

Discrete-Choice Models

What is discrete-choice modeling?

Discrete-choice modeling (DCM), sometimes called qualitative choice modeling, is an exciting new statistical technique sweeping the world of market research. DCM looks at choices that customers make between products or services. By identifying patterns in these choices, DCM models how different consumers respond to competing products. DCM allows marketers to examine the share impact of product configuration, service bundling, pricing and promotion on different classes of customers. For the first time, businesses have a quantitative tool for designing and pricing products to optimize competitive advantage.



Who uses DCM?

Although a difficult technique to put into practice, DCM has found its way into a variety of settings. Automotive manufacturers use DCM to forecast demand for new models and alternative-fueled vehicles. Telephone companies use DCM to configure new products, bundle and design rate structures for communication services. Wall Street companies use DCM to help configure financial packages. In California, regulators require that electric utilities use DCM to measure the effectiveness of conservation programs. The Australian government has used DCM to forecast attendance at large-scale sports and cultural events.

At Strategy Analytics we pioneered combining DCM with diffusion analysis to estimate both potential demand and likely adoption patterns for new products. We also developed techniques for translating model results into potential profit. We continue to apply the technique in new and exciting ways that provide fresh insights into competitive markets. Recent studies include:

- For IBM, we conducted an international study of the demand for laptop computers. IBM used the model we developed to reconfigure their product line to target various country-specific market segments.
- For digital Corp. we conducted a similar study testing new laptop product concepts across international markets.
- For AT&T wireless, we developed a model to assess demand for proposed wireless communication services.
- For Southwestern Bell (now SBC Communications), we combined DCM with a variety of leading-edge market research techniques to assess the demand for multimedia services delivered via fiber-optic cable.
- For Nynex, we conducted two separate studies: one to help them price ISDN services, another to estimate potential demand for PBX disaster-prevention modules.
- For National Semiconductor, we modeled potential demand for network interface cards.
- For Motorola, we modeled potential demand for 2-way pagers and related services. In a separate engagement we studied brand equity, feature selection and market segmentation for cellular handsets.
- For Mitsubishi, we recently completed a demand model for intelligent cellular telephones and related services.

- For Edmonton Telephone, we assessed Canadian demand for personal communication (PCS) services.
- For France Telecom, we modeled English, French and German demand for 3G services using advanced cellular technologies.

Who developed DCM?

DCM was developed in parallel by economists and cognitive psychologists. In the late 1970's, Dan McFadden, now at the University of California, Berkeley, developed the statistical estimation techniques that enabled widespread application of DCM. Dr. McFadden went on to win the 2000 Nobel Prize in Economics for this achievement. At about the same time, Moshe Ben-Akiva at M.I.T. published a Ph.D. dissertation on the subject. Jordan Louviere at the University of Utah, Don Anderson at the University of Arizona, and David Bunch at U.C. Davis helped develop original designs for DCM choice experiments.

Ben-Akiva, Train and McFadden conduct annual seminars on DCM at M.I.T. and Berkeley. The first two also wrote leading texts in the field:

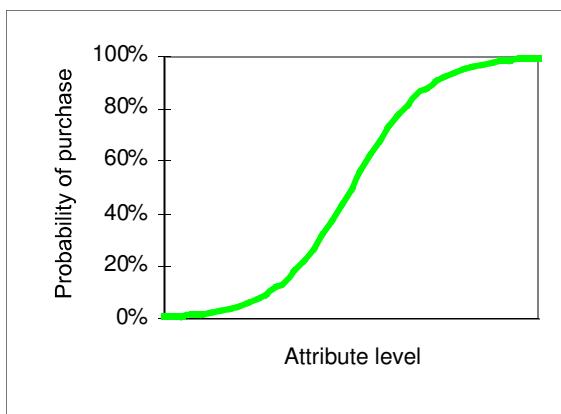
- Train, Kenneth (1986) *Qualitative Choice Analysis: Theory, Econometrics, and an Application to Automobile Demand*. Cambridge, MA: The MIT Press.
- Ben-Akiva, M. and S.R. Lerman (1985) *Discrete Choice Analysis: Theory and Application to Travel Demand*. Cambridge, MA: The MIT Press.

What is the theory behind DCM?

To some degree, all purchases involve choice. Shoppers choose among competing products or groups of products. They also choose to buy now, later, or not at all. Similarly, purchasing managers choose among suppliers, and companies choose among investment opportunities. Each of these circumstances involves choice. In some cases, the set of alternatives and the cognitive process employed in choosing are complex. Human behavior is especially complex. So much so that it is probably impossible to understand completely what lies behind a single individual's purchase decision.

However, while it is impossible to say for sure what one person will do, one *can* draw inferences from the pattern of choices that groups of people make. As an analogy, take a coin. If you flip a coin once, you cannot tell for certain whether it will turn up heads or tails; but if you flip it many times, you can be reasonably certain that the flips will be half heads and half tails. By observing many flips, you can infer a probability of 0.5 for heads and 0.5 for tails.

Likewise, by observing many consumers' choices, you can infer the probability of purchasing a given product based on the product's characteristics, pricing and the socio-demographic characteristics of the consumer.



How does a DCM study work in practice?



The first step in a DCM project, especially when studying a new product, is to conduct focus groups to identify the product's key buying factors. Focus groups explore consumers' motivations in detail and let us develop hypotheses about how consumers go about choosing one product over another. These hypotheses are later amplified and tested in the quantitative phase of the study. In addition, focus groups allow us to hear customers' impressions of products, programs, services, institutions, or other items of interest. Such impressions can be useful in suggesting ways to communicate product benefits or develop creative product concepts.

The next step involves testing hypotheses from the focus groups in an experimental setting. This step presents us with two options, both of which involve surveys. The first option, particularly useful for existing products, consists of surveying potential customers to observe what they buy or have bought. Economists call these exercises *revealed preference* studies. An advantage to this option is that observations are based on actual market conditions. They don't suffer from the discrepancies between purchase intention and purchase behavior often found in market research.



The second option presents subjects with a set of choice experiments. In these experiments, we describe a hypothetical marketplace containing a set of products and ask subjects what they would do. They can choose to buy a product, choose not to buy, or choose to buy at a later time. We then vary the pricing and other characteristics of the products according to an experimental design and ask them to choose again. Economists call these exercises *stated preference* studies.

An example from a stated-preference questionnaire appears below. By carefully designing choice experiments,

Option:	A	B	C
Device:	Cellular phone	New cordless phone	I would not choose either of these
Means of acquisition:	Purchase	Rent	
Device cost:	\$5	\$10 per month	
Monthly service charge:	\$10	\$20	
In-region cost per minute:	20¢	No charge	
Out-of-region cost per minute:	20¢	75¢	
Minimum commitment:	1 month	18 months	
Brand:	A	B	
Free minutes:	None	20 minutes	

Free nights and weekends:	Yes	No	
---------------------------	-----	----	--

we can get a good feel for how subjects make trade-offs between product characteristics and budgets.

Conducting experiments such as this yields a number of advantages. First, we are not limited to examining the set of attributes that appear in real markets; we can explore a range of product characteristics far outside of what actually exists. Such characteristics might include product style, brand impact, perceived quality, performance, shelf space, effects from promotion and advertising, and many others.



Second, we can manipulate the design to ensure that we get a diversity of opinions, across both products and classes of people. Demand for a product might differ for older vs. younger people. It might also vary by education, income, or a variety of other factors. Information from the focus groups in step one helps identify some of these factors. The quantitative analysis in step two allows us to test them more rigorously.

For new products, we are often limited to stated-preference experiments, since no comparable products exist in the marketplace. When products under study do exist, we often use revealed-preference data to calibrate results from stated-preference experiments. This helps ensure that the resulting models track purchase behavior rather than intention.

Once data have been collected, the final step is to build a computer model using complicated statistical techniques. The model-building process itself usually yields answers to some important questions. What are the key market segments for the product, and how price sensitive are they? How much is brand name worth to a product? What advertising or promotional activities appear most effective? Where should we target our efforts?

What are the deliverables from a DCM study?

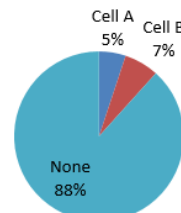
DCM studies typically generate two deliverables. The first is a report containing marketing recommendations based on the preceding analysis. The second is a computer-based simulation model that lets you construct

PCS		Created by StatWizards®	
Residential Market Simulator		Simulator version: 14.1	
Directions: 1. Enter assumptions in the blue input areas.			
2. In the Product Marketplace, describe the packages you want to simulate.			
3. View results in the pie chart and summary cells.			
4. For help on a topic, move mouse over a cell with a red triangle in the corner.			
5. For online help using the simulator's features, click here .			
Scenario Name			
Basic			
Assumptions		Product Marketplace	
Target market size (000):	216,917	Package name:	Cell A
Units:	Persons	Phone type (C,P):	C
		Device cost:	\$100
		Rent or purchase (R,P):	P
		Monthly service charge:	\$40
		In-region cost/minute:	\$0.25
		Out-of-region cost/minute:	\$0.45
		Minimum commitment (mo.):	12
		PCS device name:	
		Brand (A,B):	A
		Free minutes:	0
		Free nights & weekends:	Y
		Adjustment factor:	
		Potential market share:	5.1%
		Potential market (000):	125.2
		Potential device revenue (\$MM):	\$12.5
			6.6%
			162.6
			\$24.4

Package Name

■ Cell A ■ Cell B

■ None



hypothetical scenarios in which you can test product, pricing and gaming strategies. The illustration below contains an example based on an actual client study. The example is in the form of a Microsoft Excel spreadsheet. Using this spreadsheet, you can simulate penetrating a specific regional market that has a particular set of customer demographics. You can also simulate the presence or absence of competing products with pricing and attributes that you describe. Given this information, the model calculates the size of the potential market and market share. We can provide a copy of this demonstration spreadsheet on request.

You will likely need support to use and interpret the model. Individuals familiar with standard computer software will require less support than others will. In the past when we have shown sales and marketing veterans how to use the model, they have been impressed with how well it tracks their experience.

How can I use the results?

Results from DCM studies apply to a variety of situations that fall under two categories: strategic planning and tactical marketing decisions. Strategic applications are those which involve overall plans of action. These include:

- Identifying critical success factors for a new product or service.
- Estimating the total potential market for a new product or service.
- Segmenting a market based on customer needs.
- Conducting regional demand analysis.

Tactical applications involve actions designed to achieve strategic objectives. These include:

- Configuring products or services to meet competitive threats or opportunities in the marketplace.
- Determining the optimum pricing and/or price structure for a product.
- Positioning a product *vis a vis* competitors.
- Exploring ways to respond to actions by competitors.
- Assessing the value of branding or re-branding a new product.

These applications are only highlights. Many other uses for DCM tools await discovery.

How long does it take?

A typical DCM project takes about five working weeks to execute. Variations in a project's scope can cause this estimate to lengthen or shorten. For example, the logistics of conducting focus groups in different cities across the country will lengthen the project. Conversely, using a smaller sample size will shorten it.

How much does it cost?



Costs for DCM projects span a range from about \$25,000 to \$50,000. The reason for such variation lies in the flexible scope of projects. Examining demand for a completely new product for which no precedent exists will typically require more focus groups at \$5000 each. Where regional markets are likely to differ, focus groups may have to be repeated at key regional centers. For established products where we or our client has a good feel for key buying factors, the number of focus groups can be reduced or eliminated.

Likewise, there is a fair amount of flexibility in designing the quantitative phase of a DCM study. Here you establish the tradeoff between cost and precision. A larger sample size gives you greater precision, but costs more; a smaller sample size is cheaper, but the risks of getting a non-representative sample, greater. How the data are collected also affects costs. Where feasible, collecting data via the Internet using standing panels offers significant cost savings over traditional recruitment methods. Overall, then, the nature of each project determines the scope and cost of fees. Working together, we can help design a cost-effective scope that meets research objectives.

Importantly, the returns on investment in DCM research has historically returned huge gains, because the analysis helps firms precisely position and price products and services at launch. ROI's of 10 to 100 *times* the amount spent on research are common, not to mention a number of potentially disastrous investments that were averted.

* * *

In summary, discrete-choice modeling is rapidly becoming a major weapon in the market research arsenal. Its ability to squarely address very expensive business problems will assure its importance for years to come.