Basic Quantitative Analysis for Marketing

Simple calculations often help in making quality marketing decisions. To do good “numbers work,” one needs only a calculator, familiarity with a few key constructs, and some intuition about what numbers to look at. This note has as its primary purpose the introduction of key constructs. The development of intuition about what quantities to compute can begin with this note, but is best accomplished by repeated analyses of marketing situations and application of the concepts and techniques presented here. Case study analysis provides that opportunity.

The organization of the note is as follows. First we define key constructs such as variable cost, fixed cost, contribution and margin. Following definition of these basic constructs, we discuss a most useful quantity: the “break-even” volume. We show how to calculate and use this quantity in marketing decision making.

Basic Terminology

As marketers, we are usually concerned with understanding the market or demand for the product or service in question. However, if we are to assess the likely profit consequences of alternative actions, we must understand the cost associated with doing business as well. For example, consider a firm choosing a price for its new videocassette tape. The manager estimates weekly sales for different prices to be

<table>
<thead>
<tr>
<th>Weekly Sales Estimate</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 Units</td>
<td>$7.50</td>
</tr>
<tr>
<td>700 Units</td>
<td>6.00</td>
</tr>
<tr>
<td>1,000 Units</td>
<td>5.00</td>
</tr>
</tbody>
</table>

Which price is best for the firm? From the data given so far, we cannot answer the question. We can calculate the expected revenue generated by each pricing strategy, but without cost information, it is not possible to determine the preferred price. This is the reason we begin this marketing note by considering key cost concepts.

The cost concepts we introduce are variable cost, fixed cost, and total cost. Second, we combine the cost information with price information to determine unit contribution and total contribution. Figure A shows the relationship between a typical firm’s unit output and total cost of producing that output.
The first important feature of Figure A is that the total cost line (the solid line) does not go through the origin, i.e., for a zero output level, total cost is not zero. Rather, total cost is OA dollars as shown by the length of the double headed arrow in Figure A. We call OA the firm’s “fixed costs.” Fixed costs are those costs which do not vary with the level of output. An example of a fixed cost is the lease cost of a plant. The monthly lease fee is set and would be incurred even if the firm temporarily suspended production.

Figure A  Total Cost as Function of Output

Although OA dollars are fixed, a second component of cost, called “variable cost,” increases as output increases. As we have drawn Figure A, total costs increase in a linear fashion with output produced. In reality, it is possible for the total cost curve to be as shown in either Figure B or Figure C. Figure B represents a situation where each unit is cheaper to produce than the previous one. This would occur, for example, if the firm could buy raw material at lower unit prices as the amount it bought increased. Figure C shows the opposite situation, i.e., each unit is more expensive to produce than the previous one. This might happen if the firm faced limited supply of inputs and had to pay higher unit prices as its demand increased.

Figure B  Cost Increasing at Decreasing Rate

Figure C  Cost Increasing at Increasing Rate

While many real world examples of Figure B and C type of situations exist, we will typically be making the assumption that Figure A is a good enough approximation of actual cost behavior. The
total cost line drawn in Figure A is special, because it represents the case of each unit costing the same. Thus, for Figure A, we can write

\[
\text{Total cost for output level } V = \text{Fixed cost} + \text{Total variable cost for output level } V = \text{Fixed cost} + [k \times V] \quad (1)
\]

In Equation 1, \( k \) is the cost of producing one more unit of output. It is the slope of the total cost curve in Figure A and does not change over the range of output shown. In summary, one can divide the firm’s total cost into two parts: fixed cost and variable cost. Second, we will frequently assume that the cost of producing an additional unit of output does not change, so we can write the variable cost as \( k \times V \) where \( V \) is total output.

Having defined total, variable, and fixed cost, we can now introduce the concept of contribution. If \( k \) is the constant unit variable cost and \( P \) the price received for the good or service, then we define

\[
\text{Unit contribution (in dollars)} = P - k \quad (2)
\]

If \( V \) is the total number of units the firm sells, then

\[
\text{Total contribution} = (P - k) \times V \quad (3)
\]

That is total contribution equals unit contribution times unit volume sold.

If we take the \( V \) in Equation 3 inside the parentheses, we obtain

\[
\text{Total contribution} = \frac{PV}{T} - \frac{kV}{T} = \frac{PV - kV}{T} \quad (4)
\]

Thus total contribution is the amount available to the firm to cover (or contribute to) fixed cost and profit after the variable cost has been deducted from total revenue.

Let’s solidify our understanding of these definitions by working through the videocassette tape pricing problem. Suppose the unit variable cost \( k \) is $4; then assuming the sales forecasts for each price level given above are correct:

Price = $5

| Unit contribution | = \( P - k \) = \$5 - \$4 = \$1 |
| Total contribution per week | = \( (P - k) \times V \) = \$1/unit \times 1,000 \times 1,000 units/week = 1,000/week |

Price = $6

| Unit contribution | = \$6 - \$4 = \$2 |
| Total contribution per week | = \$2/unit \times 700 units/week = \$1,400/week |

Price = $7.50

| Unit contribution | = \$7.50 - \$4 = \$3.50 |
| Total contribution per week | = \$3.50/unit \times 600 units/week = \$2,100/week |

Since, by definition, the fixed cost associated with each output level is the same, the firm is best off by charging $7.50 since of the three possible prices $7.50 maximizes the total contribution. Demonstrate to yourself that if the unit variable cost were $1, the firm would be better off at the $5 price.
Margin Calculations

The term “margin” is sometimes used interchangeably with “unit contribution” for a manufacturer. Margin is also used to refer to the difference between the acquisition price and selling price of a good for a member of the channels of distribution. For example, consider Figure D, in which we have the videocassette tape manufacturer selling through a wholesaler, who in turn sells to retailers, who then sell to the public. Each of the three members of the channel of distribution (manufacturer, wholesaler, retailer) performs a function and is compensated for it by the margin it receives:

\[
\text{Manufacturer's margin} = \text{Manufacturer's selling price to distributors} - \text{Manufacturing cost} = $7.50 - $4.00 = $3.50
\]

\[
\text{Wholesaler's margin} = \text{Wholesaler's selling price to retailers} - \text{Price paid to manufacturer} = $8.70 - $7.50 = $1.20
\]

\[
\text{Retailer's margin} = \text{Retailer's selling price to consumers} - \text{Price paid to wholesaler} = $10.00 - $8.70 = $1.30
\]

So the dollar margin is a measure of how much each organization makes per unit of goods sold.

**Figure D** Price and Cost at Levels in the Channel of Distribution

- **Manufacturer**
  - Manufacturer cost: $4.00
  - Selling price to distributors: $7.50

- **Wholesaler**
  - Purchase price from manufacturer: $7.50
  - Selling price to retailers: $8.70

- **Retailer**
  - Purchase price from wholesaler: $8.70
  - Selling price to consumer: $10.00

- **Consumer**
  - Purchases from retailer at $10.00

The unit contributions and margins we have presented so far have all been in dollar terms. It is sometimes more useful to state margins in percentage terms. Consider the retailer in Figure D, who makes a $1.30 margin for videocassette tapes. Are all items offering the retailer a $1.30 margin equally attractive to the retailer? For example, would the retailer be interested in stocking a color television that retails for $300 if he or she has to pay $298.70 for it? The color TV offers the same $1.30 margin. Yet, intuitively, it seems the retailer would not view the $1.30 on the color TV as acceptable, whereas he or she might view the $1.30 on the tape as acceptable. In short, items offering the same dollar margin are not necessarily equally attractive. Often, margins in percentage terms are more useful.
We define the retailer’s percent margin as

\[
\text{Retailer’s percent margin} = \frac{\text{Selling price to consumers} - \text{Purchase price from wholesaler}}{\text{Selling price to consumers}} \quad (5)
\]

Note that in the denominator of Equation 5, we have the selling price to consumers. It would have been as logical to put purchase price from wholesaler there instead. It is only by convention that we divide by the selling price. For any member of the channel, we will always compute “its percentage margin by dividing its dollar margin by the price at which it sells the goods. While this is the common definition and we ‘will use it in all the cases and discussions, you should understand that this convention is not universal. Thus, you may encounter situations where an alternative convention is followed, and you must be alert to the distinction.

From Equation 5 and the numbers in Figure D, we see that

\[
\text{Retailer’s percent margin} = \frac{10.00 - 8.70}{10.00} = 13\%
\]

Using similar logic, you should be able to show that manufacturer and wholesaler percent margins from Figure D are 46.67 percent and 13.79 percent respectively.

**Break-Even Volume—Mechanics**

Perhaps the single most useful summary statistic one can compute from quantities defined above is the break-even volume (BEV). The BEV is the volume at which the firm’s total revenues equal total cost; below BEV, the firm has a loss; above BEV, the firm shows a profit. Figure E presents some example data. BEV calculation answers questions such as, if the firm charges $7.50, how many units must be sold to cover costs? We can obtain the answer by drawing a total revenue line as in Figure F. The point at which the total revenue line cuts the total cost is BEV. For volumes below BEV (to the left of BEV on Figure F), the firm runs a loss; for volumes above’ (to the right on Figure F), the firm shows a profit.

**Figure E**  Total Cost Line with Fixed Cost = $2,000 and Unit Variable Cost = $4
Figure F  Cost, Revenue, and Break-Even Volume

We can derive the BEV algebraically from the fact that at the BEV, total cost and total revenue are equal.

\[
\text{Total revenue} = \text{Total cost} \quad (6)
\]
\[
\text{Price} \times \text{BEV} = \text{Fixed cost} + (k \times \text{BEV})
\]

Solving Equation 6 for BEV, we obtain

\[
\text{BEV} = \frac{\text{Fixed cost}}{\text{Price} - k} = \frac{\text{Fixed cost}}{\text{Unit contribution}}
\]

Hence, for the example of Figure F

\[
\text{BEV} = \frac{\$2,000}{\$3.50/\text{unit}} = 571.43 \text{ units}
\]

Break-Even Volume—Applications

So, the BEV calculation is simple. Simplicity plus relevance are the characteristics which make BEV so frequently warranted in case analysis. BEV can be of help in making decisions about unit contribution (through price or variable cost changes) or the appropriate level of fixed costs for a business. We now demonstrate each.

First, with respect to unit contribution, let us carry the videotape manufacturer example a little further. We have shown that at a price of $7.50, BEV is 571 units. Since

\[
\text{BEV} = \frac{\text{Fixed cost}}{\text{Unit contribution}}
\]

a price change impacts the BEV. For example, with price at $7, the BEV increases to 666.66 units. At $8, it decreases to 500 units. Figure G shows the BEV for various price levels. All price/volume combinations of the “iso-profit curve” offer the same profit, i.e., zero. From the perspective of a pricing decision, the decision maker may say: “Do I have a better chance of trying to sell 2,000 units at $5 or trying to sell 333.33 units at $10?” Notice that for our example cutting the price in half (from $10 to $5) would necessitate a six-fold increase in volume to be worthwhile for the firm. The reason for this, of course, is that this price cut would reduce the unit contribution from $6 ($10 – $4) to $1 ($5 – $4).
Taken with some sense of the market size and competitors’ positions, this analysis can be very useful in narrowing the feasible price range for the product.

Before considering fixed cost changes, we should note that this type of analysis can be done for any given level of profit as easily as the break-even level. For example, if the firm’s goal is to make $1,000 per time period in addition to covering its fixed cost, then we can determine the volume required to achieve that goal given any particular price. All the points on the “isoprofit curve” in Figure G have the property that the (Price – V.C.) x Volume = $2,000, which is our fixed cost level. If the firm wants to make $1,000 per time period in addition to covering the $2,000 fixed cost, the relevant set of points becomes those satisfying (Price – V.C.) x Volume = $2,000 + $1,000 = $3,000. For any given price, the required volume is ($3,000)/(Price V.C.). Figure H shows these points along with the “break-even” curve of Figure G.

**Figure G**  Price and Associated Break-Even Volumes

BEV is also useful in analysis of proposed changes in fixed costs. First, it can be used to aid in the decision of whether a new product should be marketed at all. For example, consider a firm which estimates the initial setup costs for plant and equipment and initial advertising outlays required to enter the market to be $3 million. The firm also believes that unit contribution from the product will be about $1,000. Should the firm enter the market? By BEV type of analysis, it is easy to see that the firm must sell 3,000 units just to cover its initial investment. Combined with some knowledge about total market size and competitive offerings, this analysis may suggest whether or not the $3 million investment should be made.

**Figure H**  Curves for Break-Even and $1,000 Profit
Second, the question of proposed changes in the fixed costs of marketing an existing product can be analyzed. For example, a proposition is made to the tape manufacturer that a $300,000 advertising campaign be undertaken. Should the firm do it? Following the BEV logic and assuming a $7.50 price, we can see

\[
\text{Incremental volume required to justify expenditure} = \frac{\text{Incremental expenditure}}{\text{Unit contribution}}
\]

\[
= \frac{\$300,000}{\$3.50/\text{unit}}
\]

85,714 units

So for the $300,000 advertising expense to be justified, the decision maker would have to believe that the expenditure will generate incremental volume of almost 86,000 units.

Using the Numbers

In this note we have shown how one can calculate a quantity given other quantities. Essentially, we showed how to translate some facts or estimates into other facts/estimates. This translation process is useful if the end result is a fact/estimate which is suggestive of what one should do as the manager. For example, we put together a fixed cost of $2,000 (is this good, bad, or indifferent?) and a unit contribution of $3.50 (is this good, bad, or indifferent?) to come up with a break-even volume of 571 units (is this good, bad or indifferent?)—in the hope that the answer to the third question wouldn’t be “indifferent” even though it’s likely that’s what the first two answers would be.

What makes one able to say if 571 units is good or bad? To be able to say it’s good or bad, you have to have some other number in your head to compare it to. For example, if the total market for the product is estimated at 500 units, 571 is bad. If it’s 50,000 units, 571 represents only a 1.14 percent share, so maybe 571 is good.

The key point is this: numbers have meaning only when there is some benchmark to compare them to. In marketing, such benchmarks are developed from understanding the market size, growth rate, and competitive activity. The finding BEV = 571 is, in and of itself, useless unless combined with other information to provide a meaningful context.

As noted at the outset, useful numbers work requires intuition about what quantities to calculate. This short note does little to develop that intuition. Our goals were more modest, i.e., to specify terminology, mechanics, and suggest potential applications. The goal of the quantitative analysis must always be kept clear: to help in making marketing policy decisions.