Universität Hamburg

Felix Eggers

A Tutorial for Efficient Choice Set Designs

Research Papers on Marketing and Retailing
University of Hamburg

No. 37
December 2007

Tor zur Welt der Wissenschaft

Institute of Marketing and Media
Marketing and Branding

Head of the Institute
Prof. Dr. Henrik Sattler

Nr. 37

Felix Eggers*

A Tutorial for Efficient Choice Set Designs

December 2007

ISSN 1618-8985

*) Dipl.-Kfm. Felix Eggers, Institute of Marketing and Media, University of Hamburg, Von-Melle-Park 5, 20146 Hamburg; E-mail: eggers@econ.uni-hamburg.de; Tel.: +49(0)40 42838 7819; Fax: +49(0)40 42838 3650

Abstract

The efficiency of choice designs, i.e. creating specific stimuli and allocating these stimuli to choice sets, has a great effect on validity. This tutorial gives an introduction to the design procedure by Burgess and Street (2003), which is especially suited for the hybrid individualized two-level choice-based conjoint procedure introduced by Eggers and Sattler (2008).

Keywords discrete choice experiments, choice-based conjoint, efficient designs

1. Introduction

This paper intends to give a brief tutorial on the design of choice sets within discrete choice experiments according to Burgess and Street (2003). They propose an approach to designing efficient choice sets in which all attributes in a choice-based conjoint (CBC) setting exhibit two levels. Thus, it is a specific procedure for the general approach described in Street, Burgess, and Louviere (2005). The design procedure is especially suited for the hybrid individualized two-level CBC (HIT-CBC) approach described by Eggers and Sattler (2008), in which every design is reduced dynamically to the two best and worst levels of each attribute. HIT-CBC is favorable in a number of ways. For example, apart from simplifying the choice design procedure, integrating only two levels per attribute avoids the biasing number of levels effect. Please refer to the article for details.

This tutorial is just a general introduction to Burgess and Street (2003). Its purpose is to give an easy to understand point of entry in order to facilitate the realization of efficient choice designs. It cannot and will not in any case try to replace the original article. In fact, for a thorough understanding of the approach and when it can be used, e.g. for main- or interaction effect estimation, reading the original article is essential. For an additional introduction to CBC and choice set design the reader may refer to Louviere, Hensher, Swait (2000), Kuhfeld (2004) or the technical papers on the website www.sawtoothsoftware.com.

Throughout the paper the following notation will be used: k is the number of attributes. The levels of the attributes will be denoted by 0 (representing the first level) and 1 (representing the second level). m will be referred to as the number of stimuli in a choice set. F represents the (fractional) factorial and G a generator used for shifting.

2. Generation of Choice Sets

First, a (fractional) factorial F has to be identified. Each entry in that factorial F_i can be seen as a choice set of size 1. That means the size of the factorial determines the number of choice sets. If the full factorial, i.e. the number of choice sets, is too large a fractional factorial can be used. Then, the remaining m – 1 stimuli for each choice set are constructed by shifting using a design generator $G=(g_1, g_2, \ldots, g_m)$. Each design generator g_j consists of k entries. The missing stimuli are generated by adding G to each entry of the factorial F_i. In that way the alternatives of the choice sets are given by $(F + g_1, F + g_2, \ldots, F + g_m)$. Thus, the generation of choice sets consists basically of the following steps:

1. Creation of the full- or fractional factorial F,
2. Finding a generator G and creating stimuli by shifting, and
3. Randomization of alternatives and choice sets.

These steps shall now be described in more detail.

2.1. Creation of the Full- or Fractional Factorial

The full factorial is given by building all possible combinations of attribute levels. Since only attributes with two levels are considered here, the sum of possible combinations is given by 2^k, k being the number of attributes. Thus, having k = 2 attributes allows a total of 4 combinations of attribute levels: (0 0), (0 1), (1 0), (1 1). k = 3 would sum to 8, k = 4 to 16 combinations and so forth. Each combination of attribute levels can be considered as the first stimulus, i.e. alternative, of a choice sets. That also means that the size of the factorial, i.e. the number of possible combinations, determines the number of choice sets. Having more than 16 choice sets is often unfavorable due to effects of fatigue or learning. Therefore, for k = 5 and above (maybe also already for k = 4) a reduced, i.e. fractional factorial might be more suitable. Efficient fractional designs for two-level attributes are well documented and can be looked up in corresponding tables (e.g. Box, Hunter, and Hunter 1978; NIST/SEMATECH 2007)

After this step the number of choice sets has been determined and already the first alternatives of these sets are given. The remaining m – 1 stimuli have to be constructed using the design generator G.

2.2. Finding a Generator and Creating Stimuli by Shifting

The generator G is used to construct the missing stimuli by a procedure called shifting. This procedure is best explained by using an example: Consider a study with three attributes (k = 3). The full factorial F then has $2^3 = 8$ alternatives. If two stimuli are shown per choice set, i.e. m = 2, the generator consists of two entries $G=(g_1, g_2)$, each having 3 items that refer to the attributes of the study. g_1 can generally be set to 0, i.e. $g_1 = (0, 0, 0)$. The remaining generator g_2 is chosen so that the alternatives within a set are maximally different in order to fulfill the property of minimal overlap (Huber and Zwerina 1996). In this case the missing stimulus that is maximally different is just the fold-over of the first alternative. Technically, this is represented by the generator $g_2 = (1, 1, 1)$. The two alternatives of the choice set are given by $F + g_1$ and $F + g_2$. This shifting is done attribute-wise modulo 2, i.e. if a sum equals 2 this result is set back to 0 (because levels can only exhibit the values 0 and 1). The example is given in table 1.

Choice set *i*	*Full factorial* F_i	*First alternative* $F_i + g_1$	*Second alternative* $F_i + g_2$
1	0 0 0	0 0 0	1 1 1
2	1 0 0	1 0 0	0 1 1
3	0 1 0	0 1 0	1 0 1
4	0 0 1	0 0 1	1 1 0
5	1 1 0	1 1 0	0 0 1
6	1 0 1	1 0 1	0 1 0
7	0 1 1	0 1 1	1 0 0
8	1 1 1	1 1 1	0 0 0

Table 1: Choice set construction with m = 2 using a design generator

What can be seen is that the alternatives are maximally different, i.e. each attribute has a different level for the two stimuli of a choice set. This design is efficient and D-optimal (see Huber and Zwerina 1996 for efficiency criteria).

The procedure is similar for designs with m > 2. Again, it has to be ensured that the generators, i.e. the alternatives of the choice sets, are maximally different. This can be accomplished by comparing each generator with each other and counting the times an attribute is different. For example with m = 3, g_1 has to be compared with g_2 and g_3, and g_2 has to be compared with g_3. Burgess and Street (2003) develop an upper bound for this sum of differences, which is a precondition for efficient designs. This upper bound is given by:

(1) $(m^2-1)\cdot k/4$, if m is odd, and

(2) $m^2\cdot k/4$, if m is even (Burgess and Street 2003, p. 2188).

For an example with m = 3 and k = 3 the maximum sum of differences is $(9-1)\cdot 3/4$ = 6. A set of generators that fulfills this upper bound is g_1 = (0, 0, 0), g_2 = (0, 1, 1), and g_3 = (1, 0, 1). Thus, using the factorial mentioned above the three alternatives would be given by F + g_1, F + g_2, F + g_3 (see table 2). In the same manner designs for different settings can be easily constructed.

Choice set *i*	*Full factorial* F_i	*First alternative* $F_i + g_1$	*Second alternative* $F_i + g_2$	*Third alternative* $F_i + g_3$
1	0 0 0	0 0 0	0 1 1	1 0 1
2	1 0 0	1 0 0	1 1 1	0 0 1
3	0 1 0	0 1 0	0 0 1	1 1 1
4	0 0 1	0 0 1	0 1 0	1 0 0
5	1 1 0	1 1 0	1 0 1	0 1 1
6	1 0 1	1 0 1	1 1 0	0 0 0
7	0 1 1	0 1 1	0 0 0	1 1 0
8	1 1 1	1 1 1	1 0 0	0 1 0

Table 2: Choice set construction with m = 3 using a design generator

2.3. Randomization

Once the alternatives and the choice sets are determined, the order of the alternatives within a choice set and the order of choice sets should be randomized for each individual so that order and time effects are avoided.

3. Conclusion

The algorithm by Burgess and Street (2003) is indeed a very easy and quick way to construct efficient choice sets. It can furthermore be extended to more general designs as outlined in Street, Burgess, and Louviere (2005). However, to fully understand the procedure and its adequate usage the reader should refer to the cited references. This paper should have laid a good basis for it.

References

Box, G.E.P., W.G. Hunter, and J.S. Hunter (1978): “Statistics for Experimenters”, John Wiley & Sons, New York.

Burgess, L. and D.J. Street (2003): “Optimal designs for 2 choice experiments“, in Communications in Statistics. Theory and Methods, 32, 2185-2206.

Eggers, F. and H. Sattler (2008): „Hybrid individualized two-level choice-based conjoint“, in University of Hamburg Research Paper Series (forthcoming).

Huber, J. and K. Zwerina (1996): “The importance of utility balance in efficient choice designs”, in Journal of Marketing Research, Vol. 33, No. 3, 307-317.

Kuhfeld, W.F. (2004): „Marketing Research Methods in SAS“, SAS Institute Inc., Cary, NC, USA.

Louviere, J.J., D.A. Hensher, and J.D. Swait (2000): “Stated choice methods: Analysis and applications in marketing, transportation and environmental valuation”, Cambridge: Cambridge University Press.

NIST/SEMATECH (2007): „e-Handbook of Statistical Methods“, http://www.itl.nist.gov/div898/handbook/pri/section3/pri3347.htm.

Street, D.J., L. Burgess, and J.J. Louviere (2005): “Quick and easy choice sets: Constructing optimal and nearly optimal stated choice experiments”, in International Journal of Research in Marketing 22 (2005) 459-470.

Research Papers on Marketing and Retailing - University of Hamburg

Im Zentrum der Reihe Research Papers on Marketing and Retailing (Hrsg.: Prof. Dr. Henrik Sattler) steht ein marktgerichtetes, wertorientiertes Management, z. B. zu folgenden Fragestellungen:

- Mit welchen Methoden kann ein monetärer Markenwert gemessen werden?
- Wie können Markenstrategien im Handel bewertet werden?
- Wie soll der Handel gewinnoptimale Preise setzen?
- Wie können Konsumentenpräferenzen gemessen und in ein wertorientiertes Management integriert werden?
- Wie kann der Erfolg von Neuprodukten bestimmt werden?
- Welche Erlösmodelle sollen im eCommerce verfolgt werden?

The Research Papers on Marketing and Retailing (Ed.: Prof. Henrik Sattler) focus on market-orientated, value-based management, e.g.:

- Which methods to be applied as a means of measuring brand equity
- How to evaluate brand strategies in retailing
- How to set optimum-profit prices
- How to measure consumer preferences and integrate them into a value-based management
- How to determine the success of new products
- How to follow up revenue models in e-commerce.

Bisher erschienen:

Published so far:

001 Sattler, H., T. Nitschke, „Ein empirischer Vergleich von Instrumenten zur Erhebung von Zahlungsbereitschaften“, October 2001.

002 Sattler, H., F. Völckner, G. Zatloukal, „Erfolgsfaktoren von Markentransfers“, March 2002.

003 Sattler, H., „Appropriability of Product Innovations: An Empirical Analysis for Germany“, May 2002.

004 Hartmann, A., H. Sattler, „Wie robust sind Methoden zur Präferenzmessung?“, May 2002.

005 Sattler, H., S. Schrader, C. Lüthje, „Informal Cooperation in the US and Germany: Cooperative Managerial Capitalism vs. Competitive Managerial Capitalism in Interfirm Information Trading“, June 2002.

006 Hartmann, A., H. Sattler, „Commercial Use of Conjoint Analysis in Germany, Austria, and Switzerland“, August 2002.

007 Sattler, H., S. Högl, O. Hupp, „Evaluation of the Financial Value of Brands“, August 2002.

008 Sattler, H., K. Schirm, „Credibility of Product-Preannouncements: An International Empirical Comparison“, September 2002.

009 Sattler, H., „Methods for Measuring Consumers’ Willingness to Pay“, September 2002.

010 Sattler, H., F. Völckner, G. Zatloukal, „Factors Affecting Consumer Evaluations of Brand Extensions“, September 2002.

011 Sattler, H., F. Völckner, „Bestimmungsfaktoren des Markentransfererfolges. Eine Replikation der Studie von Zatloukal (2002) “, September 2002.

012 Sattler, H., „Markentransferstrategien“, March 2003.

013 Sattler, H., A. Hartmann, S. Kröger, „Number of Tasks in Choice-Based Conjoint Analysis“, December 2003.

014 Völckner, F., „Wahrnehmung und Beurteilung von Markentransfers bei kurzlebigen Konsumgütern: Eine kausalanalytische Betrachtung“, January 2004.

015 Hartmann, A, A. Steffens, „Qualitative Marketingforschung. Überblick und Anbieterverzeichnis“, February 2004.

016 Sattler, H., F. Völckner, „Empirical Generalizability of Consumer Evaluations of Brand Extensions“, March 2004.

017 Völckner, F., H. Sattler, „Markentransfererfolgsanalysen bei kurzlebigen Konsumgütern unter Berücksichtigung von Konsumentenheterogenität“, April 2004.

018 Völckner, F., H. Sattler, „Drivers of brand extension success: A structural equation modeling approach“, April 2004.

019 Völckner, F., H. Sattler, „Separating Negative and Positive Effects of Price with Choice-Based Conjoint Analyses“, January 2005.

020 Gedenk, K., H. Sattler, „Range Effects in Measuring Attribute Importance“, April 2005.

021 Völckner, F., „Determinanten der Informationsfunktion des Preises: Eine empirische Analyse“, January 2005.

022 Kaufmann, G., K. Kurt, „Rückwirkungen von Markentransfers auf die Muttermarke: eine empirische Auswertung von Fallbeispielen“, February 2005.

023 Nitschke, T., F. Völckner, „Präferenzmessung bei unsicheren Produkteigenschaften: Berücksichtigung von Risiko in Conjoint-Analysen“, March 2005.

024 Völckner, F., H. Sattler, „Empirical Generalizability of Consumer Evaluations of Brand Extensions“, May 2005.

025 Völckner, F., „Biases in Measuring Consumers’ Willingness to Pay“, May 2005.

026 Nitschke, T., H. Sattler, „Präferenzstrukturen und Zahlungsbereitschaften für Online-Medieninhalte: Eine empirische Analyse am Beispiel von Online-Videoangeboten“, June 2005.

027 Sattler, H., „Markenbewertung: State of the Art“, June 2005.

028 Völckner, F., B. Pirchegger, „Immaterielle Werte in der internen und externen Berichterstattung deutscher Unternehmen: Eine empirische Bestandsaufnahme“, June 2005.

029 Kaufmann, G., H. Sattler, F. Völckner, „Markenstrategische Optionen“, September 2005.

030 Völckner, F., „Methoden zur Messung von individuellen Zahlungsbereitschaften: Ein Überblick zum State-of-the-Art“, October 2005.

031 Völckner, F., „The Dual Role of Price: Signaling and Sacrifice Effects“, January 2006.

032 Sattler, H., „Methoden zur Messung von Präferenzen für Innovationen“, February 2006.

033 Völckner, F., H. Sattler, G. Kaufmann, „Reciprocal Effects of Brand Extensions: Evidence from a Longitudinal Field Study“, September 2006.

034 Völckner, F., J. Hofmann, „The price–perceived quality relationship: A meta-analytic review and assessment of its determinants“, October 2006.

035 Ringle, C. M., „Segmentation for Path Models and Unobserved Heterogeneity: The Finite Mixture Partial Least Squares Approach“, November 2006.

036 Farsky, M., F. Eggers, „Image Measurement with *Golden -i-* – A Technical Report“, December 2006.

037 Eggers, F., “A Tutorial for Efficient Choice Set Designs”, December 2007.

Die Research Papers und weitere Publikationen des Instituts für Marketing und Medien (Prof. Dr. Henrik Sattler) an der Universität Hamburg können Sie von unserer Homepage herunterladen:

You may download the research papers and other publications from the Institute of Marketing and Media (Prof. Dr. Henrik Sattler) at the University of Hamburg from our homepage:

www.henriksattler.de