CHAPTER 3

Introduction to Financial Analysis of Revenue Management Decisions

Management accounting and economics provide many of the tools needed to analyze revenue management proposals. In this chapter, we introduce several concepts and techniques. Chapter 7 provides further discussion.

Revenue management had its beginnings in an environment where added revenue was considered equivalent to added profit. The airline industry, credited as the originator of revenue management, had a cost structure that included substantially all fixed costs. Thus, any increases in revenue from selling seats that would otherwise be empty was deemed to fall almost entirely to the pretax bottom line. Further, the motivation for the initial application of revenue management was not profit growth, but protection from new competition by upstart, low-fare airlines. A secondary motivation was to sell expiring seat capacity at discount prices to incrementally increase revenue.

The early expansion of revenue management techniques usually was found in industries that were characterized by the traditional five *conditions* for the use of revenue management, namely (1) relatively fixed capacity, (2) perishable service capacity, (3) high fixed costs and low variable costs, (4) demand patterns that are uncertain or vary with time, and (5) ability to forecast demand.[1] Given these conditions, increased revenue could still be viewed as approximately equal to increased pretax profit.

As revenue management matures and broadens its applicability to all types of industries, profit considerations need to play a greater role in its literature. While the nominal goal of revenue management is to increase revenues, the real goal is to increase revenues *and* profits. In some cases,

profits may be increased by decreasing revenues, but we save that topic for Chapter 12 on customer assessment. Revenues are real and measurable, but profit is an accounting construct, subject to the rules, conventions, assumptions, and alternatives of measuring and allocating costs.

This chapter outlines considerations that are involved in assessing the profit outcomes of revenue management decisions.

How Is Profit Defined?

Profit can be measured for various purposes, and each purpose typically has its own set of rules and conventions. For purposes of revenue management—with emphasis on the word *management*—the primary concern may not lie with external financial reporting profit or taxable profit. These measures are firm-wide, and are subject to very precise measurement rules. While ultimately we desire that revenue management decisions positively impact firm-wide results, these measures are often not sensitive enough to evaluate decisions at the microlevel. Further, new standards for revenue recognition recently adopted by both the International Accounting Standards Board and the Financial Accounting Standards Board in the United States are likely to complicate the external reporting issues.

Thus, a management accounting concept of profit seems most suitable. Such a measure can be applied on a disaggregated basis, such as product lines or geographical regions, and can incorporate a broad set of measurement tools, as appropriate to the decisions at hand. Such measures help to isolate the effects of particular revenue management decisions.

When Should Profit Be Assessed?

A profit assessment should be part of the planning and decision analysis stage. This requires estimates of the likely impact of a price concession (or other revenue management techniques) on demand, including its use by existing customers and new customers, the expected future outcomes of such pricing (retention of new customers, customer satisfaction or dissatisfaction, etc.), and the added costs of the decision.

A second profit assessment should occur after the revenue management action has been in place, comparing the actual outcomes to the outcomes anticipated in the decision analysis stage. If the revenue management action is for a limited time, a profit assessment at the end of that time may be adequate, although effects may continue after the promotion is completed. If the revenue management action is ongoing, periodic profit assessments are in order. Postaudit is always relevant as an assessment of past decisions.

Cost Terminology

As noted earlier, initial applications of revenue management occurred in the airline industry, where the marginal cost of serving an additional customer was negligible. Thus, added revenue was virtually equivalent to added profit. The expansion to other industries where some marginal costs existed, but the cost structure was still largely fixed, did not present great problems, as such costs could either be netted against the added revenue or, in some cases, ignored entirely.

Costs are often classified by their behavior with respect to changes in sales volume. *Variable costs* are those that change proportionately as volume changes, up or down. Thus, a 10 percent increase in sales volume would cause a 10 percent increase in variable costs. *Fixed costs* are those that do not change at all as volume changes, within some range of activity. It is recognized that if volume increases enough, some additional fixed costs, such as facilities, equipment, and personnel, might be required. Increases to fixed costs are typically in fairly large increments—for example, the cost of an additional machine or additional employees—and the resulting cost pattern appears as a series of *steps*. That is, the costs are unchanged for some range of sales activity, then jump to a higher level and remain there for some range of activity, and so on. While the classification of costs as either *variable* or *fixed* is convenient for basic analysis, certainly not all costs behave in these exact manners. The term *mixed cost* is used for a cost that increases as volume increases, but not proportionately. Often, a mixed cost can be decomposed into a fixed component and a variable component.

Another important set of cost terms comes from economics, where costs are classified as *total*, *average*, or *marginal.* The term *total costs* represents aggregate costs—both fixed and variable—for some level of activity. *Average costs* are total costs divided by the level of activity. *Marginal costs* measures the change in costs for a given change in the level of activity. Marginal costs are commonly employed in decision analysis. In general, average costs are different from marginal costs and should not be used for decisions. When total costs contain a large amount of fixed costs, average costs are particularly misleading as a decision metric.

Assume that a hotel has an average occupancy of 200 rooms per day. Total operating costs for the hotel—building, furnishings, utilities, personnel, insurance, repairs and maintenance, and so on—are determined to be $18,000 per day. The average cost for a room is thus $90 (= $18,000/200). Now suppose an additional 10 rooms are occupied on a given day. Will costs increase by $900 (= 10 × $90)? No. Many of the aforementioned costs will not change as a result of the additional occupancy. To analyze a decision to rent the additional 10 rooms at a discounted price, the relevant question is what will be the marginal cost, not the average cost. The marginal costs are likely to be much less than $90 per room, involving perhaps a few more hours of maids' time, some extra laundry, and consumable supplies. Assume that these costs are estimated to be $15 per room per day. Note that the average cost of a room for that day would fall to $86.43 (= $18,150/210 rooms). The average cost is not a stable number; it is likely to be different at each level of activity.

The terms *variable costs* and *marginal costs* are sometimes used interchangeably, but they are not the same thing. Certainly, marginal costs will include any variable costs, but some fixed costs may be included as well. Suppose a restaurant runs an ad promoting a *restaurant week* special of certain dinners for $20.15, and 100 such dinners are served. The marginal costs will include not only the variable costs connected with the dinners (food, etc.) but also the fixed cost of the ad.

Cost Structure

Proper analysis of revenue management decisions requires a careful analysis of cost structure to determine the fixed and variable components.

Depending on both the business process involved and the time frame being considered, the same business's cost structure may be different in different settings.

First, as to the business process, the question is, which part of the firm's revenue function is under consideration? If hotel room pricing is the issue, then the relevant costs are those associated with providing overnight accommodations, and not, say, those connected with the restaurant or banquet rooms. Thus, a cost function is needed for each business process; using the firm's overall cost function generally does not suffice. Separating costs by process can be problematical, as one faces the question of how to handle costs that serve multiple functions.

Second, as to time frame, the question is, what is the time period over which the revenue modification is expected? For hotel room pricing, it may be a single night and for airline pricing, a single flight (or pair of flights, including return). The shorter the time frame, the more costs that are fixed and the fewer that are variable. It is said that, in the long run, all costs are variable. Given enough time, any factor of production can be modified. But the shorter the time, the fewer the changes that can be made.

In traditional applications of revenue management, the short time frame gives rise to very few variable costs. An additional passenger may cause a single flight's costs to vary only by a fuel increment and additional refreshment items. An additional overnight guest at a hotel may incur only the costs of maid service, laundry, and consumable room amenities, such as soap and shampoo. An additional restaurant meal will have somewhat higher variable costs, such as the food, drink, and supplies consumed. In each of these cases, personnel costs—often thought of as a variable cost—are probably not affected, since staffing levels for the flight or day would have been decided already.

As the time frame expands, more costs may be deemed variable. If the revenue management proposal involves offering a special seasonal rate, the opportunity exists to adjust staffing levels and possibly other cost elements as well. As more business processes are involved, a broader view of the cost structure is needed. Thus a summer promotion at a hotel may involve not only the accommodations function but the restaurant function as well.

Estimating fixed and variable costs is a very approximate process. Several techniques of varying complexity exist. The simplest, often called *account analysis*, involves classification of each account title as fixed, variable, or mixed (sometimes called semifixed or semivariable). These classifications are judgmental, based on one's knowledge of and beliefs about cost behavior. Another elementary technique is *two-point analysis* (sometimes called high–low analysis), using the change in costs between two different output levels to estimate the fixed and variable components. The change in cost over the change in output quantity would be due to the variable cost items, as we assume no change in fixed costs. Consider the following examples:

- Suppose costs of a business process are $600,000 during a time period when 20,000 units of the product or service are sold, and are $750,000 during a similar-length time period when 27,500 units are sold.
- Costs increased by $150,000 with the 7,500-unit increase in output. This implies a variable cost of $20 per unit (= $150,000/7,500).
- Fixed costs are then estimated at $200,000, by subtracting the total variable costs of $400,000 (= 20,000 × $20) from the total cost of $600,000. The same conclusion is reached if the higher cost-volume level is used.

Using a two-point analysis assumes that the underlying cost structure has not changed between the two periods being analyzed. Moreover, it assumes that cost behavior *outside* the range analyzed does not differ.

The most sophisticated way of estimating the cost structure is the use of *regression analysis*. Several data points of total cost and output are needed, and statistical techniques are used to fit a line to the data points. Once this calculation is done, the logic is similar to the preceding two-point analysis. The *slope* of the line—the rate of change from one point to another—estimates the variable cost component, and the *intercept*—where the line meets the zero-activity point—estimates the fixed costs. Basic regression analysis can be done using *Excel*™. Because multiple data points (presumably over a longer time period) are used in regression,

the assumption that the underlying cost structure has not changed becomes more critical.

By whatever means, estimating cost structure leads to an inexact measurement of a moving target. Decisions based on estimates of fixed and variable costs should keep this uncertainty in mind.

A firm offering what amounts to a single product, such as airlines or hotels, has a relatively straightforward cost structure. A multiproduct firm, such as a manufacturer, is harder to analyze, as the cost structure may vary significantly among its several products. Thus, some measure of the product cost is needed. Product costs necessarily involve allocations of many common costs. Costs determined by activity-based costing methods are generally considered the most logical, albeit difficult, cost allocations. However, activity-based costs are long-run average costs, not the marginal costs usually applied in decision analysis. That is, activity-based costs do not tell us what the cost would be at some different level of activity. Also, allocated costs (fixed costs per unit) should not be mistaken for variable costs, despite their per-unit denomination.

In short, no profit measure is possible without a determination of product costs, a process that is notoriously arbitrary and often unreliable. But it is also desirable to avoid becoming too enamored with the accuracy of product costs. For this reason, additional profit analysis tools should be employed.

Contribution Margin

The common measure used to assess the impact on profits is the *contribution margin*, measured in an *incremental* fashion by assessing the increased revenues minus the increased costs. The standard measure of contribution margin is revenue minus *variable costs*, that is, those costs that change as output (revenue) changes. When we think of contribution margin in an incremental sense, we consider not only the natural increase in variable costs that accompanies the increased volume of activity, but also the possibility that certain fixed costs may also increase, or that new costs may be added to the cost structure. New costs or added fixed costs may not be present in many analyses, but the possibility should be kept in mind.

What justifies the use of contribution margin as a metric is the notion that revenue management generally involves incremental changes to an *existing base of business*. Contribution margin ignores fixed costs, but a business does not succeed unless, over time, its revenues exceed all its costs. Using contribution margin analysis reflects the unstated assumption that a base of business that covers all costs and earns a profit *already exists*, and the proposal at hand is for an incremental change that builds on that base. Thus, revenue management proposals often seek to make relatively small modifications to an existing business base and existing price structure, with the goal of adding to the overall contribution margin of the organization.

Certainly, it is possible to use revenue management as a strategic approach to an entire price structure; in such cases, contribution margin is not the relevant metric. When dealing with the entire business segment, then something closer to full cost profitability should be used.

Losses from Revenue Management

It is often said that the industries most known for using revenue management—airlines and the automotive industry—have rather dismal profit records. Many airlines operate at a loss, and several have been through the bankruptcy process or have been forced into mergers for economic reasons. Similarly, automobile companies, especially the big-three U.S. manufacturers, have also encountered major financial difficulties in recent years. Because both the airline and auto industries face problems other than revenue—notably an inability to adequately manage their fixed costs—they do not stand as exemplars of the benefits of revenue management. One concern is that many of these companies did not have a profitable base of business to begin with. Another concern is that, as the use of revenue management techniques expanded in these industries, the relevant metric of success may not have changed with it.

American Airlines began revenue management to counter a low-cost, low-fare competitor, by offering low fares on selected competitive routes. When that effort succeeded, the price reductions were continued to reduce the number of unsold seats. These reductions originally carried restrictions, such as advance purchase and Saturday-night-stay

requirements designed to appeal only to a small subset of customers. In these contexts, a base of normal-fare business existed that covered fixed costs, allowing the special pricing to be successful as long as it exceeded variable costs (which are minimal on a per-flight basis). Gradually, however, restrictions were eased and low fares spread to more and more ticket purchases. The resulting low fares that exceeded variable costs no longer produced incremental profit because fixed costs were not being covered by nondiscount business.

Similarly, automobile companies began price concessions, such as rebates and low-cost financing, as an occasional price-reduction tool, to move inventory during the slow winter months or at the end of the model year. Occasional reductions worked as long as the company made enough sales at prices that would cover fixed costs. Again, discounted pricing spread and became the basis for more and more of the industry's sales, leading to negative financial outcomes.

The experiences of these two industries provide an important lesson in revenue management. When revenue management strategies are executed, it is important that the price reductions offered do not result in sustained price decreases during high-demand periods.

Operating Leverage

The concept of operating leverage is a quick way of expressing the cost–revenue relationship. Operating leverage has been defined in several different ways. One common definition is

Operating leverage = total contribution margin/operating income

where total contribution margin is revenue minus total variable costs and operating income is income after all (fixed and variable) operating costs, but without consideration of nonoperating items such as interest expense and income taxes. High operating leverage means that the overall contribution margin is usually well over 100 percent of the operating income, implying a cost structure with heavy fixed costs, low variable costs, and high contribution margin. This scenario is the classic revenue management environment: a business with substantial total fixed costs and low

unit variable costs, resulting in a high unit contribution margin. High operating leverage means that the added revenue will have a significant impact on the operating income.

As defined earlier, operating leverage is stated as a percentage or multiple. For example, if the total contribution margin is $100,000 and its operating income is $20,000 (indicating fixed costs of $80,000), the operating leverage is 500 percent or a multiple of 5.0. This means that a 10 percent increase in the total contribution margin would yield a 50 percent increase in the operating income. In this example, the total contribution margin increases to $110,000 and, after the $80,000 of fixed costs, the operating income is $30,000, a 50 percent increase. Note that the current level of operations affects the percentage measure of the operating leverage. At the new level just described—$110,000 contribution and $30,000 operating income—the operating leverage drops to 3.67. If revenue growth continues, operating leverage as a percentage continues to drop. If total contribution rises to $200,000 and fixed costs of $80,000 still suffice to support that amount of business, operating leverage declines to 1.67 (= $200,000/$120,000). Successive measures of operating leverage quickly reveal unwelcome variable cost changes, and show the need to generate increasingly higher revenue levels to obtain the same percentage effect on the net income.

Although often used as a metric, operating leverage is not a particularly useful measure on which to base a decision, as the calculated amount changes over a range of activity. Use of a simple contribution margin may be a better indicator of the impact of a revenue change.

Reconsidering Fixed Costs

Although the contribution margin is a useful short-term tool, one cannot ignore the fact that fixed costs constitute a very large portion of the cost structure of most companies. Over time, the fixed cost component of doing business has tended to increase. Unless revenues cover all costs, profits will evaporate. Many fixed costs are quite visible—facilities, personnel, technology, and the like. However, some cost factors are more difficult to understand and quantify. One such factor is the cost of *complexity*, which relates to the number of product components, options, or difficulty of

manufacturing. An interesting example relates to the automotive industry, which long had offered buyers a myriad of choices, sometimes mind boggling. In the 1980s, Ford was considering how to compete against its then-major competitor, General Motors (GM). Ford concluded that GM seemed to hold all the advantages: greater economies of scale and scope, more vertical integration, more experience, and greater ability to invest in technology. But its major disadvantage was its cost of complexity. The following question was asked: Assume you could produce one car per minute. How long would it take to produce one of each possible combination of options (body type, engine, color, upholstery, sound system, etc.)? The results were stunning.[2]

- Honda, 45 minutes
- Toyota, 24 hours
- Chrysler, 220 years
- Ford, 2,200,000,000 years (2.2 billion years)
- General Motors, 7,800,000,000,000,000 years (7.8 quadrillion years)

GM's apparent advantages were offset by a huge cost of complexity, a cost often not observed in typical accounting reports. The lessons were clear. Today, most automobile manufacturers make most features standard. There are far fewer options and even color choices are limited.

The Metric for Revenue Management

When revenue management techniques are used to generate incremental sales, contribution margin is a relevant metric. As long as the added revenue exceeds the marginal cost, profit will be enhanced. But marginal analysis works only at the margin. Reduced prices must be limited to a subset of the business, and done in a way that does not encourage more and more customers to seek or expect reduced prices. Tickets for Broadway shows, for example, are fairly expensive. Reduced-price tickets are often made available, at a central location, a few hours before show time. This procedure serves to help fill empty seats, hence providing a contribution to profit. But the short lead time and the uncertainty of whether seats

(or good seats) will be available discourages most customers from waiting for the reduced prices to be available. In such situations, the contribution margin remains relevant.

As revenue management techniques become the norm for pricing, however, one cannot rely on the company's fixed costs being covered by *other* business. Achieving a positive contribution margin does not guarantee that a price reduction will add to profits; management must consider costs beyond variable costs and look at the entire profit picture.

Opportunity Cost

Opportunity cost is an important consideration in revenue management. Opportunity cost is usually defined as the next best alternative's benefit that is forgone when making a decision to do something else. Thus, the opportunity *cost* is the best available *benefit* given up. In considering the revenue management strategy, what alternative opportunities exist that will be forgone by adopting the strategy under consideration?

The concept of opportunity cost is usually attributed to 19th-century economist John Stuart Mill. Scarcity is central to opportunity cost. When there is a limited supply of goods or services to be sold, a limited supply of funds to make purchases, or a limited amount of time to engage in activities, an opportunity cost exists. If there were no scarcity, there would be no opportunity cost.

Opportunity cost is often thought of in financial terms but need not be. An alternate use of one's time, or an alternate use of productive resources, also constitutes an opportunity cost—if we do A, then we cannot do B. In most revenue management applications, opportunity costs are financial in nature. In the common revenue application of offering a seat on a flight at a reduced cost, the opportunity cost is zero if the seat would otherwise remain unsold, or a higher amount if we later could have sold that seat at standard fare. In many revenue management applications, the opportunity cost is unknown at decision time. When selling a vacant seat at a reduced price, we do not know whether a full-fare passenger will later appear and be turned away. In some cases, the opportunity cost is unknowable, even after the fact. If a restaurant offers a special price

promotion, it would not know how many customers who took advantage of the special price would have come anyway at normal prices.

Capacity considerations (scarcity) are critical to an assessment of likely opportunity costs. If capacity is likely to be reached, opportunity costs are higher than if excess capacity continues to exist. Airlines routinely limit the seats they make available to customers redeeming frequent flyer credits in an attempt to minimize the chance that they displace a paying passenger. Thus, the two questions to be asked in considering the opportunity cost of a revenue management decision are: (a) What are the chances that price concessions will consume available excess capacity? and (b) how much revenue is likely to be forgone as a result? Even without a capacity constraint, the second question remains relevant: Will new customers be generated, thereby increasing revenues, or will revenues decrease because existing customers take advantage of the price concession? Opportunity costs are present in virtually any decision, but can be especially important for revenue management decisions. The fact that they may be hard or even impossible to quantify does not make them irrelevant.

Consider the case of a rapidly perishable service product, such as a hotel room or a seat on a flight. When the time frame is short for customers to materialize, the ability to estimate the chance of selling the item at the normal price may be fairly high. For products with a longer perishability horizon, such as style goods or a current model year of an automobile, the opportunity cost of selling now at a discount or later at full price is more complex. The time frame for full-price customers to appear is longer, but a current discounted sale may be valued for cash now rather than an uncertain chance of more cash later.

Another application of opportunity costs is found in overbooking strategies. An airline or hotel may overbook to reduce the opportunity cost of unsold capacity due to no-shows. However, a new opportunity cost is created, that of satisfying the displaced customer, which may involve both the immediate accommodation for the customer as well as the longer-run customer satisfaction and retention effects.

Capacity considerations are not limited to physical capacity, but may involve service capability as well. When Groupon was new, it offered limited-time discounts, say to a restaurant or other retailer, and generated a large group of customers. This led to some businesses being overwhelmed

by a short-term surge in demand. The quality of service suffered, and both new and old customers were dissatisfied. Revenue may have been temporarily increased, but an opportunity cost in the form of loss of future business may have been incurred.

Thus, opportunity costs are the profits foregone when one decision is made rather than another. A sale at a discounted price has a positive opportunity cost if that sale could have been made at full price. But that sale has no opportunity cost if it would not otherwise have occurred, the business has adequate capacity, and the discounted price at least covers marginal costs.

Opportunity costs do not appear in the accounting records, but they are real nonetheless. Admittedly, it is hard to measure something that didn't happen—that is, "what would have occurred if we did not make this decision"—but this needs to be part of a profit analysis. Revenue management decisions are not free. Management needs to consider the opportunity costs involved, even though estimating these can be a challenge.

Sunk Costs

Sunk costs are costs already incurred; they cannot be *undone*. Sunk costs include the cost of inventory on hand, costs of fixed assets, and costs of investments. Sunk costs create a psychological barrier to action. We may hesitate to sell a security if its current market price is below what we paid for it. We may hesitate to sell inventory at a loss. Yet economic theory tells us that *sunk costs are irrelevant*. Whatever we do, that cost occurred, which is unchangeable.

Sunk cost considerations apply to markdowns, which often involve selling merchandise below cost. While this is psychologically unappealing, management must consider whether it is better to generate some revenue now, or risk the merchandise continuing to sit on the shelf unsold.

While sunk costs are irrelevant to a markdown decision, or any decision to sell at current (lower) market values, they do have a long-term relevance. Selling below cost has a negative impact on profit. While accepting a loss to move slow-selling merchandise may be appropriate, it also signals a need for better purchasing decisions. The business that

has to sell a lot of its products at below-cost, markdown prices will not survive long.

Conclusion

This chapter considered the role of profit in assessing revenue management decisions. Understanding a company's cost structure is a first step to performing a profitability analysis. Contribution margin analysis is a useful tool for assessment of revenue management decisions, but it must be used with caution. Understanding of opportunity costs and sunk costs is also essential to implementing a successful revenue management application. Consideration of the opportunity cost of a decision is often overlooked. Choosing one path usually precludes following other paths. Analysis of both the revenue management methods chosen and those forgone is appropriate.