

## MEASURING CUSTOMER REACTIONS TO PRICES

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In this lecture we learn both how to price new products by using survey tools, and how to improve pricing of existing products by measuring price elasticities.

TABLE 1. Price Measurement Matrix

Variable Measured	Uncontrolled	Experimental Improvement
Pricing for the first time	Surveys	Conjoint
Improving existing pricing	Historical Sales Data (Scanner/Store)	Field-Tests

## 1. UNCONTROLLED PRICE SURVEYS

Very early in the development of survey techniques for marketing, researchers learned that it was futile to ask consumers outright what they would be willing to pay for a product.

*The Strategy and Tactics of Pricing, Nagle and Hogan*

**1.1. Unstructured Questions.** The most obvious way of finding out customers' feelings about price is to ask them a question like 'How much should this can of Coke cost?'. Such a question has problems from the outset, because the question does not demand that the customer actually buy the can of Coke. Instead it conflates 'price awareness' with willingness to pay.

**1.1.1. *Van Westendorp's Price Sensitivity Meter.*** Marginally better is: 'How much would you be willing to pay for a can of Coke'? This type of price questioning is used in a species of pricing research named 'Van Westendorp's Price Sensitivity Meter'. Here, customers are asked:

- At what price would you consider the product too expensive?
- At what price would you consider the product to be so cheap you would not consider it?
- At what price would you consider the product to start to get expensive?
- At what price would you consider the product to be a 'good value'?

This was originally proposed in 1976 as a way of gauging how important the kind of price-quality signal that we discussed in the previous lecture is for a product. However, it has been distorted from its original intention and is commonly used as a way of getting a price range for a product. The lower bound is the intersection of 'too cheap' and expensive. The upper bound is the intersection of 'too expensive' and 'cheap'.

This methodology has been discredited. I suspect its persistent popularity it lies in the facts a) that it produces a figure with intersecting lines that is reminiscent of some kind of demand and supply curve and b) 'Van Westendorp' had an impressive sounding last name.

Problems in general with open-ended questioning approach:

- The problem with this is that a customer will almost always say: it depends. After all, my willingness to pay for a can of Coke would probably vary from \$.20 in a supermarket if I was in a hurry and I had plenty of Coke cans back home, to \$5 if I was in a hotel room and the only place I could get a drink was from a hotel minibar.
- People are not very good at this kind of open-ended question since we are not called upon to make this kind of judgement often. Suppose you were

given a suitcase and asked to guess how much it weighed. People have a tough time with questions like this. However, when on the other hand people are given two suitcases and asked to say which one is heavier, they get it right 100 percent of the time.

- Lyon (2002) suggests that 20% of respondents say that the price that would be ‘right’ is lower than the price at which they say they would find the product too ‘cheap’ at.
- Such huge price ranges are they give clients an excuse to go with their gut.

1.1.2. *Monadic Pricing Studies.* Monadic pricing studies are a fancy name given to ‘single cell’ pricing research where respondents are asked a single question about a product.

- ‘If a Coke can is priced at \$0.99, how likely are you to buy it?’
- ‘If a Coke can is priced at \$0.99, how likely are you to buy it at the snack-shop at work?’
- ‘If a Coke can is priced at \$0.99, would you buy it at the snack-shop at work?’
- ‘If a Coke can is priced at \$0.99 and Pepsi is \$1.09 at the snack-shop at work, would you buy Pepsi, Coke or neither supposing, you had no soda so far that day?’

This kind of phrasing is less likely to confuse survey-takers as they just have to make a choice rather than naming a price. This would at least get you more accurate answers for your particular setting. One advantage if you test a broad enough range of prices, you can recreate a demand curve.

Potential Problems:

- By focusing the customer’s attention on a reasonable price, you may be censoring extreme responses such as \$5 which may be the basis for profitable segmentation.
- Need a lot of respondents to get an answer. Do not be tempted to use a price ladder, however. Asking follow-up questions such as ‘how about \$0.89?, How about \$0.79?. just lead the customer to behave as though they are negotiating.
- Need to ensure that the question is not overly focused on the price.

1.2. **General issues with price survey techniques.** There are three main flaws to this approach

- (1) Customers may deliberately understate their willingness to pay

- For example, a chemical distributor was told by its customers that they would pay 75 percent less than the market price for waste disposal services.
- Customers may say a price that reflects how they want the person conducting the survey to view them, but does not reflect their actual willingness to pay. For example, Phillips conducted a survey where the teenage participants said they wanted yellow boom boxes. However, when they came to leave the room, they all chose black boom boxes.
- Customers may simply be unsure about their willingness to pay. For example, an American bridal survey found that brides overstated willingness to pay five-fold.

### 1.3. Implementation.

#### (1) In person

- The key is to find the right setting. Rushed settings produce worse data. The best data comes from times when people take time and survey-taking becomes a communal activity.

#### (2) Online

- The problem here is reliability of data. We found that when we asked survey participants what browser they used, 40 percent lied. This figure actually increased when we raised their compensation.

#### (3) Focus Groups

- A crucial problem here is that the incentives of the focus group facilitator can often lead to misleading results and analysis. However, without a facilitator no pricing questions get answered.

## 2. IMPROVING PRICE SURVEYS BY USING CONJOINT ANALYSIS

Choice-based conjoint is a laboratory survey of how customers would value different attribute bundles. It is usually (and best) used for product design.

### 2.1. Conducting conjoint analysis.

- (1) You choose a limited selection of product features to permute in questions. Price should be one of these features.
- (2) Software then gives survey respondents a selection of choices between different product bundles. It is important that you make sure that respondents always have the option not to buy.
- (3) Software then conducts logit analysis and gives regression output.
- (4) The estimates of how much a customer values each product feature can be converted into rough dollar amounts by multiplying by the ratio of the coefficient on price. This allows us to establish EVC amounts.

## 2.2. Conjoint advantages.

- Conjoint analysis reduced the rather artificial focus on price in surveys by including information about features.
- Conjoint output allows researchers to give ‘utility-values’ to various components which can help accurately determine the EVC.
- Quick and relatively cheap

## 2.3. Conjoint disadvantages. Do not use conjoint if

- Customers are likely to take price as a signal of the quality of the attribute. This problem is often severe and means that you need to severely limit the number of attributes. More than 3 is often too many.
- Product features are not well understood by customers.
- Part of a more complex system of related products.

## 3. USING HISTORICAL DATA TO IMPROVE EXISTING PRICING

**3.1. Price Elasticities.** The price elasticity of a product measures the responsiveness of sales to a change in price. Price elasticity is defined as the percent change in quantity sold given a 1% change in price.

This helps analysts figure out whether revenues will be the same, higher or lower after a change in price. If elasticity=1, revenues will be the same from a price change. If elasticity is >1, revenues will be higher with a price decrease. If elasticity <1, revenues will be higher with a price increase.

*On average, price elasticities are around -2, but ‘on average’ is not very useful.*

The standard formula is

$$E_d = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}} = \frac{\Delta Q_d / Q_d}{\Delta P_d / P_d}$$

**3.2. Estimating a constant price elasticity.** One problem with the formula  $\frac{\Delta Q_d / Q_d}{\Delta P_d / P_d}$  for the price elasticity is that it can take two different values for whether  $P$  or  $Q$  are the original or final values. This shouldn’t matter if you are comparing price elasticities across segments and are always consistent about what values you use (for example the value that is used in the denominator, should be the one used to calculate the numerator).

This occurs because we are assuming a linear relationship between price and quantity. One (smart) way of getting around this is by assuming that the demand curve instead has a constant elasticity.

The functional form for a constant-elasticity demand curve is

$$Sales = aP_x^b$$

Taking logs

$$\log Sales = \log a + b \log P$$

We can then use spreadsheet analysis to find the value of the constant  $b$  which summarizes the price elasticity.

**3.3. Spreadsheet analysis.** It is quite straightforward to use a spreadsheet tool like excel to calculate a price elasticity from historical data. The steps are

- (1) Create new columns for log(sales) and log(prices). Use the excel function = LOG() to convert the raw sales data into log form.
- (2) In a new cell, insert the function ‘=SLOPE(known y’s, known x’s)’
- (3) Choose for the known y’s the log of sales, and for the known x’s the log of prices.
- (4) You should get a negative number that represents the price elasticity

One drawback to this procedure is that is not clear how reliable your estimate is. As an alternative you can also use the Data Analysis Add-In for Excel and the ‘Regression’ option to get measures called standard errors (which tell you how precise your estimate is), and R-squared which is a statistic that helps you know how much of the variation in sales is explained by price<sup>1</sup>

#### 3.4. Why is a price elasticity ever useful?

- Relative margins (More on this in our next lecture):

An electronics retailer priced batteries the same all over....[Price Elasticity Analysis] showed the battery that had the highest ”price sensitivity” in Dallas had the lowest price sensitivity in Boston. In other words, while Texans would buy this particular battery only within a narrow price range, Bostonians were far less picky about it. The store altered its prices accordingly, sold more batteries and made more money at it.

*Associated Press, 2007*

- Rule of thumb pricing tool, especially in retail sector with a large number of SKUs. This carries a weighty health warning since you are effectively assuming away your competitors, that you are already optimizing and that you have increasing marginal costs.

$$E_d = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}} = \frac{\Delta Q_d / Q_d}{\Delta P_d / P_d}$$

<sup>1</sup>You can also use the array function LINEST() should you not be able to install the ‘Analysis Add-In.’

Revenue for a firm:

$$\text{Revenue} = P \times Q$$

If they maximize revenue with respect to the quantity they sell:

$$\text{Marginal Revenue} = P \frac{\delta Q}{\delta Q} + Q \frac{\delta P}{\delta Q}$$

$$\text{Marginal Revenue} = P + \frac{\delta P}{\delta Q} \times Q$$

$$\text{Marginal Revenue} = P \left[ 1 + \frac{\delta P}{\delta Q} \times \frac{Q}{P} \right]$$

We can simplify since the price elasticity  $E_d$

$$E_d = -1 / \frac{\delta P}{\delta Q} \times \frac{Q}{P}$$

$$\text{Marginal Revenue} = P \left[ 1 - \frac{1}{E_d} \right]$$

If you are a profit maximizing firm, then you of course set price such that MR=MC.

$$\text{Marginal Cost} = P \left[ 1 - \frac{1}{E_d} \right]$$

Dividing by P and rearranging yields:

$$P = \text{Marginal Cost} \times \frac{1}{1 - \frac{1}{|E_d|}}$$

Let us suppose you estimate a price elasticity of  $E_d = 2$ , then you can calculate a rough mark-up such that your price should be twice cost. If  $E_d = 3$  then price should be 3/2 marginal cost (or a 50 percent mark-up). If demand is only somewhat elastic  $E_d = -1.5$ , then price should be three times cost.

Hint: Use the absolute value of the price elasticity. The formula is already adjusted for it being negative.

Hint: Don't use the formula for price elasticities less than one. In my opinion it does not work well for price elasticities less than 1.5.

### 3.5. Drawbacks of historical pricing analysis.

- (1) Need accurate pricing data
  - For example, the marketing division of a Web server space company faced problems when the sales force didn't keep record of discounts.
- (2) Need variation in price

- A drapes manufacturer could not calculate an elasticity because it had kept the same price for the last 10 years.
- (3) If the data goes back too far it may describe an old scenario. Don't use pricing data more than 5 years old.
- A book catalog company calculated an artificially low price elasticity by including pre-internet-era data.
- (4) Misleading because of changes in other confounding factors
- For example, ice-creams are priced higher and sell better in hot weather. However, if one performs multivariate analysis rather than univariate analysis when calculating price elasticities, it is possible to control for these 'observable' sources of bias.

### 3.6. Ways of improving historical pricing analysis.

- (1) CRUCIAL. Calculate different price elasticities for each type of customer, each region, each product.
- (2) Use more data than just aggregate sales and prices
- DHL employed software that included the reactions of customers who called and got a quote but didn't ship - that is, a failed sale. By including data from this group of customers, they improved their 'quote to book ratio' from 17 percent to 25 percent.
- (3) Use panel data econometrics where you include controls for places and times in your regression analysis. The problem is that this can get very expensive both in terms of personnel and costs of acquiring data.

## 4. IMPROVING PRICING ANALYSIS BY USING FIELD EXPERIMENTS

A lot of the problems with historical data analysis happen because the price changed for reasons that were also associated with changes in sales (for example the weather and ice-cream sales). This can be controlled for by using controlled price experiments. Can be very successful. Ambassadors travel group discovered they had a price elasticity of 0.3 and were able to increase profits by 15 percent.

Usually we tend to think of field tests as being experiments, but new tools such as Google Analytics are actually putting them easily in the reach of firms with smaller budgets.

### 4.1. Challenges with field experiments.

- (1) Ensure will have enough price-variation.
- One experiment I encountered had lowered all prices by 15%, which is only useful if your aim is to drop all prices by 15%.
- (2) If too visible, can anger customers



- Amazon had to refund \$7,000 to angry customers after its DVD pricing experiments were spotted
- (3) Stock-outs or problems with an experimental cell (such as mailing problems) can be detrimental to establishing concrete conclusions.
- (4) Multiple pricing experiments make interpretation of one cell difficult
- Fingerhut runs 30,000 pricing experiments a year, making interpretation of results that involve complements and substitutes difficult.

## MATH APPENDIX

**Mid-point elasticity formula.** If you are concerned about the approximations involved with the simple elasticity formula but are not doing the kind of detailed historical analysis which is amenable to the log transformation, you can use the midpoint elasticity formula.

$$E_d = \frac{\frac{(Q_2 - Q_1)}{(Q_1 + Q_2)/2}}{\frac{P_2 - P_1}{(P_1 + P_2)/2}}$$

$$E_d = \frac{(Q_2 - Q_1)(P_2 - P_1)(P_1 + P_2)}{\times (Q_1 + Q_2)}$$

**Using calculus to move from logs to price elasticity formula.** Our constant elasticity demand function is

$$Q = aP_x^b$$

$$\text{Let } u = \ln Q, v = (\ln p)$$

$$E_d = -\frac{d \ln Q}{d \ln P} = -\frac{du}{dv} = -\frac{du}{dq} \frac{dq}{dp} \frac{dp}{dv}$$

$$E_d = -\frac{d \ln Q}{dQ} \frac{dy}{dx} \frac{de^v}{dv} = \frac{1}{Q} \frac{dy}{dx} e^v = \frac{dy}{dx} \frac{x}{y}$$

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