from the buyer's reaction to certain fashion and social trends and conventions which can change relatively quickly in time.

The questionnaire research of market demand is adequate with respect to its possibilities; possible deviations of the values established from real values are only a matter of data processing through a suitable statistical apparatus which is able to characterise such deviations precisely. To obtain the least possible statistical error, the questionnaires were selected thoroughly prior to loading of the data into the selective set. Selection consisted of elimination of the questionnaires filled in contrary to the introductory instructions and/or the questionnaires that presented unrealistic values of consumption, both with respect to the financial possibilities of the respondent and the factual possibility of consumption of the quantities of goods shown. Such data, when incorporated into statistical calculations, would be a source of gross errors and could misrepresent the results obtained explicitly.

1 Demand Elasticity of Czech Students in 2003

A computer simulator was used for data collection in the first case. The results of this research were part of the grant project GACR 402/00/0499 "Research into Basic Characteristics of the Microeconomic Environment in the Czech Republic Using Untraditional Computer Simulation Methods". The e-shop simulator works with the same data as a standard questionnaire. Using the simulator is more efficient and faster in view of more rapid parameter changes. During the simulation, the experimenter can follow the development of key indicators in real time and adapt the simulation environment. All data was transferred to the database in Microsoft Access format, where all actions are recorded by the respondents. It is possible to use common mathematical tools for defining demand parameters for this data set.

The advantages of this approach:

- Centralised data management – no problem with the distribution and collection of data from individual respondents. The experimenter can access data immediately;
- Centralised management simulator – the program works only on the server that handles individual respondents and experimenters. All upgrading is performed on the

server. The complicated distribution of the program to all respondents is not necessary;

- Minimal demands on the respondent's computer – the demands on client computers are negligible, basically a computer with a browser and an Internet connection;

The disadvantages of the approach:

- The experimenter and respondent need an Internet connection to work with the simulator.
- Experience with the simulator has shown that the purchase time is too long. The last item on the shopping list did not correspond to real consumer behaviour. Too many items in the experiment reduce the accuracy of the model.

1.1 Description of respondents

243 respondents took part in the research. The average age of respondents was 21.5 years (median 21 years). The average monthly expenditure reported by respondents was 4,938 CZK (with a median of 3,000 CZK). The sample of respondents included 76 women and 167 men. The average income declared by the men was 5,860 CZK. The average income declared by the women was significantly lower, amounting to just 2,930 CZK. I would explain this significant discrepancy both by the fact that men are far more likely to work during their studies and that women are much more realistic (or pessimistic) in the estimation of their income. The number of respondents residing in Brno was 66; the number of respondents residing outside Brno was 151. The rest of the respondents did not disclose their residence. The average income declared by respondents from Brno was 5,000 CZK; the average of the other respondents was 4,280 CZK, i.e. 86 % of the income of respondents from Brno.

1.2 Description of experiment

The experiment as a whole was divided into two projects. The first project was named "Demand"; the second project was named "Income". In the two projects, the respondents had the same type of goods, but different income. In the first, the income level was set at 10,000 CZK, in the second the income level was set at 3,000 CZK. The respondents had to spend the whole amount as they would have done in reality.

The two projects were divided into five periods. This corresponded to five months of life in real time. To determine price elasticity, the price 50 % of the products was changed, while the price of the other 50 % of items remained unchanged. If all the prices changed, this

could lead to a considerably confusing situation for the respondents. Of the 50 % of items whose prices changed, the price of half fell, while the price of the other half increased, in all cases by ten percent in each period. This means that the price of some products fell to 59 % of the original price over five periods, while the price of other products increased to 161 % of the original price. These price changes represent a range to which the respondents might be sensitive and could lead to a change in their behaviour.

1.3 Analyses of demand curves

Analyse of the demand curves was based on a sample of more than 49,000 records of purchased items. These records were summarised and the dependence of price on purchased quantities determined.

The items that did not meet the following criteria in both projects were removed from the data sample:

- The purchase of goods in any period fell beneath ten units of the given goods;
- There was no change in the price or quantity;
- The average amount spent for five seasons and the average of the largest and the smallest item exceeded ten percent – this rule helped eliminate those samples of goods for which there was a sudden fluctuation in the number purchased for apparently non-economic reasons.

After these restrictions were applied, 239 of the total number of 352 products were excluded in the case of "demand" (113 items remained) and 289 were excluded in the case of "income" (63 items remained). The intersection of these two groups represents 54 items. Only 5 commodities will be further discussed due to the limited space available, specifically Gasoline, Bread, Coca-Cola, Beef and Beer. Benchmark values for U.S. consumers are known for these items.

For each item, there was an approximation of points using an exponential curve. Further, an analysis of demand elasticity was performed and its average value calculated.
ED is the elasticity of demand. Parameters *A* and *B* are parameters of the exponential approximation, where:

$$P = Ae^{BQ} \qquad (1)$$

Tab. 1: Price elasticity and the value of parameter approximation

Name of goods	Income = 3,000 CZK			Income = 10,000 CZK		
	A	B	E_D	E_D	A	B
Gasoline	5.79253	-0.00019	-2.80914	-2.24214	6.58704	-0.00004

Bread	36.56653	-0.00330	-1.11566	-2.32955	22.46444	-0.00097
Coca-Cola 2l	37.08086	-0.02514	-1.81223	-0.89705	64.99379	-0.02747
Beef	12.87253	-0.00560	-2.67590	-24.11843	8.86831	-0.00023
Beer	15.37062	-0.00133	-1.98490	-1.19869	21.50702	-0.00127

Source: Our own processing

2 Demand Elasticity of Czech Students in 2012

Our research focused on determination of the demand curves of 20 commodities and the structure, content and formal appearance of the questionnaire was adapted to this purpose. In conformity with the basic rules of creation of questionnaires, the respondent was familiarised in the short introductory section with the importance and objectives of the questionnaire research and was assured about the anonymous character of the whole research. In the following part only certain commodities will be described for the sake of conciseness, as for the previous research.

2.1 Determination of the size of the selective set

If T is the estimated characteristics of the basic set and if τ is its estimate following from the data of the selective set, then $|T - \tau|$ is named the error of the estimate and the ratio $|T \quad \tau|/T$ is the relative error of the estimate. Should the error of the estimate equal max. the figure Δ, then this value is named the permitted error of the estimate. Should the relative error of the estimate equal max. the figure δ, we are speaking about the relative permitted error of the estimate. The relative errors of the estimate are usually expressed in percent. The sizes of the error or the relative error are the basic indicators of the accuracy of the research and public opinion researches usually determine a permitted relative error of 5 % (Pecáková et al, 1998, Hindls, 2007).

When estimating features of the basic set by applying the data from the selective set, you can never be sure that the error of the estimate will equal max. the figure Δ and/or that the estimate of the relative error of measurement will equal max. the figure δ, and therefore we can only request these error claims to be probable adequately. This is expressed by the probability designated $1 - \alpha$ and named reliability coefficient or reliability coefficient of the estimate (e.g. for $1 - \alpha = 0.90$ we are speaking about 90 % reliability). While in technical and highly exact fields the reliability coefficient required is higher than 95 %, in case of public opinion researches the reliability coefficient is usually lower with respect to a high variability of answers.

Simple random selection without repetition was used for the questionnaire research. The following formula is valid for the scope of the selective set that would guarantee attaining the required values of error and relative error with the given probability:

$$n = \frac{u^2_{1-\frac{\alpha}{2}} \cdot \sigma^2 \cdot N}{\Delta^2 \cdot (N-1) + u^2_{1-\frac{1}{2}} \cdot \sigma^2} \qquad (2)$$

where n is the scope of the selective set, σ is the standard deviation and N is the scope of the basic set. Number is quantile of the standardised normal distribution depending on the chosen reliability 1 – α (amounting to 1.645 for the 90 % reliability coefficient value of this quantile) (Hindls, 2007). As the demand curves, from which the elasticity of certain kinds of goods is determined, have been elaborated for the basic set representing the population of the Czech Republic, it is an adequately large set enabling utilisation of the relations for calculation of the size of the selective set created by simple random selection with repetition because the results are comparable. The following is valid:

$$n = \frac{u^2_{1-\frac{\alpha}{2}} \cdot \sigma^2}{\Delta^2} \qquad (3)$$

if I extend the fraction by the arithmetic mean of the monitored characteristics, I obtain the following:

$$n = \frac{u^2_{1-\frac{\alpha}{2}} \cdot V^2}{\delta^2} \qquad (4)$$

where V is the variation coefficient defined as the quotient of the standard deviation and the average value. The literature sources (Hindls, 2007) show that in the case of the numerical variables monitored in public opinion researches and market researches, the values of the variation coefficient most frequently range from 0.3 to 1.0.

If the relevant calculation is performed, where the relative error value is required at a level of 5 %, reliability at the level of 90 % and, if assumed, that the variation coefficient is 0.65 (the centre of the interval of usual values), the following value will be obtained for the scope of the selective set:

$$n = \frac{1{,}645^2 \cdot 0{,}65^2}{0{,}05^2} = 457 \qquad (5)$$

i.e. if I want to obtain parameters of research as above, I have to address at least 457 respondents within the scope of the simple random selection.

2.2. Methodology of statistical processing of the data obtained

It is also necessary to consider that the price elasticity of demand is the indirectly measured variable which has to be calculated additionally from the measured variables. Where the variable y *is* determined on the basis of the relation, containing one or more directly measured variables $x_1 ... x_n$ and constants $C_1 ... C_n$, i.e. $y = f(x_1 ... x_n, C_1 ... C_n)$, **the error propagation law** is valid for calculation of the mean quadratic error S_y. If we assume, for the purposes of simplification, that the errors of the constants are negligible with respect to the known errors $S_{\bar{x}_1} ..... S_{\bar{x}_n}$ of the measured variables x1...x_n, *the* error propagation law is of the following shape

$$S_y = \sqrt{\left(\frac{\partial y}{\partial x_1}\right)^2 S_{\bar{x}_1}^2 + \left(\frac{\partial y}{\partial x_2}\right)^2 S_{\bar{x}_2}^2 + ... + \left(\frac{\partial y}{\partial x_n}\right)^2 S_{\bar{x}_n}^2} \qquad (6)$$

Now we can substitute into the formula, reflecting the error propagation law, to calculate the mean quadratic error of the price elasticity of demand:

$$S_{E_{Dji}} = \sqrt{\left(\frac{\partial E_{Dji}}{\partial \bar{Q}_{j(i+1)}}\right)^2 \cdot S_{\bar{Q}_{j(i+1)}}^2 + \left(\frac{\partial E_{Dji}}{\partial \bar{Q}_{ji}}\right)^2 \cdot S_{\bar{Q}_{ji}}^2 + \left(\frac{\partial E_{Dji}}{\partial \bar{P}_{j(i+1)}}\right)^2 \cdot S_{\bar{P}_{j(i+1)}}^2 + \left(\frac{\partial E_{Dji}}{\partial \bar{P}_{ji}}\right)^2 \cdot S_{\bar{P}_{ji}}^2} =$$

$$= \frac{\bar{P}_{j(i+1)} + \bar{P}_{ji}}{\bar{P}_{j(i+1)} - \bar{P}_{ji}} \sqrt{\left(\frac{(\bar{Q}_{j(i+1)} + \bar{Q}_{ji}) - (\bar{Q}_{j(i+1)} - \bar{Q}_{ji})}{(\bar{Q}_{j(i+1)} + \bar{Q}_{ji})^2}\right)^2 \cdot S_{\bar{Q}_{j(i+1)}}^2 + \left(\frac{-(\bar{Q}_{j(i+1)} + \bar{Q}_{ji}) - (\bar{Q}_{j(i+1)} - \bar{Q}_{ji})}{(\bar{Q}_{j(i+1)} + \bar{Q}_{ji})^2}\right)^2 \cdot S_{\bar{Q}_{ji}}^2} =$$

$$= \frac{\bar{P}_{j(i+1)} + \bar{P}_{ji}}{\bar{P}_{j(i+1)} - \bar{P}_{ji}} \sqrt{\frac{4\bar{Q}_{ji}^2}{(\bar{Q}_{j(i+1)} + \bar{Q}_{ji})^4} \cdot S_{\bar{Q}_{j(i+1)}}^2 + \frac{4\bar{Q}_{j(i+1)}^2}{(\bar{Q}_{j(i+1)} + \bar{Q}_{ji})^4} \cdot S_{\bar{Q}_{ji}}^2} =$$

$$= \frac{2(\bar{P}_{j(i+1)} + \bar{P}_{ji})}{(\bar{P}_{j(i+1)} - \bar{P}_{ji})(\bar{Q}_{j(i+1)} + \bar{Q}_{ji})^2} \sqrt{\bar{Q}_{ji}^2 \cdot S_{\bar{Q}_{j(i+1)}}^2 + \bar{Q}_{j(i+1)}^2 \cdot S_{\bar{Q}_{ji}}^2} =$$

$$= \frac{2(\bar{P}_{j(i+1)} + \bar{P}_{ji})(\bar{Q}_{j(i+1)} - \bar{Q}_{ji})}{(\bar{P}_{j(i+1)} - \bar{P}_{ji})(\bar{Q}_{j(i+1)} + \bar{Q}_{ji})(\bar{Q}_{j(i+1)} + \bar{Q}_{ji})(\bar{Q}_{j(i+1)} - \bar{Q}_{ji})} \sqrt{\bar{Q}_{ji}^2 \cdot S_{\bar{Q}_{j(i+1)}}^2 + \bar{Q}_{j(i+1)}^2 \cdot S_{\bar{Q}_{ji}}^2} =$$

$$= \frac{2E_{Dji}}{\bar{Q}_{j(i+1)}^2 - \bar{Q}_{ji}^2} \sqrt{\bar{Q}_{ji}^2 \cdot S_{\bar{Q}_{j(i+1)}}^2 + \bar{Q}_{j(i+1)}^2 \cdot S_{\bar{Q}_{ji}}^2} \qquad (7)$$

2.3. Results and Discussion

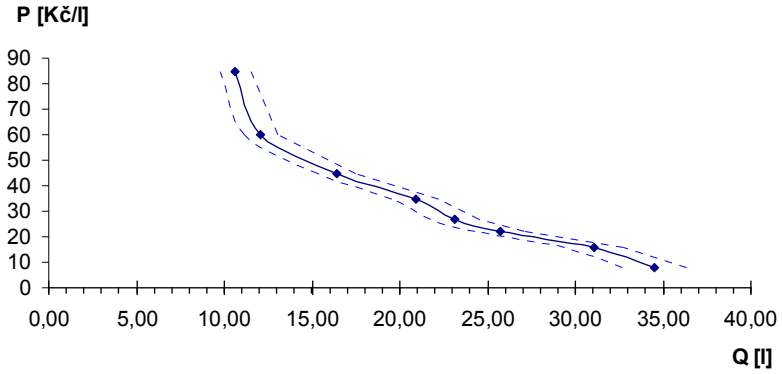
The following data concerning demand for gasoline has been obtained from the questionnaire research; it has been incorporated into the table as well as the graph.

Tab. 2: Values for demand for gasoline

Price in CZK/l	8	16	22	27	35	45	60
Overall demand in l	18,440	16,590	13,730	12,338	11,150	8,782	6,460
Average demand in l	34.53	31.07	25.71	23.10	20.88	16.45	12.10
Mean quadratic error of demand in l	1.82	1.67	1.41	1.37	1.34	1.07	0.92

Source: Our own processing

Fig. 1: Curve of average demand – gasoline



Source: Our own processing

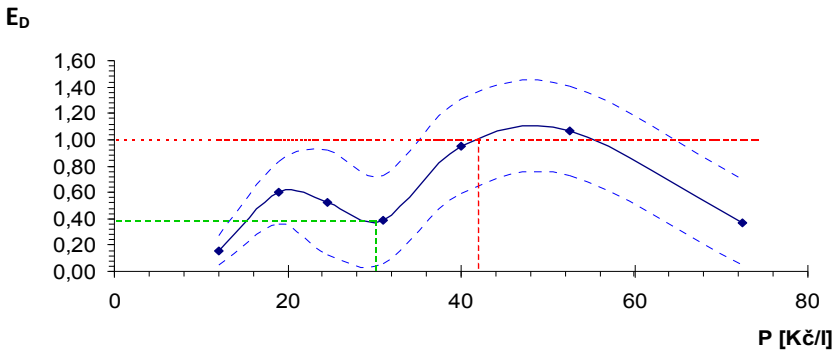
It clearly follows from the graph of demand that the demand for gasoline is the classic curve corresponding to the law of diminishing demand.

Tab. 3: Values of the price elasticity of gasoline

Price in CZK	12	19	24.5	31	40	52.5
Elasticity	-0.16	-0.60	-0.52	-0.39	-0.95	-1.07
Mean quadratic error of elasticity	0.11	0.24	0.39	0.34	0.36	0.34

Source: Our own processing

Fig. 2: Price elasticity of demand for gasoline



Source: Our own processing

If we consider the price elasticity at the so called common price (around 40 CZK) indicated in the graph of price elasticity by the red dashed lines, we obtain a value of 0.95 from the interval 0.6–1.3 determined by the mean quadratic error.

Summary result

For better illustration, the examined commodities will be arranged in the table by rising price elasticity corresponding to the common price.

Tab. 4: Commodities arranged by price elasticity

serial number	Commodity	Price elasticity at the common price	Common price in CZK/unit	Price in CZK/unit corresponding to the unit elasticity
1	Gasoline	0.38	30	42
2	Bread	0.48	30	50
2	Beer	0.80	50	68
4	Coca-Cola	1.00	18	18
5	Beef	2.95	170	90

Source: Our own processing

Conclusion

For the past 9 years, there has been a significant change in the coefficient of elasticity of demand. In 2003, most of the items ranged in values significantly greater than -1. Only Coca-Cola has remained at a very similar value for the previous 9 years. A relevant explanation of this situation may be changing income and the different structure of the consumer basket. As was clear from the first experiment, income influenced elasticity of consumers significantly. Data from 2012, but the values for American consumers do not differ significantly. Respectively, values of price elasticity are closer, as is seen from the following table.

Tab. 5: Comparing Czech and American values

Commodity	Price elasticity at the common price in the Czech Republic in 2003	Price elasticity at the common price in the Czech Republic in 2012	Price elasticity in the USA[1]
Gasoline	2.5	0.38	0.2
Bread	1.7	0.48	0.108–0.15
Beer	1.55	0.80	0.3–0.9
Coca-Cola	1.35	1.00	3.8

[1] GWARTNEY, J. D. et al., 2005: Economics: Private and Public Choice. South − Western/Cengage Learning, . ISBN 9780324205640.

Beef	13.35	2.95	0.40–0.64

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