Bayesian Design and Analysis Delivers Profits and Market Share

Isometric SOLUTIONS™

See clearly. Act decisively.

Robert Reul
Managing Director

"As a general rule those most successful in life have the best information."
Benjamin Disraeli

Today's Discussion

1. Get the product right

2. Get it to the right target

3. Get the profit

Market Potential

Kitchen Appliances Market Analysis By Product (Refrigerator, Cooking Appliances, Dishwasher), By Application (Commercial, Residential) And Segment Forecasts To 2022

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Industry Insights

The global kitchen appliances market size was valued at over USD 170 billion in 2014. Cost effective and energy efficient products are expected to gain revenue share over the next seven years owing to increasing government focus to curb energy consumption.

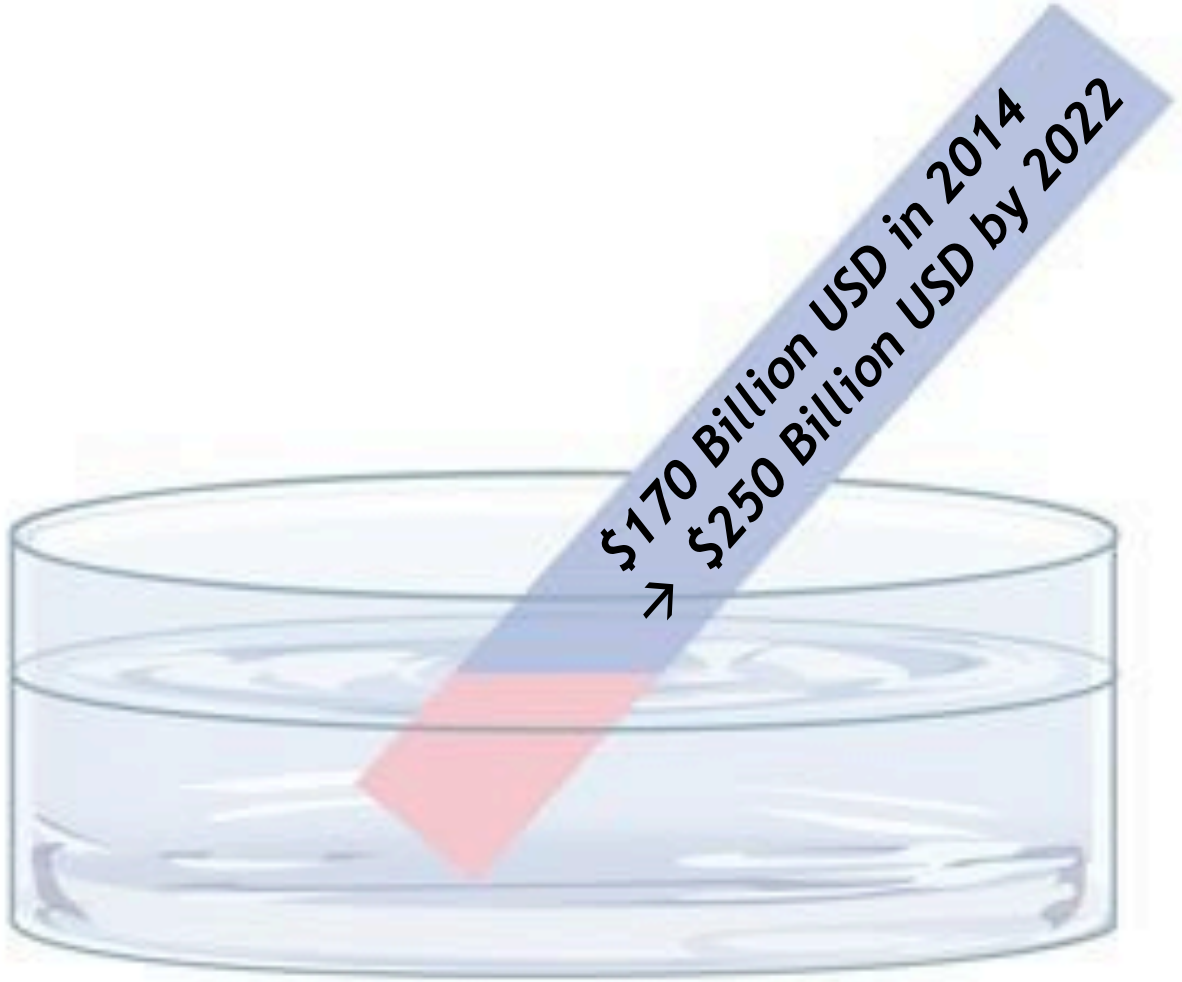
Cooking gas, electricity, renewable and solar energy are primarily used to operate these appliances. Factors affecting the supply and demand of these fuels may affect the industry. Rural electrification is anticipated to boost industry growth over the forecast period.

Industry participants make a huge investment in research and development for product innovation to retain revenue share and cater to changing preference of the customer. Quality, price, energy efficiency, and technology advancement of the products affect the customers' buying decision. The supply chain of the company plays a key role in the industry while the emergence of e-commerce portal is expected to fuel growth.

Increasing replacement demand is expected to favorably impact revenue over the forecast period. Growing preference for modular kitchen demand is also anticipated to drive the demand of standalone ovens and cook tops. Product upgrade and growing urbanization are key factors driving growth. Increasing electricity cost and government initiative to spread awareness about energy consumption is expected to fuel demand for energy efficient and eco-friendly product over the next seven years.

Rise in dual income households and fast paced modern lifestyle is anticipated to spur luxury product segment demand over the next seven years. Growing popularity of ready-to-eat food among students and single working individuals is expected to hinder industry growth over the forecast period.

Market Potential



1. Getting the Product Right (Design)

DISCRETE CHOICE EXPERIMENTATION

It's Complicated

Payment-Timing
Service-Recovery
Service-Provider
Warranty-Period
Service-Promise
Warranty-Coverage
Repair-Guarantee
Customer-Support
Appointment-Urgency
Service-Price
Pricing-Method
Quoting-Method
Appointment-Window

Choice Divergence

Initial Choice Matrix

$$7^{\wedge 4}\ 5^{\wedge 2}\ 4^{\wedge 2}\ 3^{\wedge 3}\ 2^{\wedge 3}$$

Attributes = 14

Levels = 61

Parameters = 45

Combinations = 103,723,200

Choice Convergence

Initial Choice Matrix

~~$7^4\ 5^2\ 4^2\ 3^3\ 2^3$~~

~~Attributes = 14~~

~~Levels = 61~~

~~Parameters = 45~~

~~Combinations = 103,723,200~~

Final Choice Matrix

$5^2\ 4^3\ 3^3$

Attributes = 8

Levels = 31

Parameters = 23

Combinations = 43,200

Respondent Fatigue

Assessing the Efficiencies of "Optimal" Discrete Choice Experiments in the Presence of Respondent Fatigue

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Abstract

Discrete choice experiments are an increasingly popular form of marketing research due to the accessibility of on-line respondents. While statistically optimal experimental designs have been developed for use in discrete choice experiments, recent research has suggested that efficient designs often fatigue or burden the respondent to the point that decreased response rates and/or decreased response precision are observed. Our study was motivated by high early-termination rates for one such optimally-designed study. In this paper, we examine the design of discrete choice experiments in the presence of respondent fatigue and/or burden. To do so, we propose a model that links the respondent's utility error variance to a function that accomodates respondent fatigue and burden. Based on estimates of fatigue and burden effects from our own work and published studies, we study the impact of these factors on the realized efficiencies of commonly-used *D*-optimal choice designs. The trade-offs between the number of surveys, the number of choice sets per survey, and the number of profiles per choice set are delineated.

λ Manifestations

- Low finish rate → bad
- Inattentive response patterns → worse
- Internally inconsistent response patterns → worst of all

Choice Design

Final Choice Matrix

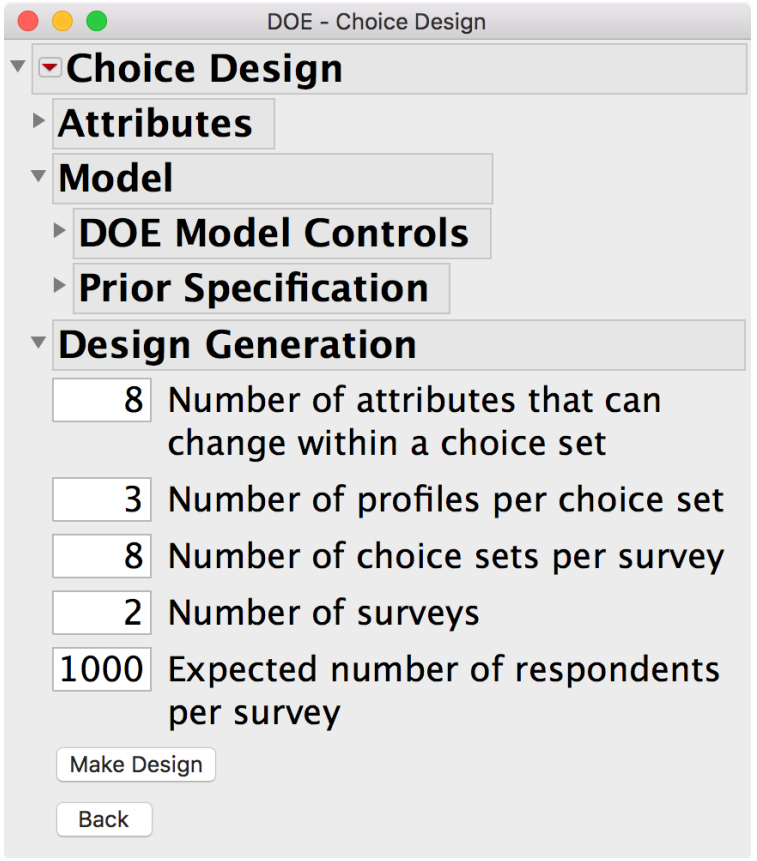
$5^{\wedge 2}\ 4^{\wedge 3}\ 3^{\wedge 3}$

Attributes = 8

Levels = 31

Parameters = 23

Combinations = 43,200



Survey Design

Choice Design

Design

Survey	Choice Set	X1	X2	X3	X4	X5	X6	X7	X8
1	1	L3	L1	L3	L2	L1	L1	L2	L1
1	1	L1	L3	L4	L1	L2	L2	L3	L1
1	1	L2	L2	L1	L3	L1	L3	L2	L2
1	2	L2	L3	L3	L3	L1	L2	L2	L3
1	2	L1	L4	L4	L4	L2	L3	L1	L2
1	2	L3	L3	L1	L1	L1	L3	L1	L2
1	3	L1	L1	L3	L1	L1	L3	L3	L1
1	3	L2	L1	L1	L4	L2	L2	L3	L1
1	3	L3	L3	L2	L3	L2	L1	L3	L2
1	4	L1	L1	L2	L1	L3	L3	L2	L2
1	4	L3	L1	L4	L3	L3	L3	L1	L1
1	4	L1	L3	L1	L1	L3	L1	L2	L1
1	5	L3	L2	L2	L2	L1	L2	L3	L1
1	5	L3	L3	L3	L4	L1	L2	L3	L2
1	5	L1	L1	L4	L3	L1	L1	L3	L1
1	6	L2	L1	L2	L1	L2	L4	L1	L1
1	6	L1	L1	L1	L2	L2	L2	L1	L2
1	6	L3	L2	L4	L4	L1	L3	L2	L1
1	7	L4	L1	L1	L5	L3	L4	L3	L3
1	7	L1	L2	L3	L3	L2	L4	L2	L2
1	7	L2	L1	L2	L2	L3	L2	L1	L2
1	8	L3	L2	L4	L5	L2	L1	L2	L1
1	8	L2	L3	L5	L3	L3	L3	L3	L1
1	8	L4	L1	L2	L4	L2	L1	L2	L1
2	9	L1	L3	L4	L2	L1	L1	L1	L3
2	9	L3	L1	L1	L3	L2	L3	L3	L1
2	9	L2	L2	L3	L5	L3	L1	L3	L1
2	10	L3	L1	L5	L1	L2	L1	L3	L2
2	10	L1	L2	L3	L3	L1	L2	L1	L2
2	10	L2	L3	L4	L2	L1	L3	L2	L2
2	11	L3	L1	L4	L3	L1	L2	L2	L2
2	11	L2	L3	L3	L2	L2	L3	L1	L1
2	11	L1	L3	L2	L4	L1	L3	L1	L1
2	12	L4	L2	L4	L1	L2	L3	L1	L3
2	12	L3	L4	L5	L4	L1	L4	L1	L3
2	12	L4	L3	L4	L5	L2	L3	L1	L1
2	13	L3	L3	L4	L4	L2	L2	L2	L3
2	13	L4	L4	L5	L2	L1	L2	L2	L3
2	13	L2	L4	L1	L2	L1	L1	L3	L3
2	14	L1	L4	L4	L2	L3	L4	L2	L2
2	14	L2	L4	L4	L1	L1	L1	L1	L2
2	14	L1	L4	L2	L3	L3	L1	L2	L1
2	15	L4	L2	L5	L2	L1	L4	L3	L2
2	15	L3	L4	L4	L5	L2	L3	L3	L3
2	15	L4	L2	L5	L1	L3	L4	L1	L2
2	16	L3	L1	L5	L5	L2	L3	L2	L3
2	16	L4	L2	L4	L4	L3	L1	L3	L2
2	16	L4	L4	L4	L1	L3	L2	L3	L2

```
function ExpDesign1()
{
        // Exp design =[  [screen0],
[screen1], ..., [screenN] ]
        // Screen = [concept0],
[concept1], ..., [conceptN]
        // Concept = [a1, a2, ...,
aN]

        return [
[

[4,3,5,3,3,3,2,1],
[2,2,2,1,1,4,1,2],
[3,4,3,2,2,2,3,1]
],

[
[1,2,1,5,1,2,1,3],
[3,1,4,2,1,4,2,2],
[4,3,2,1,2,1,3,1]
],

[
[4,1,1,2,1,2,1,1],
[1,2,3,1,3,4,2,2],
[2,2,4,4,2,3,3,1]
],

[
[4,3,3,1,2,3,2,3],
[3,3,1,4,3,4,1,1],
[1,4,5,3,1,1,3,2]
],

[
[1,3,1,4,3,2,3,2],
[2,4,5,2,2,4,1,3],
[3,2,3,3,1,1,2,1]
],

[
[1,2,5,4,1,3,2,3],
[3,3,4,3,2,4,1,3],
[2,4,2,5,3,1,3,2]
],

[
[1,1,5,5,1,4,3,1],
[2,2,4,3,2,3,1,2],
[1,4,2,4,3,1,2,3]

                ]
        ];
}
```

```
function ExpDesign2()
{
        // Exp design =[  [screen0],
[screen1], ..., [screenN] ]
        // Screen = [concept0],
[concept1], ..., [conceptN]
        // Concept = [a1, a2, ..., aN]

        return [
[

[3,3,5,5,2,2,2,2],
[2,1,3,2,3,3,1,1],
[3,4,1,3,1,4,3,3]
],

[
[2,2,5,3,3,2,1,1],
[1,1,4,4,2,4,2,2],
[3,3,1,2,1,3,3,2]
],

[
[1,3,4,5,1,1,1,3],
[3,2,3,4,3,4,3,1],
[2,1,1,1,2,2,2,1]
],

[
[3,2,4,1,1,2,2,1],
[1,1,3,3,2,3,1,2],
[2,3,5,4,3,4,3,3]
],

[
[2,3,2,3,1,2,2,2],
[4,2,4,5,3,1,3,1],
[3,2,5,1,2,3,1,3]
],

[
[1,2,1,2,2,1,2,2],
[2,3,3,1,1,2,3,3],
[3,1,2,5,1,3,1,1]
],

[
[4,4,3,4,1,2,1,2],
[1,3,2,2,3,3,2,3],
[2,1,1,1,2,1,1,1]
],

[
[4,2,2,5,2,4,1,2],
[1,4,4,1,3,2,3,2],
[2,3,3,4,1,1,2,1]

                ]
        ];
}
```

Discrete Choices

APPLIANCE REPAIR SERVICE CHOICE 1 OF 8

Consider each of the proposals presented below. Among the three, use your mouse to choose the repair service offering you most prefer and would try. You must choose just one proposal to advance.

Service Characteristics	Repair Service Option	Repair Service Option	Repair Service Option
Service Appointment	After-hours appointments at no additional charge	After-hours appointments at no additional charge	After-hours appointments at no additional charge
Appointment Window	Choose exact appointment time	2-hour appointment window	4-hour appointment window
Customer Support	Over-the-phone diagnostic and troubleshooting support	Access to a 24/7/365 hotline when you need help	Track the status of your repair service (e.g. tech location, parts ordered and shipped)
Service Guarantee	All repairs completed in 3 business days from appointment -- guaranteed	Skilled technicians who are trained and certified	On-time, everytime guaranteed
Repair Guarantee	Guarantee the specific repair + the entire appliance for one year	Guarantee the specific repair for 90 days	Guarantee the specific repair for one year
Pricing Basis	Hourly rate + cost of parts	Hourly rate + cost of parts	Hourly rate + cost of parts
Time of Payment	Pay when your repair is completed	Pre-pay the diagnostic fee at the time of scheduling your appointment and the remainder when your repair is completed	Pay in monthly installments

Survey Deployment

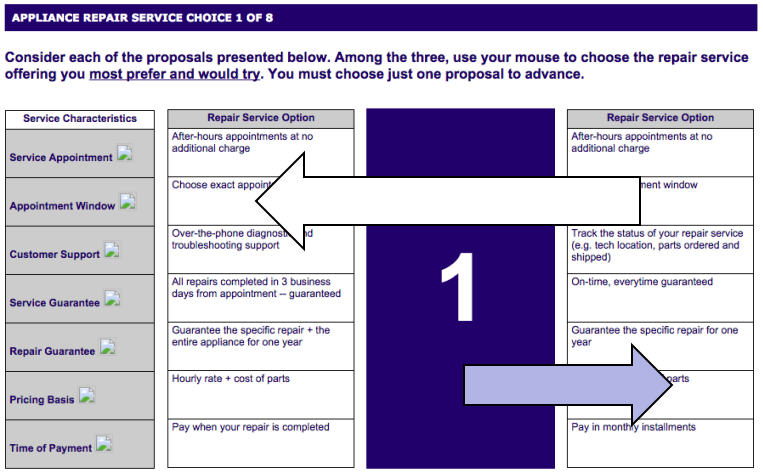
Minimizing the impact of survey fatigue

$5^{\wedge 2}\ 4^{\wedge 3}\ 3^{\wedge 3}$

- Randomize survey #1 & survey #2
- Randomize choice set sequence { 1^{st},2^{nd},3^{rd}, … 8^{th} }
- Randomize choice position {1^{st}, 2^{nd}, 3^{rd}}

Randomized Choices

```
function ExpDesign2()
{
        // Exp design =[  [screen0],
[screen1], ..., [screenN] ]
        // Screen = [concept0],
[concept1], ..., [conceptN]
        // Concept = [a1, a2, ..., aN]

        return [
[

[3,3,5,5,2,2,2,2],
[2,1,3,2,3,3,1,1],
[3,4,1,3,1,4,3,3]
],

[
[2,2,5,3,3,2,1,1],
[1,1,4,4,2,4,2,2],
[3,3,1,2,1,3,3,2]
],

[
[1,3,4,2,4,1,1,3],
[3,2,3,1,3,4,3,1],
[2,1,1,3,4,2,2,1]
],

[
[3,2,4,1,3,2,2,1],
[1,1,3,2,4,3,1,2],
[2,3,2,4,1,2,3,3]
],

[
[2,3,2,3,1,2,2,2],
[4,2,4,2,3,1,3,1],
[3,2,1,4,2,3,1,3]
],

[
[1,2,3,4,1,2,2],
[2,3,1,3,2,3,3],
[3,1,2,4,3,1,1]
],

[
[4,4,2,3,1,2,2],
[1,3,1,4,3,2,3],
[2,1,1,1,2,1,1,1]
],

[
[4,2,2,5,2,4,1,2],
[1,4,4,1,3,2,3,2],
[2,3,3,4,1,1,2,1]

                ]
        ];
}
```



Likelihood that any respondent took an identical survey?

725,760 : 1

Sample Design

Living in fear of lurking variables…

A well-designed experiment includes design features that allow researchers to eliminate extraneous variables as an explanation for the observed relationship between the independent variables and the dependent variable.

Covariate matrix: 5^2 2^2

- *Provider identity*
- *Repair proximity*
- *Appliance type*
- *Customer class* *

Priors used to make choices tougher

Choice Model

Effect Summary

Source	FDR LogWorth	FDR PValue
a2	154.518	0.00000
a8	48.185	0.00000
a1	45.103	0.00000
a7	23.547	0.00000
a5	16.026	0.00000
a6	15.439	0.00000
a4	7.800	0.00000
a3	2.282	0.00523

Effect Marginals

Marginal Probability	Marginal Utility	a2
0.0751	-1.0057	1
0.1707	-0.1852	2
0.3191	0.4404	3
0.4351	0.7506	4

Marginal Probability	Marginal Utility	a3
0.2195	0.09627	1
0.2174	0.08689	2
0.1798	-0.10347	3
0.1975	-0.00958	4
0.1859	-0.07012	5

Marginal Probability	Marginal Utility	a4
0.2607	0.27830	1
0.2003	0.01477	2
0.1805	-0.08928	3
0.1978	0.00222	4
0.1606	-0.20601	5

Marginal Probability	Marginal Utility	a5
0.4106	0.24133	1
0.3663	0.12735	2
0.2231	-0.36868	3

Marginal Probability	Marginal Utility	a6
0.1939	-0.23451	1
0.2092	-0.15846	2
0.2908	0.17071	3
0.3061	0.22226	4

Marginal Probability	Marginal Utility	a7
0.4689	0.39681	1
0.3260	0.03335	2
0.2051	-0.43017	3

Marginal Probability	Marginal Utility	a8
0.5634	0.67055	1
0.2903	0.00747	2
0.1463	-0.67802	3

Marginal Probability	Marginal Utility	a1
0.0001	-3.5549	1
0.0001	-4.3020	2
0.0000	-4.4275	3
0.0000	-4.4603	4
0.2781	4.2962	5
0.2366	4.1344	6
0.2585	4.2228	7
0.2266	4.0914	8

DOE - Choice Design

Choice Design

Attributes

Model

DOE Model Controls

Prior Specification

Ignore prior specifications. Generate the Utility Neutral design.

Prior Mean

Effect	Prior Mean
X1 1	0.000
X1 2	0.000
X1 3	0.000
X2 1	0.000
X2 2	0.000
X2 3	0.000
X3 1	0.000
X3 2	0.000
X3 3	0.000
X3 4	0.000
X4 1	0.000
X4 2	0.000
X4 3	0.000
X4 4	0.000
X5 1	0.000
X5 2	0.000
X6 1	0.000
X6 2	0.000
X6 3	0.000
X7 1	0.000
X7 2	0.000
X8 1	0.000
X8 2	0.000

Ignore prior variance. Generate the local design for the prior mean.

Prior Variance Matrix

Design

Output separate tables for profiles and responses

Combine profiles and responses in one table

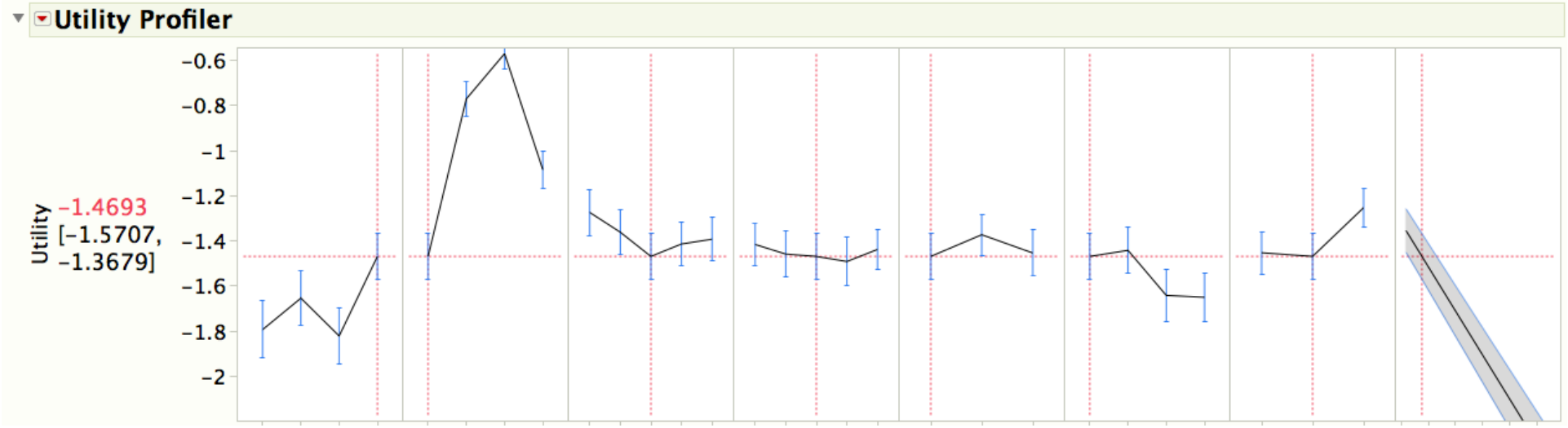
Make Table

Back

1. Getting the Product Right (Analysis)

DISCRETE CHOICE EXPERIMENTATION

Aggregate Model



2. Targeting the Right Product Right

DISCRETE CHOICE EXPERIMENTATION

Subject Variables

Choice Model

Data Format: One Table, Stacked

Select Data Table: All Respondents Coded Segmented.jmp

Select Columns

- Psychographics (20/0)
  - I'm better at fixing
  - Dream of expensive things
  - Always buy warranty at purchase
  - I extend / renew warranty
  - Have not saved for emergencies
  - I read fine print
  - I start conversations
  - Appliance warrantys waste of money
  - I'm a risk taker
  - Need applinaces fixed ASAP
  - Enjoy buying high-priced brands
  - Save lots shopping around
  - Buy what's on sale
  - I like hard-to-get applinaces
  - I shop to get out of the house
  - I try new and different things
  - I visit new stores before others
  - Shop to kill time
  - Always looking for new innovative
  - App owened are important projection

Pick Role Variables

- Response Indicator: Indicator
- Subject ID: responseid 2
- Choice Set ID: loop_screen
- Grouping: Survey (optional)

Run Model | Help | Remove

Firth Bias-Adjusted Estimates

Hierarchical Bayes

Number of Bayesian Iterations: 5000

Construct Profile Effects

Add | Cross | Nest | Macros

Degree: 2

Transform

Construct Subject Effects (Optional)

Add | Cross | Nest | Macros

Degree: 2

Transform

- Age 3
- Gender
- Craigs List
- Children
- Angie's List

Respondent is allowed to select "None" or "No Choice"

Subject Terms: 25-34 | Female | Disagree | Yes | Disagree

Parameter Vectors

Choice Model

Data Format One Table, Stacked

Select Data Table All Respondents Coded Segmented.jmp

Select Columns

Parameter Vectors (29/29)

Pick Role Variables

Response Indicator: Indicator

Subject ID: responseid 2

Choice Set ID: loop_screen

Grouping: Survey optional

Run Model

Help

Remove

Firth Bias-Adjusted Estimates

Hierarchical Bayes

Number of Bayesian Iterations 5000

Construct Profile Effects

Add

Cross

Nest

Macros

Degree 2

Transform

Construct Subject Effects (Optional)

Add

Cross

Nest

Macros

Degree 2

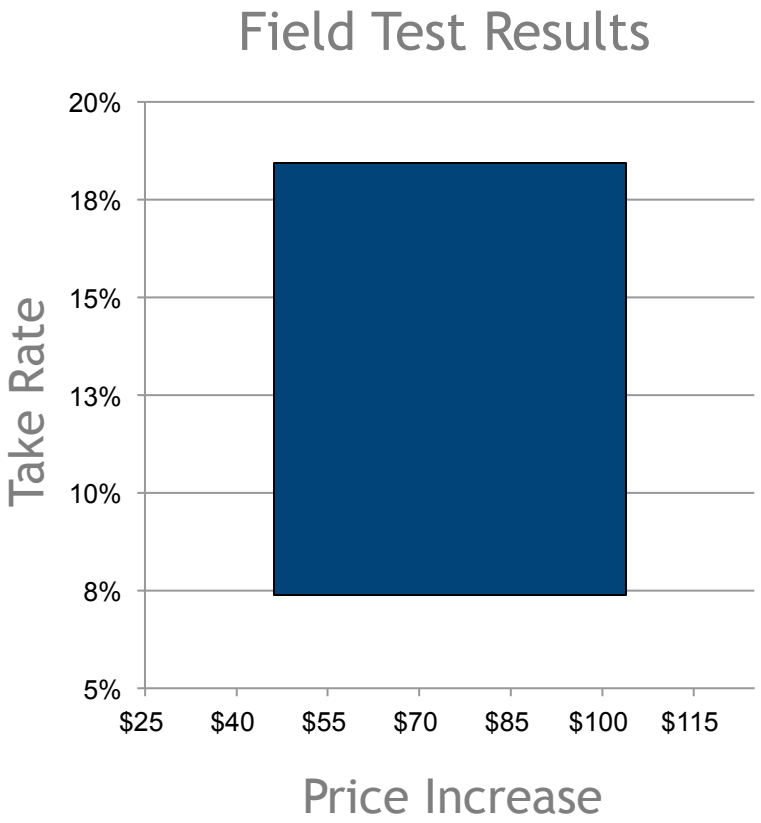
Transform

Respondent is allowed to select "None" or "No Choice"

3. Grow Profits and Market Share

DISCRETE CHOICE EXPERIMENTATION

Profit Projection



@ Volume = [redacted] repairs/yr.

Incremental Revenue = [redacted] M/yr.

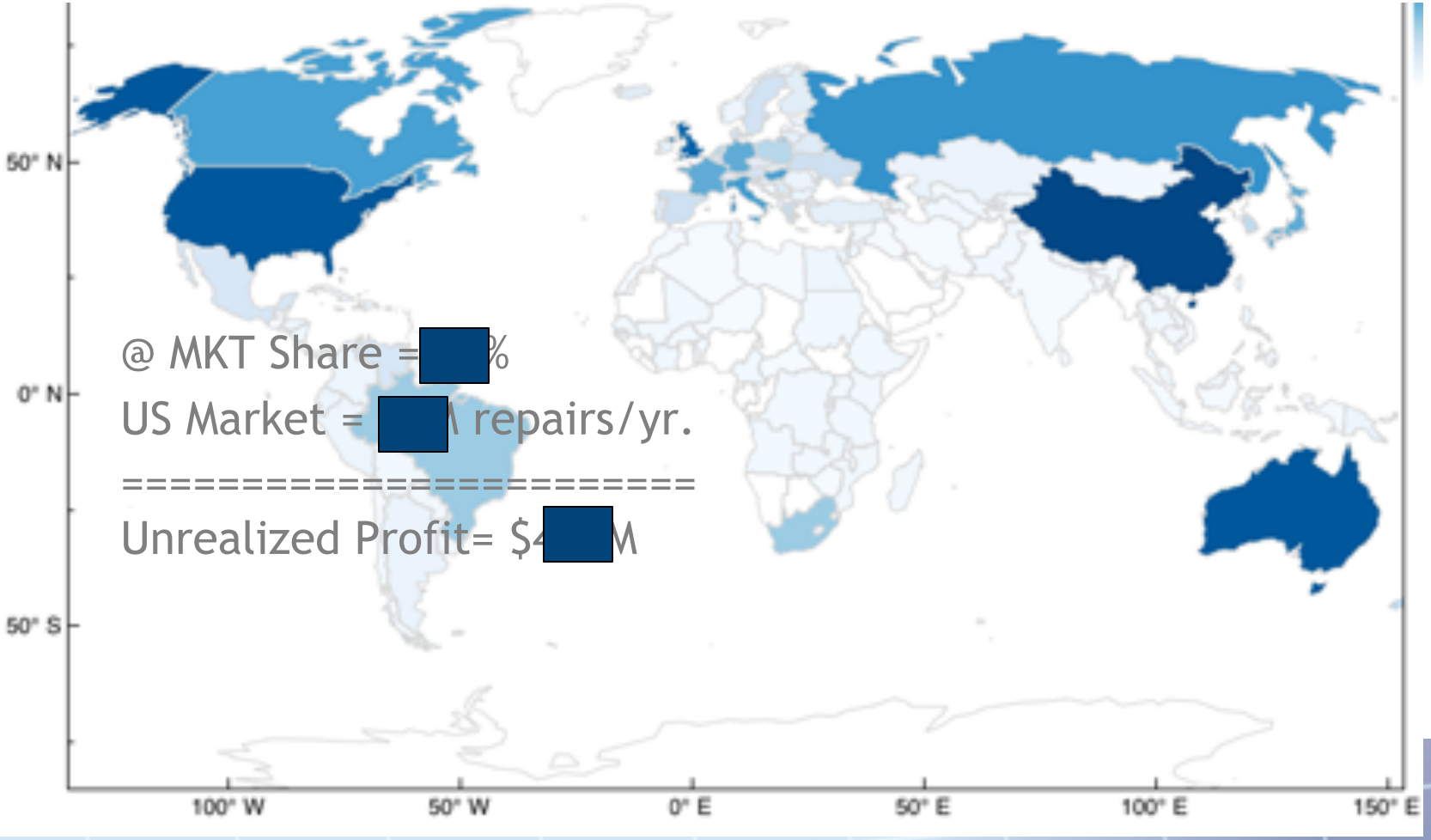
Less implementation costs

==========

Net Profit Contribution

$[redacted]/yr.

Global Market Potential



@ MKT Share = [redacted]%

US Market = [redacted] repairs/yr.

==========

Unrealized Profit= $[redacted]M

Isometric SOLUTIONS™

See clearly. Act decisively.

Thank You!

Robert Reul
Managing Director