



Application of Conjoint Analysis to Cost Estimation

Mr. Jacob J. Walzer, Kalman & Co., Inc.

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Background

- A key part of market research is understanding how potential consumers place value on product attributes
- From a marketing standpoint, the goal is to determine the product the consumers value the most, but costs the least
- However, the same analysis technique that allows for this objective item to be created can be applied to cost estimation as well
- Using legacy cost information, conjoint analysis allows for the estimation of costs of new items that may have differing capabilities from previously procured products

Capability Estimation Methods

- Analogy
 - Comparative analysis of similar systems
 - Potentially unreliable when there are many attributes
- SME Input
 - Good to use as a cross-check
 - Subjective when applied as a standalone
- Engineering Build-Up
 - Product cost rolls up from lowest-level components
 - Very reliable – but all components may not be known
- Parametric
 - Regression
 - Conjoint Analysis

Conjoint Analysis

- Conjoint analysis is a specific regression technique designed to analyze how various factors (cost, capability, brand) effect consumer perception
- Utilizing the regression outcome, additional steps can be taken that measure how the market value increases (or decreases) in capability
- Effective application of this analysis can help determine which attributes have the most impact on cost
- Goal: Anticipate the cost of products prior to their official release
- AKA: Tradeoff Analysis

Why Conjoint Analysis?

- Conjoint analysis (after data is collected) is a flexible and inexpensive (quick) to method to implement
- As a form of applied regression, it can be conducted on a variety of common software (ex: Excel)
- While it was designed to determine market preferences, the same process allows for the identification of pricing trends
- Provides the ability to compare potential costs for various items that have not yet been manufactured

Process

Summarize Weighting Data

- Collect all data and review for outliers, omissions, and other abnormalities
- In some cases, normalizing data may be necessary

Vendor	Preference	Cost	EIRP	G/T
Vendor 1	1	\$178,560	High	High
Vendor 2	2	\$188,040	High	High
Vendor 3	4	\$290,200	Medium	Medium
Vendor 4	7	\$401,728	High	Medium
Vendor 5	6	\$278,136	Medium	High
Vendor 6	9	\$180,200	Low	Low
Vendor 7	8	\$285,000	Medium	Low
Vendor 8	5	\$220,500	Medium	Medium
Vendor 9	3	\$390,200	High	Medium

Identify Correlated Data

- As in most regression techniques, correlated independent variables can negatively effect the outcome of the analysis
- Create a correlation matrix to identify which variables are highly related, and run several iterations of the regression to determine if it is improved by removing/combining variables

Create Dummy Variables

- Most variables involved in conjoint analysis are categorical, ordinal, or interval, and require the creation of dummy (also known as binary) variables
- Remember that if a variable has X possible values, X - 1 dummy variables are required (Ex: 10 = Option 1, 01 = Option 2, 00 = Option 3)

Process

Run Initial Regression

- Standard regression is run to identify variable weights
- Regression may be run multiple times with different variables (usually those with a significance level of .05 are used)
- More variables does not necessarily make the model better – be careful to avoid over specificity

Determine Attribute Ranking

- For each independent variable, identify the slopes that were associated with the corresponding dummy variable(s)
- The attribute ranking is the highest slope minus the lower slope
- Keep in mind that a because there are less dummy variables than levels of that variable, there is always an item with a slope of 0
- Attributes with a larger spread have more impact on price

Conduct Value Based Pricing

- Utilizing attribute rankings, it's possible to predict the prices of new products
- Tradeoff analysis can be conducted to determine which capabilities are achievable while remaining below a certain budget

Common Pitfalls

- Choosing the appropriate regression model
 - Usage of dummy variables increases the amount of independent variables
 - Choosing the model that “best fits” the existing data can lead to over-specificity
- Extrapolation
 - Introducing a completely new capability to a pre-existing market may be outside the scope of the analysis
 - If too many choices are offered, survey results may be inconsistent and difficult to analyze
- Assumption of Value-Based Pricing
 - Vendors could rely on either cost-based pricing or competition-based pricing

Best Practices

- Conjoint analysis is often best served as a cross-check
 - Generally, the data required to conduct conjoint analysis will also support various other regression techniques with cost as the dependent variable
 - It allows the procurer to think similarly to the manufacturer, but it may take into account information that the producer does not have access to
- Run multiple regressions
 - Optimal regression outcomes cannot be identified by creating just one model. Several must be calculated in order to identify the most meaningful weights.
 - A significance level of .05 is usually used to determine which variables to include in a model. However, the goal is to maximize the model's goodness of fit, which may result in variables initially deemed significant being included in the final analysis.

Pros and Cons

- Pros
 - Calculation algorithm is simple and efficient (simple regression)
 - Useful in predicting cost of configurations that have not previously been produced/procured
 - Provides an easy method to calculate price sensitivity
- Cons
 - Only useful in specific circumstances
 - Cannot estimate value of completely new capabilities
 - Potentially challenging to collect/obtain weighting data
 - Only accounts for Value-Based Pricing

Cost Estimation Example

Application - Setup

- Challenge: Determine the cost of a required radio configuration not currently manufactured
- Proposed Solution: Using conjoint analysis, conduct value-based pricing to estimate how vendors might cost the new configuration

Initial Data

Vendor	Preference	Cost	EIRP	G/T
Vendor 1	1	\$178,560	High	High
Vendor 2	2	\$290,200	Medium	High
Vendor 3	4	\$188,040	Medium	Medium
Vendor 4	7	\$401,728	High	Medium
Vendor 5	6	\$390,200	Low	High
Vendor 6	9	\$280,200	Medium	Low
Vendor 7	8	\$285,000	Low	Low
Vendor 8	5	\$378,136	High	Medium
Vendor 9	3	\$180,200	Medium	Medium

Initial Data

Vendor	Preference	Cost - High	Cost - Medium	EIRP - High	EIRP - Medium	G/T - High	G/T - Medium
Vendor 1	9	0	0	1	0	1	0
Vendor 2	8	0	1	0	1	1	0
Vendor 3	6	0	0	0	1	0	1
Vendor 4	3	1	0	1	0	0	1
Vendor 5	4	1	0	0	0	1	0
Vendor 6	1	0	1	0	1	0	0
Vendor 7	2	0	1	0	0	0	0
Vendor 8	5	1	0	1	0	0	1
Vendor 9	7	0	0	0	1	0	1

*Cost has been clustered into three specific tiers to allow for the creation of dummy variables

Application – Calculation & Results

Intercept	6.2
Cost High	-3.3
Cost Medium	-3.1
EIRP High	1.7
EIRP Medium	0.8

*Note that G/T was not included in the regression model. It was not closely correlated with preference, and was thus removed from the analysis

Attribute	Value
Cost	3.3
EIRP	1.7

*Attribute value obtained by subtracting the smallest coefficient from the largest coefficient. Remember – the coefficient for the options not represented by a dummy variable (Cost Low, EIRP Low) are always 0.

Cost Tiers	Value
High	\$ 390,021
Medium	\$ 285,133
Low	\$ 182,267

*Data naturally aligned into 3 cost tiers (cluster analysis can be performed when the alignment is not immediately apparent). The value displayed is the average cost of each item in the group

Application – Interpretation

- Based on the attribute values, a high EIRP is worth 7.5 points, while a medium cost decreases the ranking by 1.5 points and a high cost decreases it by 3.5 points
- Goal: Determine the cost associated with increased capability

$$\frac{\text{Medium Cost} - \text{Low Cost}}{\text{Medium Cost Rating} - \text{Low Cost Rating}} = \frac{\$284,445 - \$191,825}{-3.1 - 0} = -\$33,064$$

When starting from a low cost, increasing the cost by \$33,064 lowers the perceived rating by 1 rank.

A vendor moving from low to medium EIRP starting from a low cost could be expected to raise costs by $.8 * \$33,064 = \$27,554$

Similar calculation can be completed in order to estimate how additional capability changes would impact cost

Considerations

- Simpler is often better – more variables allow the model to more accurately describe known data, but can over specify and be a poor predictor of future results
- Whenever possible, randomly separate data into training (~75% of the data) and test sets (~25%)
 - The training set is used to build the initial model(s)
 - The model(s) are then applied to the test set to conduct a “sanity check”
- There are many types of predictive modeling techniques, and the most applicable one varies depending on the type of data requiring analysis

Questions?



Jacob Walzer

Consultant

1100 Wilson Blvd, #1000

Arlington, VA 22209

Mobile: 757-319-2884

Jacob.Walzer@kalmancoinc.com