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# Issues in predicting the demand for a new technological product

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# ISSUES IN PREDICTING THE DEMAND FOR A NEW TECHNOLOGICAL PRODUCT

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Comments welcome

ABSTRACT

This paper focuses on various issues that need to be considered when an analyst wishes to predict the demand for a new technological product. The interplay of the strategic behavior of the firm, notably with regard to preannouncing the future availability of the new product and the behavior of channel members and prospective customers is highlighted in this paper. Prospective customers' choice behavior is governed by such factors as credibility of the firm's preannouncement and expectations on the availability of the new product while a channel member's decision to accept the new product depends upon the expected sales and a demonstration of the product's acceptance by other channel members. These issues lead logically to the interdependence between the product positioning and the preannouncement decisions potential of the firm. The paper concludes with a discussion of the data requirements for implementing the approach suggested by the model and implications for product development process and competitive behavior.

## 1. INTRODUCTION

Forecasting Problems: Considerable progress has been made in the past years in forecasting new product demand. The traditional use of test markets to assess the demand for new consumer goods was essentially replaced by the use of test market simulators (pretest market models) such as the ASSESSOR model (Silk and Urban, 1978 and Shocker and Hall, 1986). The data available from these simulators and later test markets are used in the development of forecasting models (Blanchard and Harding, 1983). The use of test market simulators has spread from the US to various other countries, where specific versions of the ASSESSOR-model are being widely used (see,for example, Erichson, 1981). However, it is fair to say that the research has focussed almost exclusively on frequently purchased consumer goods and for new products which are essentially product modifications or evolutionary innovations. Although in a recent paper, Urban et al. (1989) present a model for prelaunch forecasting of new automobile models that generally uses the ideas of pretest market models employed for packaged goods, much less guidance is available for forecasting the demand for industrial goods and for specialty goods, specifically if these are considered to be highly innovative.

Specialty goods that require a high input of new technology pose specific difficulties of forecasting demand owing to the dual problem of shortening product life cycles and increasing product development times. The associated investments and risks for developing such products are considerable. Therefore, firms that market these products try to develop a number of strategies that are aimed at reducing risks as well as investments to the extent possible.

Firm's strategies: We observe four different strategies employed by such firms: (i) Reducing development time by simultaneous engineering efforts and increasing manufacturing flexibility, (ii) Following and adapting the innovations of the lead users, (iii) Prean-

nouncement of new products long before they are available, and (iv) Phased distribution or roll-out of the new product.

The first type of strategy is prominent among the US and European passenger car manufacturers designed to keep up with Japanese competition (Clark, 1990). "Western" manufacturers argue that their development time of new models of passenger cars appears to be longer than the development time for "Japanese" cars because they tend to incorporate larger technological leaps forward in their new models as compared with the Japanese. Without going into details of this argument it seems to indicate that there exists a trade-off between development time and level of technology, which is interesting to explore in the framework of product positioning models. The second strategy is to closely observe innovative changes that customers (allegedly lead users) perform on standard products, and to introduce these into future products. This behavior has been observed and explained in some industries, where suppliers could not otherwise appropriate the benefits from innovation (von Hippel, 1986; von Hippel, 1988). The third strategy of preannouncing new products (Eliashberg and Robertson, 1988) could be risk-reducing as the feedback on the preannouncement may be valuable information for the final product design, and as consumers may consider to buy the new product long before it is made physically available to the marketplace. This strategy could also preempt competitors and enhance channel members' cooperation with the firm. In fact, in a recent study of four German industries (automobiles, consumer electronics, photography, household appliances) it was found that 63% of those firms that preannounce products to reach customers intend to reach channel members, also. However, a preannouncement needs careful timing and design such as not to give too precise hints on future products to competitors at inappropriate times. In the study just mentioned, 23% of the preannouncing firms took measures to avoid too early information of competitors. Finally, the strategy of phased distribution or roll-out of a new product over separate markets (not necessarily defined geographically), could be used similar to a test market. While many companies claim that today immediate global market entry appears to be necessary to achieve the full benefits

from a new product, which might be enhanced by strategic alliances, there still remain markets where a different behavior can be observed. Thus, it is not customary to introduce a new model of a passenger car at the same time in each European country. Aircraft and aircraft engines originally developed for military purposes may later be introduced into the civilian markets, if only with modifications (Gerybadze, 1988).

Customer Choice under Conditions of Unavailability: It is fair to argue that the strategy of preannouncement of new technological products is relatively easy to implement by a firm. The effective result of this strategy is to create a situation of customer choice among products, some of which are currently unavailable. Certainly, the situations that lead to unavailability are not just limited to the use of preannouncements. Out-of-stock situations (due to production shortages or inefficient distribution) should be added. It is not known whether this is more common among consumer goods or technological (industrial or specialty) products. Our assumption is that given the relatively high value of these products and the smaller degree of standardization as compared with frequently bought consumer goods, out-of-stock situations may be more widespread for technological goods.

Studies of the effects of unavailability of technological products to all or to certain customers are of considerable importance. Questions of interest include: What kind of consumer reactions could be expected due to unavailability? How should unavailability be treated in customer choice models? How can unavailability be avoided in a product positioning framework?

In this paper we will introduce product unavailability into models of consumer choice, product positioning and channel behavior with the overall objective of developing an approach to forecast the demand for new technological products. The rest of this paper is organized into six sections. In the next and second section we will conceptualize the situation of product unavailability in a very general manner. The third section discusses the interdependencies of product positioning and probability of availability, which would be

the basis for our modeling of the behavior of a firm marketing new technological products. In the fourth section we briefly touch on the channel behavior. The fifth section discusses a model of customer behavior. We describe the data requirements for implementing the approach suggested by our models in the sixth section. Finally, various implications with respect to product development process, dynamics and competitive behavior are identified.

## 2. A CONCEPTUAL MODEL

Starting out from the perspective of a potential customer, four different choice situations may be delineated using the two factors of awareness and availability. A customer may be aware of a product and have it included in his evoked set or not, which is different from the availability issue. Thus, we arrive at the four quadrants in Figure 1. The upper and the lower part in the off-diagonal quadrants relate to two different situations, namely the availability and the non-availability of a close substitute. This would separate the situations of the revolutionary innovation from the evolutionary innovation. It can be assumed that the existence of a close substitute to a new pre-announced item, which makes it an evolutionary innovation almost by definition, should not lead to a postponement of a purchase or to avoidance of any purchase and savings. The same does not appear to be likely if the new product promises to be revolutionarily different from present-day alternatives. In fact, this type of product may open up a new category of goods, particularly if the trade channels for related products are either not able or not willing to cope with the new item. We will return to this issue later.

Figure 1: BASIC CUSTOMER CHOICE SITUATIONS

| Availability / Awareness | Product available | Product not available |
|---|---|---|
| Customer aware | Classical choice models | Seek substitution<br>---<br>Postpone purchase |
| Customer not aware | Information problem<br>---<br>No choice (Savings) | Irrelevant |

From Figure 1 we conclude that the most interesting situation in our context of new technological products is the one where the customer is aware of a product offering that is not (yet) available due to such strategies as preannouncement. He could postpone his purchase or turn to a substitute, which may be another product or the most preferred product that is available at another outlet. The two substitute options can be made comparable in terms of the opportunity cost of finding the most preferred product in the most preferred outlet, and need, therefore, not be treated differently.

If the customer is not aware of a product alternative that is available, this could be due to a lack of information or to information overload. Either one of the cases may result in buying behavior that is not utility maximizing or to no choice (which could mean postponement of a purchase or savings). The first alternative appears to be more likely if close substitutes are available, while the latter alternative appears to be likely if such substitutes are either not available or the customer is not aware of such alternatives. It will be necessary to explore under which conditions the postponement of purchases or the selection of a suboptimal alternative is rational. Obviously, the credibility of a new product announcement will influence the solution to this problem.

The firm's behavior is guided by chosing an optimal combination of product characteristics such as to attract a maximum number of customers (which is the classical product positioning problem) for a specific market entry period. The classical product positioning problem assumes that the attainment of any combination of product characteristics has the same probability. In reality this assumption has to be questioned. Thus, any forecasting model would have to take into account any interdependence between product positioning and probability of achieving this position. Product positioning is influenced by an information flow from the customers, the competitors and the technological and regulatory environment to a firm. This information is transformed into new product development decisions. As has been argued above, preannouncement behavior may serve as to reduce risks in new product launching for various reasons.

Usually, firms do not deal directly with end-users but with intermediaries. These influence the distribution of new products through their decision to accept or not to accept the product. This decision may again be dependent on the characteristics of the new product, where radically new items may not find their appropriate channel at the start, while evolutionary items are more readily accepted. An illustration of this phenomenon is the emergence of specialized computer stores that have sprung up in many places for the distribution of personnel computers. If, however, a personnel computer is considered as either a toy or an office machine, it might have been distributed through established toy dealers or office machine shops.

Putting these ideas together, we arrive at the conceptual model outlined in Figure 2 which describes the interplay of the behavior of firms, channel members and customers. We will elaborate below on the behavior of each of the three entities in this model. This model is intended to serve as a framework for further research.

[Fig. 2: Flow chart model about here]

The conceptual model may be used as a starting point for predicting demand in a more formal manner. Let us assume that individual demand of the k-th customer $s_k$ is weighted by the probability $w_k$ of the k-th customer choosing the new product. Total expected sales S would thus be

$$S=\sum_k s_k w_k .$$

The probability of choice would depend on product characteristics, the possibility of the firm to physically make the product available, the channel acceptance, as well as consumer awareness and choice. These would have to be modeled in some detail. For the first step we consider the firm's behavior to determine the product's characteristics by optimal product positioning, which may have to be modified to take care of difficulties in constructing the characteristics that would match the optimal solution point at a specific point in time.

## 3. FIRM BEHAVIOR

As suggested above, our discussion will start with a traditional optimal product positioning model. We assume that the positioning is intended for a specific period in time. This involves some assumptions on the development of the consumer tastes that are basic to this type of models (Brockhoff, 1978). Basically, the product positioning model describes the probability of acceptance of a new product from the point of view of a customer based on a comparative evaluation of product characteristics. Assuming that each customer maximizes utility, and furthermore assuming that utility is composed of a nonstochastic part and of a stochastic part that reflect individual tastes for a product alternative, McFadden (1974) derives a relative probability of purchase:

$$q_{ky} = \frac{\exp(u_{ky})}{\exp(u_{ky}) + \sum_{i} \exp(u_{ki})},$$

where

u is utility,

y a vector of product characteristics that characterizes a new product, $y = (y_1, ...., y_j, ...., y_J)$,

$i = 1,2,...,I$ a set of product alternatives to the new product.

As a first approach we let $w_k = q_{ky}$.

We now assume that the utility is related to the distance of a product from an ideal product perception, which will be called $d_{ky}$ for the new product and $d_{ki}$ for the product alternatives, and we specify this assumption as $u_{ky} = b.\ln d_{ky}$ or $u_{ki} = b.\ln d_{ki}$, all i. This assumption is supported by empirical evidence (Trommsdorff, 1975) and it approximates standard utility models like the ideal point model.

Inserting these assumptions into the expression for $q_{ky}$, we arrive at the probability measure that is used in the product positioning model by Shocker and Srinivasan (1974). Here, we have

$$S(y) = \sum_{k} s_k \cdot \frac{d^{b}_{ky}}{d^{b}_{ky} + \sum_{i} d^{b}_{ki}}.$$

The parameter $b<0$ is assumed to depend on a product class (Shocker and Srinivasan, 1974, p.931; for a discussion see: Albers and Brockhoff, 1979).

It is well known that the foundation of the model has some drawbacks, one of these being the assumption of independence of irrelevant alternatives (IIA). However, this may not

influence our decision problem too strongly, as it comes to bear primarily if product alternatives are close substitutes. In fact, McFadden suggests that his model "should be limited to situations where the alternatives can plausibly be assumed to be distinct and weighted independently in the eyes of the decision-maker" (McFadden, 1974, p.113). This corresponds to the assumption of heterogeneous technological products.

The maximization of S(y) disregards the issues of product availability. As we have argued above, the probability of being able to make a product available at a given future point in time is dependent on product characteristics. It can be assumed that the probability of achieving a specific product position at a given point in time decreases with an increase of the technical advancement necessary.

A multitude of measures for technical advancement has been suggested in the literature. One of these concepts seems to be particularly fitting for our purposes. Dodson (1970) suggested the idea of measuring state of the art technology by searching for the minimum covering sphere of technical solutions that are represented as points in a technology space similar to products in a characteristics space. Technical advance can be measured as the distance between the future technical solution point and the edge of the technical performance space. Although this is largely an industry perspective, we will adopt it from the perspective of a single firm.

Difficulties in the realization of new products arise because of their advance over and above the most advanced product offered by the same supplier. Thus, even if the new product does not advance the state of the art of an industry, its development, production and marketing may cause great difficulties for its producer. A supplier may therefore denote a product $i^*$ with characteristics $e_{i^*j}$ that serves as a basis from which to measure the distance to the new product to get an idea of the degree of technical advance that appears to be necessary to meet the optimal solution to S(y). If $y_j$ are the unknown coordinates of the new product, and if $g_j$ are weights that may be necessary to make different

dimensions of the characteristics space comparable with respect to technical advances, we arrive at a distance measure

$$\Delta(y) = \left(\sum_j g_j |y_i - e_{i*j}|^m\right)^{\frac{1}{m}}$$

with the metric parameter m larger than or equal to 1. The probability of achieving the position $y_j$ may now be

$$P(y) = 1/\Delta(y)^c$$

where c is a constant that has to be determined according to the empirical evidence available together with $g_j$, for all j. Obviously, this calls for a nonlinear estimation procedure. The objective would now be to maximize

S(y)P(y).

As S(y) is not a concave function, the same is true for the product SP. Therefore, we suggest to employ the same grid-search procedures or gradient methods to find the maximum with respect to $y_j$ as the ones suggested by Shocker and Srinivasan (1974). Possible consequences of the new objective function are shown in Figure 3 for the special case of a one-dimensional characteristics space. The larger the deviation of the optimal new product position (according to the original objective function) from the technological reference product $e_{i*j}$, the smaller is P(y). Consequently, the difference between the optimal solution according to the new objective function and the technological reference product will be smaller than the difference between the reference product and the original objective function maximum. Thus, the limited possibilities of a firm to attain arbitrarily far removed positions in the characteristics space favors more evolutionary innovations over more revolutionary alternatives. It may be more advantageous for the firm to have a less advanced concept available with greater certainty than to strive for the more advanced concept with lower probability of achieving this position. This discussion shows the inter-

dependence of product positioning decision and availability of the new product to the customer.

[Fig. 3 about here]

The problem gets more complicated if one tries to optimize S(y)P(y) also with respect to time, as changes in customer preference structures as well as different competitive strategies will then have to be taken into consideration. We do not delve into these issues, but will explore the other players in our problem in a similar manner as the supplying firm.

## 4. CHANNEL BEHAVIOR

Marketing channels serve as filters between producers and consumers. One of the channel functions is to pre-select new products, while another function is to keep products in stock from which a customer may make his choice. The acceptance of new products devalues any stock of old products that can be substituted by the new product if the new product serves some of the customers of the old product better than the new product. Therefore, it depends on the characteristics of a new product whether it is accepted by channel members, and whether it is made available through the distribution system.

Little empirical research has been conducted on explaining the probability of new product acceptance through marketing intermediaries, and the research is mostly concentrated on new consumer goods (Voigt, 1983). In a recent publication, Rao and McLaughlin (1989) review the research and add their results to it. They find (among other influences) that the probability of acceptance is significantly and positively related to the perceived product uniqueness as indicated by buyer judgments on a ten-point scale as well as to the number of competing firms which have already adopted the same product; furthermore, there exists an insignificant relationship with a variable that measures the association of a product with a family of currently sold products, which is a measure of synergy (a related issue is explored by Bayus and Rao (1989)). Successful stores tend to develop ideal point per-

ceptions for new products that match the ideal point perceptions of their customers. The probability of acceptance Q(y) of the item y could therefore be estimated from

$$Q(y) = \frac{1}{1+\exp(-a - b_1 * S(y) - b_2 x_1)}$$

where

$a, b_1, b_2 > 0$ are parameters,

$x_1$ is the number of earlier adopters in the channel (as in Rao and McLaughlin, 1989) or a similar measure of earlier adoption success, such as the cumulated first time buyers which would conform with the Bass-type models of diffusion (Bass, 1969). We could now forecast the sales potential of a new product from maximizing

$$S(y)P(y)Q(y).$$

Neglecting $x_1$, we would expect a pull towards the traditional model's optimum solution from the application of Q(y) on S(y)P(y), if the influence of P(y) is counteracted by the channel decisions. This assumes implicitly that the channel members do not discount product announcements for their probability of not being met by the producers. If such a discounting does occur, it may be captured by inserting $S(y)P_1(y)$ into the estimation formula for Q(y) rather than S(y). Here, $P_1(y)$ is calculated in a manner similar to that for P(y), however, with a different parameter value ($c_1$) that reflects the announcement credibility form the perspective of the channel members for c.

It would be an interesting empirical question, as to whether the $c_1$-values for channel members should be larger or smaller than the c-values for customers, given the expectations of both groups with respect to the capacity of the supplier to produce a product with characteristics $y_j$ in time. When we jointly consider the perspectives of both the channel members and customers regarding the credibility of the firm's preannouncement of the new product, the following four possibilities can be identified using the respective values of the parameters c and $c_1$. These four cases have different implications for product development and marketing action.

| Value of c (customers) | Value of $c_1$(channel members) | |
|---|---|---|
| | Low | High |
| Low | (1) Normal | (3) criticality of customers |
| High | (2) criticality of channel | (4) desirable, but difficult to attain |

(1) The (low, low) cell is of no consequence because channel members and customers are waiting for the new product to be realized by the firm in due course of time. This situation may be normal for most evolutionary-type new products. Considerable all-round market communication input may be needed to raise the c-values in order to speed up market introduction. (2) The (high, low) cell implies that the product is likely to be unavailable because of the channel members' doubts as to the potential success of the firm to realize the new product that has been announced; this is the case even though the customers are quite convinced of the firm's technological skills. In this situation, the firm may opt for strategies of bypassing channel intermediaries (e.g. direct marketing) or seek new channels that are more receptive to the preannounced new products. (3) However, the situation of the (low, high) cell can generally be corrected by appropriate customer marketing communication strategies. (4) The (high, high) cell is desirable for the firm although it may be very difficult to achieve for most new products.

Referring back to the early market introduction of PC's we may assume that one could not point at substantial earlier sales, that the standard channel's $c_1$ value was rather low at first, which favored the development of new channels as the customer's c appeared to have been higher, specifically as the rather unsecure and possibly small S(y) did not appear to promise a considerable business to meet expectations of established channels.

## 5. CUSTOMER BEHAVIOR

Previous research by Choffray and Lilien (1978) has shown how a customer's probability of purchase of an industrial product is influenced by awareness, acceptance (dependent on product characteristics), and group decision processes. Further, the recent work by Urban et al. (1989) also shows that the step-wise modeling of purchase probability is relevant for industrial goods. They also show that customer behavior is shaped by knowledge on the product (which, in our case, can relate to firm's preannouncement strategy). While we abstract from the group decision process issue, we adopt the ideas in the modeling of the customer behavior and propose a two stage process for describing the behavior of customers.

First, we model the choice probability for the new product assuming that it will be available (as done in various consumer choice models). Then, we modify this probability by the probability of availability of the new item.

Following the random utility modeling approach and using the assumptions of extreme value distribution for errors (see McFadden 1974 and 1986), we can express the probability of choosing the new item assuming availability and believability of the announcement for the k-th customer is the same as $v_{ky}$ defined earlier in the section of firm's behavior. Ignoring the subscript, k for the customer, we have:

$$\Pr(\text{Choose/Availability, Believability}) = \frac{\exp(v(y))}{\exp(v(y)) + \sum_{i=1}^{I} \exp(v(i))}$$

where v(.) is the deterministic component of the random utility, expressed in terms of the perceived product attributes.

We may consider two alternative formulations for the v(.) function. The first formulation is to specify v(.) as bln d where d is the distance of the customer's ideal point to the perceived location of the alternative; this option is described earlier. The second alternative is to model v (.) directly as a linear function of the perceived characteristics as $\beta$'X,

$$v(.) = \beta'X$$

where X is the vector of perceived characteristics and $\beta$ is a vector of parameters.

In either case, the advertising and related communication utilized by the firm to convey the objective and other characteristics of the new product will lead to the customer's perception of the product characteristics. While many formulations are possible to model the psychophysical transformations of objective characteristics, one simple transformation is:

| Perceived characteristic | = | objective characteristic | * | scaling factor |
|---|---|---|---|---|

We may model the scaling factor in terms of advertising as:

$$\frac{1}{1+\exp(-\gamma_0-\gamma_1 A)}$$

where A is the advertising and other communication expenditures and $\gamma_0$ and $\gamma_1$ ($>0$) are parameters. (In reality, these parameters may be product characteristic dependent and, therefore, characteristic-specific scaling factors may need to be developed accordingly.)

The availability probability will consist of the probability of belief of the preannouncement by the firm and probability of acceptance of the product by the channel intermediary. The probability of belief of the preannouncement can be modeled as:

P [Believing the preannouncement] =

$$\frac{1}{1+\exp(-\delta_0-\delta X_p-\delta_2 X_F)}$$

where $X_p$ and $X_F$ are descriptors of the new product and the firm characteristics and $\delta$ and $\delta_2$ are associate vectors of parameters and $\delta_0$ is a scalar parameter.

Combining the various elements, we have the expression for the choice behavior of the customer toward the new product as:

Pr (Choosing new item) = Pr (Choose/Availability, Believability) * Pr (Belief in preannouncement) * Pr (Acceptance of the new product by channel). This can now be related to the forecasting of the demand. The probability of choosing the new item $w_k$ is determined; if multiplied with P(y) one arrives at S(y) and optimizes product characteristics at the same time.

## 6. DATA REQUIREMENTS AND IMPLEMENTATION

Prima facie, it will appear that a large amount of data is needed to calibrate the various components of the model. But, on reflection, only small additional inputs are needed over and beyond those required to estimate a product positioning model by a firm. Additional data will include data on the behavior of channel members with respect to the preannouncement of a new product, how these preannouncements affect the channel members' willingness to accept a new product and the customers' reaction to the new product's preannouncement by the firm. These data may be collected through surveys or experiments designed specifically for the new product under question or accumulated over time across several products. In either case, the various functions will need to be estimated using appropriate non-linear estimation methods. (We will not delve into these

questions here but defer them to an empirical application of these ideas to a concrete situation.)

## 7. CONCLUSIONS

This paper has raised several issues that relate to the problem of forecasting the demand for a new product, technological in nature. While it draws upon several existing models of product positioning and customer behavior, it specifically shows the effects of the firm's behavior of preannouncing a new product long before it can be made available to the market. The paper also has shown the tradeoff that could exist for a firm to wait longer for a new product that is close to the technological frontier and risk the consequences of the preannouncement and introducing a marginally better product much sooner. Dynamic implications of this model should be studied as these could suggest that learning in progressing with small steps is more advantageous than occasional large steps in product development.

The degree to which the firm's strategy of preannouncement is credible will undoubtedly have an effect on the decision of the channel member to accept the new product and the choice process of the customer. We have shown some specific ways of including these effects in the estimation of the potential demand for new products. The submodel for the intermediary's acceptance implicitly shows the time-dependent effects on the intermediary's acceptance of the new product.

The modeling approach suggested here will need to be validated in the field. Such empirical studies are quite difficult and time-consuming. However, specific experiments may be designed to explore particular relationships hypothesized in this paper. For example, one may design an experiment with student or manager subjects to explore the relationship between the preannouncement strategy and the technological improvement of a product such as computer software or a laptop computer. Such an experiment can also

explore the effects of the credibility of a preannouncement by a well-known firm versus a start-up firm. The results may indicate an appropriate strategy for the start-up firm that intends to develop a revolutionary new product. It is interesting to note that sales growth of computer peripherals (Meyer and Roberts, 1986) as well as high-tech start-ups (Kulicke, 1987) is largest for some optimal degree of newness that is definitely smaller than the maximum degree of newness.

We have treated the effects of product unavailability and consumer's beliefs of preannouncements in a probabilistic manner. But, various other aspects of consumer choice are relevant for new technological products. These include the tendency on the part of consumers to restrict choices to an evoked set of items (Narayana and Marklin, 1975; Silk and Urban, 1978), differential reactions to non-availability of preferred choice alternatives (Bettman, 1979), and limitations of consumer budget (Lancaster, 1971). Future research is called for the development of a more comprehensive theory of consumer choice that accomodates these additional factors.

The model as presented does not incorporate the dynamic effects of the decision process of the customers. Inclusion of dynamic aspects will be an important area for future research. In that endeavor, one may be able to answer such questions as: what is the effect of the preannouncement strategy on the development time for the new product, what is the optimal time to announce the new product's future availability, what is the tradeoff between the investments in research and development and expenditures in ensuring the credibility of a preannouncement, what are the appropriate reaction strategies of competitors to firms that follow the policy of preannouncements in a routine manner? Answers to these questions will enhance our understanding of the interrelationships between technology strategy and marketing strategy of a firm marketing new technological products. We believe that the models presented in this paper will provide the basis for these inquiries.

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# Figure 2: A Paradigm for the Demand for a New Technological Product

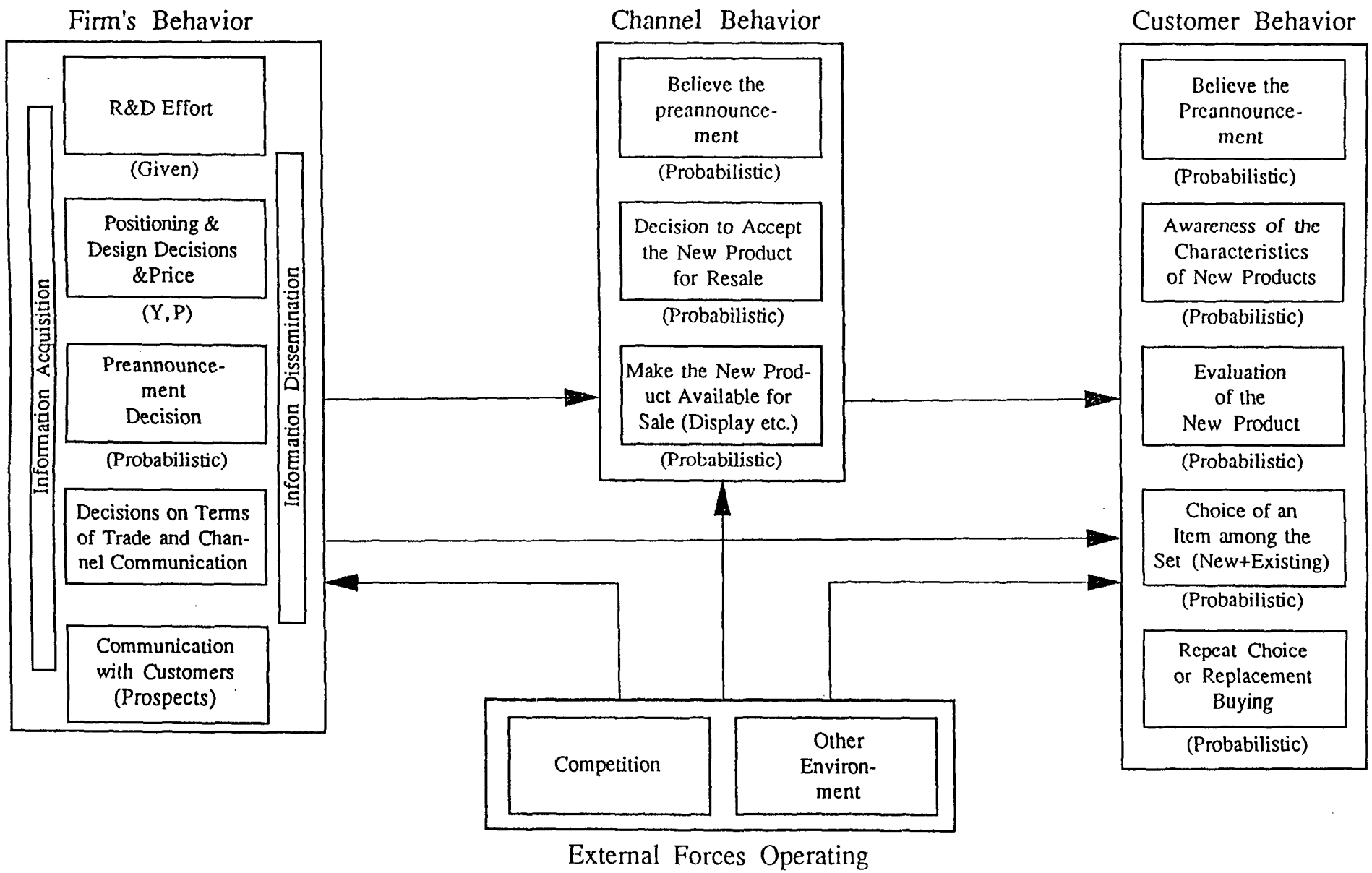

Fig. 3.

A ONE-DIMENSIONAL REPRESENTATION
OF THE EFFECT OF TECHNOLOGICAL ADVANCE
ON THE OBJECTIVE FUNCTION