This paper introduces a well known forecasting technique which is widely used to compute prelaunch market size of new products as well as that of new launches.
Introduction

The Bass model is a very useful tool for forecasting the adoption (first purchase) of an innovation (more generally, a new product) for which no closely competing alternatives exist in the marketplace. The model can forecast the long-term sales pattern of new technologies and new durable products under two types of conditions:

I. The firm has recently introduced the product or technology and has observed its sales for a few time periods; or
II. The firm has not yet introduced the product or technology, but its market behaviour is likely to be similar to some existing products or technologies whose adoption pattern is known.

The model tries to predict how many customers will eventually adopt the product and when they will adopt. These answers are important because a firm’s deployment of marketing resources on the new innovation depends on them.

Description of the Bass model

Let $F(t)$ be the fraction of customers who have adopted the innovation till time $t$ and $f(t)$ be the fraction of customers adopting the innovation in time $t$, where $f(t)$ is the probability density function (first derivative of $F(t)$) and $F(t)$ is the cumulative density function.

Now by Bayes’s rule the conditional likelihood that a customer will adopt an innovation in time $t$ given that he has not adopted it before, is denoted by the following:

$$L(t) = \frac{f(t)}{1 - F(t)}$$

(1)

Bass proposed it to be defined as

$$L(t) = p + \frac{q}{N} N(t)$$

(2)

Where,

$N(t) =$ Number of customers who have already adopted the innovation in time $t$

$N =$ Total number of customers in the adopting target segment, all of whom will eventually adopt the product

$p =$ Coefficient of innovation

$q =$ Coefficient of imitation
Equation (2) suggests that the likelihood a customer will adopt an innovation in time $t$ depends on two factors:

1. Constant propensity to adopt which is independent of how many other customers have adopted the innovation before time $t$ due to innovation ($p$)

2. The number of customers who have already adopted the innovation by time $t$ which represents the extent of favorable exchanges of word-of-mouth communications between the innovators and the other adopters of the product (imitators, $q$)

From equations (1) and (2) we get

$$f(t) = \left[p + \frac{q}{N}N(t)\right][1 - F(t)]$$

(3)

Using the fact that $N(t) = NF(t)$ and some algebraic manipulation we get the final Bass equation to predict the number of customers (sales) adopting the innovation at time $t$, which is given by the following:

$$n(t) = pN + (q - p)N(t) - \frac{q}{N}[N(t)]^2$$

(4)

Where $n(t) =$ customers (cumulative sales) in period $t$

Note: Equation (4) can be modified by adding marketing mix variables, refer to “The Bass Model: Marketing Engineering Technical Note” given in the reference.

**Estimating the model**

We need to estimate the following parameters in the model: $p$, $q$, and $N$. The equation is non-linear in parameters so any non-linear regression technique would be an appropriate way of estimating the parameters. The best way to estimate for a new launches would be to use analogs (similar product), and estimate $N$ via an external procedure (e.g., survey of long term purchase intentions).

The following will be some of the non-linear regression techniques:

- Maximum likelihood estimation
- Hierarchical Bayes estimation
- Iterative methods like –
  - Direct computation method
  - Derivative method
  - Self – starting method

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Note: The above is not an exhaustive list there are other non-linear regression methods, which can be easily implemented in SAS and be easily implemented in SAS and R

Extension of the Basic model

The Bass diffusion model is based on several assumptions but we can relax these assumptions by using sophisticated modelling technique:

I. Market potential i.e. N is a constant

We can make N function of some base factors like prices, distribution, growth of target segment etc.

II. The value of q is fixed throughout the life cycle of the innovation:

One would, however, expect interaction effects (e.g., word of mouth) to depend on adoption time, being relatively strong during the early and late stages of a product’s life cycle. This assumption is relaxed in models that incorporate a time-varying imitation parameter q(t).

III. Imitation always has a positive impact (i.e., the model allows only for interactions between innovators and non-innovators who favor the innovation):

Several models are available that allow for both positive and negative word of mouth. When word-of-mouth effects are likely to be positive (e.g., “sleeper” movies such as Ghost), it may be wise to gradually ramp up marketing expenditures, whereas when word-of-mouth effects are likely to be negative (e.g., the “mega-bomb” movie Waterworld), it may be better to advertise heavily initially to generate quick trials before the negative word of mouth significantly dampens sales.

IV. There is no repeat or replacement purchase of the innovation:

There are several models that extend the Bass model to forecast purchases by both first-time buyers and by repeat buyer.4

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References


“The Bass Model: Marketing Engineering Technical Note”, a supplement to some the materials in Chapters 1, 2, and 7 of *Principles of Marketing Engineering*, by Gary L. Lilien, Arvind Rangaswamy, and Arnaud De Bruyn (2007)