

Doing the Right Thing or Doing the Thing Right: Allocating Resources Between Marketing Research and Manufacturing

James D. Hess

Department of Marketing, University of Houston, 375 H. Melcher Hall, Houston, Texas 77204, jhess@uh.edu

Marilyn T. Lucas

School of Business Administration, University of Vermont, Burlington, Vermont 05405, mlucas@bsad.uvm.edu

Matching production with sales potential is essential for survival in volatile markets. Manufacturing and marketing managers compete for staff, space, cash, and other assets as they struggle both to determine what and how many products ought to be produced, and to actually produce them. We develop an analytical framework to answer one simple question, “How much marketing research should a firm do when it takes resources away from manufacturing the goods that generate revenue?” To understand the costs and benefits of marketing research, we account for the lost opportunities to produce these goods. Some analytical findings are striking: firms without initial knowledge of their potential customers should allocate one-third of the firm’s resources to marketing research. The model suggests a host of issues to be more deeply studied by management scientists.

Key words: marketing research; production planning; resource allocation

History: Accepted by Teck H. Ho and Christopher S. Tang, special issue editors; received May 2001. This paper was with the authors 7 months for 2 revisions.

1. Introduction

Sport Obermeyer, Ltd., designs, manufactures, and distributes a broad line of fashion ski apparel through hundreds of specialty stores throughout the United States. Over 95% of the firm’s offerings are newly designed each year to incorporate changes in patterns, fabrics, and colors. The caprice of fashion trends, weather, and the economy make sales difficult to anticipate. Long production lead times and extensive capacity requirements have compelled Sport Obermeyer to predict sales volumes in order to commit—as early as one year in advance—to specific production quantities for each item of the upcoming year’s skiwear lines. This is what their management calls “the fashion gamble” (Hammond and Raman 1994, p. 1).

Sport Obermeyer is a classic example of a company confronted with resource allocation decisions between identifying “the right thing to do” and planning “to do it right.” In this setting, identifying “the right thing to do” refers to the firm’s understanding of customers’ needs and wants, while “doing it right” means fulfilling these needs and wants by producing appropriate quantities at low costs. Both options are costly, and a firm has to decide on the allocation of its scarce resources. In this highly volatile industry, an item might not sell at all during the ski season, or its demand might be so high that it causes

stock outages and consumer frustration. Because of these uncertainties, Sport Obermeyer has tried to improve its demand predictions by delaying production while gathering information. Another strategy would have been to invest in technologies that would have allowed the firm to produce at very low cost, regardless of the production volume of a given item.

The objective of this paper is to study such alternatives. Firms must divide their resources, employees, and capital between gathering information about consumers (identifying “the right thing to do”) and developing manufacturing capabilities to produce effectively whatever product is thought to be the best (“doing it right”). While the high unpredictability of the fashion industry has long interested researchers with respect to forecasting and production (Chang and Fyffe 1971, Crowston et al. 1973, Hausman and Peterson 1972), no answer has yet been provided for the dilemma of resource division. Scholars have also analyzed the mechanisms that can be used to respond to unpredictable demands (Fisher et al. 1994, Gallego and Van Ryzin 1994, Hammond and Raman 1994, Eppen and Iyer 1997) and have developed models of production planning that incorporate early-season sales responses as a means to improve the accuracy of earlier demand predictions (Fisher and Raman 1996, Donohue 2000). We develop a simple model to answer

one question: “How much marketing research should a firm do when it takes resources away from manufacturing the goods that generate revenue?” While the relationships between marketing research and production planning are complex, analytical answers can be provided to this question.

2. A Multiproduct Model of Production and Marketing Research

Most firms offer entire product lines. Consumer tastes being heterogeneous, firms can often increase their revenues with a more varied product line to better match the needs and wants of consumers. Increased product variety, however, makes it more difficult to determine the appropriate level of resources allocated to the production of the various options.

In this paper, we model the resource-constrained allocation decision between marketing research and production for a multiproduct firm. In our setting, uncertainty is *not* about overall demand level, but about which of the product designs will flourish in the marketplace. Specifically, for simplicity, we assume that, among the various design options, only one design will be successful. The firm does not know which one, but has prior beliefs regarding the chance of success of each design. As discussed above, this situation is common in the fashion skiwear industry, where the success of products frequently depends on style and color variations. While there are many possible product styles, summarized by the design space, \mathcal{S} , only one, S , will exactly match consumer preferences and will be the trendy hit of the selling season. All other styles will remain unsold on the store shelf. We temporarily assume that there is only a finite number of possible styles: $\mathcal{S} = \{1, \dots, s, \dots, n\}$. Let p_s be the probability that style $S = s$ is this season's sales hit. The probability distribution, denoted (p_1, \dots, p_n) , represents the firm's prior probabilities on the product design space, encapsulating consumer demand for different styles.

Although only one style will be commercially successful, the firm prepares to produce a broad range of designs. The production quantity for a given style is limited by the amount of resources allocated to this design. Let R_s be the level of resources allocated to the production of style s . The firm's production quantity for a given style s is $Q_s = R_s^\alpha$, where α is the elasticity of output with respect to production resources, $0 < \alpha < 1$. For analytical simplicity, production efficiency α is identical for all styles. Under these assumptions, we first analyze decision making when only prior information is used, and then analyze how marketing research might change these decisions.

2.1. Resource Allocation Problem Without Marketing Research

The firm must decide on the level of resources to be allocated to each style: The variables of choice are (R_1, R_2, \dots, R_n) . By committing to particular styles, the firm is taking the “fashion gamble.” The total amount of resources available to the firm is denoted by R and is predetermined. The decisions are constrained by $R = \sum_s R_s$.

Due to production lead times, the allocation of resources occurs long before the market reveals which style is the big seller. If a style is successful, then the demand for that style greatly exceeds the firm's capacity: All output Q_s can be sold if s is a hit and none will be sold otherwise. For simplicity we assume that the per-unit profit margin, m , is independent of product styles. The objective of the firm is to allocate scarce resources to production capacity in order to maximize expected total profits. Specifically, the resource allocation problem is

$$\text{Max } E\pi = m \sum_s R_s^\alpha p_s, \quad (1)$$

subject to the resource constraint,

$$\sum_s R_s = R \quad \text{and} \quad R_s \geq 0. \quad (2)$$

Solving the first-order conditions for the optimizing values of R_s and λ , where λ , the Lagrangian multiplier, represents the marginal value of resources for the firm, gives:

$$R_s = R \frac{p_s^{1/(1-\alpha)}}{\sum_s p_s^{1/(1-\alpha)}}, \quad (3)$$

$$\lambda = \alpha m R^{(\alpha-1)} \left(\sum_s p_s^{1/(1-\alpha)} \right)^{(1-\alpha)}. \quad (4)$$

As expected, more resources are allocated to styles that are more likely to be the fashionable hit. This allocation is not however, directly proportional to the probabilities. The styles with high probabilities of success are given a disproportionately larger share of resources, and the extent to which this is accentuated depends on the efficiency of the process technology, α . The proportion of resources invested in a given style s is, however, independent of the total resource budget, R . In the limit as α approaches zero, the resource allocation is directly proportional to the style's probability of success. As α increases (the production system becomes more efficient), the largest share of resources is concentrated on the most probable style.

The maximum expected profit for the firm, given the resources available, the profit margin, the technology, and the probability distribution of various styles, is

$$E\pi = mR^\alpha \left[\sum_s p_s^{1/(1-\alpha)} \right]^{(1-\alpha)}. \quad (5)$$

The allocation of production resources between finite numbers of product types provides the basis for our analysis, but working with continuous probability distributions makes the analysis considerably easier. We now adjust the model to take advantage of continuity.

2.2. Continuous Style Space

We now extend the resource allocation problem to a continuous setting and describe the product's style by a continuum of values. Without loss of generality, we identify the style space \mathcal{S} as the interval from $-V$ to V , where V is a real number. Assume that the prior distribution that the firm believes reflects consumer-buying patterns is a uniform distribution on the interval $[-V, V]$, with mean zero and precision $\phi = 3/V^2$.

Under these assumptions, the summation term $\sum_s p_s^{1/(1-\alpha)}$ in Equations (3)–(5) can be replaced by $\int_{\mathcal{S}} p_s^{1/(1-\alpha)} ds$, where $p_s = 1/(2V)$. Since $V^2 = 3/\phi$, we have

$$\int_{\mathcal{S}} p_s^{1/(1-\alpha)} ds = 12^{-0.5(\alpha/(1-\alpha))} \cdot \phi^{0.5(\alpha/(1-\alpha))}. \quad (6)$$

The maximum expected profit with only prior knowledge is

$$E\pi_{\text{prior}} = \mu(R\phi^{0.5})^\alpha, \quad (7)$$

where $\mu = m12^{-0.5\alpha}$. Arrow (1987) found similar results for a normal prior distribution of consumer preferences. The firm has two resources, one explicit (symbolized by R) and one implicit (prior knowledge of consumer tastes, as symbolized by ϕ). As plans for the production of a variety of products are developed, total explicit tangible resources are important, but so too is the less tangible knowledge about the customers' desires. In summary:

THEOREM 1. *Relying only on its prior knowledge, the firm's expected profit increases with the amount of resources available, the square root of the initial level of knowledge of the consumers' tastes, and the efficiency of process technology to be employed.*

An increase in either the amount of resources R or in the precision ϕ of the prior distribution of hit styles increases the maximum expected profit. The expected profit function exhibits decreasing returns with respect to both the amount of resources available and the precision of the forecast of consumer demand,

although decreasing returns are twice as intense for precision.

What would a firm do if it could use the general resource R to supplement the prior knowledge about customers with marketing research? We answer that question next.

2.3. Production Based Upon Marketing Research

Suppose that the firm may gather information about consumer preferences before production resources are allocated to the various styles. Let ι denote the amount of information that results from marketing research. This may be interpreted as learning that consumer style preference S is distributed over a narrower interval $[-V + \delta, V - \delta]$ than the prior interval $[-V, V]$, so that some designs are dropped from the assortment. For simplicity, we assume that this information increases the precision of the posterior distribution of consumer preferences. That is, when information ι is observed, the precision is increased from ϕ to $\phi + \iota$. The more information collected through marketing research, the larger the increase in the precision of the posterior distribution.

Marketing research is costly. For simplicity, suppose the amount of resources needed for marketing research equals a constant multiple of the increase in precision. Let C be the total cost in terms of resources spent on marketing research, where

$$C = c_{mr}\iota, \quad (8)$$

and where the parameter c_{mr} is the marginal cost of research needed to increase accuracy of the forecast. The rationale here is that the variance of the sample mean is inversely proportional to the number of observations. Thus, if the costs of surveys are in proportion to the sample size, the cost of marketing research rises directly with the increase in precision.

Under the given resource constraint, any amount of resources spent on marketing research becomes unavailable for production purposes. The resource-constrained problem with marketing research is a variant of the above analysis, with the precision of the prior distribution ϕ replaced by the precision of the posterior distribution after marketing research $\phi + \iota$ and the resources allocated to the production after marketing research now being equal to $R - c_{mr}\iota$:

$$E\pi = \mu[(R - c_{mr}\iota)(\phi + \iota)^{0.5}]^\alpha. \quad (9)$$

3. How Much Marketing Research? How Much Production?

What is the optimal amount of the firm's scarce resources to be allocated to marketing research rather than to production? In this context, this is the same as determining the optimal amount of information

to gather about consumer preferences. Because of the relationship between increased precision and budget-allocated market research, knowing the amount of information gathered is equivalent to knowing the allocation of resources.

The firm chooses the measure of increased precision ι to maximize the expected profit given by Equation (9). One would expect the optimal amount of information to depend on the firm's resource level, its prior knowledge about consumers, the cost of additional information, and the process technology, $\iota^* = \iota(R, \phi, c_{mr}, \alpha)$. Maximizing the expression in (9) gives

$$\iota^* = \frac{1}{3} \frac{[R - 2c_{mr}\phi]}{c_{mr}}, \quad (10)$$

and the optimal amount of resources to be allocated to marketing research is

$$R_{mr} = c_{mr} \cdot \iota^* = \frac{1}{3}(R - 2c_{mr}\phi). \quad (11)$$

The remainder of these resources is allocated to produce the assortment of styles in quantities as dictated by the information. The resources allocated to production are:

$$R_p = R - c_{mr} \cdot \iota^* = \frac{2}{3}(R + c_{mr}\phi). \quad (12)$$

As prior customer knowledge becomes relatively more abundant, marketing research diminishes. The maximum additional information that the firm can afford is R/c_{mr} .

We set aside nonnegativity constraints in deriving ι^* . According to Equation (11), if the prior knowledge is less than half of the maximum affordable information, $\phi < 0.5R/c_{mr}$, the firm profits from learning the "right thing to do," at the expense of reduced resources available to "do the thing right." However, if the prior knowledge is sufficiently high, it does not pay to gather more costly information: There is a corner solution where the firm does no marketing research.

THEOREM 2. *The firm opts for no marketing research if it has few organizational resources, if it has significant prior experience with customers, and if research is very costly. It dedicates all organizational resources to production of the goods that the customers are believed a priori to value most.*

An example of such a "knowledge-rich" company is Sony, which introduced its first Walkman into the U.S. market in the 1980s. By 1990, more than 160 models had been launched (Sanderson and Uzumeri 1995). Sony's understanding of the U.S. market allowed it to pursue a product proliferation strategy rather than invest heavily in marketing research.

Prior information about consumer preferences for styles is "goodwill" equal to $c_{mr}\phi$, the amount of resources that would have to be used to acquire a comparable degree of understanding of the market. This intangible knowledge asset enters the decision to use tangible assets for production or marketing research. As either the cost of additional information or the precision of prior information increases, fewer resources are dedicated to marketing research and more is allocated to production. As the firm's resources increase, the allocation of resources to marketing research likewise increases, but at a rate of one-third that of the resource increases. Using (11)–(12), we define the ratio of resources allocated to marketing research versus the resources allocated to production as the marketing research-to-production ratio, R_{mr}/R_p :

$$\frac{R_{mr}}{R_p} = \frac{1/2 - c_{mr}\phi/R}{1 + c_{mr}\phi/R}. \quad (13)$$

This ratio depends on the relative magnitude of intangible prior knowledge goodwill compared to total tangible resources. If the firm had no prior knowledge of the style that would be successful for the season ($\phi = 0$), then the marketing research budget should equal half of the production budget.

THEOREM 3. *Given our model, marketing research should receive one-third of the firm's resources if there is no prior knowledge of the products that consumers value the most, regardless of the cost of marketing research or production efficiency.*

This surprising finding should serve as a cautionary tale for start-up firms that initially have little direct knowledge of their potential customers (especially given the recent history of Internet firms). Producing large quantities of products in the assortment when there is little basis for choosing one style over another is a waste of company resources.

Unexpectedly, the optimal marketing research-to-production ratio, R_{mr}/R_p , is independent of the process technology used in manufacturing, as captured by the production parameter α . An increase in process efficiency, α , improves the marginal profitabilities of information and production in a neutral fashion, so that neither is favored in the resource allocation. This is a consequence of the constant elasticity technology and is unlikely to be a general conclusion.

Substituting the optimal amount of marketing research from (10) into (9) and setting aside the nonnegativity constraints, the maximized expected profit using marketing research is

$$E\pi_{mr} = \mu \left[\frac{2}{3}(R + c_{mr}\phi)^{3/2} (3c_{mr})^{-1/2} \right]^\alpha. \quad (14)$$

Table 1 Determinants of Marketing Research vs. Production

Firm's characteristic	Expenditure on marketing research R_{mr}	Marketing research to production ratio R_{mr}/R_P	Relative advantage of marketing research $E\pi_{mr}/E\pi_{prior}$
Resource abundance R	+	+	+
Prior knowledge ϕ	–	–	–
Marketing research cost c_{mr}	–	–	–
Unit profit margin m	no effect	no effect	no effect
Efficiency of production α	no effect	no effect	+

It is not surprising that profits (14) are higher if, for example, the prior knowledge about consumer tastes ϕ is greater, but this would be true even if no marketing research is done (see Theorem 1). An unbiased comparison looks at the ratio of profits, which captures the “relative” advantage of instituting a marketing research program:

$$\frac{E\pi_{mr}}{E\pi_{prior}} = \left[\frac{4}{27} \frac{(R + \phi c_{mr})^3}{R^2 \phi c_{mr}} \right]^{\alpha/2}. \quad (15)$$

THEOREM 4. *The relative advantage of a marketing research program increases as prior knowledge of consumers’ tastes diminishes, as organizational resources increase, as marketing research becomes less costly, and as production efficiency increases.*

While improvements in process efficiency, α , have a neutral effect on resources dedicated to production and marketing research, it gives the organization using marketing research additional profits by magnifying the benefits. There are diminishing returns to using more organizational resources for both marketing research and production, but more so for production. So the relative profitability of marketing research improves as organizational resources grows.¹ Table 1 summarizes the influence of various firm’s characteristics on the amount of resources spent on marketing research rather than spent on production.

4. Suggestions for Future Research

Every firm must decide how much money, workforce, and management attention to devote to the internal measurement of organizational activities (managerial and cost accounting), the external measurement of customers and rivals (marketing research), and the delivery of goods (manufacturing and distribution). This paper provides an analytical model of the optimal allocation of resources between marketing research and production.

Of course, our theoretical model is simplified to provide clear linkages between the following ingredients: uncertainty about demand for variants in

product assortments, prior market information, cost of manufacturing and marketing research, and process efficiency. There remains a long list of factors that were not included, suggesting that much more research is needed. These factors can be grouped into three main categories: (i) those describing demand uncertainty and the information update mechanism, (ii) those relating to the consequences of better market information, and (iii) those characterizing the process technology.

The first category includes those factors describing the information acquisition process. We have modeled this process in a traditional theoretical way, with a description of the current level of knowledge (the prior probability distribution) and a description of the anticipated outcomes of the information-gathering system, conditional upon the true state (the likelihood function). This might not be the only appropriate way. The first category also includes factors describing demand uncertainty. Our demand model took an extreme form. Of all products in the assortment, consumers demanded only one, and all others were worthless. This captured theoretically the “fashion gamble” that firms like Sport Obermeyer face. More realistically, secondary products sell less briskly, but still have some sales volume. The second category includes factors relating to the consequences of better market information. We did not account for shortages, excess inventories, or for the possibility of pricing adjustments. We took the unit profit margins as given in the analytical model, and much marketing research is done to try to determine what the ideal prices (and hence profit margins) should be. Finally, the factors in the third category characterize the process technology employed by the firm. We modeled technology as a constant elasticity production function. Other classes of technologies need to be incorporated in the analytical models.

The relationships between marketing research and production planning decisions are complex. We started with a simple question, “How much marketing research should a firm do when it takes resources away from manufacturing the goods that generate revenue?” and, based on a simple analytical model,

¹Notice that the term with R is raised to the power α in Equation (7) and 1.5α in Equation (14).

suggested a host of other issues that hopefully will be more deeply studied by management scientists.

References

- Arrow, K. J. 1987. The demand for information and the distribution of income. *Probab. Engrg. Inform. Sci.* 1 3–13.
- Chang, S. H., D. E. Fyffe. 1971. Estimations of forecast errors for seasonal style goods sales. *Management Sci.* 18(2) B89–B96.
- Crowston, W. B., W. H. Hausman, W. R. Kampe. 1973. Multistage production for stochastic seasonal demand. *Management Sci.* 19(8) 924–935.
- Donohue, K. L. 2000. Efficient supply contracts for fashion goods with forecast updating and two production modes. *Management Sci.* 46(11) 1397–1411.
- Eppen, G. D., A. V. Iyer. 1997. Improved fashion buying with Bayesian updates. *Oper. Res.* 45(6) 805–819.
- Fisher, M. L., A. Raman. 1996. Reducing the cost of demand uncertainty through accurate response to early sales. *Oper. Res.* 44(1) 87–99.
- Fisher, M. L., J. H. Hammond, W. R. Obermeyer, A. Raman. 1994. Making supply meet demand in an uncertain world. *Harvard Bus. Rev.* 72(3) 83–93.
- Gallego, G., G. Van Ryzin. 1994. Optimal dynamic pricing of inventories with stochastic demand over finite horizons. *Management Sci.* 40(8) 999–1020.
- Hammond, J. H., A. Raman. 1994. Sport Obermeyer, Ltd. Harvard Business School Case 9-695-022, Harvard University, Cambridge, MA.
- Hausman, W. H., R. Peterson. 1972. Multiproduct production scheduling for style goods with limited capacity, forecast revisions and terminal delivery. *Management Sci.* 18(7) 370–383.
- Sanderson, S., M. Uzumeri. 1995. Managing product family: The case of the Sony Walkman. *Res. Policy* 24(5) 761–782.