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CONJOINT ANALYSIS AS A STATISTICAL TOOL FOR STUDYING CONSUMER BEHAVIOUR. CHARACTERISTICS, TYPES AND EXAMPLES OF USE

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Abstract: Conjoint analysis is a statistical method popular in marketing research. It allows to analyze the combined effect of many product attributes in order to look into consumer's willingness to purchase. An important advantage of this method is the ability to examine respondents' preferences without usage of the questionnaire with declarative answers. The article presents the most important types of conjoint analysis, their characteristics and examples of application. It also looks for new development paths for conjoint analysis and consumer sciences.

Keywords: conjoint analysis, consumer research, consumer study, conjoint choice-based, consumer behaviour

JEL classification: D12, D90, C19

INTRODUCTION

The beginning of conjoint methods dates back in the 1960s. The conjoint analysis as a method has developed from the 'conjoint' measurement in mathematical psychology.
Standard methods of consumer research (for example: survey questionnaire) are useful and have many advantages such as simplicity of the design and application as well as relatively low costs. However, they also have undeniable defects, such as lack of opportunity to interact with consumer and possibility of deepening the topic

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if needed. Sometimes the reality is oversimplified in survey questionnaire, even if the question is most accurately formulated - i.e. by narrowing the list of possible answers, among which the respondent chooses. The great problem of such research is its declarative nature, which also means that there could be no strong connection with decisions made in reality, which are often under the influence of impulses or not fully conscious. The consumer research area is constantly inspired by constantly changing reality, including consumer behaviour, attitudes and openness (or lack of it) in the conduct of the study. Due to the dominance of electronic devices, the classic paper interviews conducted by a trained interviewer are often displaced by (cheaper and faster) online surveys. The need to get to know consumers raises natural questions about quality of the results of standarized questionnaires, face-to-face and computer-assisted interviewing methods, such as: whether the consumer standing in front of the store's shelf will pick what he previously declared in the questionnaire? Which product characteristics affects the intention to purchase the most and which one the least? Why does the consumer choose producer A instead of B? Why consumers declare that they buy something and then choose a completely different product in a real store?

In the process of seeking answers to these questions, a conjoint analysis method was established to widen our knowledge about the consumer. To get to know consumers without specific 'filter' which is the traditional survey task with direct questions to the respondent.

Similar articles presenting the history of the conjoint analysis and its types, as well as methods of implementation, are already in the literature [Agarwal, Green 1991; Green, Krieger, Wind 2001; Louviere, Flynn, Carson 2010] but the aim of this article, in addition to the approximation of the theory, is a review of the previous studies using conjoint analysis and an attempt to discuss the future of the method also in the context of possible development paths.

HISTORY OF CONJOINT IN THE WORLD

Issues mentioned in the introduction, questioning the full usefulness of declassified data, have led scientists into the area of science previously not used in business and consumer sciences - into the areas of mathematical psychology.

The first study that gave foundations to this method was conducted by Luce and Tukey [Luce, Tukey 1964]. Kruskal and Young also contributed their scientific work [Kruskal 1965; Young 1969] and Carrol in 1969 with his paper 'Categorical conjoint measurement' presented at the Annual Meeting of the Association of Mathematical Psychology in Michigan.

The rapid development and extensive popularization of conjoint analysis was influenced by several factors. First and foremost, consumer market development has played a significant role with its need to analyze consumer preferences. The rapid development of computer software and its computing capabilities have made new types of analysis possible to be converted in a short time. Moreover, conjoint

analysis allows data collection to be intuitive for the respondent and easy to recalculate and analyze for the researcher so that the method could be easily used worldwide.

In addition, conjoint analysis responds to a very important issue that decision makers faces: why consumer may declare that he/she will buy product X when in store he/she will put into basket product Y? What are hidden reasons? And, what points-out Green [Green et al. 2001]: 'how to trade off the possibility that option X is better than option Y on attribute A while Y is better than X on attribute B?'.

Green defines that conjoint analysis uses 4 types of data collection procedures but concerning strong development of discrete conjoint techniques, it is worth to notice that data are collected in five ways:

- Full profile techniques: complete set of full-profile prop cards. Respondent has to rate each card from 0 to 100 likelihood-of-purchase scale.
- Compositional techniques: self-explicated preference-data collection (e.g. CASEMAP [Srinivasan 1988]). In this type of collecting data each respondent in first step rates the desirability of each set of attribute level (scale 0 to 100) and then rates the attributes on importance scale.
- Hybrid techniques: self-explicated evaluation task. Respondent fulfills a task where is obliged to evaluate a subgroup of full-profile cards [Green, Goldberg, Montemayor 1981]. Then, complex data is a result from utility function.
- Adaptive conjoint analysis: another version of hybrid technique [Johnson 1987]. The process of data collection is two-step. Firstly, respondent carry out a self-explication task and then evaluates a set of partial-profile descriptions. Whole process is strongly supported by computer, partial-profile descriptions are dependent on respondents earlier paired comparisons.
- Choice-based conjoint: part-worth model to respondent's evaluative choices. Research designers evaluate part-worth functions at discrete levels for each from the considered attributes. Repeating after [Green et al. 2001], when designing a study, we set P attributes and J stilmuli.

When considering a respondent, we assume that y_{jp} is the desirability of the *pth* attribute for the *jth* stimulus and that y_{jp} is inherently continuous. Then, the vector model for respondent's preference for the *jth* stimulus is s_j:

$$s_j = \sum_{p=1}^{p} w_p y_{jp} \tag{1}$$

where w_p means respondent's weight for each of the P attributes.

When we consider, the ideal-point model, preference s_j is inversably related to the weighted squared distance d_j^2 of the location y_{jp} of the *jth* stimulus from the individual's ideal point x_p, where d_j^2 is defined as

$$d_j^2 = \sum_{p=1}^{p} w_p \left(y_{jp} - x_p\right)^2 . \tag{2}$$

In the part-worth model

$$s_j = \sum_{p=1}^{p} f_p\left(y_{jp}\right) \quad (3)$$

where y_{jp} is the category level and f_p is a function denoting the part-worth corresponding to level y_{jp}. In practice, $f_p(y_{jp})$ is estimated for a selected set of discrete levels of y_{jp}.

But before conjoint analysis became such an elaborate tool, we have to go back to the 1970s. As mentioned above, the dynamic development of digitization and computer techniques has opened new paths to researchers. A new look at behavioral sciences, the development of psychometry and mathematical psychology has also resulted in marketing research development. What is worth to mention is that cluster analysis methods let the researchers use it in market segmentation [Green, Frank, Robinson 1967]. Previously, analysts used a priori market segmentation where prior to the start of the study, consumer segments are defined and then assigned to those segments, and their behavior is analyzed in this segment.

In the new approach (a posteriori) it turned out that it is worth 'let data speak for themselves' and after analyzing the data decide what are the similarities in attitudes, behaviors, choices or needs. In this version of segmentation, researchers may divide respondents basing on the purpose of the study, such as benefits sought, brand preferences, psychographics or other.

Beginings of conjoint measurement were focused on axiomatic approaches to fundamental measurement [Luce, Tukey 1964]. Subsequently, first conjoint algorithm - Monanova - was designed [Kruskal 1965] and programmed by Joseph Kruskal and Frank Carmone. It used ranked response data in order to obtain ordered metric-scale data from random-order response data and a set of factorially designed stimuli.

Later, in the 80s, new programs were introduced [Johnson 1987] - adaptive conjoint analysis used graded paired comparisons as one set of inputs in the model. This was also the time when first PC-based programs where created (e.g. [Herman 1988] full-profile with stimuli based on orthogonal designs). New possibilities of computer software development had a huge impact on popularizing this method, as well as gave new opportunities to scientists to look for better theoretical solutions and options.

CONJOINT ANALYSIS IN POLAND

Among Polish scientists who worked on the development of this analysis, certainly should be mentioned works of Marek Walesiak, Andrzej Bąk and Józef Dziechciarz [Dziechciarz-Duda, Król 2014; Dziechciarz, Walesiak 1995; Dziechciarz, Walesiak 1999].

Conjoint analysis in Poland had been develeped both in the scientific field [Dziechciarz, Walesiak 1995; Dziechciarz, Walesiak 1999; Szymańska, Dziedzic

2005; Walesiak 1997] and applied fields of business and commercial marketing research.

The development of conjoint analysis in Poland implies the implementation of the method both in scientific and business research but also a great deal of research has been devoted to the development of methodology [Dziechciarz, Walesiak 1995; Walesiak 1997], data analysis methods [Szymańska, Dziedzic 2005; Walesiak 1997] as well as the application of the method [Dziechciarz, Walesiak 1999; Walesiak, Bąk 1977]. Especially interesting is the development of statistical packages: SPSS [Walesiak, Bąk 1977] and R software (http://keii.ue.wroc.pl/conjoint/conjoint-manual.pdf). Defining new areas of exploration and applying them into real research projects makes it easier and more effective to use this analysis of consumer behavior.

An interesting addition to the conjoint analysis itself is applying hedonic regression in the first step of the analysis. If a wider approach and use existing data or market offerings (hedonic regression) is added to consumer issues by usage of conjoint analysis, it can lead to more reliable research results.

The theory of hedonic models assumes that there is a relationship between the price of good and its attributes, which is described by a certain function h (called hedonic function). The general form of the hedonic function h can be determined by the general regression model:

$$C = h(\boldsymbol{W}, \boldsymbol{\alpha}, \delta) \tag{4}$$

where:

C - product price,

W - product characteristics vector,

α - parameters vector,

δ - random component of the model.

With historical statistic market data available the probable price of a product can be determined within a certain range of attributes, as well as some 'valuation' of each attribute.

Such approach can have a profound effect on determining appropriate profiles in conjoint analysis and thus can significantly improve the quality of analysis. Consequently - also increase the reliability of the results of the analysis of consumer preferences.

This method was used in research in Poland as well as in other countries [Chen, Rothschild 2010; Costanigro, McCluskey, Mittelhammer 2007; Dziechciarz-Duda, Król 2014].

HOW TO USE IT?

Conjoint analysis is used worldwide nowadays. It is commonly used both in scientific research and business analysis. Looking at the latest researches with

conjoint usage, it can be noticed that the range of usage is very broad: from business and consumer preferences research [Meyerding 2016], across medicine and patient preferences [Hofheinz et al. 2016], housing market [Rofè, Pashtan, Hornik 2017] and even hotels and restaurants [Lee 2016].

To better understand what aspects of consumer behavior can be measured with conjoint a short example was prepared - a pork raw meat research. If trying to get the knowledge what is important for pork meat consumers, the first step is to define list of product's attributes (as in Table 1: meat, portioning, packaging, weight) and levels (each attribute has its levels, e.g. 'Packaging': Vacuum, MAP, bulk - see Table 1).

Table 1. Adaptive conjoint - scheme of the attributes and levels

Meat	Portioning	Packaging	Weight
Pork raw meat without additives	in one piece	Vacuum	250 g
Pork raw meat with additives, e.g. beta-glucan, Omega-3 acids	Minced	MAP	500 g
	sliced meat (for chops)	bulk	750 g
	meat on the stew (in pieces)		1000 g

Source: own study

The research and sample results (Table 2) were prepared for adaptive conjoint analysis.

The respondents were presented with different possible variants of the offer described by its features and asked to rank them in order from the most preferred to least preferred variant. The advantage of this technique is that we do not ask the respondent what is important to him in isolation from the environment, but the respondent simply judges how much he would be interested in the offer. The higher attribute's significance means that this is the attribute to which consumers pay higher attention. Levels must be considered as less and more preferred within the given attribute (Table 2).

Table 2. Adaptive conjoint - sample results (attribute's significance & level's utility)

Attribute	Significance	Attribute level	Utility
Meat	29	Pork raw meat without additives	28.2
		Pork raw meat with additives, e.g. beta-glucan, fiber, Omega-3 acids	6.2
Portioning	24	in one piece	16.3
		Minced	14.2
		sliced meat (for chops)	18.9
		meat on the stew (in pieces)	10.2

Attribute	Significance	Attribute level	Utility
Packaging	20	Vacuum	9.2
		MAP	9.5
		Bulk	14.5
Weight	27	250 g	14.9
		500 g	19.1
		750 g	12.3
		1000 g	16.2

Source: own study

In this sample data, it can be conducted that the most important attributes are 'meat' (29%) and 'weight' (27%). When looking at levels, it can be stated that 'pork raw meat without additives' (utility: 28.2) is preferred over 'pork raw meat with additives' (utility: 6,2). In 'weight' attribute option '500g' (u. 19.1) is preferable. In 'portioning' the most often selected was 'sliced meat' (u. 18.9) and in 'packaging' was 'bulk' (u. 14.5).
These results allow researchers to get a closer look at consumer preferences.

CONJOINT ANALYSIS - DAYS TO COME?

Having in mind the determinants that have contributed to the development of conjoint analysis, future prospects are still an open topic. Considering how much has already been done and how broadly the method is being used, one could ask is there any more space for development? Or rather the method will remain in its present form?
Thinking over about conjoint capabilities, it may be helpful to separate topics into: methodology development, application possibilities and consumer behavioral aspects.
Conjoint analysis is already widely used but there are still areas which have not yet been developed. The main methodology areas that can be predicted to be development directions are:

- virtual/more realistic visualizations of products or attributes and levels,
- dynamic simulations that consider real time action-reaction sequences,
- new research that shows conjoint's credibility and its opportunities.

Analysing potential application possibilities, following further option is likely to be realized:

- narrowed groups of respondents such as municipalities, suppliers, employees, teachers, etc.

Considering further consumer behavioral aspects, the method can explored by:

- time limits - simulation of the situation where consumer have limited time (e.g. in a hurry to work or train) and is in need to make a decision. How much time dimension affects consumer decisions?
- financial limits, e.g. 'buy 4-5 things and your budget for shopping is X'. What would the consumer choose when facing with limited budget? How consumer reacts when the shopping list consist also several other products? Does he/she choose the same products or maybe products attributes get new part-worth utilities?
- increased choice: choosing not only among similar products but among all products from the whole category shelf (e.g. buy yoghurt from whole dairy shelf). It is quite easy to choose one out of three products but what happens when (similarly to shopping situation) respondent have to find desired product among others also from other categories? Is he still so vigilant? Is the selection still focused on the same attributes?
- noise: simulation of the situation e.g. when parent with a baby is doing shopping or when in store floors are being washed or goods are serviced. How much noise affects the decision-making process? Do parents choose differently?
- technology/VR: when forcing to make decisions located in virtual reality in simulated point of sale.

Presumably these are the main development paths for conjoint analysis. Huge work in the development of this method has already been done, but there is still much to do. It can be said that conjoint is surely mature but not outdated. As long as the behavior of consumers will be important to researchers, conjoint methods will continue to be developed and applied.

SUMMARY

As discussed above, conjoint analysis has been an effective and widely used method for consumer research and understanding for many years, especially when interested in learning about consumer behavior in a simulated decision-making situation. Currently, the use of the method is very broad, both in business and in scientific research. At the same time quite extensive theory and various ways of constructing the study and analysis of the obtained data allow to choose preferred method for a particular research problem.

However, the question is interesting: what next? Has the conjoint analysis theory had been completed already? Or can it be further extended? Is there a gap in the current state of knowledge? Do the researchers notice any shortcomings? Does the method effectively evaluate consumers' decisions? Could there be elements that are not covered/described/explained enough by the analysis?

Such element that is not considered in conjoint analysis, can be time constraint (during respondent decision making process). As a matter of fact, the respondent during survey is not in a hurry, he/she has the comfort of responding at his/her own

pace. But what if he/she acted under the pressure of time? It is completely different to choose products in the store when we have the convenience of time in the store, and otherwise, when we know that if we do not buy the necessary products within minutes, we miss our train or plane. There is an open question about how time pressure can be incorporated into a conjoint test and how much the theory and methods of analysis will change.

Surely it can be assumed that conjoint analysis still has interesting development prospects ahead, which will probably have a positive impact on its ability to analyze consumer behavior. Forthcoming years can bring new ways of analyzing consumers and their decisions and conjoint analysis have the opportunity to take part in widening this knowledge.

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