DIRECTV: Forecasting Diffusion of a New Technology Prior to Product Launch

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We conducted research for planning the launch of a satellite television product, leading to a prelaunch forecast of subscriptions of satellite television over a five-year horizon. The forecast was based on the Bass model. We derived parameters of the model in part from stated-intentions data from potential consumers and in part by guessing by analogy. The 1992 forecast of the adoption and diffusion of satellite television proved to be quite good in comparison with actual subscriptions over the five-year period from 1994 through 1999.

Although the company called DIRECTV was officially founded in 1991, several years earlier Hughes Electronics Corporation began to lay the technical and administrative groundwork for a planned direct-broadcast-satellite (DBS) service. (We refer to direct-broadcast satellite (DBS) and direct-to-home (DTH) to distinguish this service from such systems as cable and other network-based-nonsatellite broadcast systems.) In December 1984, the Federal Communications Commission (FCC) granted Hughes the authority to construct a DBS system with 27 frequencies. Hughes' goal was to provide a multichannel alternative to cable that did not involve big, expensive C-band reception dishes, which then measured up to 10 feet in diameter and retailed for as much as $5,000.

Many experts then believed that the greatest potential for developing a widely accepted direct-to-home (DTH) satellite business in the United States depended on a number of factors, including the use of high-power satellites that broadcast in a
frequency not shared by other satellites. The FCC identified and authorized the use of three primary orbital slots with coverage over the contiguous United States for direct-broadcast-satellite services. Moreover, the FCC determined that these DBS satellites would provide their services at a high Ku-band frequency (12.2 – 12.7 GHz) known as the broadcast-satellite-services (BSS) band.

The minimum spacing for satellites operating at this higher-powered BSS frequency is nine degrees in contrast to two degrees spacing for the traditional, lower power Ku-band and C-band satellites. The wider spacing reduces interference from neighboring satellites and also enables the use of much smaller consumer antenna dishes, 18-inches and smaller in diameter.

In the early 1990s, additional breakthroughs in digital video-compression technologies combined with the development of high-power satellites drastically changed the economics of DTH broadcasting. The result was an affordable product and unobtrusive consumer equipment. Digital compression technology guaranteed that a marketable 175-channel DBS service could be created. Unlike cable, for which cable operators borrowed billions of dollars to lay wire into homes, the Hughes’ plan for DBS required less initial investment, especially on a per-subscriber basis. And if viewers were already willing to pay for cable TV, the logic went, surely they would pay an equivalent amount, or even a little more for five times the channels with crystal-clear pictures and sound.

Digital compression altered the economics of direct-to-home broadcasting by creating previously unattainable economies of scale. For most then-current applications, one analog broadcast-quality video signal was transmitted through one satellite channel or transponder. As a result, a typical cable-dedicated C-band satellite at that time could transmit only 24 video-programming services. Digital compression, however, turned video into digital data, while reducing its redundant content. The result is a digital video signal that requires only 10 to 25 percent of a satellite transponder’s bandwidth to transmit. Depending on the type of programming to be broadcast, the technique allows anywhere from six to 10 channels of programming to be transmitted through a single transponder.

Technological advances in satellite design also greatly increased the power capability and quality of broadcast signals. Transponders were three times as powerful as the transponders on medium-power Ku-band satellites. Such a spacecraft design was ideal for sending compressed TV signals to a dish that could be made tiny enough to fit on a windowsill at the viewer’s home. The viewer would need a decoder box to expand the digital signal, convert it back to analog form, and feed it into a standard television set.

Manufacturing and Distribution Partnerships

Less than six weeks into 1992, DIRECTV selected Thomson Consumer Electronics and News Datacom to develop and manufacture the consumer receiving system for DIRECTV. Under the RCA brand name, Thomson would provide the antennas, decoder boxes, remote control units, and the digital compression technology. London-based News Datacom (later renamed
NDS) would provide the conditional access and smart-card security for the system.

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first million dishes sold. Thomson also gave the new venture a critical edge in distribution, with more than 20,000 locations across the US selling consumer electronics products under the RCA brand and other Thomson brands.

Product Positioning and Competition

The primary competition for DIRECTV was and still is cable television, with its installed base of over 65 million subscribers. In addition to the strength of its installed base, cable had two important advantages over DIRECTV. First, cable television required little or no up-front investment by the subscriber. One call, and the local cable operator came out to the house and installed and activated the service. Second, because cable is distributed locally (11,000 cable head ends nationwide), it can carry over-the-air local-network channels, something DIRECTV and other satellite providers were legally prohibited from doing. However, DIRECTV managers believed that many cable television systems would be vulnerable to the DIRECTV offering for several reasons. Since the average number of channels in a cable system was about 40, DIRECTV’s ability to offer new and differentiated channels would have appeal. Moreover, out of the 65 million subscribers, only about 29 million could receive pay-per-view programming, and only 4.2 million had the ability to order pay-per-view programming instantly. These features are important because it has been demonstrated that impulse-ordering capabilities increase buy rates for pay-per-view movies and other programming.

In addition to these product features, cable television was hampered by high debt loads. Initial construction costs along with a string of system sales in the 1980s had left the industry debt at approximately $1,000 per subscriber. The downside of having no up-front investment by the consumer was that cable operators felt obliged to recover sunk costs through monthly subscription fees and through frequent fee increases. With monopoly status for cable systems throughout the country, the rate increases, though highly unpopular with consumers, were enforceable. In addition to monopoly control over pricing, large cable-system operators had control over programming. TCI and Time Warner owned or partly owned most of the popular cable networks and had little incentive to provide programming for competing systems.

As a result of increasing consumer displeasure with cable operators, in 1992, Congress overwhelmingly passed the Cable Act, which essentially stated that vertically integrated major cable-system operators could not withhold their programming from other distribution systems, such as satellite. In addition, the act ordered them to offer that programming at prices equivalent to the prices paid by cable operators.
**Research Questions**

At this point, all the pieces for the DIRECTV concept were in place: namely, affordable consumer equipment with a small, unobtrusive antenna bearing a well-known brand name, the technical capability to offer three to five times the programming choices as the competition, and the ability to provide the current programming services at the same price as the competition. Only two questions remained: (1) what would the design of the product be (pricing and programming), and (2) who would buy and how many would buy?

DIRECTV realized that to succeed it needed to build a large, nationwide, and loyal subscriber base by creating a product that would be affordable and more attractive than the current competitive product. It understood that consumers would not readily purchase a system that was merely cable with a $700 price tag. Early market research had established $700 as the highest price DIRECTV could charge before it encountered a cliff in demand. The next step was to determine what programming would be so compelling that it would cause consumers to spend $700 on equipment to receive it. In addition to the broad issues of pricing and programming, managers saw some possible perceived downsides to the new service that might cause consumers to ask specific questions:

—What were the up-front costs for single- and multiple-room viewing? (Viewing different channels simultaneously from a single dish was technically feasible but would require purchase of special receiving equipment.)

—How did the monthly costs of the system, with the $700 cost of buying and owning equipment and a monthly fee for programming, compare with the monthly cost of a long-term cable contract for programming?

—Where and how would the equipment (antenna and receiver) be installed, and how much would it cost to have an experienced professional install it?

—Would DIRECTV offer the variety and selection of basic, premium, and pay-per-view programming that we want?

—Would we get local broadcast network channels? How would we watch local news, weather, and sports? (The FCC prohibited the transmission of local channels by DBS programming providers. But Congress recently changed the law, and DIRECTV now offers local channels for an additional monthly fee.)

—How would I obtain satellite television if I lived in an apartment building?

The firm developed a research plan to determine the optimal programming mix and how to price it, and to conduct a large-scale demand survey incorporating those findings to obtain the basis for forecasting the adoption and diffusion of satellite television to determine how many would buy and when.

**Preconcept Test and Penetration Forecast**

In the months leading up to the October 1992 forecast of DBS market penetration, SMART conducted various qualitative and quantitative research programs for DIRECTV:

—It reviewed relevant syndicated research and secondary information (industry, technology, programming, competition, analogous products).

—It investigated in-home tests of interac-
After reviewing different approaches to survey-based forecasting of market penetration and different forecasting methods for innovative technologies, SMART asked Frank Bass, an authority on the diffusion of innovations and the creator of several widely recognized marketing models, to collaborate in designing an experiment that would produce the survey-based ingredients needed to forecast adoption and diffusion of satellite television.

**Data Collection Methodology**

SMART used a call-and-then-interview (CATI, phone-mail-phone) data-collection method to provide the optimal combination of nationally representative sampling, visual exposure to the DBS concept, and data-collection quality. It used a random-digit probability telephone sample proportionately representative of telephone-owning households to recruit a nationally representative sample of TV viewers. It initially contacted consumers by telephone and screened them for minimal eligibility requirements. Qualified and willing respondents participated in a 15-minute interview concerning their behavior and attitudes related to various forms of television viewing and their complete geo-demographic profiles. SMART assigned eligible respondents randomly to one of two monadic concept-price cells to facilitate testing potential price sensitivity toward the DIRECTV equipment.

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**DBS Concept Test and Forecast Inputs**

In September 1992, two years before DIRECTV was launched, DIRECTV commissioned SMART to conduct a DBS concept test among a nationally representative sample of TV households. The main purpose of the survey was to obtain data for forecasting DBS market penetration and diffusion over its first 10 years (1994 through 2003) for the total market and for three market segments: cable TV subscribers, nonsubscribers among households where cable was available, and homes where cable was not available. Secondary objectives included diagnosing the strengths and weaknesses of the DIRECTV concept and profiling consumers most likely to acquire DIRECTV on the basis of geo-demographics and television-viewing attitudes and behavior.

The results provided SMART and DIRECTV with a good basis for proceeding with a larger-scale DBS concept test and related forecasts of market penetration and diffusion.

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alistic business-plan assumptions, and asked them to complete brief questionnaires. The brochure provided a clear and complete description of equipment features and prices, retail availability, installation options and prices, programming content, and prices for monthly subscriptions and for the premium channel package. SMART conducted 22-minute telephone callback interviews to obtain responses to the self-administered questionnaires that respondents completed in advance and that comprised the essential concept measures. It also asked each respondent to answer a battery of agree-disagree statements. In addition, it asked questions to obtain answers that it used directly as primary inputs to the forecast. These questions concerned stated intentions of buying the DBS offering: likelihood to acquire on a five-point semantic scale, stated likelihood (probability) of acquiring on a 0–100 scale, as well as perceived value and affordability. Secondary inputs included measures of the primary questions across cable-status subgroups, strengths and weaknesses of the concepts, and differences between acceptors of the DBS concept and rejectors. A total of 1,145 consumers ultimately completed the mailed-out questionnaires and the final telephone questionnaires within the allotted time (69-percent completion ratio). Data collection began September 18 and ended October 19, 1992.

**Forecast Overview and Framework**

On the basis of data collected by SMART and managerial judgments provided by DIRECTV managers, Frank Bass provided a forecast that would answer the following questions: how many of the television homes in the US would subscribe to satellite television, and when would they subscribe? The forecast was developed on the basis of the Bass model [1969] of the adoption and diffusion of new technologies, a model that describes the adoption pattern of many new products and technologies and is an empirical generalization of the adoption process (Appendix). This model is based on the proposition that the conditional probability of adoption by potential consumers (the fraction of the population of potential adopters that has not yet adopted) of a new product at a given time will be a linear-increasing function of the number of previous adopters. The proposition is grounded in observations from the diffusion-theory literature that contagion effects are enhanced because of imitation or learning based on the number of previous adopters. Not all adopters will be influenced by previous adopters, however. Some of them (innovators) will act independently.

The underlying idea of the conditional probability of adoption at a given time as a linear function of the number of previous adopters leads to a nonlinear differential equation, the solution of which provides an equation of the cumulative number of adopters over time of the new product. For satellite television, this will be the number of subscribers for each time period. The model has three parameters: $p$, representing the influence of innovators and thus called the coefficient of innova-
tion, \( q \), representing the influence of previous adopters (imitators) and thus called the coefficient of imitation, and \( m \), the ultimate number of adopters (subscribers).

The forecasting problem, then, reduces to the problem of determining \( p \), \( q \), and \( m \).

For \( p \) and \( q \), the method of guessing by analogy may be used. That is, select \( p \) and \( q \) by finding similar new products that were introduced earlier and where historical data were fitted to estimate \( p \) and \( q \).

For \( p \) and \( q \), then, the issue is to select the best analogy to use out of the large set of previously introduced products. For \( m \), the survey data provide information from consumers on stated intention to purchase and on attitudes concerning various aspects of satellite television. It is well known that stated intentions, although related to actual behavior, overstate actual purchase behavior. For information on methods of adjusting stated intentions to more accurately reflect actual behavior, we used the data provided in the study by Jamieson and Bass [1989]. They derive methods of predicting actual initial purchase of new products based on stated intentions. They collected intentions data for five consumer-durable products and five consumer-nondurable products and compared them to actual purchase six months later. For each of the 10 products, they calculated the ratio, \( k \), of the actual purchase fractions (of the population) to the average stated probability of purchase. The ratio, \( k \), varied considerably over the 10 products. They included in the study several variables that could affect the variation of \( k \) over the different products, including such factors as Consult (Would you talk to or consult with anyone or anything before purchasing the product?), Awareness (How familiar or knowledgeable are you with this product: Very, Somewhat, Not very, Not at all?), Liking (How much would you like to have this product?), Afford (Very easy to purchase, somewhat easy, somewhat difficult, very difficult?), Avail (Have you ever seen this product in stores where you shop?).

To study the way \( k \) varied with moderating variables, they regressed \( k \) on the variables across the different products. They used a jackknife-like procedure in which they estimated the relationship between \( k \) and the moderating variables for each product using data for the nine other products to avoid predicting with the same data used for estimation.

They examined various combinations of the variables and found the best-fitting equation:

\[
k = -0.899 + 1.234 \text{ Afford} + 1.203 \text{ Avail}
\]

(1)

where Afford is the fraction of the population that stated that the product is very easy to purchase (the top box of four), and Avail is the fraction of the population that stated that they had “ever seen this product in the stores where you shop.”

We used equation (1) to forecast the fraction of TV homes that would have acquired satellite television six months after Avail reached some specified value and after we estimated Afford from the survey responses.

Although we could use equation (1) to forecast early penetration of satellite television, we could not use it to estimate the ultimate number of subscribers because we had derived it from data based on only
six months. We made that estimate (guess) using managerial judgment of the appropriate discount to apply to stated-intentions data from the survey (that is, the average stated choice probability).

**Comparison of Actual and Forecast**

For the forecast of early penetration of satellite television based on equation (1), of the people surveyed, 13 percent indicated that satellite television was very affordable. For Avail, we assumed that 65 percent of potential consumers would have “ever seen satellite television in stores where you shop” one year after the product was introduced. Using these values for Afford and Avail in equation (1), along with the average stated probability of subscribing from the survey of 0.32, we forecast penetration percentage of TV homes after one year as 1.37. The actual percentage was 1.21 (Table 1), a comparison of forecast and outcome that many would consider to be quite good. In May 1995, the DBS/small-satellite-dish category achieved 63-percent total unaided/aided awareness. Awareness and Availability were highly correlated (0.886) in the Jamieson-Bass study, and thus the assumption of Avail being about 65 percent after one year was approximately realized. Although direct-broadcast satellite-TV systems formed a niche-product category and had much lower ultimate market potential than many other consumer-electronic products (VCRs for example), the product category was the fastest-selling new-product introduction in consumer-electronics history in its first year, with more than one million customers.

For the forecast over several years using the Bass model, it was necessary to guess by analogy to choose the \( p \)'s and \( q \)'s and to specify a discount factor for the average stated choice probability of the consumers in the survey. This average was 0.32. We presented four scenarios to management for their judgment:

1. \( m = 0.32 \times TV \) Homes and Diffusion \( p \) and \( q \) like Color TV in the 1960s,
2. \( m = 0.32 \times TV \) Homes and Diffusion \( p \) and \( q \) like Cable TV in early 1980s,
3. \( m = 0.16 \times TV \) Homes and Diffusion \( p \) and \( q \) like Color TV in the 1960s,
4. \( m = 0.16 \times TV \) Homes and Diffusion \( p \) and \( q \) like Cable TV in early 1980s.

Management chose the fourth as the most likely outcome for satellite television. This represented a fairly rapid rate of diffusion and a discount factor of .5 for the average stated choice probability.

A comparison of the 1992 forecast for the years 1994 to 1999 and the actual outcome for each fiscal year in that period shows that the forecast was quite accurate (Table 1, Figure 1). We did not update the forecasts each year as actual values became available. The 1992 forecast for 1998–1999 differed from the actual outcome by less than six percent, and the yearly forecast values closely paralleled the actual values over the five-year period.

Most observers would consider this forecast outcome to be quite good, and some would consider it to be remarkably good. (In some of the more optimistic forecasts, industry executives in 1995 predicted 20 million subscribers by the year 2000!)

**Comments on Scenarios and Forecasting (Guessing Without Sales Data)**

The most critical forecast for any new product is the forecast made prior to prod-
Table 1: A comparison of the actual and the 1992 forecast of satellite TV subscribers in millions of homes and as a percentage of homes for each year from 1994 to 1999 indicates that the forecasts track the trends in actual values and that the forecasts for 1998–1999 are quite close to the actual values.

<table>
<thead>
<tr>
<th>Year (7/01/94–6/30/95)</th>
<th>1992 Forecast (Millions)</th>
<th>Actual Number of TV Homes Acquiring DBS (Millions)</th>
<th>1992 Forecast of Percent of TV Homes with DBS (Percentage)</th>
<th>Actual Yearly Percent of TV Homes with DBS (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/01/94–6/30/95</td>
<td>0.875</td>
<td>1.15</td>
<td>0.92</td>
<td>1.21</td>
</tr>
<tr>
<td>7/01/95–6/30/96</td>
<td>2.269</td>
<td>3.076</td>
<td>2.37</td>
<td>3.21</td>
</tr>
<tr>
<td>7/01/96–6/30/97</td>
<td>4.275</td>
<td>5.076</td>
<td>4.42</td>
<td>5.25</td>
</tr>
<tr>
<td>7/01/97–6/30/98</td>
<td>6.775</td>
<td>7.358</td>
<td>6.95</td>
<td>7.55</td>
</tr>
</tbody>
</table>

Figure 1: The 1992 forecast of homes with satellite TV tracks the actual quite well. The dashed line (squares) shows the actual number of subscribers and the solid line (diamonds) indicates the forecast number of subscribers. For 1998–1999 the forecast was for 9.4 million subscribers and the actual was for 9.9 million subscribers.

To the available data. The average stated choice probability of the consumers surveyed was 0.32. However, it would have been unrealistically optimistic to assume that 32 percent of TV homes would ultimately have adopted satellite TV. In various studies of purchase intention and actual behavior, researchers have found that the stated intention measures for most respondents overstate the actual behavior [Jamieson and Bass 1989]. Therefore, we never gave the upper limit of 0.32 serious consideration. Management chose a discount factor of 0.5 and, as indicated by the forecast, this number proved to be a good one. We have recently made forecasts for other new technology products based on the research design employed for DIRECTV, and we have chosen and applied discount factors to the average stated choice probabilities for those products. Over time we expect that as our experience with the methodology grows, so too will our knowledge of the factors and conditions that influence the discount factor.

For the possible diffusion pattern for satellite TV, we considered two possibili-
ties: color TV in the 1960s and cable TV in the 1980s. In searching for analogies, we considered product similarity (that is, television). We judged cable TV to be more like satellite TV in that it is a subscription product and its introduction was closer to the launch time for satellite TV.

The 1999 forecasts for the four scenarios were (1) 3.6 million, (2) 18.8 million, (3) 1.8 million, and (4) 9.4 million. As indicated, we never seriously considered Scenarios 1 and 2 because the ultimate market potential was unrealistically high. In the end, the choice came down to a slower growth associated with Scenario 3 in contrast to the more rapid diffusion associated with Scenario 4. Clearly, Scenario 4 was the far better choice.

The art of forecasting the diffusion of new products prior to product launch is still in development. Algorithms for choosing analogies are being developed, and experience is growing concerning the relationship between the ultimate market potential and stated choice probabilities. We hope this case history will contribute to the growing knowledge base for forecasting in the new-product arena.

Postlaunch Developments

At DIRECTV, research is an ongoing process, not an event. Before and after the 1992 concept test and forecast, DIRECTV has partnered with SMART in conducting other research studies to support and enhance the initial forecast. These efforts have encompassed a curriculum of business issues, including (1) identifying and profiling four distinct, homogeneous segments of potential customers with similar attitudes who were likely to exhibit similar purchase behavior; (2) mapping the perceived positions of DIRECTV, Prime-star, Dish Network, and local cable TV relative to important brand-image variables; (3) measuring, modeling, and simulating the relative values of attributes that contribute to consumer purchase decisions in a competitive context (trade-offs among brand, equipment, installation, programming, packaging, pricing, and promotional offers); and (4) benchmarking and tracking category and brand awareness as well as attitudes and behaviors across critical segments. (In addition, in 1994, the SMART-Bass research team ran comparable DBS concept tests and made penetration forecasts for DIRECTV in Mexico, Brazil, and Argentina.)

Eight years after the 1992 forecast, the DBS market conditions and forecast assumptions have changed considerably. The DIRECTV-branded DBS concept that respondents considered in 1992 did not include assumptions for industry consolidation, the reception of local channels, multiple-room viewing, non-RCA equipment manufacturers (including Sony), apartment-building installation, business applications (hotels, bars, airlines), HDTV capability, interactive services, telephone-company distribution partnerships, or the convergence of the Internet with DBS. Today there are only two competitors for DBS out of the original five players. DIRECTV acquired PRIMESTAR in 1999, and the merged company has about 70 percent of the subscribers, while the remaining portion belongs to EchoStar. Because of these changes in the environment for satellite television, forecasts for the year 2000 forward are much larger than those we made in 1992.
Managerial Uses of the Forecasts

DIRECTV’s management made use of our 1992 forecast in several important ways:
—The forecast for the first year that indicated very rapid consumer acceptance of direct broadcast satellite systems supported DIRECTV’s decision to launch a second million-dollar satellite sooner than originally planned. The second satellite permitted DIRECTV to carry a greater variety of programming.
—DIRECTV planned and budgeted for distribution arrangements and advertising expenditures to achieve the availability and awareness levels we had assumed as necessary in making the forecasts.
—DIRECTV management used the forecast to solicit funding from GM/Hughes and in developing partnerships with equipment manufacturers (for example, Sony), programming providers (for example, Disney), and national retailers (for example, Radio Shack).

Conclusions and Lessons

The 1992 forecast of the adoption and diffusion of satellite television proved to be quite good in comparison with actual diffusion over the five-year period from 1994 through 1999. The success of the forecast is partly the result of the methodology and partly the result of good judgment (by management) in the choice of a good analogy for $p$ (the coefficient of innovation) and $q$ (the coefficient of imitation) and a good discount factor to apply to the average-stated-choice-probability statistic from the survey. As we gain experience in applying the methodology to new products and new technologies, we also gain knowledge concerning the basis for choosing analogies and the discount factor to apply to stated intention. We hope this case history will spur others to share information about forecast-outcome comparisons for new technologies so that the knowledge base may grow further.

The DIRECTV forecast and follow-up experience offers some lessons:
—Managerial participation in the judgmental facets of a forecast is important. Managers can provide useful information as related to survey data and model parameters and simultaneously gain confidence in the credibility of the forecast.
—Surveys of consumers’ stated intentions to purchase new technologies that they do not know or understand well can, if properly administered, provide valuable inputs for forecasts. Stated intentions to purchase are related to actual behavior but will overestimate actual behavior and must be discounted. We used a discount of 0.5 in this case, but little is known so far about how the discount factor varies with products and circumstances.
—Choosing the appropriate analogy of previously introduced new products is important for the Bass model. However, little is known about the best way to guess by analogy other than to say that it depends on judgment. Lilien, Rangaswamy, and Van den Bulte [2000] provide historical data for numerous previously introduced new products along with software that is useful for exploring the sensitivity of forecasts to the choice of the analogy. The software gbass.xls is available with the forthcoming book New Product Diffusion Models edited by Mahajan and Wind [2000]. The software permits exploration of the effects on diffusion of variation in parameters of...
the Bass model and of the generalized Bass model [Bass, Krishnan, and Jain 1994], and it also provides a module for parameter estimation in connection with products in the database that is embedded in the software.

—The choice of specific forecast methodology depends on several factors, including the product, the market, the firm, the ability to collect information, the uses intended for the forecast, and managers’ desired participation in developing the forecast. Lilien, Rangaswamy, and Van den Bulte [2000] provide descriptions of several applications of Bass-type diffusion models and related experiences for a variety of conditions and factors, including competition, product replacement, multiple purchases, multiproduct interactions, and multimarket effects. Although new-product forecasting always involves risks, and actual outcomes are not always as closely related to the forecasts as they were for DIRECTV, there is reason to believe it is possible to develop reasonably accurate forecasts for new products over a wide variety of circumstances.

APPENDIX

The basic equation from which the Bass model is derived is:

\[ f(t)/(1 - F(t)) = p + qF(t), \]  

(1)

where

- \( p = \) the coefficient of innovation;
- \( q = \) the coefficient of imitation;
- \( f(t) = \) the density function of time to adoption;
- \( F(t) = \) the fraction that has adopted by time \( t \).

If \( m \) is the number of ultimate adopters, the number that will not have adopted by time \( t \) is \( m(1 - F(t)) \), and letting \( mf(t) = Y(t) \) and \( mf(t) = S(t) \), equation (1) may be used to obtain

\[ S(t) = m(1 - F(t))(p + qF(t)) \]

\[ = pm + (q - p)Y(t) - (q/m)[Y(t)]^2. \]  

(2)

\( S(t) \) will be sales at \( t \) (adopters at \( t \)) and \( Y(t) \) will be cumulative adopters at \( t \). Equation (2) is a differential equation that may be solved to find \( Y(t) \). The solution for \( S(t) \) is

\[ S(t) = \frac{m((p + q)2/p)e^{-(p+q)t}/(1 + (q/p)e^{-(p+q)t})^2}{(1 + (q/p)e^{-(p+q)t})^2}. \]  

(3)

\( S(t) \) will rise to a peak at \( t* = (1/(p + q)) \ln(q/p) \) and decline after \( t* \). If the parameters \( p, q, \) and \( m \) are known, equation (3) may be used to predict the number of new subscribers to satellite television at time \( t \), and the number of subscribers at \( t \) will be \( Y(t) = \frac{m(1 - e^{-(p+q)t})/(1 + (q/p)e^{-(p+q)t})}{(1 + (q/p)e^{-(p+q)t})^2} \).

References


