Choice Simulator

Aurelie Lemmens

Reminder: the Conjoint Process

- In the previous sessions, we learned how to estimate the part-worths (preferences) per segment
- Based on the unveiled preferences, we can design market shares simulators to guide managerial decisions, such as which assortment to compose, which product to introduce on the market and which price to charge.



Choice Simulator



$$i = respondent, i = 1, ..., N$$

 $p = number of attributes$

Example

- Suppose that the market is composed of
 - Magnum Force, 10 yards, \$8.99
 - HighFlyer Pro, 15 yards, \$8.99
- After discussion with our R&D, we can produce balls that can reach 10 yards
- After discussion with our accounting and marketing, we can charge for these balls a price of \$8.99
- Question: should we partner with Eclipse or use our own brand (Long Shot)?

Example



$$i = respondent, i = 1, ..., N$$

 $p = number of attributes$

Goals of the Simulator

- I. New product introduction
 - What product to offer to maximize shares given the competitive environment?
- 2. **Product** amelioration
 - How can I modify an existing product to capture more relative demand?
- 3. Sensitivity analysis
 - What is the relative price sensitivity of different brands?
 - If I raise my price by 10%, how will it affect my brand and how will it affect competitors' brands?
- 4. Product portfolio/line optimization
 - Product line with products that appeal to distinct segments to increase overall share for your product line
 - Add one product that occupy a niche that is not currently being served.

How Does the Simulator Work?

Design Simulation	• Specify the set of products available to the customer.
Compute Choice Shares	 Compute each respondent's probability of choosing one of the available products (choice share). Sawtooth has several options for simulating choice shares. We will use "Randomized First Choice," which is the default simulator
Aggregate across Respondents	 Calculate market share for each product (share of preference) by aggregating the choice shares across individuals.

How Does the Simulator Work?

Which color is preferred? Consider the following utilities

	Blue	Red	Yellow
Respondent #I	50	40	10
Respondent #2	0	65	75
Respondent #3	40	30	20
Average:	30	45	35

Red has the highest average preference. But, does any one respondent prefer red?

How Does the Simulator Work?

Which color is preferred? Consider the following utilities

<u>Attribute:</u>	Blue	Red	Yellow	<u>"Choice</u>
Respondent #I	50	40	10	Blue
Respondent #2	0	65	75	Yellow
Respondent #3	40	30	20	Blue
Average:	30	45	35	First Choice

- Blue is "chosen" twice. Yellow once.
- That is the opposite that what utilities suggested! That is why we need the simulator...

Simulation Methods

- First choice
 - Every respondent selects the product with the highest individual utility (winner takes all). Only with HB. Tends to give all shares to one product and zero to the others.
- Share of preference
 - Shares are estimated using the logit formula.
 - The share of preference for stimulus i in a market composed of J stimuli can be calculated using the exponents of the utilities of each stimulus U_i

share of
$$pref_i = \frac{\exp(U_i)}{\sum_j^J \exp(U_j)}$$

 It takes into account the relative desirability of all products. Problematic when the products are similar (see later: the logit rule assumes Independence of Irrelevant Alternatives, called IIA)

Simulation Methods

- First choice
 - Every respondent selects the product with the highest individual utility (winner takes all). Only with HB. Tends to give all shares to one product and zero to the others.
- Share of preference
 - Shares are estimated using the logit formula. Takes into account the relative desirability of all products. Problematic when the products are similar (see later: the logit rule assumes Independence of Irrelevant Alternatives, called IIA)

Randomized first choice

Combines first choice and shares of preferences. Can be slow but is usually the best approach. Can be used with LCA and HB.

First Choice or Share of Preferences

					/=	$= \frac{1}{\exp(8)}$	exp(8))+exp(5)+exp	$\overline{\mathcal{D}(3)}$
<u>Custo</u>	<u>mer l</u>							
			Shar	re of Choice				
Product	Utility	Exp(U)	First Choice	Share of Preference				
Α	8	2981	100%	94.6% 🚩				
В	5	148	0%	4.7%				
С	3	20	0%	0.6%				
Total		3149					Ma	rket Shares
						Product	First Choice	Share of Preference
Custo	<u>mer 2</u>					А	50%	50%
			Shar	e of Choice		В	0%	3%
Product	Utility	Exp(U)	First Choice	Share of Preference		С	50%	47%
А	4	55	0%	4.7%		Total	100%	100%
В	3	20	0%	1.7%			7	
С	7	1097	100%	93.6%				
Total		1171						

First Choice or Share of Preferences

First Choice

- Buyers never purchase with 100% certainty the product that gets the highest utility.
- Immune to "share inflation" of similar products

Share of Preferences

 Intensity of preferences is taken into account.

 Assumes Independence of Irrelevant Alternatives, which is most often not realistic

Independence from Irrelevant Alternatives IIA

 Ratio of any two product's shares is assumed independent of all other products



What You Would Expect...



What is Predicted by the IIA



Before Introduction of Alternative A

			Share of Choice		
Product	Utility	Exp(U)	First Choice	Share of Preference	
В	5	148	100%	88.1%	
С	3	20	0%	11.9%	
Total		168			

Before Introduction of Alternative A

			Share of Choice		
Product	Utility	Exp(U)	First Choice	Share of Preference	
В	5	148	100%	88.1%	
С	3	20	0%	11.9%	
Total		168			

After Introduction of Alternative A similar to B

Product	Utility
А	4.5
В	5
С	3
Total	

Before Introduction of Alternative A

			Share of Choice		
Product	Utility	Exp(U)	First Choice	Share of Preference	
	-	,			
В	5	148	100%	88.1%	
С	3	20	0%	11.9%	
Total		168			

After Introduction of Alternative A similar to B

			Sł	nare of Choice	
Product	Utility	Exp(U)	First Choice	Share of Preference	Percentage Loss in Share
А	4.5	90	0%	34.8%	
В	5	148	100%	57.4%	34.8%
С	3	20	0%	7.8%	34.8%
Total		259			

Both B and C suffer from the introduction, and in proportion to their original shares

Before Introduction of Alternative A



B always has 7.39 times more shares than C

Is IIA Realistic?

- Not realistic to assume that similar items take a proportional share from all alternatives
- The resulting net share for both buses is 66.66%, rather than 50% when only Red Bus was offered
- We call this "share inflation" for similar products
- A solution to this problem is Randomized First Choice, which combines the benefits of first choice and share of preferences.

Randomized First Choice

Per respondent

- 1. Repeatedly add random noise to both part-worths and overall utilities
- 2. Apply first choice rule per realization (per iteration)
- 3. Compute the choice share of an alternative as the proportion of times across all iterations that it had the highest utility

Then across respondents

- 4. Compute the aggregate choice share as the average choice share across respondents
- \Rightarrow Takes into account that our model is not perfect
- \Rightarrow More realistic shares

Choice Simulator: Part 2

Aurelie Lemmens

Golf Balls: Attributes and Levels

• Remember:

- Brand [4 levels]:
 - High-Flyer Pro
 - Magnum Force
 - Eclipse+
 - Long Shot
- **Performance** [3 levels]:
 - Drives 5 yards farther than the average ball
 - Drives 10 yards farther than the average ball
 - Drives 15 yards farther than the average ball
- Price [4 levels]
 - \$4.99 for a package of 3 balls
 - \$6.99 for a package of 3 balls
 - \$8.99 for a package of 3 balls
 - \$10.99 for a package of 3 balls



Base Case Scenario

- How much primary demand will a golf ball shop create with the following assortment and what are the market shares?
 - [A] High-Flyer Pro, drives 5 yards farther than average ball, \$4.99 per three
 - [B] Magnum Force, drives 10 yards farther than average ball, \$6.99 per three
 - [C] Eclipse +, drives 15 yards farther than average ball, \$10.99 per three

Base Case Scenario

 After establishing shares for the base case scenario, we will perform modifications.

				Choice Simulator	
	My Scenario	o Settings			
ا <mark>(گ)</mark> د انگار ا	Duplicate Rename CENARIOS	Utility Simulate	Sets Sets Sup (CBCgolfexe V Sets Sets Sets Sets Sets Sets Sets Sets	 Utility Report Create Excel Report Create PowerPoint Report REPORTING 	Create Client Simulator Package Create Excel Simulator
Scenar	rio ×				
odu	icts	Simulate			
ouu					
Lab	bel	Brand:	Performance:	Price:	
Proc	duct A	High-Flyer Pro, by Smith and Forester	Drives 5 yards father than the average ball	\$4.99 for package of 3 balls	
Proc	duct B	Magnum Force, by Durango	Drives 10 yards farmer than the average bal	II \$6.99 for package of 3 balls	
Proc	duct C	Eclipse+, by Golfers, Inc.	Drives 15 yards farther than the average bal	II \$10.99 for package of 3 balls	
				Base C	Case Scenario
				Re careful (e	σ first choice with HF



First Choice rule assumes that every respondent selects the product with the highest individual utility when computing the aggregate choice shares (winner takes all). Only for HB!!!

Include "no-choice" to account for primary demand

My S	Scenario ×		Randomi	zed First Choice
Products		Simulate	No 0 shares d	ue to added randomness
	Label	Brand:	Performance:	Price:
	Product A	High-Flyer Pro, by Smith and Forester	Drives 5 yards farther than the average ball	\$4.99 for package of 3 balls
	Product B	Magnum Force, by Durango	Drives 10 yards farther than the average ball	\$6.99 for package of 3 balls
	Product C	Eclipse+, by Golfers, Inc.	Drives 15 yards farther than the average ball	\$10.99 for package of 3 balls
+				
Re	esults	8 🖬		

	А	В	С	D	E				
1	Shares of Preference								
2	Respondent Count	250							
3									
4	Label	Shares of Preference	Std Error	Lower 95% CI	Upper 95% Cl				
5	Product A	38.94 %	1.23 %	36.54 %	41.34 %				
6	Product B	35.24 %	1.19 %	32.92 %	37.57 %				
7	Product C	6.46 %	0.59 %	5.31 %	7.62 %				
8	None	19.36 %	1.85 %	15.73 %	22.98 %				
4	Results S	Summary Simulation Set	tings 🕂	: •					

New Product Introduction

Optimizing Market Share

- Suppose we are the High-Flyer Pro brand and we know that the current market offerings we have to compete with are
 - [B] Magnum Force, drives 10 yards farther than average ball, \$6.99 per three
 - [C] Eclipse +, drives 15 yards farther than average ball, \$10.99 per three
- Which product A should we offer to maximize market share (relative to the competition and no-choice)
 - [A] High-Flyer Pro, drives ?? yards farther than average ball, \$?? per three

Optimizing Market Share

My So	cenario ×				
Pro	oducts	Simulate			
	Label	Brand:		Performance:	Price:
	Product A	High-Flyer Pro, by Smith and For	rester	range(1,3,1)	range(1,4,1)
	Product B	Magnum Force, by Durango		Urives 10 yards farther than the average ball	\$6.99 for package of 3 balls
	Product C	Eclipse+, by Golfers, Inc.		Drives 15 yards farther than the average ball	\$10.99 for package of 3 balls
+					

Prohibitions

Prohibitions Prohibitions can be used in the simulator to help prevent combinations from being simulated which should not be. Prohibitions can be full or partial concepts. Prohibition rows can also be linked together to form a between-concept prohibition. X Delete Performance: Price: Brand: Drives 15 yards farther than the average ball \$4.99 for package of 3 balls S Link Drives 15 yards farther than the average ball \$6.99 for package of 3 balls C2 Unlink Drives 10 yards farther than the average ball \$4.99 for package of 3 balls Highest performance level not with price < \$8.99 Second highest performance level not with price < \$6.99 Prohibition Enforcement Behavior Prevent simulations from running when a prohibited combination exists in a non-search scenario Exclude prohibited combinations from search results

Sequential Search on Price

Re	esults 🗄					
	А	В	С	D	E	F
19						
20						
21	Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:
22	Product A	41.18 %	1.28 %	High-Flyer Pro	2.00	2.00
23	Product B	28.91 %	1.12 %	Magnum Ford	Drives 10 yards	\$6.99 for p
24	Product C	8.51 %	0.68 %	Eclipse+, by G	Drives 15 yards	\$10.99 for
25	None	21.39 %	1.90 %	*	*	s
26						
27						
28	Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:
29	Product A	34.48 %	1.12 %	High-Flyer Pro	2.00	3.00
30	Product B	36.35 %	1.21 %	Magnum Ford	Drives 10 yards	\$6.99 for p
31	Product C	8.11 %	0.68 %	Eclipse+, by G	Drives 15 yards	\$10.99 for
32	None	21.06 %	1.90 %	*	*	•
33						
34						
35	Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:
36	Product A	15.30 %	0.71 %	High-Flyer Pro	2.00	4.00
37	Product B	50.36 %	1.47 %	Magnum Ford	Drives 10 yards	\$6.99 for p
38	Product C	9.21 %	0.72 %	Eclipse+, by G	Drives 15 yards	\$10.99 for
39	None	25.13 %	2.05 %	*	*	*
40						Ψ
	 Performa 	ance Price Simulatio	n Settings 🚥 🕂 🕴 🔳			Þ

Restrictions prohibit unrealistic attribute level combinations

Sequential Search on Performance

Results

8 🖬

	А	В	С	D	E	F					Perfo	rmance	:			
13	Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:										
14	Product A	21.49 %	0.88 %	High-Flyer Pr	1.00	2.50										
15	Product B	45.33 %	1.31 %	Magnum For	Drives 10 yards	\$6.99 for	p	45 %								
16	Product C	8.99 %	0.69 %	Eclipse+, by 0	Drives 15 yards	\$10.99 fo	r									
17	None	24.19 %	2.04 %	*	*	*		40 %								
18								25.00								
19								35 %				/				
20	Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:		ũ 30 %								
21	Product A	37.09 %	1.18 %	High-Flyer Pr	2.00	2.50		efer								
22	Product B	32.84 %	1.18 %	Magnum For	Drives 10 yards	\$6.99 for	p	ੂ <u>ਦ</u> ੋ 25 %		1						
23	Product C	8.57 %	0.69 %	Eclipse+, by 0	Drives 15 yards	\$10.99 fo	r	¥ 20 %		•						
24	None	21.50 %	1.90 %	*	*	*		La la								
25								15 %								
26								10.0								
27	Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:		10 %								
28	Product A	44.84 %	1.39 %	High-Flyer Pr	3.00	2.50		5 %								
29	Product B	31.63 %	1.26 %	Magnum For	Drives 10 yards	\$6.99 for	p									
30	Product C	5.09 %	0.55 %	Eclipse+, by 0	Drives 15 yards	\$10.99 fo	r	0 %	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
31	None	18.43 %	1.76 %	*	*	*		0.00	0.00	2.00	2.50 F	erforman	ce:	2.00	2.50	
32							Ŧ									
	Perform	ance Price Simulatio	on Settings 🚥 🕂 🕴 🔳)		Performance:	Price:							

×

Optimizing Market Share with Prohibitions

Sequential search with prohibitions

• Best option is:

Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:
Product A	44.84%	1.39%	High-Flyer Pro, by Smith and Forester	Drives 15 yards farther than the average ball	<u>\$7.99 for package</u> of 3 balls
Product B	31.63%	1.26%	Magnum Force, by Durango	Drives 10 yards farther than the average ball	\$6.99 for package of 3 balls
Product C	5.09%	0.55%	Eclipse+, by Golfers, Inc.	Drives 15 yards farther than the average ball	\$10.99 for package of 3 balls
None	18.43%	1.76%	*	*	*

Product Amelioration

Product Amelioration

- Suppose the market looks like our base case scenario and we sell the High Flyer Pro balls:
 - [A] High-Flyer Pro, drives 5 yards farther than average ball, \$4.99 per three
 - [B] Magnum Force, drives 10 yards farther than average ball, \$6.99 per three
 - [C] Eclipse +, drives 15 yards farther than average ball, \$10.99 per three

Base Case Scenario

• Our current shares are:

Label		Shares of	Preference	St
	Product A		38.94 %	
	Product B		35.24 %	
	Product C		6.46 %	
	None		19.36 %	
	Results S	ummary	Simulation Set	tin

How can we change our product to gain more shares?

Product Amelioration

Sequential search with prohibitions

• Best option is:

Label	Shares of Preference	Standard Error	Brand:	Performance:	Price:
Product A	44.84%	1.39%	High-Flyer Pro, by Smith and Forester	Drives 15 yards farther than the average ball	<u>\$7.99 f</u> or package of 3 balls
Product B	31.63%	1.26%	Magnum Force, by Durango	Drives 10 yards farther than the average ball	\$6.99 for package of 3 balls
Product C	5.09%	0.55%	Eclipse+, by Golfers, Inc.	Drives 15 yards farther than the average ball	\$10.99 for package of 3 balls
None	18.43%	1.76%	*	*	*



Profitability analysis: does the increase in share and price compensate the extra costs (R&D)?

Profitability Analysis

- Does the increase in share and price compensate the extra costs (R&D)?
- Profit = shares x population size x (unit price unit cost)

Populat	ion size	= 1,000 c	ustomers
			Net Profits per
Shares	Price	Unit Cost	1,000 customers
0.39	\$4.99	\$2.00	\$1,166
0.45	\$7.99	\$3.00	\$2,245
		\$4.00	\$1,795
		\$5.00	\$1,345

Sensitivity Analysis

Price Sensitivity Analysis

- Suppose the market looks like our base case scenario and we sell the High Flyer Pro balls:
 - [A] High-Flyer Pro, drives 5 yards farther than average ball, \$4.99 per three
 - [B] Magnum Force, drives 10 yards farther than average ball, \$6.99 per three
 - [C] Eclipse +, drives 15 yards farther than average ball, \$10.99 per three

Base Case Scenario

- We would like to charge more for our current offering but we don't know how the market shares would change?
- Our current share is:

Label	Shares of Preference	St	
Product A	38.94 %		
Product B	35.24 %		
Product C	6.46 %		
None	19.36 %		
Results S	Simulation Set	tin	

Price Sensitivity Analysis



- Current share:
 - > 38.94% at \$4.99
- New shares
 - > 23% at \$6.99
 - > 21% at \$8.99
 - 10% at \$10.99
- It does not seem good to increase price... however:
 - Does the higher price compensate for the loss in sales?

Profitability Analysis

Profit = shares x population size x (unit price – unit cost)

Unit cost	= \$2			
Population size	= 1,000 custome	ers		
Shares	Price	Net Profits per 1	,000 customers	
39%	\$4.99	\$1,166		
23%	\$6.99	\$1,148		
21%	\$8 .99	\$1,468		
÷ 10%	\$10.99	\$899		



At a unit cost of \$2, increasing the price to \$8.99 is the most profitable option, even if it generates a decrease in market share of 18%!

Cross-Brand Effects

The shares of the competitors also change. Who gain the most from these changes?

$\mathbf{D}_{\mathbf{r}iac} = \mathbf{f} \mathbf{I} 0 0$	Shawaa of Duofewara	<u> Price = \$8.99</u>	Shares of Preference
<u> Frice – \$4.99</u>	Shares of Preference		
Product A	38 94%	Product A	21.05%
HOULCEA	30.7470		
Product B	35.24%	Product B	46.54%
			0 (19/
Product C	6.46%	Product C	8.61%
Nono	19369	None	22 01%
INONE	17.30%	INONE	23.01/0

Product B (compromise option) benefits a lot from the change in price.Shares of Product C (most expensive option) is hardly affected.A group of customers exit the market because the cheap option disappeared

Product Portfolio/Line Extension

Suppose we are High Flyer Pro and we have already introduced a low-cost product on the golf market (product A):

[A] High-Flyer Pro, drives 5 yards farther than average ball, \$4.99 per three
 [B] Magnum Force, drives 10 yards farther than average ball, \$6.99 per three
 [C] Eclipse +, drives 15 yards farther than average ball, \$10.99 per three

Base Case Scenario

 We now think this is time to add a high-performance variant to our product line

[D] High-Flyer Pro, drives 15 yards farther than average ball, \$?? per the three

At which price should we introduce this variant to maximize our total shares/profits?

- At which price should we introduce this variant to maximize our total shares/profits?
- The goal is to:
 - Minimize cannibalization
 - Steal from competitive sales
 - Grow primary demand
- The current market situation is:

Label	Shares of	Preference	St
Product	Α	38.94 %	
Product	В	35.24 %	
Product	C	6.46 %	
Nor	ne	19.36 %	
Result	s Summary	Simulation Set	tin

Scenario ×			
roducts	Simulate		
Label	Brand:	Performance:	Price:
Product A	High-Flyer Pro, by Smith and Forester	Drives 5 yards farther than the average ball	\$4.99 for package of 3 balls
Product B	Magnum Force, by Durango	Drives 10 yards farther than the average ball	\$6.99 for package of 3 balls
Product C	Eclipse+, by Golfers, Inc.	Drives 15 yards farther than the average ball	\$10.99 for package of 3 balls
Product D	High-Flyer Pro, by Smith and Forester	Drives 15 yards farther than the average ball	Range(1,4,1)



- We had 39% of the market with the low-cost product
- If we introduce the highquality variant, we can increase our market share up to 45%-53%, i.e. a boost of 6%-14%.

Cannibalization

 The increase in total shares comes at the cost of a decrease in the share of Product A

		Scenario I	Scenario 2
	99	\$8.99	\$10.99
Share A prior to exten	38.94%	38.94%	
Product D	51% 3	28.76%	11.43%
My netted shares	64. 5%	53.14%	44.93%
Net increase in share	= netted share – share A prior to extension	14.20%	5.99%
Cannibalization from A	= netted share – share A prior to extension – product D	-14.56%	-5.44%

There is less cannibalization when the price is higher (attracts different segments...)

Profitability Analysis

Profit = shares x population size x (unit price – unit cost)

Population size	= 1,000 customers			
	Shares	Price	Unit Cost	Net Profits per 1,000 customers
Product A before extension	39%	\$ 4.99	2	\$ 1,166
<u>Scenario 1:</u>				
Product A after extension	24%	\$ 4.99	2	\$ 718
Product D	29%	\$ 8.99	4	\$1,447
Total profit after extension				<u>\$ 2,165</u>
<u>Scenario 2:</u>				
Product A after extension	34%	\$ 4.99	2	\$ 1,017
Product D	11%	\$ 10.99	4	\$ 769
Total profit after extension				\$ 1,786



Extension is profitable, especially at \$8.99, despite the higher cannibalization

Conclusions

- The choice simulator is like a crystal ball!
 - Almost any analysis/scenario you have in mind can be realized
- As long as you have part-worths and costs, you can determine what is the most profitable strategy for the firm
 - Maximizing shares can be different from maximizing profits
- Be careful: scenarios can only use levels that have been implemented in the CBC design
 - Extrapolation to new levels is possible for continuous attributes but has to be done with care (Lucas Critique)