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AN APPLICATION OF CONJOINT ANALYSIS FOR PREFERENCE MEASUREMENT

The application of the conjoint analysis to the choice of study major problems is discussed. Each course is described by five variables: advice from parents, teachers, and friends; fashion; degree of course difficulty; attractiveness of the job after graduation; coincidence with personal intellectual interests. A sample of Wroclaw University of Economics students were asked to express their preference. The data was collected in autumn 1997. The orthogonal array of 16 variants was constructed. The respondents were asked to evaluate proposed variants by ranking them. In order to estimate the part-worths, and relative importance of each characteristics in the choice process, collected data is analysed with the conjoint measurement methodology. As the result of the analysis, the relative importance of each variable to the overall evaluation of the study major choice is shown and the market segments were determined.

1. INTRODUCTION

The theoretical background of the conjoint analysis and reviews of applications in marketing for method are given in: Carroll, Green (1995), Fenwick (1978), Green, Krieger (1991), Green, Srinivasan (1978; 1990), Green et al (1988), Green, Wind (1975), Hooley, Lynch (1981), Louviere (1988; 1994), Walesiak, Bąk (1997). For consumer preference evaluation in marketing applications, conjoint measurement is used. As a basis for that, a set of products described by the vector of its characteristics' values is used. The conjoint impact of two or more product characteristics measured on the nominal scale (independent variable), on the dependent variable with the values measured on the ordinal, interval or ratio scale is determined.

Conjoint analysis is one of the multivariate techniques, which can be used to measure consumer preferences for competitive products (services). Variants of products (or services) considered may be real or hypothetical and are called profiles. Attributes and levels of each attribute describe each profile. Generated profiles are presented to respondents to get their overall evaluations. This is based on the assumption that respondents simultaneously take into account all specified attributes, not only one attribute at a time. In this way respondents can rank presented profiles from the best to the worse, according to their own preferences.

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Overall respondents' preferences are used to estimate coefficients (parameters) called attribute-levels utilities (part-values). This means that utilities are values estimated by conjoint analysis model according to each level of each attribute. Utility estimation methods used in conjoint analysis can be classified into three groups:

– metric methods (dependent variable is, at least, intervally scaled), such as OLS (ordinary least squares) regression, MSAE (minimizing sum of absolute errors) regression;

– nonmetric methods (dependent variable is, at most, ordinally scaled), such as MONANOVA (monotonic analysis of variance), PREFMAP, LINMAP, Johnson's nonmetric trade-off procedure;

– choice-probability-based methods, such as LOGIT and PROBIT.

In this work ordinary least squares regression (OLS) was used in order to estimate individual level utilities. OLS regression is one of the most popular parameter estimation techniques and it is implemented in many computer programs. (In this study statistical package SPSS for Windows was used.) Estimated utilities were used as a basis for segmentation procedure presented in section 3. Typical procedure of conjoint analysis, which involves several steps, is presented in Table 1. In the last column of this table options of alternative methods used in the case study reported in the paper are shown.

Table 1

Conjoint analysis procedure.

Conjoint analysis step	Alternative methods	Method applied in this study
1.Selection of a preference model	vector model, ideal-point model, part-worths function model, mixed model	part-worths function model
2.Data collection method	full profile approach (concept evaluation), trade-off method (two factors at a time), method of paired comparisons	full profile approach
3. Stimuli set construction for the full profile method	fractional factorial design, random sampling from a multivariate distribution, Pareto-optimal designs	fractional factorial design
4. Stimuli presentation	verbal description, paragraph description, pictorial or three-dimensional model representation, physical product	verbal description
5. Measurement scale for the dependent variable	rating scale, rank order, paired comparisons, constant-sum paired comparisons, graded paired comparisons, category assignment	rank order
6. Estimation method	MONANOVA, PREFMAP, LINMAP, OLS, MSAE, LOGIT, PROBIT	OLS regression

Source: Green and Srinivasan (1978; 1990).

2. EMPIRICAL RESULTS

Market economy rules apply also to the education sector. In Polish realities in the nineties, changes observed at the university level education may be described as follows:

- establishment of numerous new private schools,
- introduction of new curricula,
- new demand structure for graduates,
- new type of expectations among students.

Universities have to take into consideration the above listed market and environment realities. It implies the necessity of extensive market research in order to learn market expectations and to formulate an appropriate market strategy.

In the study the conjoint analysis method was applied to identify the factors of study major choice. The results obtained enables us to describe students' preferences. This in turn gives the basis for the study major adjustment according to students' expectations. Such a procedure gives a competitive advantage for the university and benefits students.

According to the literature suggestions and as a result of a preliminary survey and focus group research, a list of five study major choice descriptors was compiled:

1. Advice from parents, teachers and friends (strongly recommended [A], moderate support [B], none [C]),
2. Fashion (yes [A], no [B]),
3. Degree of course difficulty (easy [A], moderate [B], difficult [C]),
4. Attractiveness of the job after graduation (yes [A], no [B]),
5. Coincidence with personal intellectual interests (yes [A], no [B]).

In this inquiry a sample of 215 (out of which 182 questionnaires were useful for the analysis) Wrocław University of Economics students were asked to express their preferences. The data was collected in autumn 1997. Cattin and Wittink (1982) report that the sample size in commercial conjoint studies usually ranges from 100 to 1,000.

Instead of asking for the evaluation of all possible combinations of characteristics' values (i.e. 72 possibilities: $3 \times 2 \times 3 \times 2 \times 2 = 72$), the orthogonal array of 16 variants was constructed (Table 2). The respondents were asked to evaluate proposed variants by ranking them.

In order to estimate the part-worths and relative importance of each characteristic in the choice process, the collected data was analysed with the conjoint measurement methodology. As the result of the analysis (Hair et al 1998; Anttila et al. 1980):

–the relative importance of each variable to the overall evaluation of the choice of study major is estimated,

–the relative contribution of each variable level to the overall evaluation of the study major choice is determined,

–the market segments (groups of students) were defined.

Table 2

Orthogonal array of 16 variants (study major choice descriptors).

	Attributes				
Number of profile	1	2	3	4	5
1	C	B	C	B	A
2	A	A	A	B	B
3	C	A	A	A	B
4	C	A	B	B	A
5	A	B	B	A	A
6	A	B	B	B	B
7	C	B	A	A	B
8	A	A	C	B	B
9	B	B	A	B	A
10	A	B	A	B	B
11	B	A	B	A	B
12	A	A	A	A	A
13	A	A	C	A	A
14	A	B	A	A	A
15	B	B	C	A	B
16	B	A	A	B	A

Cell letters represent the level of each attribute for each course.

Source: The Categories option of SPSS v. 8.0 for Windows is used in construction of orthogonal array.

Ordinary least squares regression with dummy variables was used for the estimation of part-worths separately for each respondent. In the regression analysis dependent variable is a reversed ranking attached to each course by the respondent.

In order to enable the measurement of the relative importance of each characteristics value, dummy variables reflecting respondents' evaluation of the given level of the independent variable are introduced into the model. Any nominal variable with k categories can be represented as $k-1$ dummy variables. In our example we should use seven dummy variables in regression analysis.

Multiple regression model with seven dummy variables for the s–th respondent is following:

$$\hat{Y}_s = b_{0s} + b_{1s}X_{1s} + b_{2s}X_{2s} + b_{3s}X_{3s} + b_{4s}X_{4s} + b_{5s}X_{5s} + b_{6s}X_{6s} + b_{7s}X_{7s} \quad (1)$$

where: $b_1,\ldots,b_7$ – regression parameters; b_0 – constant; $X_1,\ldots,X_7$ – dummy variables defined as follows (termed effects coding):

Variable Z_1	X_1	X_2
Level I	1	0
Level II	0	1
Level III	−1	−1

Variable Z_2	X_3
Level I	1
Level II	−1

Variable Z_3	X_4	X_5
Level I	1	0
Level II	0	1
Level III	−1	−1

Variable Z_4	X_6
Level I	1
Level II	−1

Variable Z_5	X_7
Level I	1
Level II	−1

The estimates of part-worths (utilities) for the s-th respondent are following (see Walesiak (1996)):

a) for variable with two levels

Variable Z_j	Dummy variable X_p	Part-worths (utilities)
Level I	1	$U_{j1}^s = b_{ps}$
Level II	-1	$U_{j2}^s = -b_{ps}$

b) for variable with three levels

Variable Z_j	Dummy variable X_p	Dummy variable X_q	Part-worths (utilities)
Level I	1	0	$U_{j1}^s = b_{ps}$
Level II	0	1	$U_{j2}^s = b_{qs}$
Level III	-1	-1	$U_{j3}^s = -(b_{ps} + b_{qs})$

where: $U_{jl_j}^s$ – part-worths of the l-th level of the j-th variable for the s-th respondent; j – number of variable ($j = 1,\ldots,5$); p, q – numbers of dummy variables ($p,q = 1,\ldots,7$); l_j – number of level for the variable j-th ($l_1 = l_3 = 1, 2, 3$; $l_2 = l_4 = l_5 = 1, 2$); s – number of the respondent ($s = 1,\ldots,182$).

Next we calculate the relative importance of each attribute in the choice process of study major. Empirical results are presented in Table 3. The formula (2) is used for calculating the relative importance W_j^s of each attribute for the s-th respondent (Hair et al. 1995, p. 608):

$$W_j^s = \frac{\max_{l_j}\{U_{jl_j}^s\} - \min_{l_j}\{U_{jl_j}^s\}}{\sum_{j=1}^{m}\left(\max_{l_j}\{U_{jl_j}^s\} - \min_{l_j}\{U_{jl_j}^s\}\right)}. \qquad (2)$$

Furthermore, total utility for i-th study major and s-th respondent is given by the expression (Walesiak 1996, p. 93):

$$U_{is} = \sum_{j=1}^{m} U_{jl'_j}^s + b_{0s} \qquad (3)$$

where: l'_j – number of level for the j-th variable in the study major the i-th; $i = 1, \ldots, 10$ – number of study major variant; b_{0s} – constant for the s-th respondent.

3. SEGMENTATION

The segmentation of markets with conjoint analysis traditionally involves a two-stage approach in which the identification of segments and the estimation of conjoint models are performed separately and approaches with integrated segmentation methods (i.e. the estimation and segmentation stages are integrated). (Wedel, Kamakura 1998, p. 308.) Integrated conjoint segmentation methods generally outperform the two-stage procedures with respect to coefficient and segment-membership recovery (Vriens et al. 1996). The results of this research also show that two-stage segmentation methods require less computer time and usually give good fit with respect to R^2 value. Besides, there are easy obtainable computer programs in which these algorithms are implemented (e.g. SPSS for Windows).

In order to identify the market segments, a two-stage segmentation procedure was used. This contains individual level part-worths estimation and k-means clustering method. In part-worths matrix each row stands for one respondent. The number of columns equals the number of all attribute levels. This matrix is a basis for market (students) segmentation. After the application of two-stage segmentation procedure, as a final result five market segments were obtained. Empirical results for segments are presented in Table 3.

Table 3

Conjoint analysis empirical results for the overall sample and for the segments

Attribute	Overall sample	Segments				
		I	II	III	IV	V
	Part-worths estimates					
1. Advice						
a) strongly recommended	0.308	0.138	0.622	0.514	0.208	−0.518
b) moderate support	0.324	1.198	1.196	−0.064	0.413	−1.629
c) none	−0.632	−1.336	−1.818	−0.450	−0.622	2.147
2. Fashion						
a) yes	0.207	−1.155	0.750	0.674	0.038	0.053
b) no	−0.207	1.155	−0.750	−0.674	−0.038	−0.053
3. Course difficulty						
a) easy	−0.238	−0.023	−1.243	0.224	−0.028	−0.491
b) moderate	0.436	0.555	0.237	0.552	0.431	0.285
c) difficult	−0.198	−0.532	1.006	−0.776	−0.403	0.206
4. Attractiveness of the job						
a) yes	2.617	2.513	3.169	3.637	1.903	−0.224
b) no	−2.617	−2.513	−3.169	−3.637	−1.903	0.224
5. Coincidence with interests						
a) yes	1.448	0.228	1.230	1.408	3.594	−0.204
b) no	−1.448	−0.228	−1.230	−1.408	−3.594	0.204
6. Constant	8.483	8.471	8.655	8.316	8.455	8.752
7. Kendall's tau	0.950	0.950	0.950	0.933	0.950	0.544
Attribute	Relative importance of each attribute					
a) advice	18.20	21.66	20.63	13.00	11.75	37.09
b) fashion	10.22	16.96	9.54	9.76	7.44	7.95
c) course difficulty	15.78	18.01	16.49	13.09	11.48	27.80
d) attractiveness of the job	34.72	32.27	38.23	45.98	23.95	15.87
e) coincidence with interests	21.08	11.10	15.11	18.16	45.38	11.28

Kendall's tau – correlation between the observed and estimated preferences (this statistic displays how well the model fits the data).

Source: The Categories option of SPSS v. 8.0 for Windows is used in analysis of this example.

The first three segments include students who consider the attractiveness of the job after graduation as the most important.

Additionally, the first segment regards advice from parents, teachers, and friends as very important. In this segment men represent 62%. This is characterized by the highest percentage of students who have full or part-time jobs (51.7%). Students in this segment have the highest income (the median of monthly income is 412.5 zl).

The second segment treats advice from parents, teachers, and friends as important. Women slightly dominate this segment (54% of the total number).

The third segment is the most numerous (33% of the sample). Coincidence with personal intellectual interests is of second importance. Parents' money is regarded as the main source of income.

The fourth segment thinks that coincidence with personal intellectual interests is the most important and attractiveness of the job after graduation in the second place. Average number of household members is the lowest (3.5).

In the fifth segment, the least numerous, men represent 68%. Advice from parents, teachers, and friends is considered decisive. A degree of course difficulty is placed as second. Students in this segment have the lowest income. The median of monthly income is 289.1 zl. The percentage of working students is also the lowest and equals 21.1%. Average number of household members is the highest (4.2).

Detailed characteristics are in Table 4.

Table 4

Characteristics of market segments.

Variables		Segments				
		I	II	III	IV	V
Sex (female / male)		11/18	20/17	32/29	18/18	6/13
Source of income (% of students)	(1)	48.3	51.4	57.4	63.9	31.6
	(2)	48.3	21.6	36.1	38.9	26.3
	(3)	72.4	86.5	88.5	86.1	78.9
	(4)	13.8	18.9	9.8	19.4	15.8
Median of monthly income at student's disposal (in Polish Zlotys)		412.5	319.4	334.2	395.8	289.1
Percentage of students having full-time or part-time jobs		51.7	32.4	44.3	47.2	21.1
Average number of household members		3.6	3.8	3.9	3.5	4.2
Permanent place of residence (% of students)	A	65.5	48.7	44.3	44.4	63.2
	B	17.2	5.4	14.8	16.7	10.5
	C	10.4	43.2	36.0	33.3	21.0
	D	6.9	2.7	4.9	5.6	5.3

Key: (1) – scholarship,
(2) – personal income (job),
(3) – parents' money,
(4) – others.

A – town with more than 100,000 inhabitants,
B – town with 50,000 to 100,000 inhabitants,
C – town with less than 50,000 inhabitants,
D – village.

Source: own research.

4. CONCLUSIONS

The results of segmentation study, with the conjoint measurement and cluster analysis methodology, may be useful:

a) for examining the students' of choice study major,

b) for university management to examine their study major and make appropriate changes,

c) to inform university management that communication is very important with all people (parents, teachers and friends) who help to make students decisions.

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