Problem Chosen	2020 MCM/ICM Summary Sheet	Team Control Number
C		2006011

Sales analysis of new products based on time dimension

Summary

Based on the data given in the title, we construct a marketing model (the basic principle is BASS model).

Firstly, in our basic model, product A is analyzed separately. Since the quality of new products, as well as the external factors of sales personnel and sales channels are relatively stable, there is no subjective influence on the research.

Next, in the time-based model, we consider the time model. We analyzed the sales expectation curve of the product with the promotion of the product into the market, as well as the factors affecting the product sales volume, so as to obtain the sold image of the product and give the expectation according to the established marketing model.

In addition, based on the characteristics of products competing with each other, we consider the competition situation of products and give the model analysis, and give the competition curve through the system equation of BASS model.

To sum up, we comprehensively consider the objective factors and subjective factors of the new product, and give the following analysis and report on the market competition relationship of the comprehensive product according to the sales time clues put into the market.

Key words: commodity competition; Time measure; Market reputation; Future expectations;

Team:2006011

Dear marketing director,

I am writing to you on behalf of MCM team 12345.We are very concerned about the future development of the new products launched and sold by sunshine company.According to the data provided by sunshine data center, we carried out the mathematical model analysis of the system.

At present, people's purchase of products has not only stayed in the simple actual demand, in many cases, consumers' subjective evaluation of a product in the market has become more and more important, just as the so-called gold cup silver cup is not as good as a good reputation, for the objective factors of product sales we have done the analysis for you.

After an in-depth analysis of the available data, we propose some sales strategies that can boost sales.We suggest that through the accumulation of product word-of-mouth, and through the scientific time sales curve analysis to determine the market capacity, so that your company's products to achieve better sales.

Compared with other commodities, your company's products are more deeply into people's lives.More conducive to the transfer of objective external factors, through research, product sales and public praise has a 25% relationship, which has played a decisive role in a commodity marketing program system.And with the time that our products are put into the market, such advantages will be further revealed.

These advantages make in the premise of maintaining the quality and price of products under the good gradual accumulation of word of mouth has become a sales breakthrough.We built a model to simulate the change in sales volume over time under the influence of external factors.The simulation results show a good sales prospect.By focusing on both external and internal factors, product sales will rise along the desired curve.

As for the competitive relationship of sales products, we also built a mathematical model. Through the simulation of relevant functions and the processing of the provided data, we also gave the curve of the competitive relationship of products, taking into account the influence of internal and external factors, which will be of great help to the sales planning of products.

For the above reasons, we put forward the sales analysis of new products based on the time dimension. We sincerely hope that you can accept our Suggestions.

Yous,

MCM 2020 team 2006011

Team:2006011

Contents

1 introduction

1.1 statement of problem

The company plans to launch and sell three new products in the online market. This paper discusses the sales strategy under the rating analysis provided by customers related to other competitive products, the analysis expectation of sales volume over time, and the impact of subjective and objective factors related to sales volume on product sales.

1.2 Correlation data analysis

Figure 1

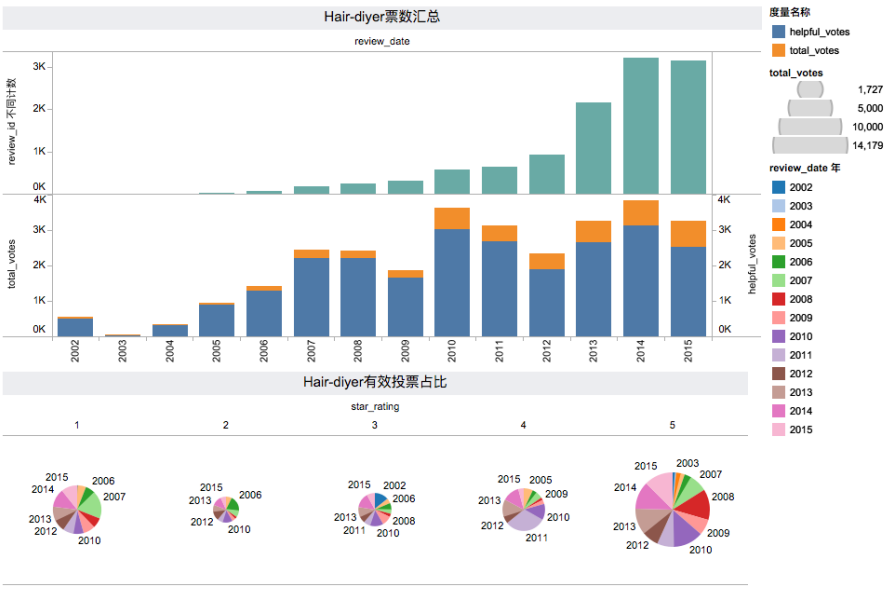
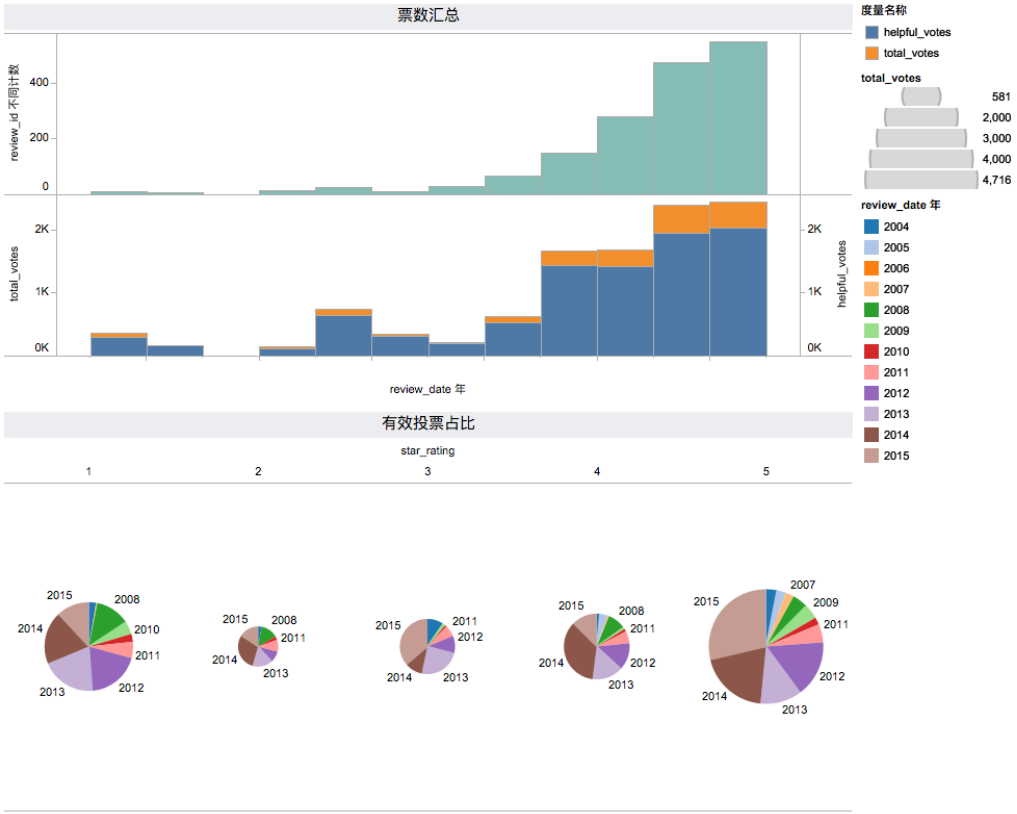


Figure 2



Firgue 3

Data analysis: we get the above picture through big data analysis. First, let's introduce the meaning of the above picture:

1. At the top is the name of each product.
2. The icon in the first line directly above represents the number of id's sold each year.
3. In the middle is the number of comments in each year. They are composed of two parts, the yellow part is total votes, and the blue part is help votes.
4. Finally, the stars of each year and their proportions are given.

The problem given in the data and there is no exact product sales, the amount of our annual review of product a certain percentage of the count (some commentators are not necessarily really buy) to approximate instead of on the analysis of the total sales, to analysis the change trend of product sales curve, and according to the given below each star rating in each of the percentage of the total years to determine whether based on the quality of the reviews and comments levels are closely related.

We use the text search, microwave locus of 2015 said due accounts for the proportion of the majority, after a week we specially take care good, fantastic, excellent, such as the number of words, found the percentage than with his accounts for the year increased compared with the findings (basically no 1000 will be 600 of them corresponding comments), and the bad in 2008, not words like also were higher than the year which nearly 100 will have 30 of them corresponding comments).Therefore, we consider the percentage of each star rating in the total year to determine that quality-based comments are closely related to comment level.We observed the sales situation of each year and found that the sales curve was very similar to the BASS model, so the following is the marketing model based on the BASS model.

2 Assumptions and symbols

2.1 Assuming that

To simplify the problem, we make the following basic assumptions. Each of our assumptions is reasonable and consistent with the basic facts.
1. Other external factors affecting the sales of new product A, such as price, quality and sales situation of sales personnel, are relatively stable and have no impact on the research;
2. The market demand for product A is limited;
3. Commodity buyers are undifferentiated and homogeneous;
4. There is no supply constraint;
5. The publicity of product A is independent from that of other products, that is, the publicity of other products has no influence on product A;
6. The geographical boundaries of social systems do not change with the process of diffusion;
7. The sum of the demand for new product A and similar products and the remaining demand is the total demand;
8. Without considering the accidental damage of A, A is A durable goods, and the product remains unchanged with the passage of time;
9. Early exponential distribution of new product A;
10.A) there are still people willing to buy after it is scrapped.

2.2 symbol

Here are all the notations we used in this article.
M: the total demand on the market
X (t): cumulative demand for product A at time t
$\frac{dx(t)}{dt}$: product demand at time t
A1: external influence coefficient of product A
B1: internal influence coefficient of product A
Y (t) : cumulative demand for similar product B at time t
$\frac{dy(t)}{dt}$: demand for similar product B at time t
A2: external influence coefficient of similar product B
B2: internal influence coefficient of similar product B
P is the coefficient of external influence
Q is the internal influence coefficient
F (t): probability density of the proportion of the number of purchasers to the total number of potential purchasers at time t
F(t): the accumulation ratio of purchasers at time t
N(t): adopter accumulated at time t
N (t): number of adopters at time t

3 Model to create

3.1 BASS model principle

According to the BASS model

$f(t)$ // 1 - F (t) = p + qF (t)

N (t) = m * F (t)

There are:

$$N(t) = \int_0^t n(t)dt = MF(t) = \int_0^t M\,f(t)dt$$

N (t) = M $f(t)$

= p + q [M - N (t)] [M - N (t)] $\frac{N(t)}{m}$

So you get N of t is equal to M[]. $\frac{1-e^{-(p+q)t}}{1+\frac{q}{p}e^{-(p+q)t}}$

$$n(t) = M[\frac{p(p+q)^2 \cdot e^{-(p+q)t}}{(p+q\cdot e^{-(p+q)t})\text{^}2}]$$

According to the analysis of p and q, draw an image. If q is >p, the purchase curve has the highest point, that is, the diffusion of the product is successful.If, the growth curve has no extreme value point, and the growth curve declines exponentially with time, it indicates that this product is a failed product:$q \leq p$

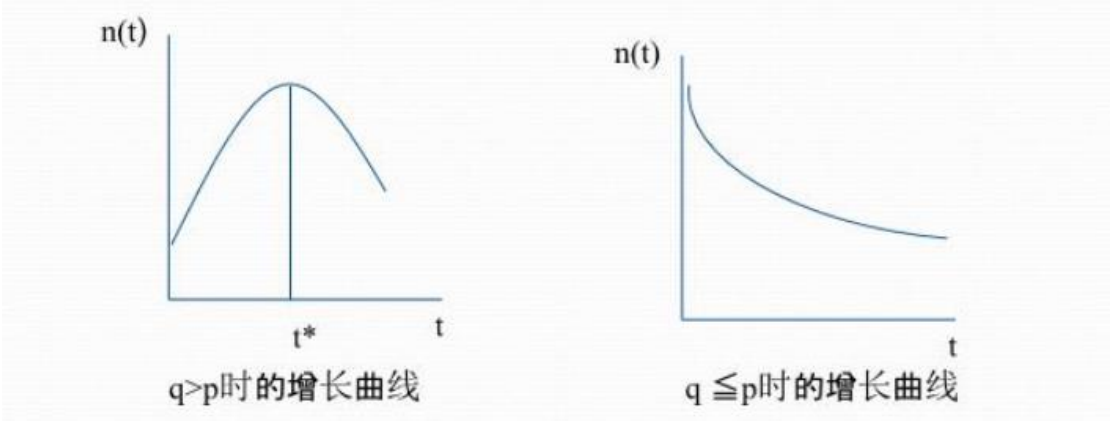


Figure 4: growth curve with different values of p and q

3.2 Nested analysis of models and practical problems

When A new product is launched, it must enter the market through advertising and promotion, including the rating factor mentioned in the title. The price, quality and sales ability of the sales staff of new product A and other external factors that affect the sales of new product are relatively stable. Therefore, A BASS model for new product marketing is established:

For product A:

The cumulative demand for product A at time t is:

$$x(t) = x_{(t-1)}(t) + a_1\left(M - x_{(t-1)}(t)\right) + \frac{b_1}{M}x_{(t-1)}(t)\left[M - x_{(t-1)}(t)\right] \qquad (1)$$

Then the demand for product A at time t is:

$$\frac{dx(t)}{dt} = x(t) - x_{(t-1)}(t) = a1[M - x(t)] + \frac{b_1}{M}x(t)[M - x(t)] \quad (2)$$

For (2), the representative due to external factors to buy new products by the number of these adopters are not affected by people have used this product, the remaining because others buy

and buy and applications is to see the stand or fall of other comments and the influence of commodity star in procurement, called imitate buyers, also is a by product reviews inciting and buy products, obviously related with the external factor b1, then we analyze the b1 according to comments.$a1[M-x(t)]\frac{b_1}{M}x(t)[M-x(t)]$When t is equal to 0, it doesn't sell at the beginning.$x(0)=0$

We assume that M=10000, external influencing factor a1=0.01, and external influencing factor b1=0.1, which can be obtained

$$x=-\frac{1000e^{\ln(10)-\frac{11t}{100}-10000}}{e^{\ln(10)-\frac{11t}{100}+1}}$$

Matlab drawing can be used to obtain the image of goods sold:

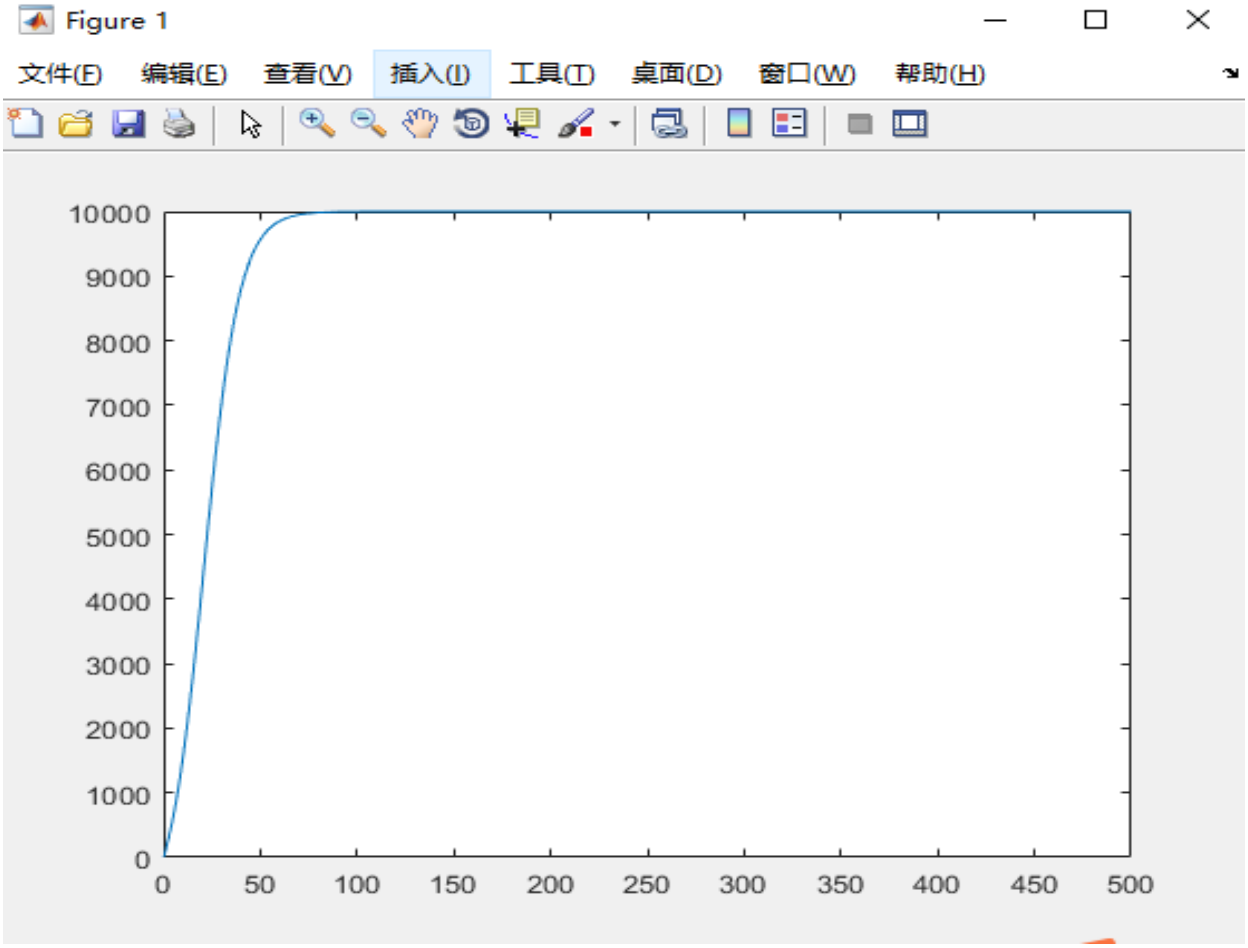


Figure 5: image of merchandise

Application:

```
>> dsolve("Dy-(0.01+0.00001*y)*(10000-y)","y(0)=0")

ans =

-(1000*exp(log(10) - (11*t)/100) - 10000)/(exp(log(10) - (11*t)/100) + 1)

>> fplot(ans,[0,500])
>>
```

Next, the coefficient a1=0.01 was kept unchanged, and b1 was changed to 0.05
So let's draw a picture:

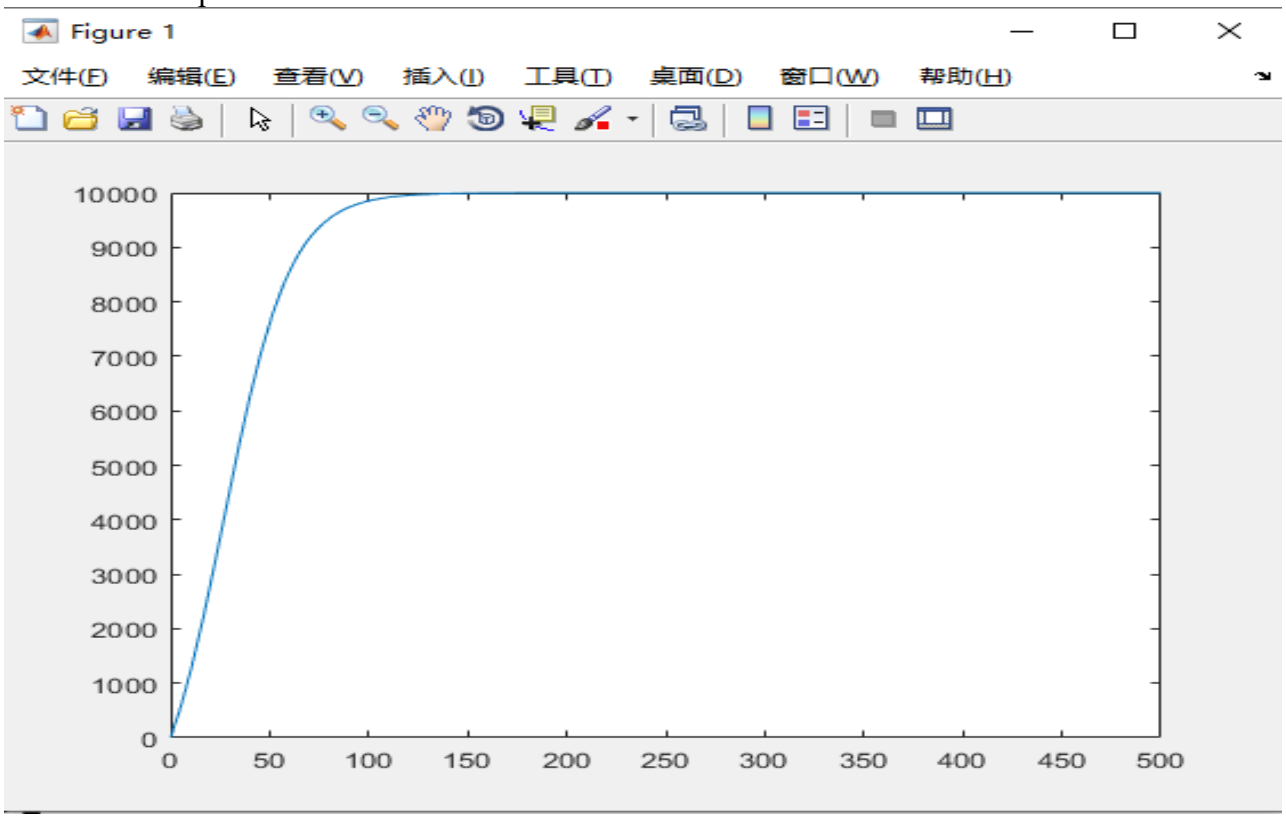


Figure 6

Application:

```
>> dsolve("Dy-(0.01+0.000005*y)*(10000-y)","y(0)=0")

ans =

-(2000*exp(log(5) - (3*t)/50) - 10000)/(exp(log(5) - (3*t)/50) + 1)

>> fplot(ans,[0,500])
```

First of all, it can be seen from the figure that the sales of the two image products increased from 0, reached the maximum value around 30, and remained stable. According to the BASS model analysis, when a1=b1, the product growth rate gradually decreased, which was consistent with the point that the product did not increase when it reached a certain level.Contrast, found the products within the influence, the greater the demand for the time of arrival in greatest demand is less, the internal demand for the product marketing has a positive effect, so in the process of marketing, establish a good reputation among consumers (is the result of evaluation grades, help grades and comments, etc.) is very important, which requires the company to ensure the quality requirements in terms of production.

3.3Model analysis of new product competition

Now consider the product curve when two products compete:
In the last problem, the change curve and function composition of A single product A were analyzed. For the competition of two products,
According to the kinetic system equations of BASS model, there are:

$$\frac{dx(t)}{dt} = a1[M - x(t) - y(t)] + \frac{b_1}{M}x(t)[M - x(t) - y(t)]$$
$$\frac{dy(t)}{dt} = a2[M - x(t) - y(t)] + \frac{b_2}{M}y(t)[M - x(t) - y(t)]$$

So let's say that.$y_0(t) = 0.15M$

Since product A is A new product and competes with product B after it is put into the market, it is assumed that the two products are similar, that is, the internal influence coefficient is the same, that is, b1=b2.

In order to analyze the assumption that a1=a2=0.01,b1=b2=0.02, according to the matlab drawing:

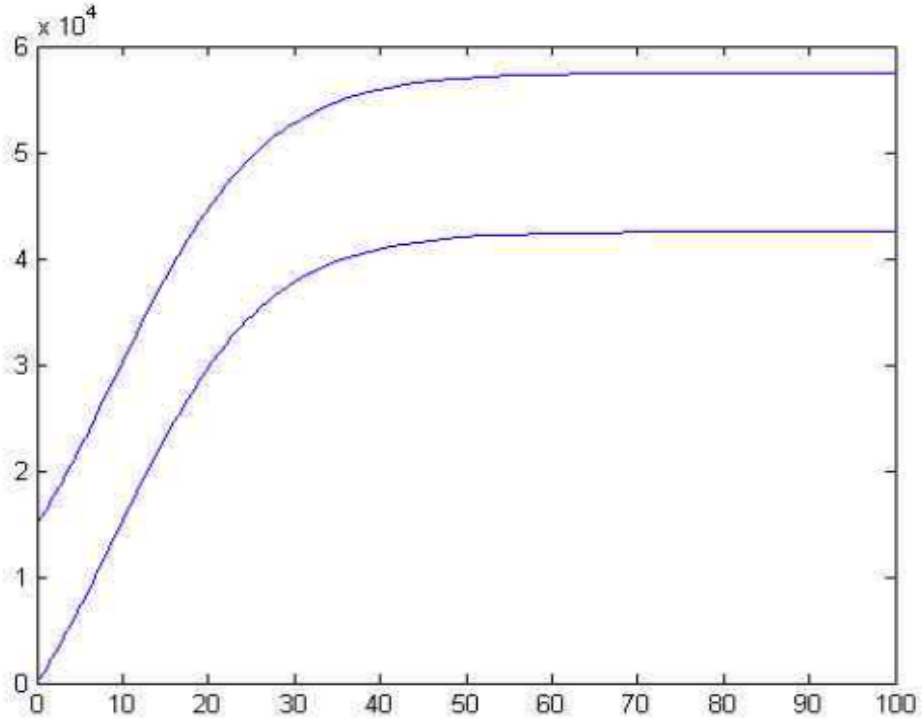


Figure 7

Can see from the picture, inside the external influence coefficient and influence coefficient are all the same, on the basis of A, B two products almost near 40 time reached the maximum at the same time, but because of the effects of B, A product of the market share, obvious drop, reach A balance of total market share is less than 45%, the competition in the company, to expand the market, the company must increase the quality of their products, comments on reduced to minimize market reputation, reduce the existence of bad review.

4 Comment on star rating considerations

Finally, it analyzes the consideration of external factors of product evaluation stars.

To the internal factors and external factors, the early for product of two factors is the relative changes, but by the end of a certain period of time to stop the product update product factors can be regarded as a constant, we now consider the two factors, we only consider good score and low score, because for medium grade as three points, two points is not incite other consumers mind, and in consideration, we will star in consideration area within the scope of

and value say more as the embodiment of the value of the product itself, say less just consider as a help for the value level, we analyzed the following:
Here, we use BASS model, because p and q are the same as a1 and b1 in the above model. In order to facilitate calculation, we use the method of least square method to simulate two parameters:p和q
N (t) = M $f(t)$

= p + q [M - N (t)] [M - N (t)] $\frac{N(t)}{M}$

It can be transformed into:

$$n(t) = pm + (q - p)N(t) - \frac{q}{m}N^2(t)$$

The approximate deformation is:
$n(t) = a + bN_{t-1} + c\mathbb{N}_{t-1}^2$
Among them,.$a = pM, b = q - p, c = -q/p$Hence, therefore$q - p = -mc - \frac{a}{m} = b$

$$m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Thus, the parameter estimation problem is transformed into the estimation problem.p、q、ma、b、cIt should be noted that in N(t), the error is not too large when observing more data.
Here:
P = coefficient of innovation (external influence), that is, the likelihood that people who have not yet used the product will start using it due to the influence of mass media or other external factors.
Q = imitation coefficient (internal influence), that is, the likelihood that people who have not yet used the product will start using it due to the influence of users' word of mouth.

5 Model expectations for future markets

For each commodity release, the external coefficient of the product is fully affected at the beginning. Based on the estimation of the previous years alone, the verified internal coefficient is almost zero, and the basic difference between the external coefficient and that of a few years later is not much. So we can be sure that the internal coefficient, the imitation coefficient is related to the acquired word of mouth. According to the marketing curve of microwave oven, we used tableau software to draw and fit the corresponding curve, and solved the number of correlation, as follows:

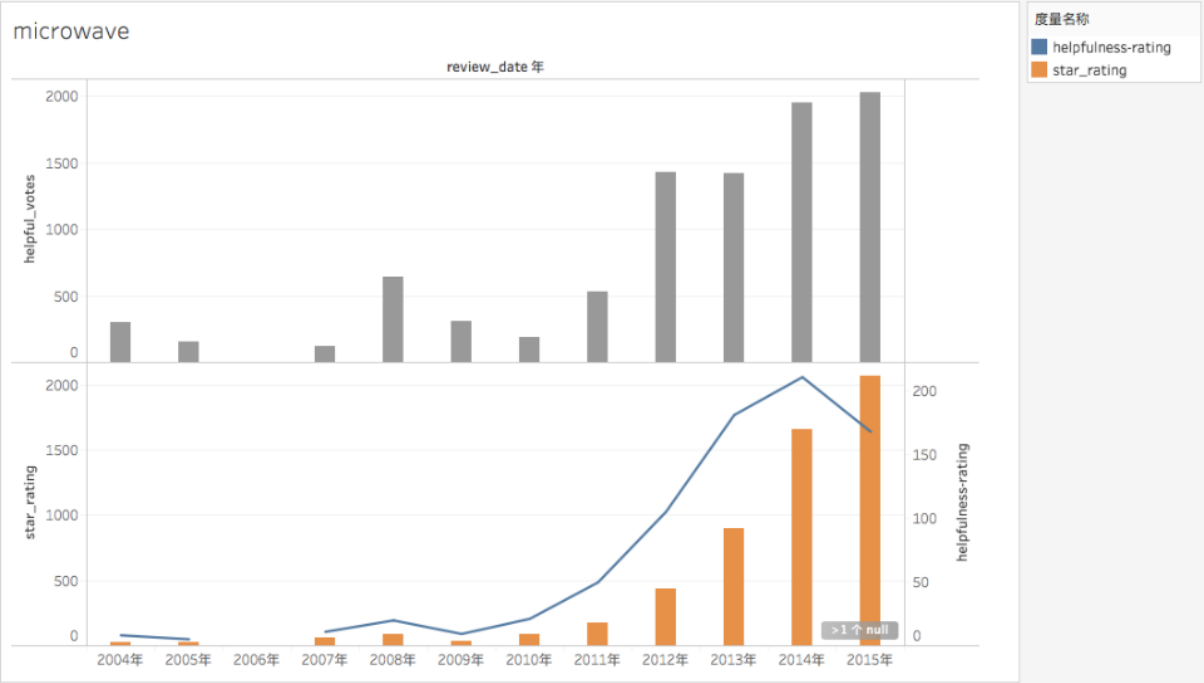


Figure8

For a new product, it is not more accurate to predict when it does not meet the market demand. For example, in the figure above, we can easily find the correlation coefficient by combining the above model, which has a good similarity with the previous model.

6 Analysis of advantages and disadvantages of the model

6.1 advantage

1. The model is suitable for the analysis and prediction of consumer durables and has a good simulation for the prediction of new products
2. Simple and clear, and consider the competition of products, more suitable for the promotion of products
3. There is a good simulation of the initial innovator using the product to the imitator using the product
4. Have a good control of the dynamic change of goods.

6.2 disadvantage

1. The factor of product life is not considered.
2. If the data is insufficient, the error of parameter estimation will be relatively large.
3. Using discrete time series to estimate continuous variable model (integration process) will produce time interval error.
4. The phenomenon of consumers' repeated purchase is not taken into account

7 conclusion

Through the above marketing model based on time, according to the fitting of the digital, through all the years of star, comment and help we were able to estimate the corresponding coefficient, and at the beginning of the data, the use of text mining we can come to a particular star would cause more comments, and based on the text of the comment associated with these star has a great level.