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ADVANTAGES AND DISADVANTAGES OF THE USE OF CONJOINT ANALYSIS IN CONSUMER PREFERENCES RESEARCH

Abstract. The point of the following paper is to outline conjoint analysis, one of the methods of multidimensional statistical analysis. The conjoint analysis is very useful to get knowledge about consumer preferences. The paper contains basic information about methods of collecting variables, building regression functions of utilities and estimators.

Key words: preferences, conjoint analysis.

I. RUDIMENTS OF UTILITY THEORY

The analysis of human behavior and the processes connected with decision-making have always been within the interest of various fields of science. People with their attitudes and social interactions have been subjects of scientific studies, not only for social sciences such as sociology or psychology, but economic studies as well, e.g. the theory of decision-making, operational research, mathematical programming, systems analysis, microeconomics, marketing and others.

A number of theories which aim at explaining consumer behavior on the market have been formed in economic sciences. Those theories are based on the assumption that consumers make continuous economic choices between goods satisfying their needs and enabling them to reach maximum satisfaction.

Consumer behavior can be described in three principles:

a) economic rationality – consumers make conscious choices, having their self-interest in mind,

b) maximization of benefit – the decisions made maximize the satisfaction reached,

c) the optimum and limitation – the decisions made are optimal within the existing limitations.

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The subjectively felt consumer satisfaction arising from the realization of a specific consumption structure is called utility in the theory of economics. Utility may refer both to a particular commodity or to a basket of goods. The utility of a commodity (service) means that in particular circumstances of choice making it has the characteristics which satisfy consumers' needs and expectations.

According to M. Walesiak and A. Bąk (1996, p. 6), the theories of utility develop in two trends: topological – set and probabilistic. The topological – set trend assumes non-measurability of utility. The so called ordinal utility theory belongs to this category. On the other hand, cardinal utility theory and random utility theory exist within the probabilistic trend. They all assume measurability of utility.

In the random utility theory majority, minority or equality relations can be defined, that is only the order between available variants. It is impossible to determine which variant is preferred. The only thing possible is to determine the direction of the preference by monotonic arrangement of variants in an ascending or descending way.

More information can be obtained when applying the cardinal utility theories. Apart from arranging variants, thanks to the assumption of utility quantification, preference intensity can be established. It enables to measure the extent to which one variant is more preferred to another.

Thanks to the random utility theory it can be taken into account that consumers don't always follow the principle of maximum benefit. It is possible owing to the assumption that in the utility function a systematic element and a random element can be distinguished. U-utility, MU-marginal utility and utility function are important categories in the theory of utility.

Utility is the sum of satisfactions reached by the consumption of the goods owned. Marginal utility is the satisfaction reached by purchasing (consuming) another commodity. Marginal utility can be expressed with the formula (*Mikroekonomia* 1994, p. 76):

$$\mathrm{MU} = \frac{\Delta U}{\Delta Q} \tag{1}$$

where:

ΔU – change of utility,

ΔQ – change of the quantity of consumed goods.

Consumers make their choices driven by avocations, habits, tastes, preferences among groups of available variants and with the existing limitations. Measuring the level of satisfaction felt by consumers is impossible (Walesiak,

Bąk 1996, p. 18), therefore its quantification is carried out by means of the preferences expressed with utility function.

The utility function enables to assign numerical characteristics to particular, assessed variants. Because of this, it is the basis that enables to determine preference relations or indifferences between variants in question.

Consumer preferences may be expressed by the features of the products they choose, therefore the knowledge of utility function is not necessary. Preferences can also be known indirectly by isolating homogeneous consumer groups with regard to the features of the product they have chosen.

Some of the most frequently used preference measurement methods are the methods of Multivariate Statistic Analysis, which is basically simultaneous analysis of data concerning a few variables (more than two) (Aczel 2000, p. 849). Examples of Multivariate Statistic Analysis are as follows:

- MANOVA – *multivariate analysis of variance*,
- *discriminate analysis*,
- *canonical correlation analysis*,
- *factor analysis*,
- *multidimensional scalling*,
- *cluster analysis*.

These methods are well known and described in literature, both foreign and Polish. Owing to that, it has been focused on a method scarcely present in Polish literature, both from the theoretical and application side; this method is also one of MSU tools, called *conjoint analysis* (MSU classification are proposed by: Jajuga 1993, Walesiak 1996, Zaborski 2001).

II. VIEW THROUGH CONJOINT ANALYSIS

Conjoint analysis, multifactor measurement, the measurement of joint interaction of variables, common analysis of objects is all about presenting respondents with a group of profiles (concerning services or goods) to assess; profiles described using chosen attributes (independent variables). The assessment of profiles (the values of dependant variable) aims to get information on the integral preferences of the consumers in question. Using statistical methods, thanks to gathered assessments, the integral preferences are decomposed by calculating the percentage of each attribute in the estimated integral value of profile utility.

The general form of preference structure model is as follows:

$$\hat{U}_{is} = f_s(u_{1(is)}, u_{2(is)}, \ldots, u_{j(is)}) \tag{2}$$

where:
U_{is} –integral utility of i profile for s respondent,
f_s –analytical form of the preference function of s respondent,
$u_{j(is)}$ – location of i profile with reference to j variable, seen by s respondent.

The values of dependant variable are the result of direct assessments of the respondents and represent their preferences. Hence they are called U- utilities of objects (so called profiles) assessed by respondents.

The values of explanatory variables represent the levels of attributes describing assessed objects. The way respondents see these values, together with reference to a given profile or according to a different method of presentation, influences the profile position, that is U-utility. The conjoint analysis procedure aims to decompose U-utilities to so called partial utilities, connected with individual levels of explanatory utilities. Therefore, while U-utilities are referred to objects (e.g. baskets of goods), partial utilities concern levels of attributes which describe these objects. U-utilities are the result of direct measurement, while partial utilities (conjoint analysis model parameters) are the result of estimation.

In the process of conjoint analysis modelling, detailed models are built with reference to the following phenomena:

a) rules describing the kind of connections between variables, that is the character of dependencies between variables,

b) preference structure, that is the sort of dependencies between the values of partial utilities and the values of levels of variables.

The rules describing the kind of connections between variables refer to the way in which respondents, in the process of product perception integrate partial utilities of individual variables in order to estimate U-utility of a given product (profile). Two types of models dominate here, both determining the dependence of U-utility on partial utilities:

– additive model (of main effects),
– model taking into account interactions between explanatory variables (of main effects and co-operation).

The number of profiles given to respondents to assess, as well as the way of estimating the value of partial utilities, will depend on the chosen model. Additive model implies less profiles to assess [This aspect is very important because increasing of profiles number negatively refer to respondents perception. It is recommended to take not more then six attributes and between three and five levels of attributes.].

In case of preference structure we are dealing with the type of dependencies between the values of U-utilities of individual objects and the values of the levels of variables which describe these objects. Four types of relationships between U-utilities and variable levels can be distinguished:

– linear model,

- square model,
- model of separate partial utilities,
- mixed model.

In case of metric data, the most frequently used method of the estimation of conjoint analysis additive model parameters is the classic method OLS – Ordinary Least Squares. In regression analysis, preference attributed to individual profiles by a given respondent is the dependant variable. The way of defining explanatory variables in manifold regression model depends on the accepted type of relationship between U-utilities and variable levels.

The general model of manifold regression model takes the following form:

$$\hat{Y}_s = b_{0s} + \sum_{j=1}^{m} b_{js} Z_{js} \tag{3}$$

where:
$b_{1s}, b_{2s}, ..., b_{ms}$ – regression equation parameters,
b_{0s} – constant term,
s – respondent number,
$Z_1, Z_2, ..., Z_m$ – explanatory variables (attributes).

For the model of individual partial utilities a model of manifold regression with artificial variables is built in the following form:

$$\hat{Y}_s = b_{0s} + \sum_{p=1}^{n} b_{ps} X_{ps} \tag{4}$$

where:
$b_{1s}, b_{2s}, ..., b_{ns}$ – regression equation parameters,
b_{0s}, – constant term,
$X_1, X_2, ..., X_n$ – artificial variables.

Some of the most frequently used methods of coding non-metric variable levels are:

a) zero-one coding,
b) quasi-experimental coding,
c) orthogonal coding (Brzeziński 1997, p. 370–379).

For the model with artificial variables the levels of explanatory variables are categories. The influence of every variable level on the assessment assigned to profiles by a given respondent is taken into account by introducing artificial explanatory variables into the model. The number of variables introduced into the model depends on the number of profiles assessed by respondents. The number of profiles should be at least equal to the number of estimated model parameters.

Conjoint method is applied in various aspects, such as market segmentation, competitiveness analysis, price setting, moving product on the market and others. Using the method for the original purpose, that is preference research, is crucial.

Utility values that every respondent connects with a given variable level are estimated with the help of chosen method. Matrix of partial utilities is the result of this stage of analysis. The number of rows of the matrix corresponds to the number of respondents, and the number of columns equals the number of levels distinguished for all variables. Results presented in the form of partial utility matrix are subject to analysis and interpretation in further procedures, serving as the basis for solving issues of market segmentation and forecasting market share of introduced products (services).

The matrix of partial utility coefficients, the result of applying conjoint analysis methodology, is used in market research to:

– calculate U-utility for each respondent separately and for a group of respondents,

– determine relative value of each variable in the process of choosing product (service) by the purchaser,

– separate segments of potential buyers with similar choice preferences,

– forecast market share of chosen products (services).

For i variant (profile) and s respondent U-utility is calculated with the following formula:

$$\hat{U}_{is} = \sum_{j=1}^{m} U^{s}{}_{jl^{i}{}_{j}} + b_{0s} \tag{5}$$

where:

$U^{s}{}_{jl^{i}{}_{j}}$ – partial utility of l *level* j *variable* i profile for s respondent (s =1,..., S),

$l^{i}{}_{j}$ – level number for j *variable* and i profile,

$i = 1, ..., n$ –profile number,

$j = 1, ..., m$ –variable number,

b_{0s} –free statement for s respondent.

U-utility (attractiveness) for i variant (profile) is calculated with the formula:

$$U_i = \frac{1}{S} \sum_{s=1}^{S} \left(\sum_{j=1}^{m} U^{s}{}_{jl^{i}{}_{j}} + b_{0s} \right) \tag{6}$$

where designations like in formula (5).

Relative importance of every $W^s{}_j$ variable for s respondent is determined with the formula:

$$W^s{}_j = \frac{\max\limits_{l_j}\left\{U^s{}_{jl_j}\right\} - \min\limits_{l_j}\left\{U^s{}_{jl_j}\right\}}{\sum\limits_{j=1}^{m}\left(\max\limits_{l_j}\left\{U^s{}_{jl_j}\right\} - \min\limits_{l_j}\left\{U^s{}_{jl_j}\right\}\right)} \cdot 100\% \qquad (7)$$

where:

$U^s{}_{jl_j}$ –partial utility of *l level j* variable for *s* respondent,

l_j – level number for Z_j variable .

Average importance of W_j variables is calculated with the formula:

$$W_j = \frac{1}{S}\sum_{s=1}^{S} W^s{}_j \qquad (8)$$

where: W^S_j determined with formula (7).

III. EMPIRICAL EXAMPLE

The example below has been carried out as part of research taken at the Department of Management and Economics of Services. The aim of the research was to determine preferences of students while choosing nightclubs. Four most popular in Szczecin (in the students' opinion) were taken into consideration.

Since every nightclub is a collection of many features and their levels, to begin with the factors were established which according to the students had the greatest influence on the choice of a club. The number of variables was limited as the integral profile method was to be applied. Eventually three variables were selected: the name of the club, the kind of music played there, the price of beer:

A_1 – the name of the club: A_2 – the kind of music:

– Trezor (A)
– Pinokio (B)
– Can Can (C)
– Pralnia (D)

– Dance (A)
– Techno (B)
– Hip Hop (C)

A_3 – the price of beer:

– four zloty (A)
– five zloty (B)
– six zloty and more (C)

On the basis of so chosen variables and their levels, 36 hypothetical variants can be created, whose number is the product of variable levels: 4x3x3=36. Since respondents wouldn't have been willing to assess so many variants, their number

was reduced to ten. [In case of big amount of profiles to assess we could limit number of profiles arbitrary or using statistical methods].

Table 1. Club attractiveness profiles

Numbers of profiles	Factors determinig club		
	A_1	A_2	A_3
1	B	B	A
2	B	A	B
3	C	B	B
4	C	A	C
5	A	C	A
6	A	A	B
7	A	B	C
8	D	B	B
9	D	C	A
10	B	C	C

Sources: own elaboration.

Thanks to the above number of profiles and not many variables, 192 correctly filled in questionnaires were received. In case of conjoint analysis, there are no formal instructions concerning the size of the test, and it is up to the researcher to establish it.

The respondents assessed the variants presented to them in the 1 to 100 range, where the limit data meant the least and the most attractive nightclub. Because of this, the classic MNK method with changing parameters was applied to estimate partial utility parameters.

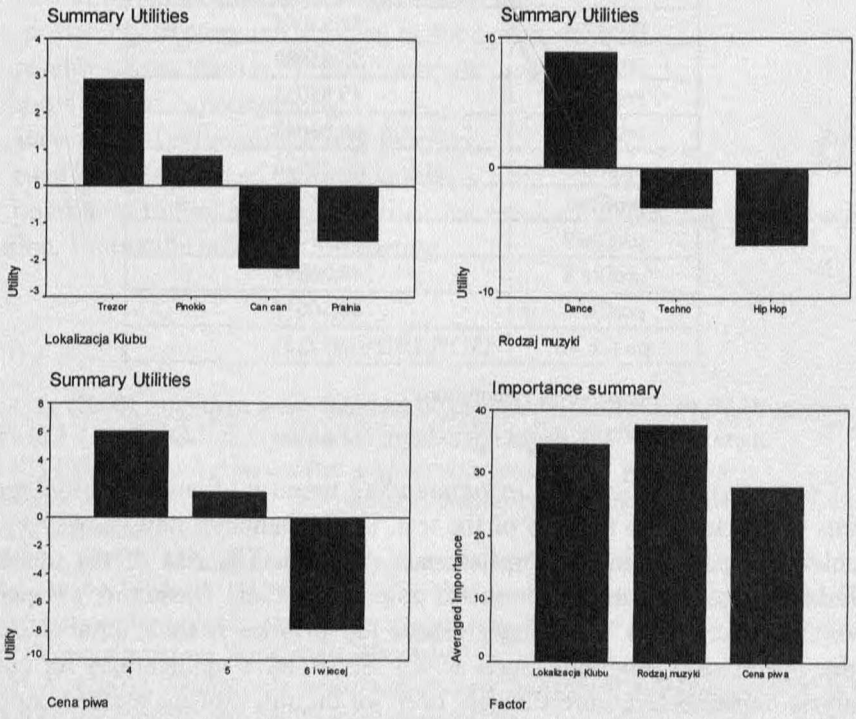
The values of relative importance of individual attributes are presented in table 2.

Table 2. The importance of variables

Variables	Relative importance of each variable [%]						
	Respondent number						
	1	2	3	4	–	192	average
1. name of club	33.31	17.50	30.01	35.21	~	8.70	34.56
2. kind of music	50.01	53.10	51.13	47.32	~	65.22	37.60
3. price of beer	16.68	29.40	16.86	17.48	~	26.09	27.84
R coefficients	0.980	0.997	0.957	0.932	~	0.982	0.986

Source: own elaboration.

Since graphic presentation is far less complicated than assessment, the importance of individual variables and their levels is presented below. Apart from preferences/variables ratio, the importance of profiles to be assessed by respondents was also calculated. Table 3 [Graphs and calculations was reached in SPSS] presents the values of integral attractiveness of a given variant organized from the most to the least preferred arrangement of variables and their levels.



Taking into account each variable separately, the most useful nightclub for the respondents turned out to be Trezor, whereas Can Can was the least attractive. The best music for a club party was dance and the least preferred – hip hop. As expected, the students chose the cheapest beer. Let's look at the last chart presenting preferences towards the club assessed as a joint collection of chosen variables. It turned out that the most important attribute which the respondents took into account while choosing the club was music; then came the name of the club , and finally the price of beer.

Profile six was the most useful from all assessed. In this profile Trezor was the club, dance – the music played and five zloty – the cost of one beer. The second only slightly less preferred set of variables was the one from the second

profile: Pinokio nightclub, dance music and five zloty for a beer. It confirms previous conclusions that students nowadays do not choose clubs where beer is the cheapest, but where they can dance to their favourite music.

Table 3.Summary utility of variants

	Attractiveness of a given variant
profile 6	59.53085
profile 2	57.43889
profile 1	49.83037
profile 5	49.03048
profile 3	46.78926
profile 4	44.83508
profile 9	44.63053
profile 8	43.26894
profile 7	38.10614
profile 10	33.12201

Source: own elaboration.

Conjoint method is worth recommending because of lack of formal requirements connected with the size of the test. Its fundamental flaw, however, is the problem with collecting appropriate statistic data. The rise of the number of variables causes geometric increase of possible profiles. The author's experience says that respondents unwillingly assess full profiles if their number exceeds eight. Specialized programs, such as e.g. SPSS, have applications for conjoint analysis implemented, unfortunately only for the full profiles method. Applying the method of comparison of pairs is a way out, but then one is forced to use other methods of estimating the parameters of utility function, e.g. Logit or Probit , which complicates the whole procedure.

Advantages and disadvantages of the use of conjoint analysis in consumer preferences research we can formulate in following points:

Disadvantages :

– because of respondents' perception capabilities:

- limited number of variables (attributes),
- limited number of levels of variables,
- limited number of profiles to assess,

– because of the conjoint method:

- numerous arbitrary assumptions (size of test, number of variables, number of attributes, number of levels of attributes, number of profiles to assess),

• lack of clear instructions how to choose an appropriate preference structure measurement model,

• choice of a method of data presentation, kind of connections, function form, etc.,

• lack of possibility to explicitly verify the correctness of received results,

Advantages :

– resulting from the conjoint method:

– lack of formal requirements as to size of test,,

– -possibility to carry out a partial factor experiment,

– resulting from the use of ready computer applications:

– short time of experimenting,

– short time of estimating utility function,

– easy interpretation of received results,

– possibility to find other applications for received results, e.g. market segmentation, simulation analysis, forecasting.

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WADY I ZALETY UŻYWANIA ANALIZY CONJOINT W BADANIU PREFERENCJI KONSUMENTÓW

Niniejszy artykuł ma na celu przybliżenie tematyki związanej z badaniem preferencji przy wykorzystaniu metody conjoint. Metoda ta jest jedną z metod wielowymiarowej analizy statystycznej. Jej istotą jest dekompozycja użyteczności całkowitej na użyteczności cząstkowe przy wykorzystaniu metod ekonometrycznych w celu zbudowania funkcji użyteczności.