Conjoint Analysis

Learning Objectives

- **What is Conjoint Analysis?**
- **Show how Conjoint is related to DOE.**
- **Depict how Conjoint can be useful in developing better decisions.**
- **How to set up Conjoint experiment.**
- **How to interpret the results of a Conjoint experiment.**

Conjoint is a study of human preferences in decision making that was originally created in the science of Psychometrics.

Conjoint Analysis is used primarily in business to ascertain potential product positioning and new product development ideas.

Conjoint Measurement provides a theory for creating a measurement scale from judgments on compound or conjoint objects by accepting that:

- *individual preferences can be expressed in numerical terms that depict behavior*
- *reviewing multiple features that requires comparing high levels of one with the low levels of others*
- *factorial designs will be the analytical framework to maintain independence*
- *analyzing the comparative decisions of buyers reflects a reasonable reflection of true buying decisions*

Why Does Conjoint Work?

- Conjoint forces the respondent to evaluate conflicting alternatives when having to choose, as between car type and price at the same time…just as would happen in a real situation.

    - This is a reasonable simulation of the trade-off activity that should parallel the actual buying behavior.

- The conjoint task, which is comparing choice alternatives on a variety of dimensions, can be converted into a measure of UTILITY. UTILITY is a metric that serves to depict which factors within the alternatives are important.

- Analysis is done from Orthogonal (Factorial) designs. Factorial designs are used because all treatments (profiles) are unique and therefore independent.

    - Orthogonal designs are very efficient in determining the impact of main effects and interactions.

A Few Key Questions

- ✓ **Can a customer realistically evaluate these alternatives?**
  - **Are the various factors and levels tangible enough that their evaluations are accurate?**
  - **Are there too many choices (combinations or levels)?**
  - **Are the factor level differences appropriate?**
    - **Too many?**
    - **Too far apart?**
    - **Too close together?**

- ✓ **Can we ignore interactions?**

- ✓ **What is the level of decision making we are trying to achieve?**
  - **Respondent's "likelihood to buy"**
  - **Respondent's ordered preference (don't want to be fooled)**

What should be the Range of Factor Levels?

- **If the range of variation in attributes is much larger than would normally appear in the marketplace, the believability of the exercise is reduced, leading respondents to potentially reduce their interest and involvement in the exercise, which reduces validity. Respondents give "extreme" reactions to extreme values.**

- **On the other hand, if the difference between factor levels is too small, the respondents may fail to make distinctions between the levels. A rule of thumb is that at least a 10% difference between the lower level and the higher level of a metric variable is necessary for typical respondents to react meaningfully to the difference.**

There are a variety of conjoint models to use depending on the situation being addressed.

CONJOINT VALUE ANALYSIS

- **calculates a set of utilities for each individual using the factorial method and does so with either rankings or ratings**

We will be looking at the CONJOINT VALUE ANALYSIS model as it is a reasonable starting place and can be used in conjunction with other model types. This was the mainstay of conjoint study for many years

CHOICE-BASED

- **Mimics the purchasing process in a competitive context. Instead of ranking or rating product concepts, respondents are shown a set of products and asked which one they would purchase.**

ADAPTIVE CONJOINT ANALYSIS

- **Key feature is that it allows for analyzing many attributes in steps; but, not all at the same time. Often used in conjunction with another method.**

Choice-based

If you were shopping for a credit card and these were your only options, which would you choose?			
VISA **$40 annual fee** **10% interest rate** **$2,000 credit limit**	**MasterCard** **$25 annual fee** **17% interest rate** **$5,000 credit limit**	**American Express** **No annual fee** **14% interest rate** **$1,000 credit limit**	**NONE:** **I would delay my purchase**

This method closely mimics the purchase process in the competitive context. Instead of ranking, respondents must choose from full profiles and asked to indicate which one they would purchase.

Adaptive Conjoint Analysis

If you were assessing different options of Credit cards, like in this case – BRAND - and doing so one at a time, you might see this

Step 1, rank levels for each attribute

Rank these features from most to least Preferred:

1. **Discover**
2. **MasterCard**
3. **VISA**
4. **American Express**

Assume respondent ranks American Express Best and Visa worst

Step 2, assign attribute importance

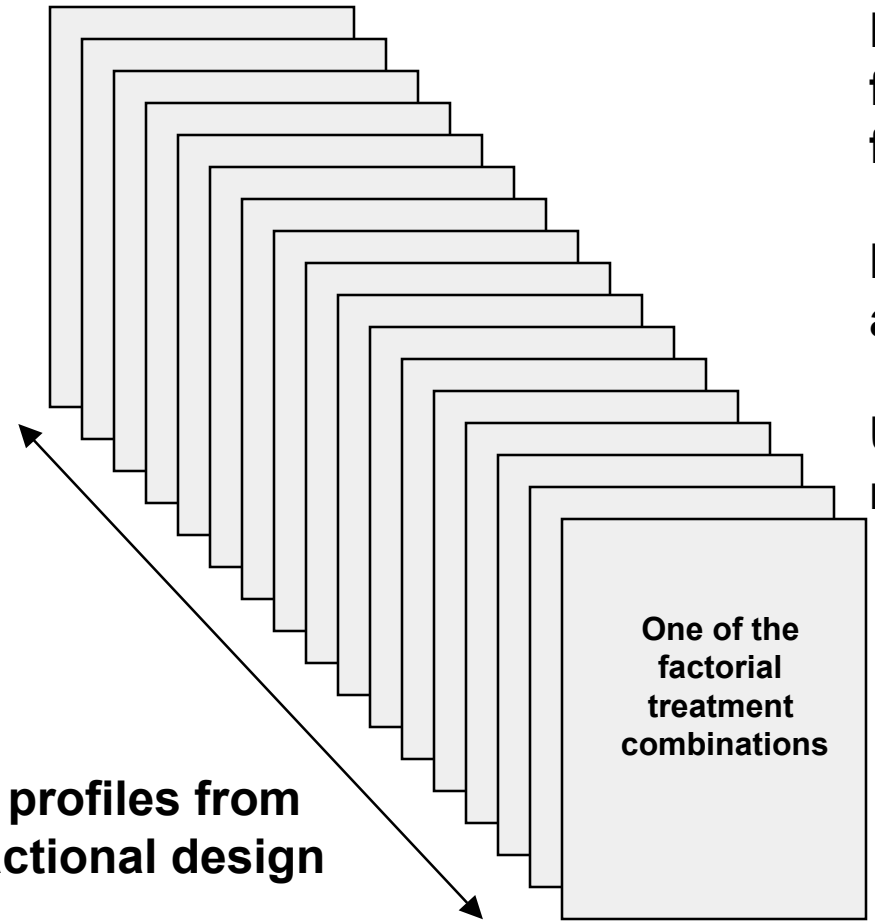
If two credit cards were acceptable in all other ways, how important would this difference be?

American Express v. VISA

4 = Extremely Important
3 = Very Important
2 = Somewhat Important
1 = Not Important at All

This is called the self-explicated context and emphasizes evaluating products feature by feature rather than by judging products as a whole or in a competitive context.

Conjoint Value Analysis



Full profile conjoint is made up of a factorial design, typically a fractional design.

Each individual respondent assesses all the profiles.

Utilities are determined from the respondents answers.

This method forces the respondent to suspend their expectations or limits in buying and indicate their intentions in a non-competitive situation.

DoE and Conjoint

Conjoint Value Analysis is an application of DOE.

- The **X**s are the **features and levels** of your offering.
- The **Y** is the respondents' **expression of choice** … rating, ranking, buy /not buy. The challenge is designing an experiment from which a customer can realistically evaluate and can accurately express their values.
- Conjoint studies are designed as a DOE but analyzed on a respondent by respondent basis … which you would not do in a traditional DOE.
- It is a common practice to make the number of profiles 1.5 –3.0 times the number of factors.
  - If the number of profiles = the number of factors then the design is considered saturated and there is no ability to assess error.

Conjoint Analysis Purpose

The purpose then of CONJOINT Analysis is to

1. **Collect the trade-offs**
2. **Estimate the buyer value systems**
3. **Make choice predictions**
4. **We do this with the factorial experimental structure**

…let's look at an example

Let's say your are the *GIMIC* cellular phone company and you have to decide on a set of product features that will allow for solid market placement.

What can you do?

How do you decide what features are key, which to ignore or how the weight of all the features in ads that will gain a certain class of market share?

Price, color, weight, size, managed features (call waiting, caller id, mailbox, etc), battery life, ergonomics, age group, regional, national, global?

…Lots to choose from

Digital Cellular Phone Conjoint Study

After much discussion about market forces, expert opinions and some surveys on what appears to be important, the factors below are the ones that offer the most leverage in making a choice of phones

Factors: levels

- ***Radio: yes or no (2 levels)***
- ***Walkie-Talkie: yes or no (2 levels)***
- ***Talk Time: 1 Hour Talk Time; 1.5 Hours Talk Time, 2 Hours Talk Time; 3 Hours Talk Time (4 levels)***
- ***Flip: yes or no (2 levels)***
- ***Price: Free (With 2 Year Subscription); $100; $200; or $300 (4 levels)***

- ***This results in a Full factorial, orthogonal array of 128 profiles***

Profile Set 1	Profile Set 2	Profile Set 3	Profile Set 4
Treatments 1 - 16	Treatments 17 - 32	Treatments 33 - 48	Treatments 49 - 64
Profile Set 5	**Profile Set 6**	**Profile Set 7**	**Profile Set 8**
Treatments 65 - 80	Treatments 81 - 96	Treatments 97 - 112	Treatments 113 - 128

= 128 possible profiles

Design Specifications: Fractional Factorial Design (main effects only)

16 Profiles (Profile Set 2) (of the 128 possible); profile to factor ratio = 3.02

Treatments 17 - 32 =

Profile	Radio	Walkie Talkie	Talk Time	Flip	Price	PI
Profile 17	YES	YES	1H	NO	300	
Profile 18	YES	YES	1H	YES	FREE	
Profile 19	NO	YES	3H	NO	FREE	
Profile 20	YES	NO	3H	YES	200	
Profile 21	NO	NO	2H	NO	200	
Profile 22	YES	YES	1.5H	NO	200	
Profile 23	NO	NO	1H	YES	FREE	
Profile 24	NO	NO	1.5H	NO	200	
Profile 25	NO	YES	3H	NO	100	
Profile 26	NO	NO	3H	NO	100	
Profile 27	YES	NO	3H	YES	FREE	
Profile 28	YES	NO	3H	NO	300	
Profile 29	YES	NO	2H	YES	100	
Profile 30	YES	NO	2H	NO	300	
Profile 31	YES	NO	1.5H	YES	200	

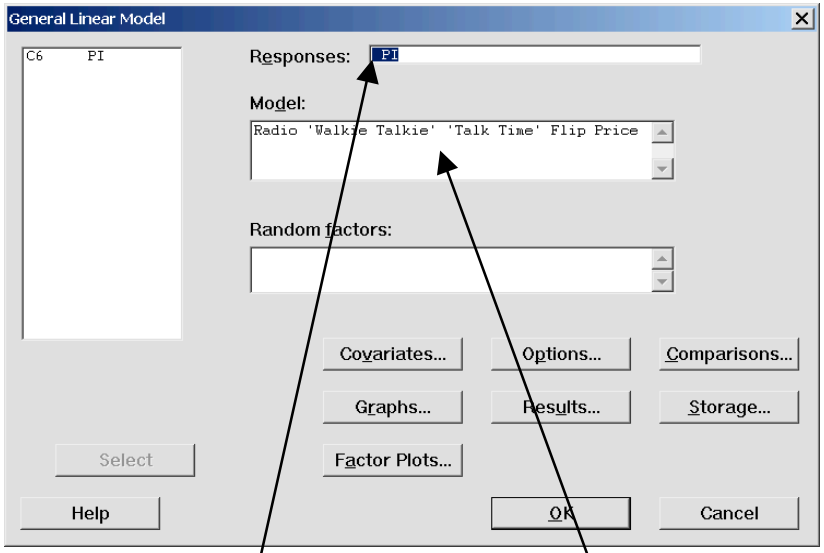
Assume respondent 1 provided the following ratings to the 16 profile cards of PROFILE SET 2 (the scale is a 1 to 10 purchase interest scale).

Treatment 17: 1	**Treatment 25 : 6**
Treatment 18 : 5	**Treatment 26 : 8**
Treatment 19 : 8	**Treatment 27 : 10**
Treatment 20 : 6	**Treatment 28 : 7**
Treatment 21 : 3	**Treatment 29 : 7**
Treatment 22 : 4	**Treatment 30 : 4**
Treatment 23 : 4	**Treatment 31 : 2**
Treatment 24 : 1	**Treatment 32 : 5**

The Coded Design Matrix and Purchase Intent (PI)

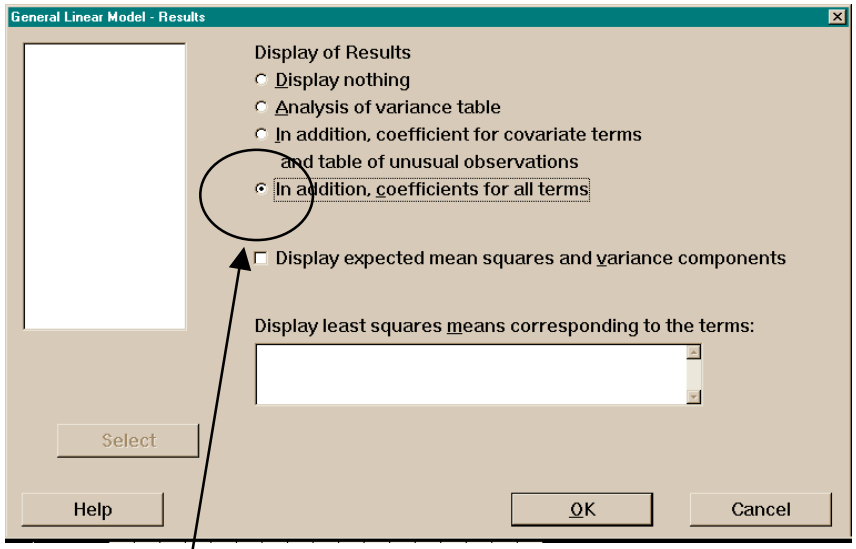
Radio	Walkie Talkie	Talk Time	Flip	Price	PI
1	1	1	2	4	1
1	1	1	1	1	5
2	1	4	2	1	8
1	2	4	1	3	6
2	2	2	2	3	3
1	1	3	2	3	4
2	2	1	1	1	4
2	2	2	2	3	1
2	1	4	2	2	6
2	2	4	2	2	8
1	2	4	1	1	10
1	2	4	2	4	7
1	2	3	1	2	7
1	2	3	2	4	4
1	2	2	1	3	2

Stat > ANOVA > General Linear Model



PI is the response variable

Enter the Factors as the Model



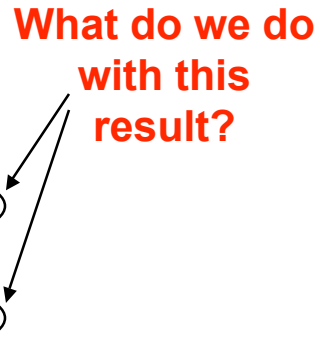
choose that you want the coefficients

GLM Results

Factor	Type	Levels	Values
Radio	fixed	2	NO YES
Walkie T	fixed	2	NO YES
Talk Tim	fixed	4	1.5H 1H 2H 3H
Flip	fixed	2	NO YES
Price	fixed	4	100 200 300 FREE

Analysis of Variance for PI_1_1, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Radio	1	0.038	2.658	2.658	2.17	0.191
Walkie T	1	0.492	0.104	0.104	0.09	0.780
Talk Tim	3	69.198	44.992	14.997	12.24	0.006
Flip	1	7.742	0.000	0.000	0.00	0.992
Price	3	16.119	16.119	5.373	4.39	0.059
Error	6	7.349	7.349	1.225		
Total	15	100.937				



GLM Results (cont'd)

Term	Coef	SE Coef	T	P
Constant	4.3204	0.5230	8.26	0.000
Radio				
NO	-0.7067	0.4797	-1.47	0.191
	0.7067			
Walkie T				
NO	0.1320	0.4524	0.29	0.780
	-0.1320			
Talk Tim				
1.5H	-0.8142	0.8430	-0.97	0.371
1H	-2.1901	0.9238	-2.37	0.055
2H	0.3378	0.6785	0.50	0.636
	2.667			
Flip				
NO	0.0061	0.6064	0.01	0.992
	-0.0061			
Price				
100	0.6085	0.5648	1.08	0.323
200	-1.4544	0.7277	-2.00	0.093
300	-1.3485	0.9713	-1.39	0.214
	2.194			

UTILITY

1.413 = 13.87%

0.264 = 2.59%

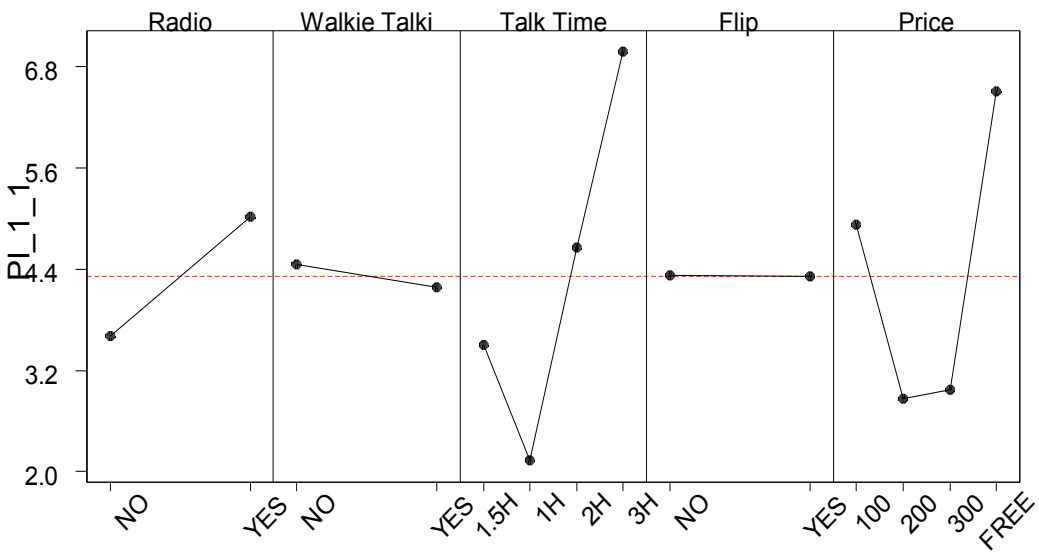
4.857 = 47.665

0.012 = 0.12%

3.648 = 35.8%

10.19

Main Effects Plot - LS Means for Customer



The optimal product configuration for this individual would be:

Radio	**0.7067**
No walkie talkie	**0.1320**
3 Hours of Talk Time	**2.667**
Flip – doesn't matter	**0.0061**
Free (w/2yr sub)	**2.194**
Constant term*	**4.36**
Total Utility	**10.02**

What about Market Segments?

After collecting the conjoint data

- cluster respondents based on their raw data responses
- collect the respondents models within the clusters
- look at the variance in each utility across respondents within a cluster to see if the clusters are acceptable (I.e. what is the variance of the utility for phone weight within clusters relative to across clusters.)

✓ Examine the clusters against other measured characteristics (outside of the conjoint experiment part of the study) to see if it forms a logical picture

✓ Report the results

Market Share Estimates

Two approaches are used most often for estimating shares for combinations of product features (assuming equality of factors not in the experiment)

1. Winner-takes-all. This method assumes that for each individual in your sample for any two or more combinations of features, the one with the highest score is assumed to be the one bought. This obviously unnecessarily discounts other options as not being possible market niche products. Many find this unacceptable.

2. Share of Preference. This method assumes that purchases will be made proportional to the total preference scores given to the offerings examined. So, if the scores for two different combinations of features are calculated and the sums across all respondents are 450 for one combination and 620 for another … they idea is that they will split the market 450/1070 = 49% and 620/1070 = 51%. This can produce a very different answer than the winner-takes-all approach.

Through the Conjoint data, it can be determined that there are other market segments willing or unwilling to purchase differing sets of features, at a variety of prices.

Two Alternative Configurations

Configuration 1		Configuration 2	
Description	**Utility**	**Description**	**Utility**
RADIO -yes	0.7067	RADIO -no	-0.7067
Walkie Talkie -yes	-0.132	Walkie Talkie - yes	-0.132
Talk Time- 2.0	0.3378	Talk Time- 1.0	-2.1901
Flip -yes	0.0061	Flip - yes	-0.0061
$100	0.6085	$300	-1.349
Constant	4.3204	Constant	4.3204
Total Utility	*5.85*	*Total Utility*	*-.0635*

Neither configuration was included in the fractional factorial.

Questions

Questions that have been addressed using conjoint analysis include:

- **Which combination of features maximizes the number of customers who would choose our offering over the features of a competitor's offering?**
- **What feature levels can I change to improve our bottom line and still have an attractive market share?**
- **If our competitor makes the change we anticipate … what is our best countermove?**
- **What is the best price to maximize profit without decreasing our share? Could I charge more for an improved offering?**
- **Can we create better offerings for differing market segments?**

How Should the Profiles be Presented to Respondents?

The closer the presentation is to reality … the better.
There is little coherent evidence on this issue but, prudence says, be "as real" as you can.

- If you can make prototypes…use them.
- If you can have samples, video, whatever…use them.
- Try to make the experience as realistic as you can.

Potential Issues

- In general, it is reasonable to increase the sample size as the number of attributes and levels increase. Large, complex designs should have comparable sample sizes. Smaller, more simple designs can be accommodated with fewer respondents.

- Holdout profiles (i.e. combinations that were not used in the actual experiment) should always be used to compare with the evaluations that would be predicted from the conjoint analysis. A minimum of two holdout profiles are recommended to calculate a correlation coefficient for each respondent.

Refrigerator Study

You have been asked to study the impact of attributes in regards to purchasing a refrigerator by consumers. The attributes below have been assigned levels which now need to be resolved

BRAND NAME: GE; SEARS;WHIRPOOL; MAYTAG (4 levels)

CAPACITY: Cubic Feet -, 20, 21, 22 (3 levels)

ENERGY COSTS: Annualized @ $70, $90, $110 (3 levels)

PRICE: Sell price to customer - $700, $850; $1150 (3 levels)

DISPENSER: Dispenses ice and water through the door or it does neither (2 levels)

Conjoint Class Project

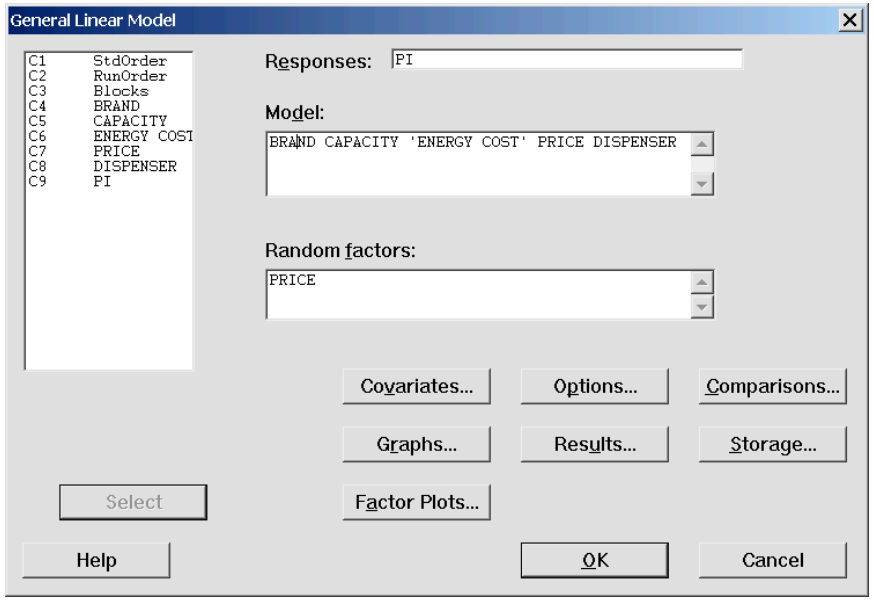
a product that is likely to fail in the market place

a product that will be extremely successful

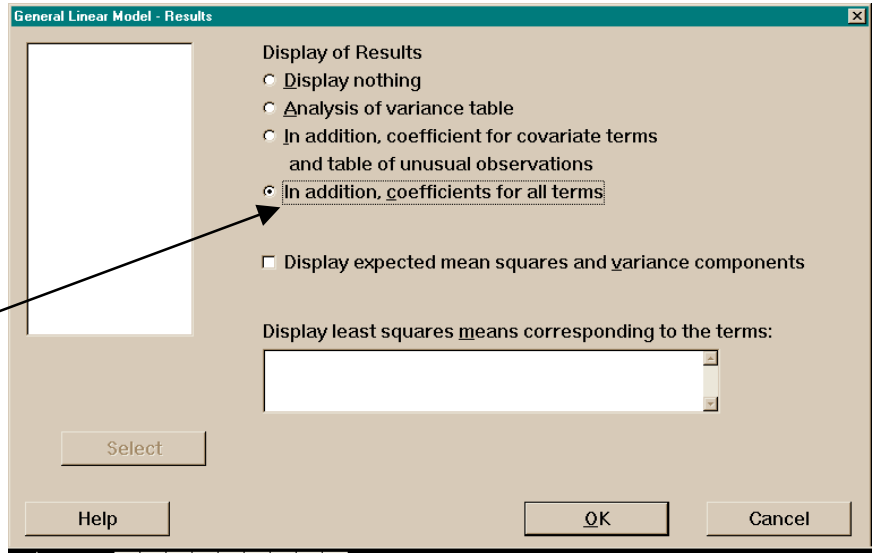
1 2 3 4 5 6 7 8 9 10

BRAND	CAPACITY	ENERGY COST	PRICE	DISPENSER	PI
WHIRLPOOL	22	110	1150	YES	
WHIRLPOOL	22	110	1150	NO	
SEARS	21	70	850	NO	
GE	22	90	700	NO	
SEARS	20	110	700	NO	
SEARS	21	90	1150	NO	
SEARS	20	90	700	NO	
SEARS	20	70	850	NO	
GE	20	110	700	NO	
WHIRLPOOL	20	90	850	YES	
SEARS	22	110	700	YES	
MAYTAG	21	90	1150	NO	
SEARS	21	90	850	NO	
SEARS	22	70	1150	NO	
WHIRLPOOL	21	70	850	NO	
GE	21	90	850	NO	
MAYTAG	21	90	700	NO	
GE	20	110	1150	NO	
MAYTAG	21	70	1150	YES	
WHIRLPOOL	22	110	700	NO	
GE	22	70	1150	NO	
MAYTAG	20	110	700	YES	
WHIRLPOOL	21	70	1150	YES	

Stat > ANOVA > General Linear Model



Get coefficients for Model



Summary

1. DOE can be used to design experiments you may use to obtain respondents' choices and decompose these choices into the contributions of the experimental factors.
2. Many applications ignore interactions and concentrate on main-effects only (at some risk).
3. While the fitting of the individual models is not "statistical", it may be a useful description of individual choices.
4. The most typical uses of conjoint studies are:
    a. Segmentation, and
    b. Offering Optimization

References:

www.sawtoothsoftware.com
www.dssresearch.com/conjoint/default.asp
www.surveysite.com/newsite/docs/conjoint-intropage.htm
www.rtihs.org/services_conjoint.cfm

EXAMPLES:

Internet Adaptive Conjoint Research: Employee Retention. POPULUS, working with Sawtooth Software®, pioneered the implementation of web-based Adaptive Conjoint Analysis research methodology for two employee retention studies conducted by an international corporate consulting firm. The web-based instrument included customized web pages and skip patterns for more than 100 different companies with employees around the world. Customized e-mail respondent recruitment notices included unique passwords to control data collection.

Home Box Office. **POPULUS began working for HBO in 1988. Our first project was an assessment of the demand for high definition television; this was difficult to do ten years before HDTV was introduced into the United States. POPULUS' pioneering work applied conjoint measurement to both psychometric perceptual discrimination as well as the emotional rewards offered by HDTV. Our report became part of the FCC's public rule making which eventually led to the standards for HDTV. Other projects for HBO involved assessment of video on-demand, churn segmentation, program scheduling, multiplexed services, and new product development.**

Food Packaging Reconfiguration. **A leading national food and beverage producer wanted to determine consumer preferences and demand for a packaging reconfiguration (price, size, and package type) of one of its most popular products. The client also wanted to determine which pairing of reconfigured packaging options would generate the greatest customer appeal. POPULUS designed a research instrument that used five different price scales based on local market conditions and seven different package configurations (size and package type) that enabled the client to see which configuration captured optimal consumer purchase interest.**

Optimizing Communications Technology. A multi-national corporation wished to standardize the technical platform for its next product generation. POPULUS working with a team of engineers from Europe, Asia, and the Americas developed a conjoint and discrete choice questionnaire that was fielded with product users in 12 countries (developed and less-developed). One of the major accomplishments of this project was POPULUS' ability to lead a diverse group of engineers to consensus on the research design and the creation and programming of the questionnaire in a three-day intense meeting.