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*RESEARCH PAPER SERIES*

## Formulating Attributes and Levels in Conjoint Analysis

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Defining proper conjoint attributes and levels is arguably the most fundamental and critical aspect of designing a good conjoint study. An *attribute* is a characteristic of a product (e.g. color), made up of various *levels* (there must be at least two for each attribute) or degrees of that characteristic (e.g. red, yellow, blue). The underlying theory of conjoint analysis holds that buyers view products as composed of various attributes and levels. Buyers place a certain utility (value) on each of those characteristics, and can determine the overall utility of any product by summing up the value of its parts (levels).

In conjoint experiments, respondents express their preferences for products described by varying levels of attributes. By observing how respondents evaluate products in response to changes in the underlying attribute levels, we can estimate the impact (utility) each attribute level has upon overall product preference. Once we learn respondents' preferences for the various attribute levels, we can predict how buyers might respond to *any* potential combination of levels in our study, whether or not that actual product was ever displayed during the interview.

Typical full-profile conjoint studies in practice (like CBC and CVA) involve about six or fewer attributes, each described on about two to five levels. ACA studies often include many more attributes, each also described on about two to five levels. Some attributes are *nominal* (e.g. color, brand), and we cannot know ahead of time whether respondents prefer one level over another. Some attributes are *ordinal* (e.g. "expedited delivery" vs. "normal delivery"), and we know ahead of time that rational respondents would usually prefer the levels in a certain order. And other attributes are quantitative, such as price (e.g.. \$10, \$15, \$20), where there are numeric values associated with (for example) the weights, speeds, money, or time amounts.

## Guidelines

In generating attributes and levels, consider the following guidelines:

1. Levels should be concise statements with concrete meaning. Avoid using ranges to describe a single level of an attribute, such as "weighs 3 to 5 kilos." Rather than leave the interpretation to the respondent, it would be better to specify "weighs 4 kilos." Levels such as "superior performance" also leave too much in question. What does "superior performance" mean? Try to use specific language to quantify (if possible) the exact meaning of the level.
2. Attributes should be independent. This is especially important for partial-profile conjoint studies such as ACA and partial-profile CBC studies. With partial-profile or hybrid conjoint (ACA involves both), attributes that have overlap in meaning can get "double counted," resulting in too much inferred influence on product choice. It is therefore important to economize; including attributes with overlapping meanings is wasteful.

Furthermore, levels for related attributes may not combine naturally with one another. Though it can lead to more realistic interviews, it is often detrimental (and sometimes fatal) to prohibit levels from occurring with others. (There are some intriguing exceptions to this that we will not discuss here.)

3. Levels within each attribute should be mutually exclusive. This point becomes clear when you specify products using the market simulator (during the analysis phase) and are forced to choose only a single level from each attribute.

Consider the following attributes for a study on optional automobile features:

Optional Features:

Sunroof

GPS (Global Positioning System)

Extended warranty

This formulation doesn't permit simulating preference for a car that has both a Sunroof *and* a GPS. Similarly, we could not simulate preference for an automobile that had none of these features. There are two ways to resolve this quandary:

a) Create an attribute with all potential combinations of these features. This results in an eight-level attribute, if you include the option that none of these features is available.

b) Formulate three separate attributes each with two levels: (No Sunroof, Sunroof), (No GPS, GPS), (No Warranty, Warranty).

Option (a) adds seven parameters to the model and forces the measurement of an explicit three-way interaction. With the more complex model definition, we can investigate whether there are diminishing returns by bundling the features. By splitting the options into three distinct binary attributes (Option b), only three parameters are added to the model; however, interactions are not measured.

4. Attribute levels should cover the full range of possibilities for existing products as well as products that may not yet exist, but that you want to investigate. Although the market simulator allows you to extrapolate and interpolate, only linear interpolation and extrapolation are possible. Thus, although interpolation is likely to produce acceptable results, extrapolation is prone to error and should be avoided. One way to ensure that you are including the appropriate levels and ranges is to ask your client to specify ahead of time the market simulations to be run during the analysis phase of your study. That exercise can often reveal weaknesses in your attribute specifications.

5. Prohibitions should be used sparingly, or not at all. Specifying unnecessary or excessive prohibitions is one of the most common mistakes. The problem usually begins when either the analyst (or the analyst's client) notices that some product combinations displayed during the interview are not realistic, given what currently exists in the market. Sometimes a product is shown with all the best features at the lowest price; or two attribute levels that would not

naturally occur in the real world are paired together. The inclination is simply to prohibit such combinations. We urge you to exercise restraint when considering prohibiting pairs.

Too many prohibitions, in the best case, can lead to imprecise utility estimation and, in the worst case, confounded effects and the complete inability to calculate stable utilities. It is better to prompt respondents that they will see combinations during the interview that are not yet available in the market or that seem unlikely. You can urge respondents to answer as if these products were actually available today.

There are other strategies for dealing with prohibitions. Consider the example below with brands of soda and package types:

Brand:

Sawtooth Spritz

Kong Kola

Splut

Package Type:

2-liter bottle

6-pack of 12-oz cans

Suppose that Splut was only available in 6-packs of cans. Furthermore, you are displaying actual pictures of the products, and thus can only display actual (not potential) products. Rather than define a prohibition between Splut and the 2-liter bottle, it would make more sense to combine these two attributes as a single attribute with five levels:

Sawtooth Spritz in a 2-liter bottle

Sawtooth Spritz in a 6-pack of 12-oz cans

Kong Kola in a 2-liter bottle

Kong Kola in a 6-pack of 12-oz cans

Splut in a 6-pack of 12-oz cans

Under this strategy, no prohibitions are required. However, you will not be able to assess easily the effect of brand and package type as separate effects in this case. This is probably not an issue if market simulations are used as the primary method of analysis.

CBC and CVA are even more sensitive to too many attribute prohibitions than ACA. ACA tends to be more robust in the face of attribute prohibitions given that a significant portion of the information used to estimate utilities comes from the priors section, which is not affected by attribute level prohibitions.

6. The number of levels you choose to define an attribute can have a significant bearing on the results. The first concern has been called the “Number-of-Levels Effect.” All else equal, attributes defined on more attributes tend to get more importance. There is a large body of literature on this subject, and researchers recognize that both psychological and algorithmic effects play a role in the Number-of-Levels Effect. The Number-of-Levels Effect is less

problematic in ACA than full-profile conjoint methods such as CBC and CVA. We suggest you at least approximately balance the number of levels across attributes.

The second concern is that you limit the number of levels on which quantitative attributes are described. We suggest not including more than about five levels to describe attributes such as price or speed. It's usually better to have more data at each price point than to have thinner measurements at more price points. Measuring too many points along a quantitative function can result in troublesome reversals. If you cover the entire range of interest with fewer levels, you can interpolate between levels within the market simulator to get finer granularity if needed.

7. Attributes that cannot be adequately described in words should be represented in multimedia. But if attributes do not require multimedia to adequately communicate their properties, it would probably be a mistake to make them multimedia. Though the interview might appear more attractive, it might bias the results in favor of multimedia attributes.

8. In our experience, respondents have a difficult time dealing with more than about six attributes in full-profile conjoint methods like CBC and CVA. When faced with too much information, respondents often resort to simplification strategies to deal with the difficulty of the task. Unless respondents employ the same sort of simplification strategies when making real-world decisions, full-profile results may place too much emphasis on the few most important features.