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Mathematical Modeling and Analysis of Classified Marketing of Agricultural Products

Fengying WANG*

School of Logistics, Beijing Wuzi University, Beijing 101149, China

Abstract Classified marketing of agricultural products was analyzed using the Logistic Regression Model. This method can take full advantage of information in agricultural product database, to find factors influencing best selling degree of agricultural products, and make quantitative analysis accordingly. Using this model, it is also able to predict sales of agricultural products, and provide reference for mapping out individualized sales strategy for popularizing agricultural products.

Key words Agricultural products, Classification, Marketing, Logistic regression

In recent years, China's agricultural management system constantly changes. With the extensive application of agricultural science and technology, agricultural production capacity gradually increases. At the same time, foreign agricultural products constantly pour into Chinese market. Therefore, marketization and commercialization of domestic agricultural products constantly increase, and market competition becomes more and more fierce. Since the marketing of Chinese agricultural products is faced with new challenges, it is of great significance to exploring an effective and feasible way for marketing of agricultural products. With the aid of the relatively mature Logistic Regression model, we discussed marketing strategies of agricultural products from the perspective of classified marketing, in the hope of providing certain reference for marketing of Chinese agricultural products.

1 Study ideas, data source and study methods

1.1 Study ideas In classified marketing, the basis of classification is the information in product database, such as product brand, manufacturer, raw material, mixture, additive, nutrient, production process, quality guarantee period, price, packaging, capacity, product functions, and sales volume, *etc.* How to make correct classification on the basis of the above information is a problem urgently to be solved in classified marketing, and also a key problem for enterprises to find potential best selling product and make customized marketing strategy, and expand sales market.

At present, enterprises adopting classified marketing generally divide their products into best selling product and middle run according to sales volume. Although this classification method is simple, it neglects other production information and often leads to loss of some potential best selling products. In particular, some potential best selling product remain at early stage of marketing

and the sales volume is not high, if they are incorporated into middle run and fail to receive effective propaganda and extension, these potential best selling product may be gradually exit the market or be developed into best selling product by other enterprises.

In fact, factors influencing sales of products are varied. To make quantitative analysis of the relationship between these factors and the best selling degree of products, we can use the regression analysis method. At first, Logistic Regression Model was used in pathology. Later, it is used extensively in numerous disciplines, including economics and management science, and has made great achievements. In classified marketing, products need being classified into two types. The Logistic Regression Model is a regression analysis method for two types according to many attributes. Therefore, using Logistic Regression Model can classify products and accordingly predict whether a certain product can become best selling product.

1.2 Data source We selected data of agricultural product enterprises of certain (Shanxi specialty product) agricultural product in Xicheng District of Beijing City.

1.3 Study methods The product database has accumulated a lot of information (called attributes), including product function, product categories, manufacturer, raw material, mixture, additive, nutrient, production process, quality guarantee period, price, packaging, capacity, product function, and propaganda means, *etc.* Among these attributes, some are closely related with best selling degree of products, while some are not related with best selling degree of products. To classify products according to these attributes, we firstly should consider result classified according to single attribute. Namely, we take a certain attribute as basis of classification for best selling degree of products, and classify products into best selling and non best selling groups.

For example, we classify products according to the annual sales, take annual sales as variable X , and give it an amount t , when $X > t$, it is deemed that the product is a best seller, otherwise, the product is not a best seller. According to this, we derive the variable Y , $Y = \begin{cases} 0 & X < T \\ 1 & X \geq T \end{cases}$. Considering classification results

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* Corresponding author. E-mail: fengying73@sina.com

of many indicators, we assume that n indicators are related to best selling degree of product, and these indicators are taken as X_1, X_2, L, X_n respectively. Take Y as dependent variable, and X_1, X_2, L, X_n as independent variables, and use Logistic Regression Model to analyze the relationship between Y and X_1, X_2, \dots, X_n .

Set p_i as the probability that the i -th product in the data set is the best seller, *i.e.* $p_i = P(y_i = 1 | (x_{i1}, x_{i2}, \dots, x_{in}))$, we can get the Logistic Regression Model.

$$P_i = \frac{1}{1 + e^{-(a + b_1x_{i1} + b_2x_{i2} + \dots + b_nx_{in})}} = \frac{\exp(a + b_1x_{i1} + b_2x_{i2} + \dots + b_nx_{in})}{1 + \exp(a + b_1x_{i1} + b_2x_{i2} + \dots + b_nx_{in})} \quad (1)$$

From the product database, we randomly select a sample with capacity of m . Using classification result data of m unknown samples and maximum likelihood method, we can estimate a, b_1, b_2, L, b_n in Logistic Regression Model, and obtain the estimated value of $\hat{a}, \hat{b}_1, \hat{b}_2, \dots, \hat{b}_n$.

1.4 Prediction methods of potential best selling products

For enterprises implementing classified marketing, if potential best selling product can be found timely and correctly, and tailor-made effective propaganda and promotion are carried out, it will make these potential best selling products become real best sellers as soon as possible, and bring continuous profit for enterprises accordingly.

When enterprises grasp basic information of a product, firstly, we can calculate the probability of the product being a best seller according to values of indicators X_1, X_2, \dots, X_n ; then, by selecting a proper threshold, we can infer if the product is the po-

tential best seller. We might as well set estimated values of a, b_1, b_2, \dots, b_n in Logistic Regression Model as $\hat{a}, \hat{b}_1, \hat{b}_2, \dots, \hat{b}_n$ respectively. If X_1, X_2, \dots, X_n values of a certain product are x_1, x_2, \dots, x_n , the probability of this product being a best seller is as follows:

$$\hat{p} = \exp(a + b_1x_1 + b_2x_2 + \dots + b_nx_n) / 1 + \exp(a + b_1x_1 + b_2x_2 + \dots + b_nx_n)$$

Suppose the preset threshold is θ , when $\hat{p} > \theta$, the product is a potential best seller; otherwise, it is a middle run.

2 Application of the model

Table 1 gives the data processing results obtained using SPSS software simulating the product database (*i.e.* the agricultural product described in 1.2). We selected 6 indicators to consist of independent variables: production function, category, price of unit product, package, quality guarantee period, and propaganda means. Product function, category and propaganda means are classification variables, and their possible values are:

$$\begin{aligned} \text{Product function} &= \begin{cases} 0 & \text{Food} \\ 1 & \text{Health care} \end{cases} \\ \text{Category} &= \begin{cases} 1 & \text{Fresh} \\ 2 & \text{Dried} \\ 3 & \text{Bagged cooked} \\ 4 & \text{Others} \end{cases} \\ \text{Propagandameans} &= \begin{cases} 1 & \text{TV} \\ 2 & \text{Internet} \\ 3 & \text{Shop recommendation} \end{cases} \end{aligned}$$

Table 1 Results of Logistic Regression output

| Variables for model | Regression coefficient B | Standard error | Wald value | Degree of freedom | Significance level | Exp (B) |
|------------------------------|--------------------------|----------------|------------|-------------------|--------------------|---------|
| Product functions | 2.720 | 0.940 | 8.375 | 1 | 0.004 | 0.066 |
| Price of each unit | 0.01 | 0.000 | 44.339 | 1 | 0.000 | 1.010 |
| Quality guarantee period | -0.150 | 0.060 | 6.238 | 1 | 0.013 | 0.861 |
| Product propaganda means | | | 46.061 | 2 | 0.000 | |
| Product propaganda means (1) | 2.672 | 0.424 | 39.715 | 1 | 0.000 | 14.469 |
| Product propaganda means (2) | 4.482 | 0.971 | 21.307 | 1 | 0.000 | 88.411 |
| Constant | -2.690 | 0.981 | 7.519 | 1 | 0.007 | 0.068 |

From the table, it can be known that there are four variables for Logistic Regression Model: product functions, price of each unit, quality guarantee period, and product propaganda means. Propaganda means is originally three categorized variables: propaganda means (1), propaganda means (2), and propaganda means (3). Here, we take the original propaganda means (3) as reference category, and corresponding values are as follows:

$$\text{Propaganda means (1)} = \begin{cases} 1 & \text{TV ads} \\ 0 & \text{Others} \end{cases}$$

$$\hat{p} = \frac{\exp(-2.69 - 2.72x_1 + 0.01x_2 - 0.15x_3 + 2.672x_4 + 4.482x_5)}{1 + \exp(-2.69 - 2.72x_1 + 0.01x_2 - 0.15x_3 + 2.672x_4 + 4.482x_5)} \quad (2)$$

Suppose there are two products: Product A is food product, its price of each unit is 50 yuan, quality guarantee period is 6 months, and propaganda means is internet; Product B is health

$$\text{Propaganda means (2)} = \begin{cases} 1 & \text{Internet ads} \\ 0 & \text{Others} \end{cases}$$

$$\text{Propagandameans} = \begin{cases} 1 & \text{Shop recommendation} \\ 0 & \text{Others} \end{cases}$$

With the aid of SPSS software, we set these five variables, *i.e.* product functions, price of each unit, quality guarantee period, product propaganda means (1) and propaganda means (2) as X_1, X_2, X_3, X_4, X_5 , and obtained the probability of the product being a potential best seller

care product, its price of each unit is 180 yuan, quality guarantee period is 18 months, and propaganda means is TV ads. Thus, basic
(To page 26)

husbandry production, but also help to ensure the income and life quality of farmers and herdsmen, and resolve the regional income gap of farmers and herdsmen.

5.2 Accelerating the strategic input and improve the investment environment Accelerating the strategic input is to increase the input for long-term development and resource advantages. It is necessary to choose those investment projects that can fundamentally have a sustainable impact on economic development.

5.3 Actively improving the urbanization in various leagues and cities Small towns are important for the economic development of rural and pastoral areas. Small towns provide a gathering place for population in rural and pastoral areas and surplus labor, and create more non-farm employment opportunities for the surplus labor in rural and pastoral areas. The development of non-farm and livestock industries in turn further strengthens the urban construction. Therefore, the development of small towns is the need of further development of non-farm industry and small towns can promote the township enterprises to conglomerate to reduce costs and improve efficiency.

5.4 Actively promoting the farming and animal husbandry industry structure transformation It is necessary to accelerate the transformation of traditional farming and animal husbandry production techniques, to gradually realize the modernization of agricultural means of production. At the same time, it is necessary to accelerate the region's non-agricultural and non-animal husbandry development, and increase the share of modern agriculture and animal husbandry industry in the overall economic development of farming and animal husbandry, to enhance its economic competitiveness, thus speeding up the transformation of the regional eco-

omic structure, and promoting the transformation of overall economic pattern in the rural and pastoral areas.

5.5 Strengthening regional economic integration and economic exchanges Good economic ties are the basic conditions for each region to effectively get a variety of production inputs. In the extensive economic exchanges and contacts, the rich resources and labor advantages of all regions can get the financial and technical support of developed areas, so that the potential advantages become a reality, and the industry in the rural and pastoral areas truly becomes the leading force for non-farm and non-animal husbandry development in the rural and pastoral areas.

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(From page 20)

information of these two products can be denoted as $X_A = (0, 50, 6, 1)$ and $X_B = (1, 180, 18, 1, 0)$, and suppose the

$$\hat{p}_A = \frac{\exp(-2.69 + 0.01 \times 50 - 0.15 \times 6 + 4.482 \times 1)}{1 + \exp(-2.69 + 0.01 \times 50 - 0.15 \times 6 + 4.482 \times 1)} = 0.8009$$

$$\hat{p}_B = \frac{\exp(-2.69 - 2.72 + 0.01 \times 180 - 0.15 \times 18 + 2.672 \times 1)}{1 + \exp(-2.69 - 2.72 + 0.01 \times 180 - 0.15 \times 18 + 2.672 \times 1)} = 0.0256$$

Since $\hat{p}_A > 0.75$, $\hat{p}_B < 0.75$, we can conclude that Product A is a potential best seller, while Product B is a middle run. Decision makers can formulate or adjust promotion and marketing strategies separately according this condition.

3 Conclusions

Varied information can be used to classify products. We set up classification method on the basis of Logistic Regression Model. Using this method, we can take full advantage of information in product database, and accordingly find factors influencing best selling degree of products. This method not only can be used to objectively and correctly classify "old products", but also can be used to judge whether new products can become best selling products, so as to provide importance reference for decision makers

threshold as 0.75. According to formula (2), we can calculate the probability of these two products being best selling products:

formulating individualized promotion strategies. However, the prediction function of this classification method should be exercised at market, need proper use of agricultural product enterprises, accurate and complete information. Only through this, may functions of this method be brought into play.

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