Intro to Market Simulations & Theory

Outline

- Mechanics of conjoint simulations
- Gaps separating preference share and market share
- Preference share simulation as one component of a larger forecasting system
- Improving forecast accuracy

Why Conduct Market Simulations?

- Reflect real-world behavior
  - Represent idiosyncratic preferences of segments and individuals (remember, you don't have to appeal to the "fat" part of the market to carve out a profitable business)
- A "choice laboratory" for testing of alternative marketing strategies
- Results expressed in terms that make sense to managers

Why Conduct Market Simulations? (cont.)

- Examining utilities and importances only gets you so far
  - Average utilities cannot tell the whole story
  - Fallacy of Division
- Helps to answer strategic questions:
  - At what price will people switch to a competitor?
  - Can we modify our product to reduce cost while maintaining share?
  - Should we launch a high-end product or a budget model (or both)?
  - Will the new product cannibalize our own sales?

Preferred Color?

- Consider the following utilities:

	Blue	Red	Yellow
Respondent #1	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?

Chosen Color?

- Each respondent's preferred color:

	Blue	Red	Yellow	"Choice"
Respondent #1	50	40	10	**Blue**
Respondent #2	0	65	75	**Yellow**
Respondent #3	40	30	20	**Blue**
Average	**30**	**45**	**35**	

- Blue "chosen" twice, Yellow once

Competitive Effects

- Assume 80% of market prefers round widgets, and 20% prefers square ones
- Which should you take to market?
- In the absence of any other information, round would be the logical choice
- But what if there currently are 10 competitors in the market, ALL only offering round widgets?

Simulations: Mechanics

- OK, simulations are good--but how do we do it?
- First we need utilities for product features, ideally for each respondent

	Resp. 1	Resp. 2	...	Resp. 500
Vanilla	2.5	-1.0		3.7
Chocolate	1.8	1.0		0.5
$0.25	5.3	1.2		1.0
$0.35	3.2	0.7		0.8
$0.50	1.4	-1.9		0.5

Many Ways to Simulate

- First Choice Rule (also called “maximum utility rule”)
- Logit Probability Rule
- Randomized First Choice

“First Choice” Market Simulations

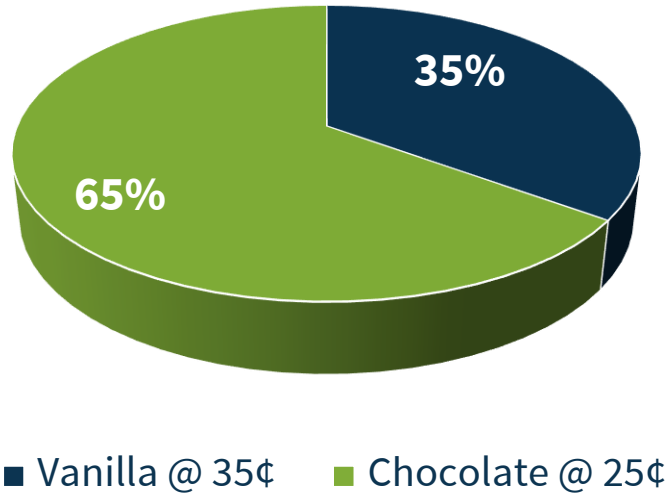
- For each respondent, assume respondent chooses the product with the highest utility
- Count these respondent choices (be careful about calling them “Market Shares”)

Market Simulation Example

	Resp. 1	Resp. 2	...	Resp. 500
Vanilla	2.5	-1.0		3.7
Chocolate	1.8	1.0		0.5
$0.25	5.3	1.2		1.0
$0.35	3.2	0.7		0.8
$0.50	1.4	-1.9		0.5
$0.25 Choc.	7.1	2.2		1.5
$0.35 Van.	5.7	-0.3		4.5
Winner	**Chocolate**	**Chocolate**		**Vanilla**

Market Simulation Results

- Predict responses for 500 respondents, and we might see "shares of preference" like:



- 65% of respondents prefer the 25¢ Chocolate cone

How Realistic is the First Choice Rule?

- First choice model is simple to do and easy to understand, but usually oversimplifies consumer behavior
  - Assumes a product barely preferred over another is chosen 100% of the time (winner takes all)
- Less efficient use of data: we learn about which product is preferred, but don't capture anything about relative preferences of not preferred options
  - Standard errors of simulated shares relatively high

First Choice Rule: When to Use

- Despite the theoretical problems, there are certain conditions under which First Choice can work quite well
  - Large sample size
  - The situation we want to model really is “winner take all” (e.g. large purchases where consumers actually DO only ever “buy” one
    - Automobiles
    - Refrigerators
    - Etc.

The Unpredictable Buyer

- Buyers never purchase with 100% certainty the product our model says is most preferred within a set
  - Error present in model estimation, respondent choices
  - Some “random” behavior occurs
  - Other unaccounted for influences (e.g. out-of-stock, children in the cereal aisle) can alter choice
  - Variety seeking

How to Model Uncertain Behavior?

- For each respondent, perhaps we can estimate continuous probabilities of purchase rather than either 0% or 100% each alternative (vote splitting)

	First Choice	"Share of Preference"
A	0%	10%
B	100%	60%
C	0%	30%

- But how to do it?

The Logit Rule (Share of Preference)

- Available when utilities estimated using a logit model
- Probability of choosing alternative A with utility U_a from set of product alternatives {A B C} is

$$P(A) = \frac{\exp(U_a)}{\exp(U_a)+\exp(U_b)+\exp(U_c)}$$

- Where "exp(U_i)" is the antilog of U_i, also known as raising the constant "e" (2.7183…) to the power U_i

Logit Rule Example

- Assume three product alternatives with the following utilities (after adding up their respective part worths):

A	0.75
B	0.00
C	-1.25

- Share of A:

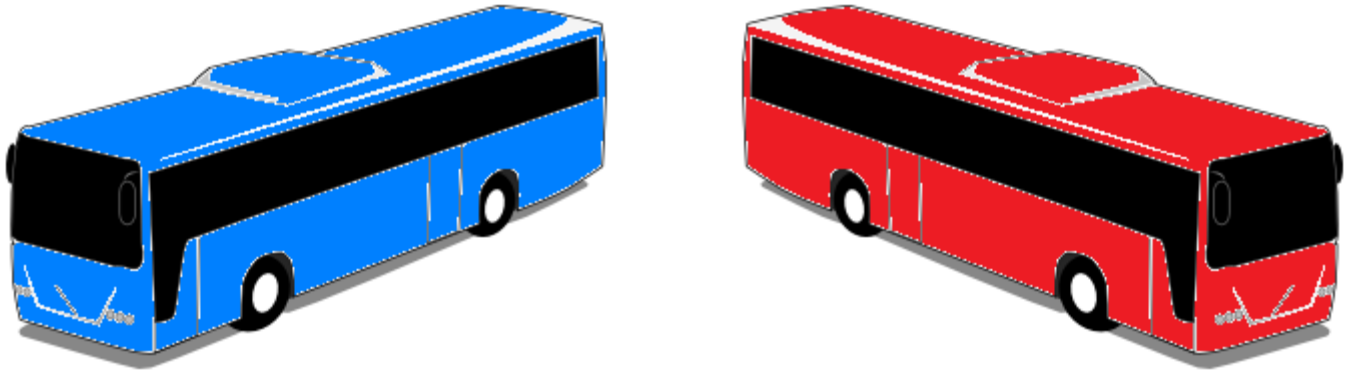
exp(0.75) / [exp(0.75)+exp(0.00)+exp(-1.25)]

= 2.117 / [2.117 + 1.000 + 0.287]

= 62.2%

Red-Bus/Blue-Bus Problem (IIA)

- Logit has a property called “Independence of Irrelevant Alternatives” or IIA
  - This property states that the ratio between any two alternatives’ shares should be independent of all other alternatives
  - This property also implies constant substitution rates, which is unrealistic



IIA Example

- Consider two drink alternatives, Pepsi and Milk, with the following logit utilities:

Pepsi	1.0
Milk	2.0

Share for Pepsi = exp(1.0)/[exp(1.0)+exp(2.0)]
= 2.72/(2.72+7.39)
= 26.9%

Share for Milk = 7.39/(2.72 + 7.39) = 73.1%

Consider the Introduction of Coke

- Assume a new alternative appears, Coke, with a logit utility (like Pepsi) of 1.0
- What are the new shares for Pepsi, Milk, and Coke?
  - Pepsi = 2.72/(2.72+7.39+2.72) = 21.2%
  - Milk = 7.39/(2.72+7.39+2.72) = 57.6%
  - Coke = 2.72/(2.72+7.39+2.72) = 21.2%
- Coke takes share proportionally from Pepsi and Milk:

	Original	New	Change
Pepsi	26.89	21.19	-21.19%
Milk	73.11	57.61	-21.19%
Coke	N/A	21.19	

Reducing IIA Troubles

- When we use Latent Class or HB modeling to generate utilities and to accommodate heterogeneity, the Red Bus/Blue Bus problem may be reduced.
  - Similar products tend to compete more closely with one another.
- Simulation methods that directly assess and penalize product similarity can help even more.

Randomized First Choice (RFC)

- RFC sits in a middle ground between the First Choice and Logit choice rules
- Can be used with aggregate or disaggregate utilities
- “Splits” shares but reflects more accurate substitution effects for similar products than does the Logit Rule
- Is tunable, in terms of scale and product similarity

Market Simulation – One Vote/Respondent

	Resp. 1	Resp. 2	...	Resp. 500
Vanilla	2.5	-1.0		3.7
Chocolate	1.8	1.0		0.5
$0.25	5.3	1.2		1.0
$0.35	3.2	0.7		0.8
$0.50	1.4	-1.9		0.5
$0.25 Choc.	7.1	2.2		1.5
$0.35 Van.	5.7	-0.3		4.5
Winner	**Chocolate**	**Chocolate**		**Vanilla**

Splitting Respondents' Votes

	Resp. 1 Actual Util.	Resp. 1 Iteration 1	…	Resp. 1 Iteration 10,000
Vanilla	2.5	2.5 + 0.015		2.5 + 1.5
Chocolate	1.8	1.8 - 0.75		1.8 – 1.25
$0.25	5.3	5.3 + 0.20		5.3 – 0.75
$0.35	3.2	3.2 – 1.33		3.2 + 0.5
$0.50	1.4	1.4 + 2.15		1.4 - 0.14
$0.25 Choc.	7.1	6.55		5.1
$0.35 Van.	5.7	4.385		7.7
Winner	**Chocolate**	**Chocolate**		**Vanilla**

Weaknesses of RFC

- If a correction for similarity is applied to Price
  - Creates distortions in the demand curve due to severe product similarities of reference brands held all at the same price
  - But, you can turn off the "correction for product similarity" for price! (This happens almost automatically in the online simulator, but you must remember to change the setting in SMRT)
- If simulating for many (say, 20+ products) some shares can become so small that the random component introduced by RFC makes such small shares imprecise, unless you increase sampling iterations considerably.

Simulator Options

- Sawtooth Software offers two off-the-shelf options:
  - Choice Simulator integrated into Lighthouse 9 and available as a standalone simulator
  - Online Simulator: Web-based simulator

- Build-Your-Own in Excel, etc.

Conjoint Market Simulation Assumptions

- We have interviewed the right people
- Each person is in the market to buy
- Respondent answers are reliable and valid
- We've used a proper measurement technique and matched it with an appropriate statistical model
- All attributes that affect buyer choices in the real world have been accounted for

Conjoint Market Simulation Assumptions

- Equal availability (distribution)
- Respondents are aware and equally familiar with all products
- Long-range equilibrium (equal time on market)
- Equal effectiveness of sales force, social media, word-of-mouth
- No out-of-stock conditions

Shares of Preference ≠ Market Shares

- Not all conjoint simulator assumptions hold true in the real world
- But this doesn't mean that conjoint simulators are not valuable!
- Simulators turn esoteric "utilities" into concrete "shares"
- Conjoint simulators predict respondents' interest in products/services assuming a level playing field

“Tuning” Logit Simulations

- Multiplying all part worth utilities by value > 1 causes relative shares to become steeper (<1 shares become flatter)

- With these utilities:

A	0.75
B	0.00
C	1.25

- Shares under different multipliers:

	0.01	1.0	5.0
A	33.6	62.2	97.7
B	33.4	29.4	2.3
C	33.0	8.4	0.0

Scale Factor (λ)

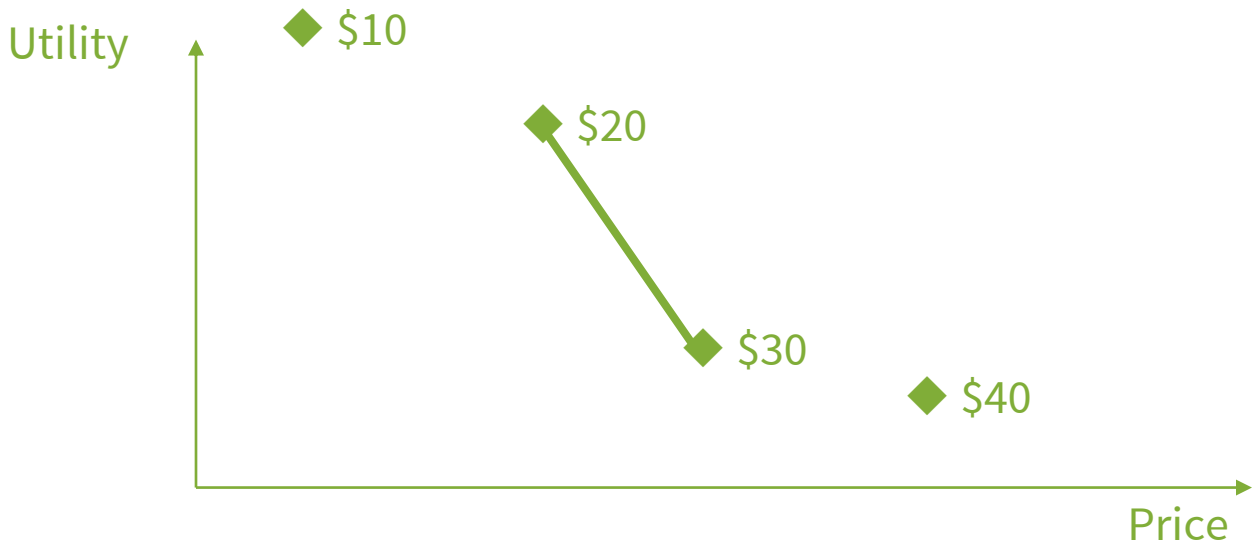
- The multiplier applied to all utilities referred to at Sawtooth Software as the "Exponent"
- As $\lambda \rightarrow \infty$, shares become First Choice (best alternative gets 100% share)
- As $\lambda \rightarrow 0$, shares flatten to become equal

Tuning to Survey Data or Market Data

- The scale factor built into utilities reflects the degree of uncertainty in conjoint judgments within the questionnaire
- You may choose to adjust the scale factor (for all respondents) by a uniform additional degree
  - To better fit actual market share information
  - To better fit "holdout choices"
    - Within the questionnaire – no reason it should be different
    - Better yet, holdout choices made by holdout respondents
- Sawtooth Software's "exponent" does that
- This is the same as if you multiply all utilities by the desired scale factor in a spreadsheet simulator

Interpolation

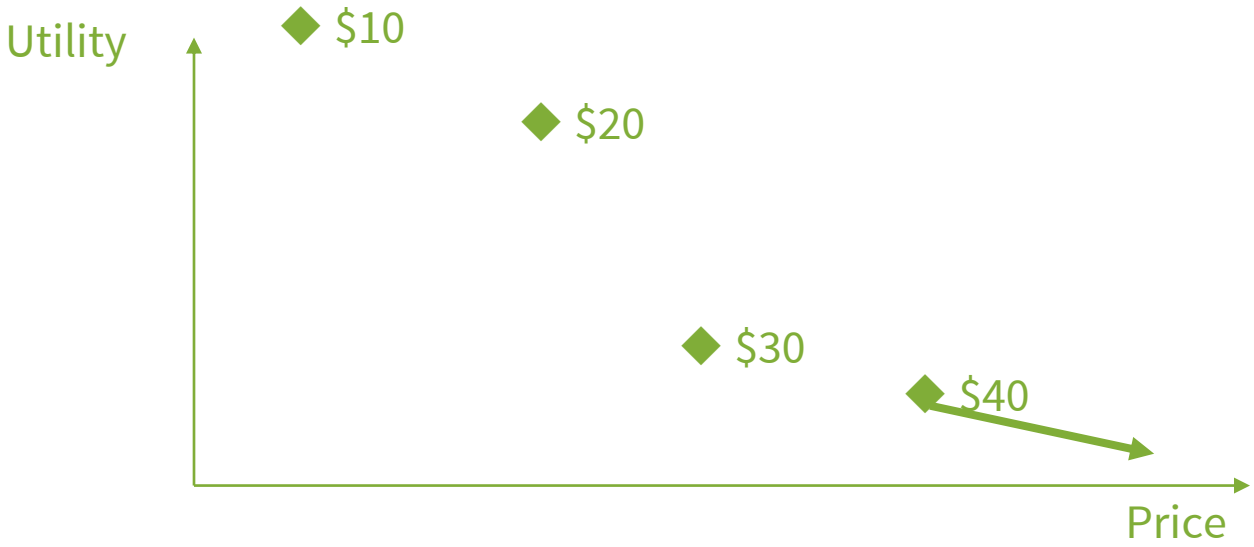
- Straight-line interpolation often used to simulate for a level between two that were measured:



- Usually a fairly accurate, safe procedure for “ordered” attributes

Extrapolation

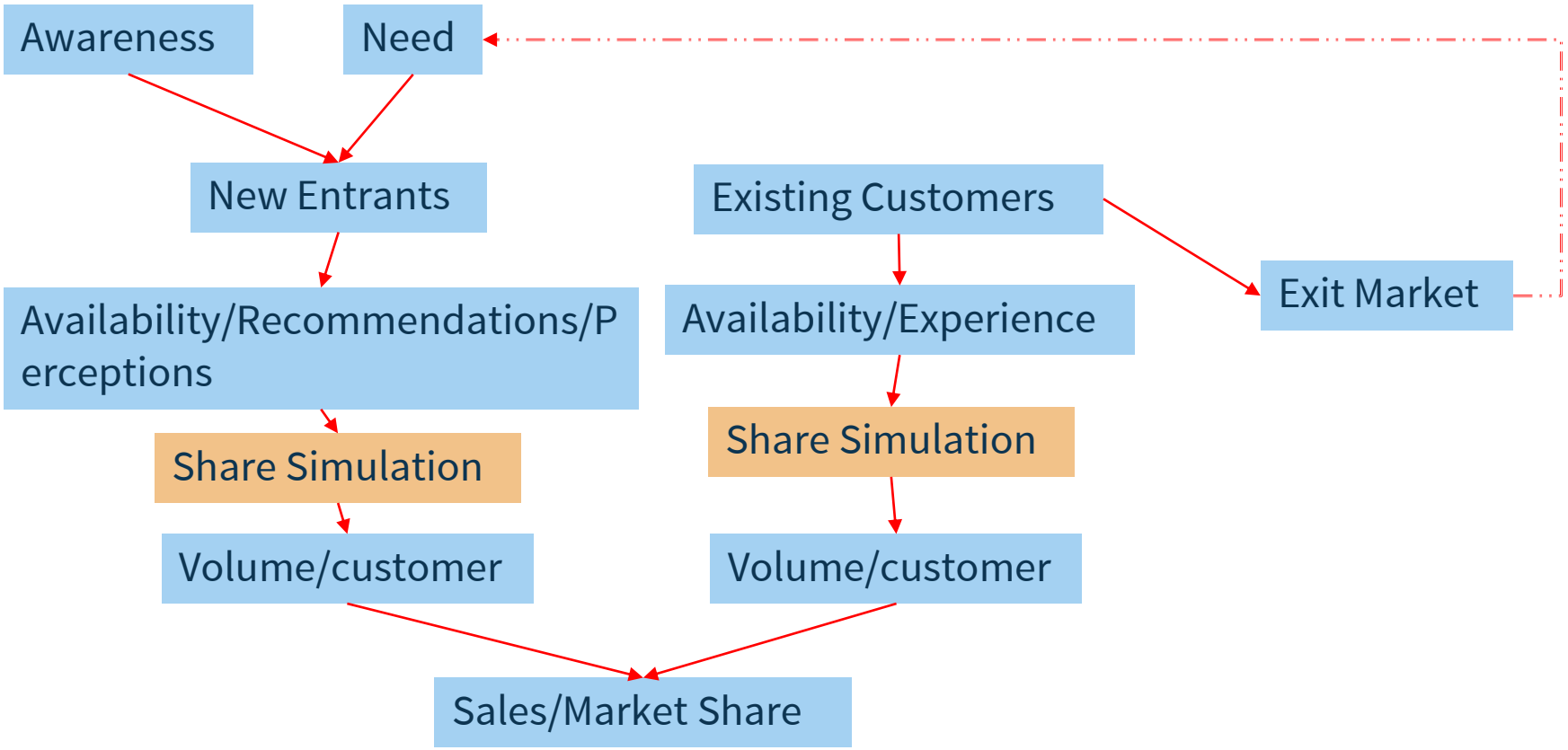
- Extrapolation is dangerous - used when clients request a simulation beyond the levels included in the design



- Who says that the relationship from $30 to $40 should continue beyond $40?

Simulations as Part of a Forecasting System

- Share simulations may be just part of a larger forecasting effort



Humility

- *The Economist* recently reported ("A Mean Feat" 2016)
  - The IMF, using the best data in the world, has a mean error of prediction about national growth rates of 2.6 percentage points (21 months out)
  - This is better than a random number forecast (4.3 percentage points) or a forecast equal to the previous year's result (2.9 percentage points)
  - But not by a lot

Accuracy in Forecasts

- Forecast accuracy improves as
  - Our simulations capture our market realistically
  - Our simulations have enough sample size to provide precision
  - We understand more of the levers that drive sales/share
  - The other components of our forecast system complement our simulations, filling in information gaps about those levers
  - Errors in all parts of the forecast system tend to cancel out (i.e. they are many, small and independent, so that the central limit theorem can be our friend)

QUESTIONS?

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References

"A Mean Feat" (2016) *The Economist*, January 9, p. 65.