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Marketing Research / Advanced Analytics

Trade-off Analysis:
A Survey of Commercially Available Techniques

Trade-off analysis is a family of methods by which respondents' utilities for various product features are measured. This article discusses trade-off analysis, including basic concepts and the four main types of trade-off: conjoint, discrete choice, self-explicated and hybrid.

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Overview

Trade-off analysis is a family of methods by which respondents' utilities for various product features (usually including price) are measured. In some cases, the utilities are measured indirectly. In this case, respondents are asked to consider alternatives and state a likelihood of purchase or preference for each alternative. As the respondent continues to make choices, a pattern begins to emerge which, through complex multiple regression (and other) techniques, can be broken down and analyzed as to the individual features that contribute most to the purchase likelihood or preference. The importance or influence contributed by the component parts. i.e., product features, are measured in relative units called "utils" or "utility weights."

In other cases, respondents are asked to tell the interviewer directly how important various product features are to them. For example, they might be asked to rate on a scale of 1 to 100 various product features, where 1 means not at all important to their purchase decision and 100 means extremely important to their purchase decision.

Trade-off analyses produce several types of information. First, they tell us what features (and levels of features) are most valued by customers. Second, they allow us to model how likely people will be to purchase various configurations of products, the share of revenue these products will most likely receive and what role price plays in the assessment of acceptability.

There are four main types of trade-off:

- Conjoint
- Discrete Choice
- Self-explicated
- Hybrid

One additional model, the MACROModel©[1], will be discussed which does not fall into any of the above four categories.

We will discuss each of these trade-off types after reviewing a few basic concepts.

[1] *P. Richard McCullough, MACROModel©-A Price Sensitivity and Volumetric Approach to New Product Concept Screening, Mountain View, CA, 1995. A MACRO white paper.*

Experimental Design

A critical issue in most trade-off methods is the selection of product attributes to be combined together to create each product configuration to be tested.

If every possible combination of attributes were included in the study, the study would be said to be using a complete or full factorial design. This is desirable but very seldom practical. For example, if we had 6 attributes with 3 levels each, the total number of possible combinations would be 36 or 729. This is much too large to ask one respondent to rate (and 6 attributes with 3 levels each is untypically modest).

When a fractional factorial design is used, only a fraction of the total possible number of product combinations needs to be tested. For the above example, a fractional factorial design could be generated (usually with the help of a computer) that would require perhaps as few as 14 product configurations to be rated. It must be kept in mind, however, that whenever a fractional factorial design is used, some information will be lost. It is the job of the researcher creating the experimental design to ensure that the information being sacrificed (usually higher order interaction effects) does not compromise the project's ability to answer the research objectives.

Bridging

Occasionally, even with the most efficient fractional factorial design, we still end up with more products than can be practically accommodated. One possible solution to that problem is bridging[2]. Bridging allows the attributes to be divided into two or more sets (with some attributes common to all sets). Each set of attributes is treated like its own trade-off study. A fractional factorial design is created for each set of attributes. Respondents are asked to rate or rank two smaller sets of products rather than one large set. The utilities are calculated for each trade-off exercise independently and bridged together to create one final set of utilities.

Cognitive and Non-cognitive Behavior

Critical to the selection of an appropriate trade-off technique is the issue of which type of behavior, cognitive or non-cognitive, best represents the behavior being measured. Cognitive behavior is behavior that is based on rational, conscious decision making. Such factors as price, functionality or durability are typically cognitive. Non-cognitive behavior is behavior that is based on less tangible or even less conscious factors such as status, aspiration, insecurity, perceived taste, etc. One might argue that the selection of a life insurance policy, a computer or a water heater are all cognitive decisions and that the selection of a beer, a skin cream or a pair of pants are all non-cognitive. One might also argue that all decisions made by humans are non-cognitive.

However, trade-off techniques that employ direct questions (self-explicated and hybrid) all assume that the behavior being modeled is cognitive, because at least some of the product features are being rated in a way that requires both awareness and honesty from the respondent. That is, the respondent must be aware of the degree to which a product feature affects his or her purchase decision and also be willing to admit to that degree of affect.

Additionally, any data collection methods that rely on verbal or written descriptions of product features all assume that the behavior being modeled is cognitive, because the process of understanding a verbal or written description is itself a cognitive behavior.

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[2] *Pierre François, Douglas L. MacLachlan and Anja Jacobs, Bridging Designs for Conjoint Analysis: The Issue of Attribute Importance, Leuven, Belgium, 1991-2. An unpublished paper.*

Non-cognitive trade-off models should be based on an indirect trade-off technique (conjoint or discrete choice) and data collection that relies on experience rather than language to communicate the product choices. For example, if you are modeling the pant selection process, show respondents a variety of pants that they can see and touch. A consumer may respond to the phrase "light blue pants" very differently than he or she would to a particular pair of light blue pants.

The Four Main Types of Trade-Off

I. Conjoint

Conjoint analysis is the original trade-off approach and uses linear models. There is metric conjoint, where respondents monadically rate various product configurations, and non-metric conjoint, where respondents rank a set of product configurations. There are also full-profile conjoint, partial-profile conjoint and pairwise conjoint. Full-profile conjoint uses all product features in every product configuration. Partial profile conjoint uses a smaller subset of available product features in the product configurations. Pairwise conjoint requires the respondent to rate their preference for one product over another in a paired comparison. We will only discuss conjoint methods in general in this paper.

Conjoint models are simply regression models which are constructed for each individual respondent. Typically, each respondent rates or ranks 20 to 30 product configurations. Each product configuration contains different levels of the product attributes being tested. If the product levels are varied appropriately (the role of experimental design), a regression model can be estimated for each individual, using the product ratings as cases. The coefficients from the model are the utilities or utils.

A conjoint approach should be used if a limited number of attributes needs to be tested and utilities need to be estimated for individual respondents, e.g., conjoint-based segmentation.

II. Discrete Choice

Discrete choice differs from conjoint in that respondents are shown a set of products from which they pick the one they most want to buy or none if they are not interested in any of the choices shown (rather than rate or rank choices). Respondents are shown several sets of choices sequentially. For each choice set, they are asked to pick one or none. This is in contrast to most forms of conjoint where respondents are not allowed to choose none of the product options (MACRO incorporates no-buy choices into its conjoint models). The discrete choice procedure has the advantage of being more like the actual purchase decision process than do any of the data collection methods used in most conjoint studies.

Also, in conjoint methods, the mathematical models constructed to simulate market behavior are based on linear regression models. In discrete choice, the basis is the multinomial logit model[3], which is non-linear. Another analytical difference is that, in conjoint procedures, the utility weights are estimated for each respondent individually. These weights can often provide the basis for a very powerful customer segmentation. Most commercially available forms of discrete choice do not allow this option, although this may be rapidly changing.

Further, because discrete choice models are generally estimated at the aggregate level, there exists the possibility that respondents will have strong but opposite preferences to one another. These preferences will effectively cancel each other out when the model is constructed at the aggregate

[3] *R. Duncan Luce, Individual Choice Behavior: A Theoretical Analysis, New York: John Wiley, 1959.*

level, yielding the incorrect conclusion that respondents had no strong preference. This is sometimes referred to as the heterogeneity problem.

There are two basic forms of discrete choice: classic and exploding data[4]. Classic discrete choice involves showing a respondent a series of sets of products (as described above). In exploding data discrete choice, respondents are asked to rank order a set of products based on purchase interest (similar to non-metric conjoint). This rank-ordered data set can be transformed into a format suitable for logit model estimation. Exploding data discrete choice has the advantage of more efficient data collection over classic discrete choice. The exploding data approach creates many times more data points (or cases) than the classic approach with the same interview length.

Discrete choice should be used if the primary objective of the study is to estimate market share or price sensitivity, a limited number of attributes need to be tested and the sample population is known to be homogeneous with respect to all product attributes.

III. Self-Explicated

Conjoint and discrete choice both determine respondents utilities indirectly.

Self-explicated determines respondents' utilities directly. With self-explicated scales, respondents are asked directly how important all levels of all attributes are to their purchase interest. Despite its conceptual simplicity, self-explicated models have been shown to be comparable to conjoint models[5].

Self-explicated conjoint analysis requires respondents to reveal their utilities directly. Accordingly, standard questionnaire methods can be used to collect the information. The technique involves the following steps:

- Respondent are informed about all the attributes and their levels, and the respondents are then asked to identify attribute levels that are totally unacceptable to them
- From among the acceptable levels of the attributes, respondents are asked to indicate which are the most preferred and least preferred levels of each attribute
- Using the respondents' most important attribute as an anchor, elicit importance ratings for the other attributes (on a 0 - 100 scale)
- For each attribute, rate the desirability of the different acceptable levels with the attribute
- Utilities for acceptable attribute levels are obtained by multiplying the importance rating and the desirability ratings

The utilities are then entered into a choice simulator program, and choice information similar to other conjoint programs can be obtained.

Self-explicated approaches are useful when there are a large number of attributes and the decision process being modeled is cognitive.

[4] Randall G. Chapman and Richard Staelin, Exploiting Rank Ordered Choice Set Data Within the Stochastic Utility Model, Journal of Marketing Research, August, 1982.

[5] V. Srinivasan, A Conjunctive-Compensatory Approach To The Self-Explication of Multiattributed Preferences, Decision Sciences, 1988, vol. 19.

IV. Hybrid

Hybrid models are models that use a combination of the above techniques. The most famous hybrid model is ACA, Adaptive Conjoint Analysis[6].

Adaptive Conjoint Analysis

In this procedure, a computer program prompts the interviewer with questions. The procedure is as follows:

Respondents are first walked through a battery of feature-importance ratings and rankings; second, through a series of pairwise trade-offs of different product configurations. The product configurations shown to any one respondent may not include all of the attributes being tested.

The configurations to be paired are based on the answers to the importance questions and rankings asked in the beginning of the interview. Items that are considered of little importance show up in the comparisons less often. Items that are considered of greater importance show up in the comparisons more often.

For each pair of products being tested, the respondent is to indicate which product they prefer and the degree to which they prefer it.

The software continues prompting with pairwise comparisons of product configurations until enough data has been collected to estimate conjoint utilities for each level of each feature. Since the procedure is adaptive, only a fraction of the total number of possible product combinations are tested.

ACA is an approach that is appropriate for building preference models of cognitive behavior with large numbers of attributes. It may not be as useful when price sensitivity, non-cognitive purchase decisions or interaction terms are to be modeled.

Cake Method© and Logit-Cake Method©

Other hybrid models include the Cake Method©[7] and the Logit-Cake Method©[8]. Both of these models have been developed by MACRO Consulting and were designed to overcome weaknesses in other models.

Cake Method©

The Cake Method© is a unique, proprietary approach to conjoint analysis which offers several advantages over other conjoint methods:

- A large number of product features (50 or more) can be included in the model
- First order interactions can be estimated at both the disaggregate and aggregate levels

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[6] ACA is a product of Sawtooth Software, Inc., Sequim, WA. Sawtooth Software offers a broad range of trade-off software products.

[7] P. Richard McCullough, The Cake Method©-A Proprietary Hybrid Conjoint Approach to Trade-off, Mountain View, CA, 1997. A MACRO white paper.

[8] P. Richard McCullough, The Logit-Cake Method©-A Proprietary Hybrid Choice-Based Approach to Trade-off, Mountain View, CA, 1997. A MACRO white paper.

- There is complete control over the experimental design, in a full-profile format
- Since product combinations are specified, via traditional experimental design, before the interview takes place, physical exhibits can be easily incorporated into the interview

The approach involves a specific data collection procedure as well as a unique analytic protocol. The basic outline of the approach is to:

- Collect self-explicated scales on most of the product attributes tested
- Conduct a full-profile conjoint exercise with a limited number of product attributes, some of which are common to the self-explication exercise
- Estimate conjoint utilities for each respondent
- Bridge self-explicated scales to utility weights

The Cake Method© should be used when there are a large number of attributes, utilities need to be estimated for individuals, interaction terms need to be measured and the purchase decision is at least partially cognitive.

Logit-Cake Method©

The Logit-Cake Method© is a unique, proprietary approach to choice-based trade-off analysis which offers several advantages over other conjoint methods:

- A large number of product features (50 or more) can be included in the model
- The heterogeneity problem long associated with aggregate logit models is avoided
- The traditional advantages of logit models over conjoint models are maintained
- First order interactions can be estimated
- There is complete control over the experimental design, in a full-profile format
- Since product combinations are specified, via traditional experimental design, before the interview takes place, physical exhibits can be easily incorporated into the interview

The approach involves a specific data collection procedure as well as a unique analytic protocol. The basic outline of the approach is to:

- Collect self-explicated scales on all product attributes tested
- Conduct a full-profile choice-based exercise with a subset of product attributes
- Segment the sample based on self-explicated scales
- Estimate logit models for each respondent cluster
- Bridge self-explicated scales to logit-based utility weights

The Logit-Cake Method© should be used when there are a large number of attributes, market share and price need to be estimated, interaction terms need to be measured and the purchase decision is at least partially cognitive.

MACROModel©

One other model will be discussed in this paper. It does not fall into any of the four main types of trade-off models. In fact, it is not strictly speaking a trade-off model because it does not estimate utilities for any product attributes. The MACROModel© was developed by MACRO Consulting to address a specific research methods need that frequently occurs in new product development and packaging.

The MACROModel© is a unique approach to new product screening which offers several advantages over other methods:

- A large number of concepts or packages (50 or more) can be screened at one time
- Price sensitivity can be calculated for every new product concept screened
- Price/volume can be individually optimized for every product concept tested
- New product concepts can be screened and/or completely rank ordered on consumer appeal, market share, unit volume, gross dollar volume or gross profits

The approach involves a specific data collection procedure as well as a unique analytic protocol. The basic outline of the approach is to:

- Sort a stack of new product concepts cards (all new product concepts, each at three price points) into two piles: would definitely buy and would not buy. Note: Stack would contain several existing products as reference.
- Have them rank order the would buy pile on a continuum from most want to buy to least want to buy.
- Note: If the number of items to be sorted is too large for one sorting exercise, the task can be broken down into several smaller exercises, with two or three items common across sorting tasks. After the data are collected for all respondents for the various sorting exercises, a bridging technique can be used to incorporate the data from the separate exercises into one rank ordering of all of the items used in the study.
- Once the data are combined into one rank order data set for each respondent, the MACROModel© (a first choice share of preference model) can be constructed.

The MACROModel© should be used when the product is too complex to decompose into attributes, e.g., packaging graphics, when a large number of highly different products are to be included, e.g., new product screening, when price sensitivity needs to be measured and when products will be screened based on their revenue potential.

Conclusion

There are a variety of approaches to trade-off analysis, each with its advantages and disadvantages. Which trade off procedure is best is dependent on the issues and constraints of each marketing problem. The marketing problem should be discussed with a researcher who is knowledgeable in all appropriate methodologies before a research approach is selected.

If you would like more information, please telephone Dick McCullough, president of MACRO Consulting, Inc., at (650) 823-3042 or email him at richard@macroinc.com. You may also refer to the Articles and White Papers section and/or the Selected Bibliography section of MACRO's home page, www.macroinc.com, for related literature.

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