
Forecasting New Product Potential Market

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Abstract

New-product plans need dynamic processes to forecast market behavior during product life time. This paper intends to present an innovated model to predict new product potential market by renewed method. Accordingly, the model parameters organized by product attribute values and developed by analogical insight based on the adoption patterns through Bass model over product life time. The findings highlighted that the suggested model is reliable enough for forecasting optimum demand of potential market without any market history in pre-launch phase. Therefore, the results provide valuable viewpoint for planners to investigate product attributes and evaluate effective parameters respect to the optimizing market size on product life time.

Keywords: Bass Model, Bass Coefficient's Estimation, Automotive Pre-launch Forecasting.

1. Introduction

Firms need to adjust their products to keep customer advantages according to changes in customers' needs via products development in potential market. New products demand forecasting is an iterative method for calculate approximately the number of a product or quantity of services that the customer will purchase or consume [1]. Anticipate of demands which include the formal and informal procedure of forecasting used in areas such as making pricing decisions, assessing the future requirements capacity or making decisions on whether to implement new production line for the new target market. It is essential for companies in particular to produce the required quantities at the right time and arrange well in advance for the several elements in the production processes [2].

Evaluation of product diffusion is the procedure to know whether a new idea or new product is successful in market or not. The concept of diffusion still remains complex phenomena and it is an innovative way to find the rate of adoption process which is the speed of the new idea brought from one consumer to the next. Adoption (the reciprocal process as viewed from a consumer viewpoint rather than

distributor) is similar to diffusion but it deals with the psychological processes an individual goes through rather than a cumulative market process. Thus, various approaches, methods and computer models have been developed to investigate the market diffusion of new products.

Theory of innovation diffusion investigated by researchers of consumer behavior, marketing management, economics and management etc. to find in what way a novel idea of a new product and/or a new service is accepted among the members of its potential consumer population over time [3] Although the above studies of potential market provide valuable viewpoints in estimating new products adoption rate, however most of them are based on qualitative estimates or focused on the technology aspects only. This paper intends to use a mathematical modeling approach to consider the market scope, user adoption behavior, and future outlines of previous technologies which are making product development in target market. In this regard, forecasting market diffusion has been verified as an authoritative tool for predicting the market for new products. Furthermore, these models can estimate market potential and describe how the new product will penetrate in market as well. The model results provide important information for marketing plans to implement their strategy with respect to market behavior.

In the following, the second section summarizes the literature review and previous findings also the model and methodology of research illustrated in the third section then the model findings and sensitivity analysis results are presented in the last section of this study.

Generally, new product demand or potential market forecasting is a process that describes sales rates under a given set of conditions just like an estimating game result. New product can be explained by various concepts to different people and can be classified into six dissimilar categories which are new-to-the world, new-to-the firm or setting new product line, developing or modifying the existing products, repositioning and cost reductions. Forecasting potential market of new product is similar

to demand forecasting of new product. Sometimes, instead of demand complexity because of local strategy or monopoly reasons it might be easier to forecast. In short, models are the best way for modeling the conditions and concepts to estimate the theories.

Bass Model (BM) (1969) stems mathematically from the social behavior. The assumptions are similar in certain respect to the theoretical concepts emerging in the literature on adoption and diffusion of new-product as well as in the application categories [4]. The model which is investigated in this paper differs from other models in term of the assumptions are explicated. In addition the model presents a rationale algorithm for calculating new product demand. Therefore it has found wide-ranging applications in many industries.

The Bass model is the most common diffusion model used in marketing and it is a mixed model capturing both innovative and imitative effects. The model assumed that the potential adopters are influenced by innovation and imitator behavior [5].

In automobile industry during the elapsed few decades, the number of automakers increased by more than 50% because of diversity of vehicle types produced by companies and some of them joint together for making core-competence. This variety provides complexity in market models respect to innovator and imitators behavior and make higher car demands.

The past studies in this industry merely focus on the value of customer only by investigating on customers' purchase history (Gupta & Lehmann, 2003; Ho, Park, & Zhou, 2006, Gupta, Mela, & Vidal-Sanz, 2006). Other studies considered the customer behaviour in life cycle whereas several studies have investigated Adoption rate in the technology and market changes. The previous studies based on Bass model in automobile industry investigated by Dimmick, Patterson, & Albarran, (1992) had modified BM model to Nich markets and some studies attempt to forecast the diffusion of new technology and demand in a market by BM. Kim, Shin, & Park, (2009); Radojicic & Markovic, (2009) and Litman, (2014) predicted the implementation analogy of vehicles based on previous vehicle related technologies (automatic transmission, air bags, hybrid vehicles, subscription vehicle services and vehicle navigation systems) changes in market rate. Jensen et al. (2014) used Norwegian new car registration data from 2003 to 2013 to estimate the electronic Vehicles demand model in Denmark market, and studied these findings directly as lifestyle and economic conditions of the two countries were generally very similar.

Furthermore, Park, Kim, & Lee, (2011) used Japanese sale volume of HEVs to estimate diffusion model for HFCV in Korea by adjusting the imitation parameter based on other previously estimated models in the two countries.

However, the past studies investigated the market but Bass parameters haven't used as exclusive method for synthesis forecasting market diffusion whereas the diffusion model represented in previous studies forecasted the parameters in Bass model by the product market data history over continues time for local markets. This study aims to fill this gap, as limited studies been cited in the literature on new product vehicle demand forecasting, this paper attempts to improve bass model by parameter analogy estimation in potential market and forecasting new vehicle demand with optimizing potential market size by the following methodology

2. Methodology

2.1 Bass diffusion model

Bass model was developed by Frank M. Bass in 1969 and generally used for new product forecasting theories. The Bass model and its revised various forms have been used for forecasting innovation diffusion in; retail service, industrial technology, agricultural, educational, pharmaceutical, and consumer durable good markets additionally it use in successfully predicts the actual shape of the diffusion curve, the sales behavior over time and magnitude of its peak sales for a number of products. Bass divided the adopters into two groups of an innovation— 'Innovators' who makes a purchase on being influenced by mass-media communication – and 'Imitators' who makes a purchase on being influenced by the word of mouth communication

The mathematical equation describing Bass model is as follows:

$$\frac{dN(t)}{dt} = \left[p + q \frac{N(t)}{\bar{N}} \right] (\bar{N} - N(t)) \quad (1)$$

$N(t)$: Product purchases in period t

\bar{N} : Cumulative product purchases until beginning of period t

p : Coefficient of innovation

q : Coefficient of imitation.

In Bass model Hazard rate $H(t)$ is derived alternatively by changing the mathematical form of the rate of adoption per remaining adopters given as

$$H(t) = \left[p + q \frac{N(t)}{\bar{N}} \right].$$

Bass Diffusion Model assumes that in the beginning launch of the product there will be m initial purchases of the product. Because consumer durables are products consumers' purchase which is infrequent, the unit sales of the product will equal the number of initial

purchases for the period of the time interval that excludes replacement sales.

The model explains the behavior of adopters of a new innovation is influenced either by mass media, or by word of mouth (WOM). Meanwhile, the buying influence distinguishes innovators from imitators in addition innovators are not influenced by the number of previous purchasers, while imitators are influenced by the number of previous purchasers.

If supposed that $N(t) = \hat{N}F(t)$ thus $f(t)$ and $F(t)$ are the probability density function and the cumulative distribution function of adoption at time t , the product purchases defined by the number of customer's adopters in time t represented by:

$$f(t) = [p + qF(t)](1 - F(t)) \quad (2)$$

Flexibility in Bass model (1969) can be captured by proposing a logistic time dependent form for $H(t)$, given by :

$$F(t) = \frac{1 - e^{-(p+q)t}}{1 + (q/p)e^{-(p+q)t}} \quad (3)$$

When the new product or technologies are introduced into the market, the number of innovators decreases because of the less potential innovators. While, the imitator increases due to the WOM communications that give durable effect to the imitators where more users adopt the new product. Then, the internal influences rise the noncumulative adopters to a peak and drops gradually as the market beginning. Accordingly, by nonlinear estimating approach the parameters $S(t)$ is the diffusion rate at time t , m represents the total potential adopters and $Y(t) = mF(t)$ is the total number of adopters by time t and $e(t)$ represents the random error term. For the estimation of model parameters, we used a nonlinear least squares estimation algorithm.

$$Y(t) = \int_0^t S(t) dt = m \int_0^t f(t) dt = mF(t) \quad (4)$$

$$S(t) = [m - Y(t_{i-1})] \left[\frac{F(t_i) - F(t_{i-1})}{1 - F(t_{i-1})} \right] + e(t_i) \quad (5)$$

Since $Y(0) = 0$, p represents the probability of an initial purchase at time 0 and its magnitude reflects the importance of innovators, the product $q/mY(t)$ reflects the pressure of prior adopters on imitators.

$$S(t) = mf(t) = pm - (q - p)Y(t) - q/mY_t^2 \quad (6)$$

The Bass model parameters (m , p , and q) can be identified by using regression and ordinary least square method. [6] Two conditions for estimating parameters demand of new product are; forecasting model base on the availability of market historical data and second is the non-availability of these data or less data available which the researchers may investigate by expert's judgment or analogy to forecast best output of regressions. In this paper we analyze the model outputs by analogy and made sensitive analysis for evaluation optimum market size for new product.

2.2 Data Analysis

The forecasting of potential market for four kinds of car (all in class C) estimated based on the historical sales data which were collected from official World Bank statistic center for three brands such as Ford, Toyota Prius and Hybrid Electric Vehicle (HEV) through least for one decade. Whereas For new brand of car without any market data the parameters forecasted by analogy and expert judgment to estimate potential market in pre-launch phase moreover the market potential studied by Iran statistic center¹ for new brand type of vehicle estimated amount 600000 in 2015. As mentioned above, the model of research aim to explore the different estimation parameters method in automobile industry to find the optimum potential market respect to adopters' diffusion over product life time. Therefore, the parameters are estimated by using least square regression method from historical data of three brands and set up an innovated analogy regression for one new car brand. The details of the findings and assumptions are described in the following section.

3. Findings and Discussions

3.1 Parameter Estimation

The parameters of Bass model are regularly used to investigate potential target market instead of new products or technologies. This theory was selected as the ten most frequent reference paper in 2004 in the 50 years history of management science². As the literature review and the other authors estimates [7, 8] suggested these parameters essential for forecasting model of diffusion in market.

The new-car-brand parameters without historical market data are estimated through analogy making in product attribute values among the same class, nearest price and nearby potential market grows vehicles in Iran and other countries. The diffusion patterns and analogy variables are figured out by extending literature review and discussions directly with focus group meeting with experts. Further in the second step related criteria identified and finally by investigating accuracy and removing irrelevant factors, the reliability of variables tested through Kolmogorov-Smirnov by SPSS. In the research method, product attribute values as presents 19 variables figured out for the product aspect in four key factors of market, competition, technology and buyers/users (see Table.1).

Table 1. Product diffusion variables		
Key factors	Variables	Abbreviations
Market	Types of income elasticity	TIE
	Number of potential customers	NPC
	The number of agencies	NOG
	Diversity of distribution channels	DDC
	Level of price	LOP
Competition	Facilities and Safety	FAS
	Types of competitive structure	TCS
	Support from government	SOG
	value of Brand	VOB
Technology	Indicators of Environment	IOE
	Rate of technological change	RTC
	Easiness of imitation	EOI
	Degree of functional variety	DFV
	Degree of novelty	DON
Buyers/ Users	Necessity of repurchase	NOR
	Duration of use	DOU
	After sale services	ASS
	Level of quality	LOQ
	Guarantee and warranty	GAW

The model predict by designing of matrix of experts to enhance the power of prediction. According to bellow algorithm and identified parameters the prediction outcome is formulated by gathering the output of all experts in likert scale.

The regression made by analogy of expert judgments related key factors weighted and then estimated for new brand car innovation and imitation's coefficients. The analogy mechanism is designed by comparison between the products of j in terms of product dimension i then regression forecasted. In summary for evaluation of p and q regarding the similar p_j and q_j which are evaluated as the same level car by using the similar estimation for each expert and the outcome of a formula

through combining the experts and two coefficients of BM model estimated by multiple regression (MR). This type of regression is an extension of simple regression that enable research to evaluate the dependent (predicted) variables relationship with several independent (predictor) one.

Table 2. Parameter estimated results for comparative brands potential market

Brands	M	p	Q	R ²	Sources
Ford	1683770	0.03673	0.4323	0.98	2000-2012-Australia
HEV	1650320	0.01040	0.3897	0.99	2000-2011-Korea
Toyota Prius	2878826	0.0016	0.04451	0.99	2001-2014-US
Iranian new brand	600000	0.0036	0.3062	0.97	Experts analogy

The bass factors rates based on the economy, adopters, and mass media flexibility. The comparison based on similar products for evaluation of potential market provides insight in implementation of this method in making

strategy for companies. The authors made comparative study for same class cars for different markets to indicate a prospective analogy.

As shown in Table 2, the coefficient of p and q are in between 0 and 1, market potential exceed first purchase and r-squared value estimated more than 0.98% of the variation of 'independent' variable for all types. In other words it can be explained by variation of 'dependent' variable, which means that r-squared value describes the growth rate of brands quite well. Moreover, we improve the

model based on evaluation of coefficients in potential market reflection over time. The evaluation of the results is illustrated for four brands as given in figure 1 and 2 respectively.

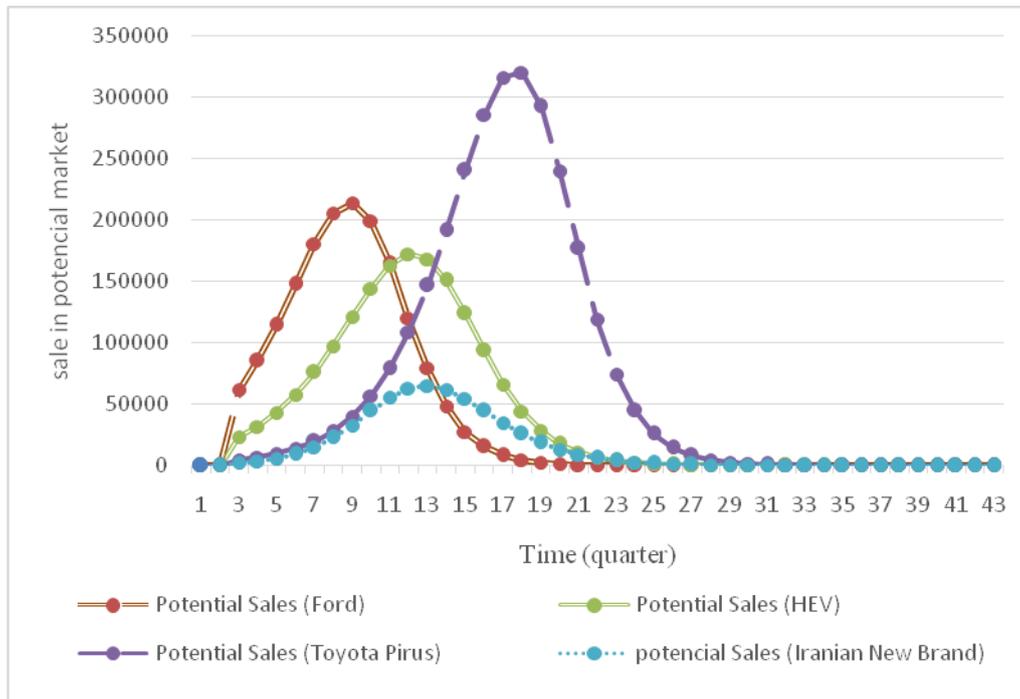


Figure 1. Comparative forecasting market potential for four automobile brands

Despite of other findings through Bass diffusion model in forecasting new products. In this study, we use new brand of car as a new product. Since there is no historical data for new product, we employ the comparative procedure with the similar products or technology in the same organization for estimating the parameters.

The similar products are already discussed in section above. Estimation parameters using ordinary least square gives good result to identify the similar product.

The findings of same class automobile comparison study showed that for each market and brand the coefficients are different and behavior of market growth is dissimilar as well but in all case categories $p, q < 1$ and the potential product market life is bell shaped over time. Meanwhile, Potential market life after introduction to market as Figure 1 indicates the

sales increase every year and reaches its peak sales in before half of product life time. Then, the sales will slowly drop which means the new product has reached its saturated state. The peak sale point (peak time/ time life) in Ford at time 9/33, HEV at 12/42, Toyota Pirus on 18/44 and new Iranian brand car in 13/44 are forecasted.

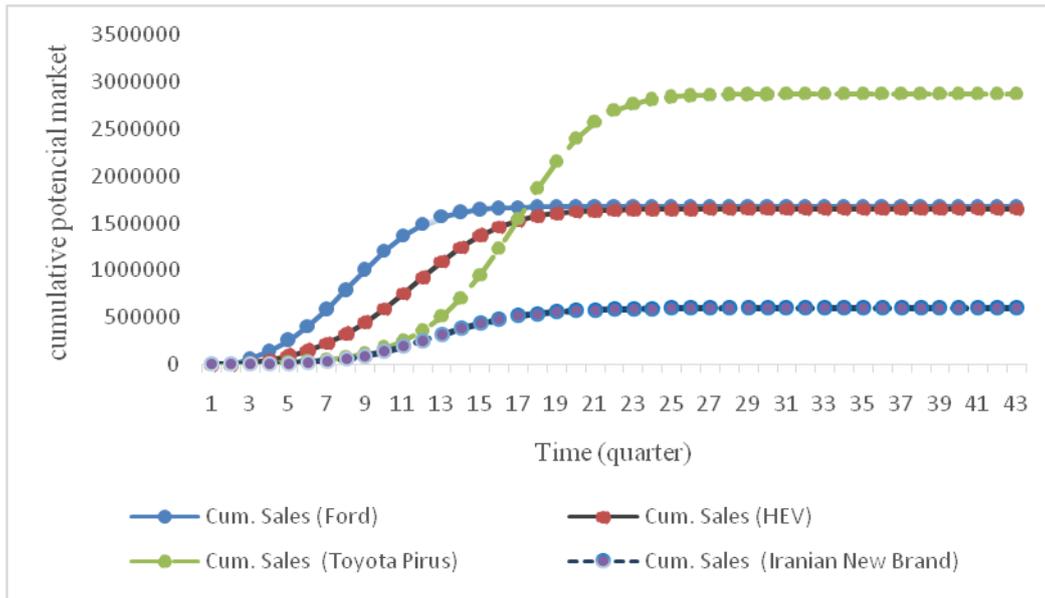


Fig 2. Comparative forecasting cumulative market potential for four automobile brands

The penetration curves in cumulative market are shifted over time when the three major variables (market size, the innovation factor, and the imitation factor) change for each brands. All vehicles life time amounts 41 to 43 period (quarterly) with different peak and takeoff time. The Ford brand with the higher innovation record (coefficient of p) pioneer than others raised in the market whereas Toyota Pirus has the behind of other brands tacked up in the potential market. The hybrid electric vehicle (HEV) and Iranian new brand have same behavior in market because of near imitator coefficients trend. Summary of parameters findings showed that the solid outline of dispersion of the reported evaluation values suggests that the use of any patterns in target market have different results. In the same way, it is probable to object that a Bass model calibrated on world wide of local market data is of limited relevance for application of this model for a brand in a single country.

3.2 Sensitivity analysis

Sensitivity analysis is a useful tool for model evaluation and finding model optimum point. In this research base on the Bass model the assumption is to preserve all other variables constant, and investigate the model results changes based on the value modifications in one element of interest. In this study, the market size may changes between 20-140% of Iranian total potential market, considerably for recognizing how may change the adoption pattern of new product with assumption of p and q stability in the future.

Market penetration curves estimation are illustrated based on different market sizes and showed in Figure 3. According to Eq. (6) the potential market over time is affected by potential market size and the best and reasonable parameter estimation as the mean absolute percentage error (MAPE) is the smallest.

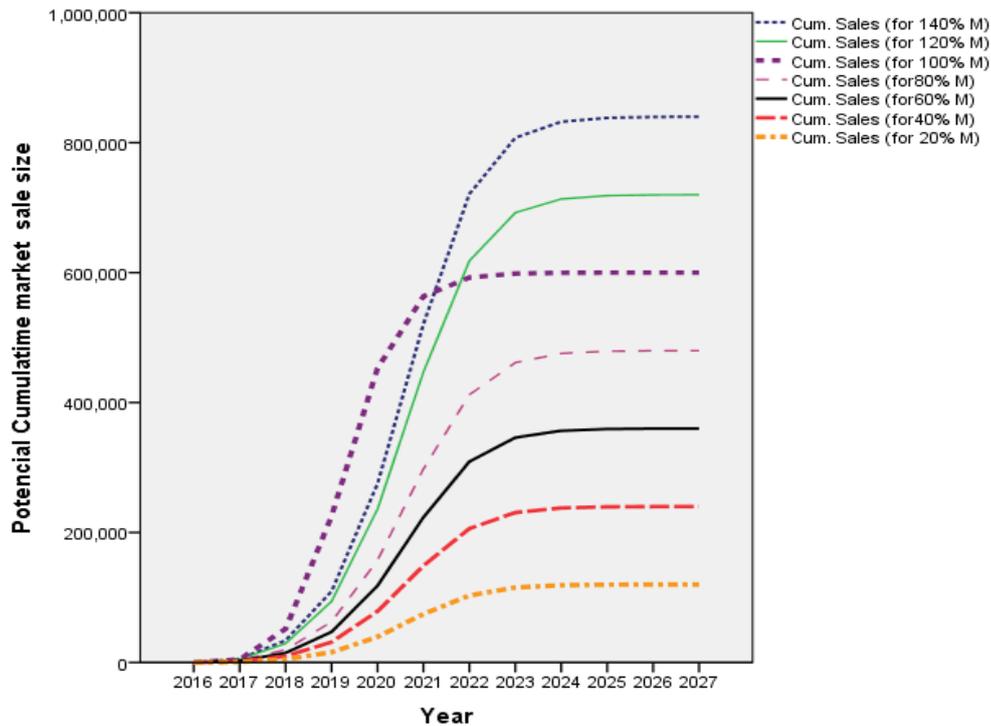


Figure 3. Forecasting Cumulative market for new vehicle in market

The figure 3 shows the market penetration over time and indicates much higher adoption rates when market size is larger, indicated by the deeper and different slopes. While the saturation point does not show difference also the product life time has tolerance between 47 to 53 respects to the market size. The fast market size in 20% (120000 sets) over 48 time

period and the longest life time belong to 140% market size (about 0.84 million vehicles). As mentioned before the MAPE is rate of actual and forecast data for finding optimum market size. The finding of optimum market size belongs to 120% (about 720000 sets) potential market.

Table 3. Sensitive analysis for potential market size

Market size	M	Time life (quarter)	R ²	Peak point	MAPE %	p-value
20%	120000	47	0.967	21	33.20	0.00
40%	240000	49	0.968	26	33.53	0.00
60%	360000	50	0.969	20	33.77	0.00
80%	480000	51	0.969	20	34.00	0.00
100%	600000	43	0.946	18	43.58	0.00
120%	720000	52	0.971	20	30.21	0.00
140%	840000	53	0.970	20	34.42	0.00

$P < 0.05$, $P = 0.0036$, $q = 0.3062$.

As shown in Figure 3, the penetration curves are very close, except that the diffusion curve is shifted to one year later or more when potential market changes from 20% to 140%. The saturation point does not differ much across the market size levels, with the soonest 20 occurring around 2027 with 20% market size (about 0.12 million vehicles) and the latest around 2028 with 140% market size (about 0.84 million vehicles). This indicates higher adoption rates when market size is larger while the peak points is same, p and q hasn't significant relation with market size. It could indicate that the external variables have less

effect in comparison with the three major variables (market size, the innovation factor, and the imitation factor) in the Bass model.

4. Conclusions

This research used basic Bass model to analysis new brand diffusion rate and estimate market demand behavior respect to product features. Hence, we have found some similar products (for different vehicle brands) to make analogy through their diffusion models and forecast optimum market size respect to new brand life time base on sensitive analysis in different potential market dimensions.

The proposed study is useful to the literature by providing a quantitative approach to new vehicle life and estimate market penetration based on product attributes by adoption experiences. Research results showed that p , q and M significantly effects on product life time and the annual sales increase up to its highest sales rate earlier point of product half-life time. Furthermore, two coefficients p and M in model which have positive effect on raising product demand (potential sale curve) over time. In addition, the parameter estimates fitness derived from ordinary least square regression provides reliable descriptions for the new product penetration sale in market. Meanwhile, Sensitive analysis results haven't investigated any significant relations among three category of peak time, potential market size and new product time life. Therefore, the study outcomes provide valuable insights in terms of the possible market diffusion patterns and the impacts of different factors on user adoption.

For covering present research limitations, future researches investigate model development by updating the assumption in internal variables effects on the Bass model and develop model by considering external variables to forecast time life changes over time.

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