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## Number of Tasks in Choice- Based Conjoint Analysis

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# Number of Tasks in Choice-Based Conjoint Analysis

## Abstract

The most popular method for measuring (customers') preference structures is choice based conjoint analysis (CBC). The paper focuses on the neglected, but important issue of how many choice tasks a respondent should decide on within a CBC interview. This question is of particular relevance because the validity as well as the costs of data collection for CBC is strongly influenced by the number of tasks involved. Our empirical analysis is based on 22 data sets covering a wide variety of product categories. The total sample size sums up to almost 7,000 respondents.

## Keywords

choice experiments

choice-based conjoint analysis

number of choice tasks

predictive validity

## I Introduction

One option to study (consumer) choices are choice experiments (see Zwerina, 1995, p. 5). A unique feature of an experimental choice process is that researchers have the opportunity to design their data by assigning a series of attributes and attribute levels to be included in choice sets. A choice experiment presents consumers with a set of alternatives that differs in these attributes and asks them to specify their preferred alternative. Researchers can use the responses to estimate a model of choice behaviour that allows estimation of marginal values for each attribute level or total values for any particular collection of attribute levels. They can also estimate the marginal rates of substitution, or trade-offs, respondents are willing to make between any two attributes (Kanninen, 2002). The main goal of these multi-attribute choice experiments is prediction of real world consumer choices depending on changes in the marketing mix.

In their empirical research Hartmann & Sattler (2002) found Choice-Based Conjoint Analysis (CBC) is the method most often applied for the measurement of consumers' preference structures in commercial use. For scientific studies Haaijer, Kamakura & Wedel (2000) state that CBC will become the dominant method. In particular the software by Sawtooth Software for design, interviewing and estimation of CBC is very popular.

Past research on CBC has focused on unobserved heterogeneity (Andrews, Ainslie & Currim, 2002) and hybrid models (Ben-Akiva et al., 2002). Very little research has been done on the question of how many choice tasks a respondent should decide on within a CBC interview and what the impact of the number of tasks is on the CBC results. It is common practice to let respondents choose several times between alternatives (see overview in Haaijer & Wedel, 2003). This is done because it is usually cheaper to increase the number of tasks each respondent needs to answer than to increase the number of respondents answering just one task. This is in particular necessary because a single observed CBC decision indicates only which concept is chosen, with no indication of strength of preference, as is available in ratings-based conjoint (see Johnson & Orme, 1996).

A particular problem with a high number of choice tasks is that respondents might get fatigued or bored and do not answer according to their preferences but randomly in order to finish the interview. Thus, it might be that adding more choice tasks does not improve or even biases parameter estimations. Furthermore, by increasing the number of tasks respondents' sensitivity to certain attributes might be artificially increased (e.g. increased price sensitivity) or respondents choose none of the offers presented in a particular choice set more often. There is a risk that respondents' preferences change during the interview. Thus, the number of choice tasks might have a strong effect on the validity of CBC.

There has been very little systematic empirical research on the number of choice tasks effects in CBC (Louviere, Hensher & Swait, 2000, p. 134). A notable exception is the empirical study by Johnson & Orme (1996), abbreviated J&O in the following. The authors

analyse 21 commercial CBC studies. In particular, they focus on the following three research questions:

1. How many choice tasks should a respondent be asked?
2. Do respondents become more or less likely to choose the “None” option as the interview progresses?
3. Do estimated parameters (e.g. importance weights for price and brand name) change as the interview progresses?

With respect to the first question J&O investigated the effect on reliability as the number of tasks per respondent increases. For up to 20 tasks they found no evidence for decreasing reliability. Thus, the authors conclude that one can ask at least 20 choice tasks without degradation in data quality. However, the effects of the number of tasks on validity were not measured. Concerning the second question J&O found that respondents are more likely to choose the “None” option as the interview progresses. With respect to the third question the authors found that brand becomes less important and price becomes more important during the interview.

In this paper we replicate and extend the research by J&O. The replication is done by using 22 CBC data sets with almost 7,000 respondents. While J&O focus on US data sets, our data mainly stem from central Europe. The extension refers to the possibility of our data set to analyse effects of the number of tasks on predictive validity, whereas J&O investigated reliability only. Moreover, our data sets cover some additional issues such as the analysis of more choice tasks (up to 25 instead of a maximum of 20 in the J&O study).

The remainder of the paper is organized as follows: Section II describes the design of our empirical study. Sections III to V refer to the results concerning the three research questions listed above. In section VI a short summary of the results is given.

## **II Design of the Empirical Study**

We evaluated 22 different CBC studies with randomised design. 17 data sets were contributed by Research International (RI), 5 were from various academic studies. All studies were designed for real research problems. The attributes of the RI studies were disguised for confidentiality reasons. The studies included a wide variety of product categories ranging from fast moving consumer goods to clothes and services. The numbers of attributes ranged from two to six, and the number of choice tasks from seven to 25. The numbers of respondents ranged from 104 to 626. The total sample size sums up to almost 7,000 respondents. In 17 of the 22 studies a “None” or “Constant” option was included. Seven studies contained one to five holdout tasks each that could be used to assess predictive validity.

The analysis is done as follows: Because of the randomised design it is possible to analyse the data task by task. First, only the very first of the choice tasks of the interview is used for aggregate parameter estimation and all other information is discarded. This mimics an estimation based on an interview with only one choice task. Second, the first and the second choice tasks are used. Third, the first three choice tasks are used, etc. This procedure continues until the total number of choice tasks implemented in the respective study is used. If a study contains sixteen choice tasks, for instance, in this way sixteen different sets of parameters are estimated based on an increasing amount of information. The various estimations are then compared to each other.

### **III Predictive Validity: How Many Choice Tasks per Respondent?**

There is empirical evidence that the number of choice tasks can produce shifts in respondents' preference structure, i.e. preferences change as the CBC interview progresses. E.g., as already mentioned above, J&O found that brand becomes less important and price becomes more important during the interview. Also the increased proportion of respondents choosing the "None" option reported by J&O could result in preference shifts. Both results, increased choice of the "None" option and shifts in brand / price importance weights, could be replicated by our data (see sections IV and V).

Given that preference structures change as the CBC interview progresses (i.e. between the early and the late part of the interview), the question arises which is the valid preference structure depending on the number of choice tasks. In contrast to J&O we can test for predictive validity which is measured by the correct prediction of holdout tasks. Seven of the studies included one to five holdout tasks each, leading to a total of twenty holdout tasks. The various sets of parameters were used to simulate the holdout tasks using the logit simulator. The results are compared with the actual choice shares from the interview. The deviation of the prediction of the various sets of parameter estimates can be compared. The mean absolute deviations (Leeflang, Wittink, Wedel & Naert, 2000, p. 506) are given in table 1.

**Table 1: Mean absolute deviation (holdout simulation from holdout share) in percentage points**

number of tasks	Holdout																			
	a	b	c	d	e	f	g	h	i	J	k	l	m	n	o	p	q	r	s	t
0 (random)	7	6	7	5	4	4	4	8	11	23	14	11	4	5	4	6	5	22	24	12
1	1	3	2	4	5	2	4	4	5	6	6	2	3	2	4	4	6	7	10	11
2	1	2	1	3	4	2	4	5	4	8	6	3	4	3	5	7	7	4	9	5
3	2	1	1	2	3	2	4	5	3	8	5	3	3	2	4	5	8	4	10	3
4	2	1	1	3	3	2	3	4	4	7	4	3	3	2	4	4	7	4	9	3
5	3	1	2	3	3	2	3	4	3	7	4	3	3	2	4	5	8	5	8	2
6	3	1	2	2	3	2	3	4	3	6	3	3	3	2	4	4	7	5	8	2
7	3	1	2	3	3	3	3	4	2	7	4	3	3	2	4	4	7	4	7	3
8	3	1	2	3	3	3	3	4	2	7	3	3	3	3	4	4	6	4	7	3
9	3	1	2	3	3	3	3	4	2	7	3	3	3	3	4	4	6	4	6	3
10	2	1	1	3	3	3	3	4	2	6	3	3	3	3	4	5	6	5	6	3
11	2	1	1	3	2	3	3	4	2	6	3	3	3	3	4	5	6	5	6	3
12	2	1	2	3	2	3	3	4	2	6	3		3	3	4	5	6	5	6	4
13	2	1	2	3	2	3	3	4	2	6	3		3	3	4	5	6	5	5	4
14	2	1	2	3	2	3	3	4	2	6	3		3	3	4	5	6	5	5	4
15	2	1	2	3	2	3	3	4	2	6	3		3	3	4	5	6	5	4	4
16	2	1	1	3	2	3	3	4	2	6	3		3	2	4	5	6	5	4	4
17	2	1	2	3	2	3	3	4	2	6	3		3	3	4	5	6	5	4	4
18	2	2	2	3	2	3	3	4	2	6	3		3	3	4	5	5	5	4	4
19	2	1	2	3	2	3	3	4	2	6	2		3	3	4	5	5	5	4	4
20	2	1	2	3	2	3	3	3	2	6	2		3	3	4	5	5	5	4	4
21				3	2	2	3													
22				3	2	2	3													
23				3	2	2	3													
24				3	2	2	3													
25				3	2	2	3													

Only in three of the twenty holdouts there is a continuous decrease in error if the number of choice tasks considered for estimation is increased (notably for holdout s, only slightly for holdouts e and q in table 1). In five cases there is a decrease for up to six tasks or less but not after that (b, d, i, k, r). Surprisingly in eleven out of twenty cases there is only a negligible decrease in error if any at all. In one case there is even a slight increase of error after a minimum at 5 or 6 tasks (holdout t).

#### IV Choice of the “None” Option

One advantage of choice-based conjoint analysis over other preference structure measurement methods is the possibility to include an option to choose none of the offers. This option makes the task more realistic in case that all other options are unacceptable to the respondent and s/he would go to a different shop or postpone her/his choice. The “None”-option could be interpreted as a “Constant” alternative as well. This is useful if the consumers show inertia in the product category of interest, e.g. in telecommunications . The “Constant”

alternative would be “I stay with my current provider” (Orme, 2000). However, there is an indication that the number of respondents choosing that option is not constant during an interview. Respondents are more likely to use the “None” respective “Constant” option in later tasks: J&O report an average of 19.8 % “None” responses in the first task to 23.5 % in the tenth tasks.

We analyse seventeen studies containing a “None” option and track the fraction of respondents choosing it. Table 2 shows the share of respondents in each of the 17 studies depending on how many choice tasks are considered.

In two studies (number 15 and 16 in table 2) this fraction varies strongly but not systematically during the interview. Both are characterized by a very small number of respondents choosing the “None” option at all. In two further studies the share of the “None” option does not vary (number 4 and 8) and in one it decreases slightly (number 5). But in the majority of studies (the remaining 12 out of 17) the fraction of choices of the “None” option increases, in part notably. Thus, the most prevalent pattern seems to be that of an increasing choice of the “None” option. This confirms the results of J&O.

**Table 2: Share of the “None” option in percentage points**

number of tasks	Study																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	28	21	20	19	19	15	11	11	11	7	6	4	3	2	1.4	1.0	32
2	27	22	18	18	19	15	12	11	12	7	6	5	5	3	0.8	1.0	35
3	27	21	18	19	18	15	14	12	12	8	6	6	7	5	0.8	0.8	32
4	28	21	19	19	19	16	14	11	13	8	6	6	9	5	0.7	0.8	34
5	28	21	20	19	19	17	15	11	13	9	6	6	9	5	0.7	0.6	35
6	28	21	20	19	20	17	15	11	14	9	6	6	10	5	0.8	0.6	36
7	28	22	21	19	20	17	16	11	14	9	6	6	9	5	0.8	0.6	37
8	28	22	21	19	19	17	16	11	14	10	7	6	9	6	0.9	0.5	37
9	29	22	22	19	18	17	16	11	14	10	7	6	10	6	1.0	0.6	38
10	29	22	22	19	17	17	16	11	14	10	7	7	10	6	0.9	0.8	38
11	29	23	22	19	17	18	17	11	14	10	7	7	10	6	0.9	0.7	38
12	29	23	22	19	17	18	17	11	14	11	7	7	10	6	0.9	0.7	38
13	29	23	22	19	16	18	17	11	14	11	7	7	10	6	0.9	0.7	39
14	30	23	22	19	16	18	18	11	14	11	7	7	10	6	1.1	0.7	39
15	30	23	22	19		18	18	11	14	11	7	7	10	6	1.0	0.7	39
16	30	23	22	19		18			14		7		11	7		0.8	39
17		23	22	19							8		11	7		0.8	39
18		23	22	19							8		11	7		0.9	40
19		23	22	19							8		11	7		0.1	40
20		24	23	19							8		12	7		0.9	40
21		23		19							8						
22		24		19							8						
23		24		19							8						
24		24		19							8						
25		24		19							8						

## V Stability of Parameters Estimated

A researcher’s minimum requirement could be the stability of the interview in the sense that the rank orders of the attribute levels do not change anymore. Thus, we check at what point the rank order of the levels do not change anymore for each attribute. The number of choice tasks necessary for stability varies strongly: Whereas some attributes are stable after a few tasks or even the very first task, others show no sign of stability even at the end of the interview.

Several possible influencing variables on the number of tasks necessary for stability are analysed. Neither the product category nor the number of attributes show any connection. There is, however, an influence of the number of attribute levels. A regression analysis shows that one additional level requires 1.5 additional choice tasks for stability (R-square: 0.65,  $p < 0.01$ ).

With regard to the rank order of the attributes the analysis confirms the findings of J&O: The importance of the attribute brand is always higher than the one of the attribute price.

However, while the importance of the attribute brand decreases over the time, the importance of price increases. Therefore, the gap between the importance of brand and the one of price gets smaller with increasing number of choice tasks.

## **VI Summary**

Recapitulating, respondents become more price-sensitive during a CBC interview and are more inclined to choose the “None” or constant option. These are threats to the validity of the interview. The predictive validity does not increase after six tasks in the vast majority of studies. In addition, due to cost considerations one would favour a small number of tasks per respondent. Thus, for an aggregate estimation six tasks seem to suffice. If there are no more than four attributes this number should lead to stable level rank orders in most cases, too.

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