Introduction to Choice Models

Outlook

- Choice Models
  - Utility theory
  - Logit versus multinomial logit
  - Model fit
  - Interpretation of coefficients
- Business Applications

Choice Models

1. Observe choice:
   - Buy/not buy – direct marketers
     Brand bought – packaged goods
2. Capture related characteristics data:
   - Demographics
   - Attitudes/perceptions
   - Market conditions (price, promotion, etc.)
3. Link
   - 1 to 2 via “choice model” – the model *predicts* customers’ probabilities of purchase and also *reveals* importance of characteristics.

Choice Models

Binary Choice

- Buy or Not Buy
- Yes or No
- Own or Don’t own

Multinomial Choice

- Wisk, All, Tide, and Yes
- Bus, Train, or Plane
- Yes, No, Don’t Know

Choices are mutually exclusive. The customer chooses only one of the options at a given choice occasion.

Underlying Assumptions

- Consumers are rational utility maximizers
  - Well-ordered preferences for any set of choice alternatives
- Alternative with maximum utility is chosen
- Utility assigned to alternatives is unobserved
- Observables are available about
  - the chosen alternatives (Tide, Wisk, etc.)
  - customer characteristics (age, income, etc.)
  - products (price, feature, display, etc.)
- Translating utilities to choice probabilities

Utility Theory and Model Formulation

Consumer Behavior Assumptions

- In a multinomial logit, the choices reflect tradeoffs the consumer must face
  - Tide is of high quality but of higher price
  - Cheer is not so good, but the price is lower
- These tradeoffs are captured in the consumer's utility function for each choice alternative

How the Model Maps Utilities to Choices?

- j indexes the choices (J of them)
  - No need to assume equal choices
- i indexes people (N of them)
- Y_{ij} = 1 if person i selects option j, = 0 otherwise
- U_{ij} is the utility or net benefit of person i if they select option j

How the Model Maps Utilities to Choices?

- j indexes the choices among “Tide,” “Wisk,” “YES,” “Cheer” (J = 4)
  - No need to assume equal choices
- i indexes people (N of them)
- Y_{ij} = 1 if person i selects option j, = 0 otherwise
- U_{ij} is the utility or net benefit of person i if they select option j
- Suppose customer chooses Tide (j = 1)

How the Model Maps Utilities to Choices?

- Then there are a set of 3 (J - 1) inequalities that must be true
- $U_{itide} > U_{iwisk}$
- $U_{itide} > U_{iYES}$
- $U_{itide} > U_{icheer}$
- Choice of Tide dominates the other
- A multinomial logit model will ensure the coefficients reflect these behavioral assumptions about consumers

Compute Choice Scores

Relay C (Binary Logit)
Probability of retaining customer i =

$$P_i = \frac{e^{(U_i)}}{1 + e^{(U_i)}}$$

(Multinomial Logit)
Probability of customer i choosing j =

$$P_{ij} = \frac{e^{(U_{ij})}}{\sum_{k=1}^{K} e^{(U_{ik})}}$$

Probability of customer i choosing alternative “Cheer” among choices “Tide,” “Wisk,” “YES,” “Cheer”

$$= P_{icheer} = \frac{e^{(U_{icheer})}}{e^{(U_{itide})} + e^{(U_{iwisk})} + e^{(U_{iYES})} + e^{(U_{iCheer})}}$$

Map to Market Share

$$p_{ij} = \frac{e^{u_{ij}}}{\sum_k e^{u_{ik}}}$$

$$m_j = \frac{\sum_{j=1}^{n} p_{ij}}{n}$$

u_{ij} = Total utility of product bundle j for consumer i

p_{ij} = Proportion of purchases that consumer i makes of product j or

p_{ij} = probability that consumer i will choose product j

Market share for product j (m_j) = average p_{ij} across consumers

Business Applications

Conjoint Analysis, Part 1

Why Conjoint Analysis?

Asking direct questions about preferences often leads to unenlightening answers.

- What load would you like to pay on your mutual fund?
- What annual fee would you like?
- Would you like online access to your funds?

Consumers want everything and they want it for free!

How Has the Method Been Applied?

New Card Benefits

Room Configuration

THE RITZ-CARLTON®

Baltimore Ravens Logo

COURTYARD® Marriott

New Hotel Concept for Business Travelers

New Services

FedEx

First AT&T cell phones

Why Do Firms Use It?

Firms want to increase profits by providing the product features that consumers value.

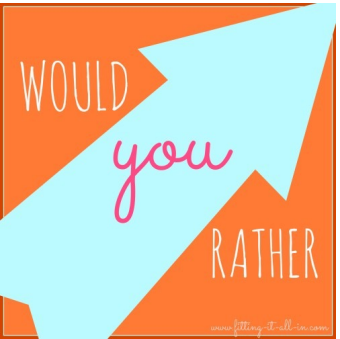
What happened to "free" airline meals?

Why Do Firms Use It?

Firms want to increase profits by providing the product features that consumers value.

Fly to SFO for $499 (includes meal)

Fly to SFO for $489 (without meal)



What happened to "free" airline meals?

Alternatively, Directly Asking Can Be Misleading . . .

When people are directly asked, . . .
“Durability
+ Quality
+ Reliability”

. . . but from the conjoint consumers really care about
Price + Design

It Works with Services Too…

All that is needed is a decomposition of the attributes

Mutual Fund = Past Returns + Fees + Brand Name + Online Access

What about B2B?

If you were Boeing, what are your customers willing to pay for your new aircraft?

Value of Aircraft =

+ Capacity
+ Max Range
+ Fuel Efficiency
+ Price
+ Service Contract + . . .

What about Clothing?

Business Applications

Conjoint Analysis, Part 2

Aid for Pricing Decisions

- Sellers want to increase profits by providing cost-effective products that consumers value.
- First step in this process is to determine the trade-offs consumers are willing to make among various attributes.

Choice-Based Conjoint Analysis

Below are several offers for a Kitchen Mixer from different retailers. Each Kitchen Mixer is for the same original price of $350, but for a different deal or shipping fee. Please indicate which product you would most likely purchase.

Eligible for amazon.com Prime

	Price	Shipping	Notes	
TARGET	$280.00 ~~$350~~ (Save 20%)	$39.99 3 Days	30 days return policy Item may be placed on back-order 1-3 days	○
amazon.com	$315.00 ~~$350~~ (Save 10%)	Free 2 Days	No return policy Item may be placed on back-order 1-3 days	○
Walmart	$350.00	$19.99 1 Day	No return policy Item is in stock and ships immediately	○
None of these choices				○

Next

Choice-Based Example: Parent-Teen Decision-Making

Assess how a parent-teen dyad evaluates the following levels of each personal computer attribute:

Attributes	Levels
Computer brand	IBM
	emachines
Microprocessor brand	Intel Pentium III
	AMD K6-2
Microprocessor speed	600 MHz
	433 MHz
Warranty	2-year warranty
	No warranty
Price	$1,299
	$1,799

Choice Tasks

Below, we describe three personal computer (PC) alternatives with different features. Please check (in the space provided) the PC you prefer the most.

Please check one PC even if you do not like any of the three alternatives. We are only interested in your most preferred choice from the available alternatives. While evaluating these alternatives, please focus only on the features included in the study because alternatives are identical in every other respect.

Please do not skip any questions.

Choice Tasks

Question 1: Please check (in the space provided) the PC you prefer the most.

Alternative 1: IBM PC Intel Pentium III 433 MHz 2-yr warranty service $1,799		Alternative 2: eMachines PC Intel Pentium III 600 MHz 2-yr warranty service $1,299		Alternative 3: IBM PC AMD K6-2 433 MHz No warranty service $1,799

Question 2: Please check (in the space provided) the PC you prefer the most.

Alternative 1: eMachines PC AMD K6-2 433 MHz 2-yr warranty service $1,799		Alternative 2: IBM PC AMD K6-2 600 MHz 2-yr warranty service $1,299		Alternative 3: IBM PC Intel Pentium III 600 MHz No warranty service $1,299

Discrete Choice Model

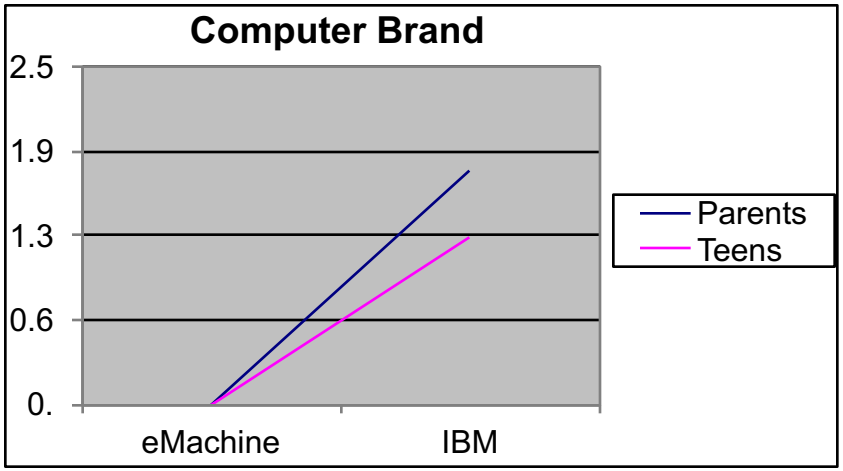
$$\Pr(\text{"1" gets chosen}) = \frac{\exp(V_1)}{\sum_{k=1}^{3} \exp(V_k)}$$

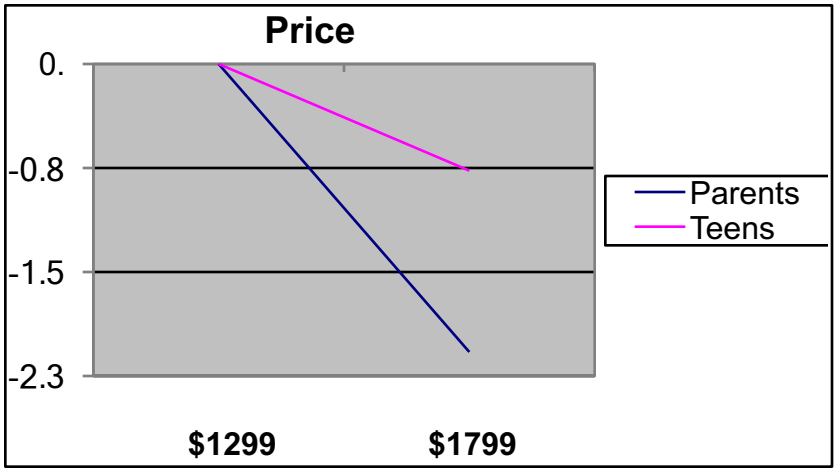
$$V_1 = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5$$

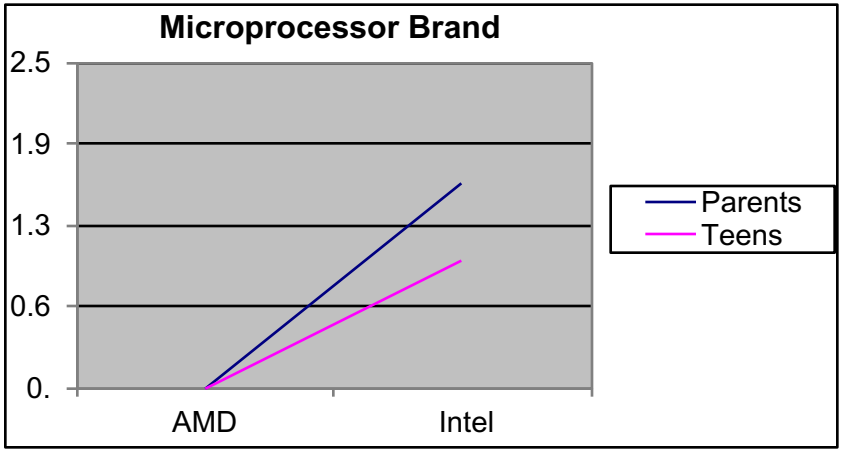
where
X1 = 1 if computer brand is IBM and 0 otherwise
X2 = 1 if microprocessor brand is Intel and 0 otherwise
X3 = 1 if microprocessor speed is 600 MHz
X4 = 1 if warranty is two years and 0 otherwise
X5 = 1 if price is $1,799 and 0 otherwise

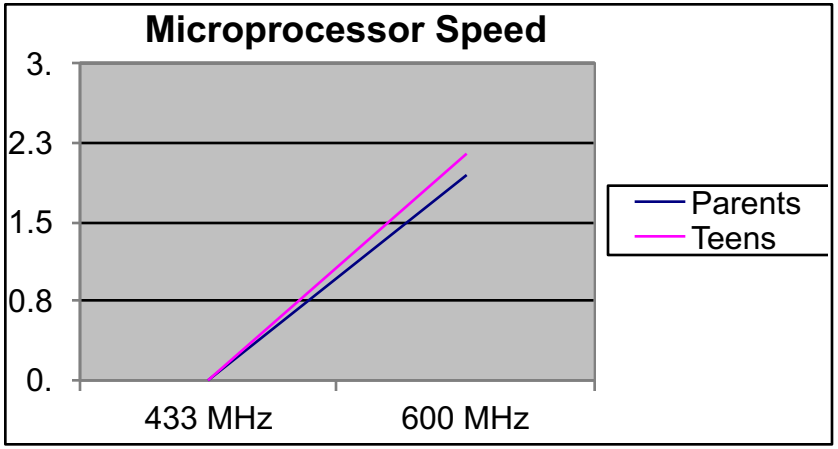
The baseline PC is eMachine; AMD; 433 MHz; no warranty; $1,799

Utilities for Different PC Attributes









Business Applications

Conjoint Analysis, Part 3

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Embedded Premium Promotion: Why It Works and How to Make It More Effective

Neeraj Arora
University of Wisconsin-Madison, 4191 Grainger Hall, 975 University Avenue, Madison, Wisconsin 53706,
narora@bus.wisc.edu

Ty Henderson
Red McCombs School of Business, University of Texas at Austin, 1 University Station B6700, Austin, Texas 78712,
ty.henderson@mccombs.utexas.edu

In this paper we define an embedded premium (EP) as an enhancement that involves a social cause added on to a product or service. We characterize EP as a sales promotion strategy and juxtapose it with traditional approaches, such as discounts and rebates. Across three experiments, using a nationwide Internet panel and employing stated measures and model-based inference, we find that at low denominations EP is more effective than an equivalent price discount. We describe how an EP's social association may influence consumer choice quite differently than price promotions and, contrary to the asymmetric price promotion effect documented in the promotions literature, we find that EP benefits an unknown brand more than a known brand. Our hierarchical Bayes approach uncovers heterogeneity in EP effectiveness that can be explained by affinity toward the focal charity, personal motivations, and demographic markers. An identifiable segment of individuals prefer the "other" over "self," suggesting possible EP optimization and segmentation strategies. Two such strategies, customization and coverage, are empirically tested, and the former is shown to be very effective. Our findings have broad implications for brand managers with regard to resource allocation and EP program return on investment (ROI), as well as important social welfare implications.

Key words: embedded premium; sales promotion; consumer choice; hierarchical Bayes; ROI; cause-related marketing

History: This paper was received January 17, 2006, and was with the authors 1 month for 1 revision; processed by Peter Lenk.

Choice-Based Conjoint Example

Attribute	**Levels**
Brand	National Bank, Capital One
Interest rate	9.9% APR, 12.9% APR
Payback percentage	1%, 5%
Payback destination	WHO, WHO & Habitat, charity of choice, cash back

Choice-Based Conjoint
Arora and Henderson 2007

- Respondents indicate their charity preference by selecting one cause from five:
  - American Cancer Society, World Health Organization, Habitat for Humanity, SchoolWise, National Wildlife Federation
- Choice-based conjoint, 16 tasks
- Respondent characteristics
  - Usage, cause affinity, demographics

Example Choice Task

2 *If evaluating a credit card offer with a charitable donation option that lets you decide who receives your money, which one of these five organizations would you choose to support? (click one)

- American Cancer Society
- World Health Organization
- Habitat for Humanity
- SchoolWise (for local schools)
- National Wildlife Federation

Capital One Visa	**Capital One Visa**	**National Bank Visa**
9.9% Fixed APR	**12.9% Fixed APR**	**9.9% Fixed APR**
1% of your monthly charges donated to the World Health Organization and Habitat for Humanity	**1% of your monthly charges donated to the charity you selected**	**5% of your monthly charges credited back to you**
A	B	C

Data Collection

National Internet Survey (n = 495)

- 60% female
- 62% married
- 57% over age 44
- 41% w/ at least bachelor's degree
- 24% w/ household income > $75K

Choice Design Matrix Coding

Nine dummy variables

- Brand [x1] (Capital One = 1)
- Interest rate [x2] (9.9% = 1)
- Level * Payee interaction [x3..x9]

Model Specification

$$U_{ij} = \beta_{1,ij}x_1 + \beta_{2,ij}x_2 + \beta_{3,ij}x_3 +$$

Capital One 9.9% APR 1% Cash

$$\beta_{4,ij}x_4 + \beta_{5,ij}x_5 + \beta_{6,ij}x_6 +$$

5% Cash 5% WHO 1% Both

$$\beta_{7,ij}x_7 + \beta_{8,ij}x_8 + \beta_{9,ij}x_9$$

5% Both 1% Choose 5% Choose

Business Applications

Cross-Selling

Predicting customer behavior is so difficult that companies spend millions inundating – and alienating – customers. Here's a way to crunch the data that makes it possible to offer customers what they want, when they want it.

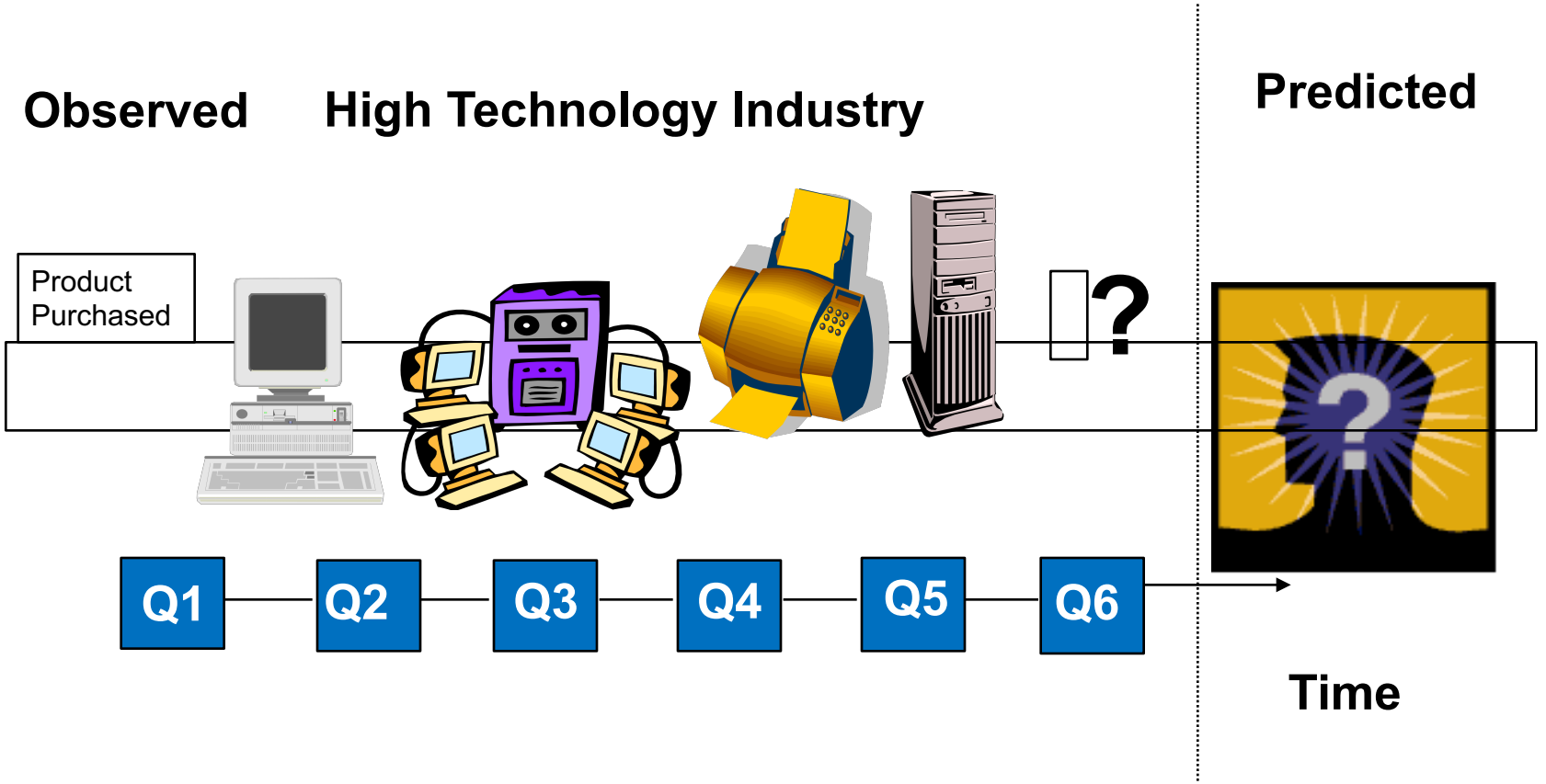
Knowing What to Sell, When, and to Whom

by V. Kumar, Rajkumar Venkatesan, and Werner Reinartz

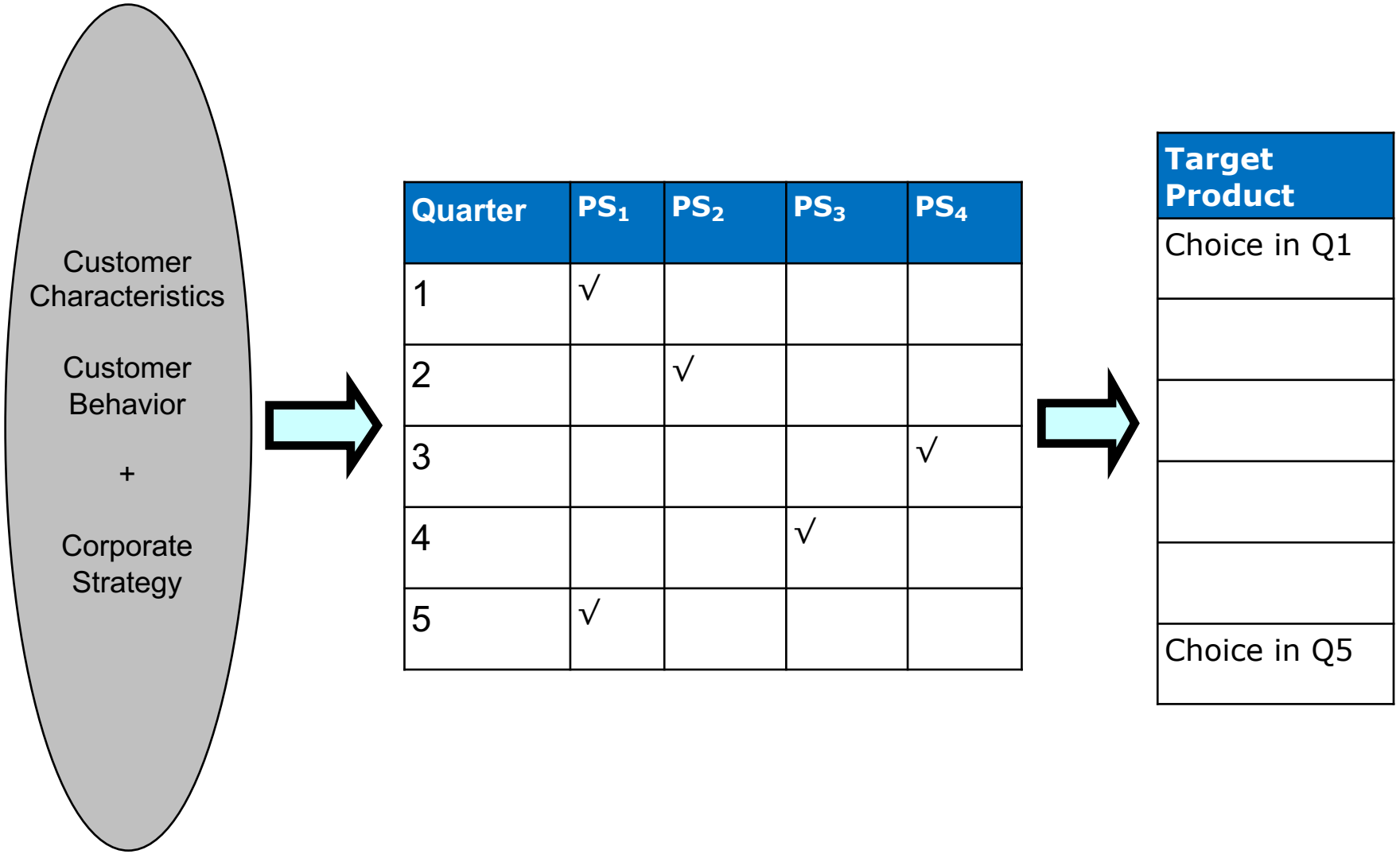
Propensity Modeling for Cross-Selling

- Important to understand when a customer is “ready” for their next purchase.
- Some of this depends on the reality of budget cycles.
- Some of this depends on the complexity of the client’s business.
- But some also depends on some predictable patterns in company behavior that can be modeled.

Research Issue: Purchase Sequence



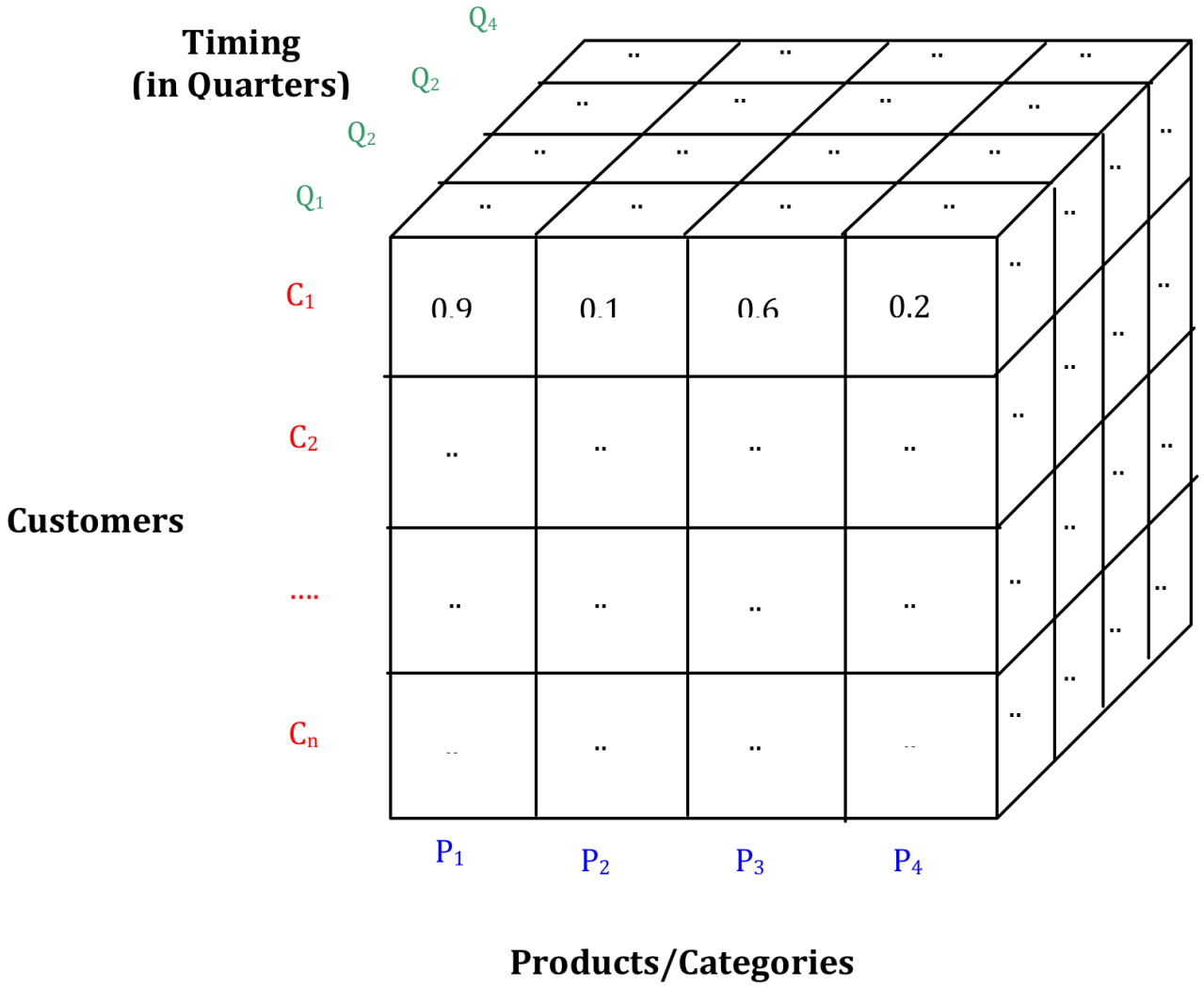
Multiple Product Adoption



Quarter	PS_1	PS_2	PS_3	PS_4
1	√			
2		√		
3				√
4			√	
5	√			

Target Product
Choice in Q1
Choice in Q5

Customer Profitability Cube



Customer Development—Marketing Sales Interface

Year over Year Changes from Implementing a Customer-Focused Sales Force

	Lift in Test Group	Test Group: Customer-Focused Sales Campaign	Control Group: Product-Focused Sales Campaign
Financial Metrics			
Revenue ($)	204%	1,828*** (15,710)[b]	898* (15,263)
Number of Contacts before Purchase	-4%	-4** (11)	1 (11)
Profits ($)	4%	3,734*** (9,519)	890* (8,694)
Return on Investment	1538%	2*** (1.5)	0.13 (1.3)

b Values in the parentheses represent the levels in the pre-experiment time period.
c The Relational Metrics are measured in a 10-point interval scale, where 10 represents Completely Agree and 1 represents Completely Disagree.
* Significant at α = 0.10, ** Significant at α = 0.05, *** Significant at α = .01

Kumar, Venkatesan, and Reinartz. Journal of Marketing, 2008.

Conclusion

Conclusion

- Multinomial logit regressions are used when consumers choose one out of many options. Typical examples include brand choice in grocery stores.
- Similar to the propensity models, multinomial logit regressions also follow the utility theory of consumer behavior.
- Conjoint analysis is a major application of multinomial choice.
  - A conjoint analysis allows the researcher to evaluate trade-offs consumers make among different features of a product, including price and brand name.
- Cross-selling or predicting the next product to buy is another application of multinomial logit regressions.