DETERMINATION OF THE OPTIMAL COMMODITY NOMENCLATURE BY PROFIT AND COST

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Annotation

The work proposes a method of definition of commodity classifications (goods nomenclature) based on the nomenclatural function. The advantage of the proposed method is the possibility of definition of commodity classifications even when the profit on every single unit of the nomenclature differs. The basis of the method is the definition of a nomenclature as a function of the geometric mean of a set of nomenclatures. That makes possible to determine the gain in the direct proportion to the value of the function of the nomenclature.

The purpose of the article is to outline the methodology for determining the nomenclature while maintaining the full range of goods. This is impossible with standard optimization using the arithmetic mean. Since the nomenclature function is a positive value, then, unlike the arithmetic mean, any item of the nomenclature cannot be zero in the geometric mean. The proposed technique is an alternative to the classical linear programming problem. The method's advantage is the absence of any additional restrictions on the parameters of the optimal solution. In principle, such restrictions can also be introduced after analyzing the solution. There are no nonlinear restrictions in the methodology, so the optimal solution can vary proportionally depending on the required value of profit or cost. We propose to implement the algorithms using the mathematical modeling program MathCad. Two variants of algorithms are considered: optimization by cost and by profit. The aim of this work is to create the most simple algorithms. The algorithms implement the optimization of the range of goods in its full assortment, that is, in the absence of zero nomenclature values.

Keywords: nomenclature function, cost function, cost incentives, geometric mean, damping vector of nomenclature, profit of unit of nomenclature, cost of unit of nomenclature.

Results and discussion

High-quality business management is based on usage of information systems of mathematic methods of data processing [1]. In connection with the transition to modern information technologies, the problem lies in the formulation of new econometric models to ensure a new quality of management [2, 3]. A large number of mathematical models in the field of economics are given in work [4, 5].

Only systematic promotion work will help to increase sales and improve the company's image. In a highly competitive environment and the trend of consumer protection, an important factor is the definition of a range of products that not only provides maximum profit, but also allows the company to stay in the competitive market. From the perspective of the missions of this company, this task is much more important in comparison with immediate profit. A reckless process of releasing goods is very dangerous from the standpoint of the company's survival in a competitive market, that is why the techniques of soft regulation of the range of goods are so important, ensuring the optimal profit of the company.

In the practice of marketing activities, both cost and non-cost incentives for promoting goods to the market are used. Cost incentive finds wider practical application, ensuring the required profit of the company. The consumer is very susceptible to buying at a discount: he is attracted by goods, the price of which is temporarily reduced. However, he is suspicious of products that are too often offered at discounted prices. Temporary price reductions have advantages and disadvantages. Some manufacturers and resellers believe that it is much more profitable to go for a price reduction, than to satisfy all new consumer demands regarding quality, nomenclature and assortment of goods. The initiators of this incentive tend to emphasize the temporary nature of the price cut. Critics of this incentive method point out that price reductions are costly for businesses, destroys the image of the product, does not provide the proper impact on the consumer. The effectiveness of price reduction decreases when this method is often used throughout the product's life cycle. The advantage of this method is that it allows you to quickly organize it in cases where you need to immediately respond to the actions of competitors. Sale at reduced prices is especially effective when the price plays a decisive role in the choice of goods (for example, products: sugar, dairy, etc.). In this case, the consumer is interested in buying it in a particular store or retail outlet. The size of the price reduction must be tangible enough to build an advertising message on them; stimulating demand enough to compensate for falling profits; attractive enough to force the consumer to buy the product. Obviously, a decrease in the producer's price for some goods should be offset by higher prices for other goods. In such a situation, one cannot do without calculations related to the optimal volume of the nomenclature, which provides the maximum or specified profit in the mode of cost incentives [6,7].

The types of incentives based on price reductions can be divided into 3 groups: direct price reductions; distribution of coupons with the right to purchase at a discount; reduction of prices with a delay in obtaining a discount.

Direct price reductions are often initiated by the commercial network. Sometimes products of one nomenclature are combined with new items of another nomenclature or with those that require special promotion. At the initiative of the manufacturer, the price reduction is accompanied by the provision of discounts to the commercial network. If the price of the manufacturer's product is higher than the prices of competing products, the price reduction is self-evident.

Special prices or small wholesale sales are beneficial for the consumer in that he is offered a more significant price reduction of the entire batch of goods. These lots are usually sold in large wholesale markets and supermarkets.

Combined sale is used for a set of items, each of which is not a mandatory addition to the other. The price of the set is lower than the total price of each product. For a manufacturer, such a sale is effective when a new product is introduced to the market. It also allows you to combine a product that is difficult to sell separately.

In connection with the prevalence of cost incentives, the methodology for determining the range of goods at a known cost, including the cost in the process of promoting goods, is of great importance. Obviously, when the price of goods of different nomenclature changes in the market, it becomes necessary to optimally correct the volumes of the nomenclature to ensure the required profit.

The idea of an optimal process for determining the nomenclature of goods according to a strictly formalized algorithm is given in [8]. The essence of the idea is to introduce a nomenclature (X_j is the volume of the j-th nomenclature) function, which is the multiplication result of all values of X_j. From an economic point of view, this idea makes sense of unit powers of X_j, provided the same profit from a unit of the nomenclature

$$f(X) = \prod_j X_j$$

In this work, the methodology proposed in [8] is supplemented by the possibility of unambiguous determination of the nomenclature by the amount of profit. In addition, it is proposed to take products of nomenclatures with degrees different from the first, which determines the possibility of a soft or hard process of regulating the launch or introduction of certain commodity nomenclatures on the market.

If we relate the profit from the entire sold item to the function $f(X)$, then it is easy to show that this dependence will be linear only for the modified function [9]

$$f(X) = \sqrt[n]{\prod_j X_j}$$

where n- volume of the nomenclature (length of vector X). In the proposed version, $f(X)$ is from a mathematical point of view the geometric mean, and its use as a nomenclature function, in contrast to the arithmetic mean, guarantees the absence of a zero value for any of the nomenclatures.

If the profit of the units of the nomenclature is different, then the proposed method can be generalized by introducing the size of the batch of the given nomenclature in comparison with the product with the maximum profit:

$$h_j = \frac{B_k}{B_j}$$

Taking into account the function *f*(*X*), optimization is carried out for each batch of goods. In addition to the function *f*(*X*) and the amount of profit, the algorithm uses the target function minimized according to the criterion of the minimum cost of the batch of goods purchased by the consumer:

$$fff(X) = \sum_j A_j X_j$$

где A_j - the cost of the h_j consignment.

The proposed algorithm is easily implemented, for example, in the MathCad environment [10,11]. A fragment of the listing of the algorithm is shown below:

ORIGIN:=1

Profit from unit: B:=$(10\ 12\ 21\ 23\ 5\ 14)^T$ Item unit cost: A:= $(23\ 15\ 25\ 30\ 8\ 18)^T$

Size of vectors B and A: n:=rows(B) j:=1..n

Nomenclature containment vector: c:=$(1\ 1\ 1\ 1\ 1\ 1)^T$

as:=max(B) cn:=$\frac{1}{\sum c}$

The vector of the lot size reduced to the same profit: $h_j := \frac{as}{B_j}$

Item batch cost: $A1_j := A_j h_j$ Nomenclature function: $f(X) := \left[\prod (X_j)^{c_j}\right]^{cn}$

Initial starting value of the item volume: $X_j := 1$

Function of the total cost of the entire item: : $fff(X) := \sum_j A1_j X_j$

Profit from whole range: $Y(X) := \sum_j B_j\ X_j$

Given

The base value of the item function: f(X)=100 X>0

The function of minimizing the total cost of the entire item

X:=Minimize(fff,X)

X^T=(62.853 115.81 121.605 110.937 90.469 112.563) Y(X)=9152

Planned profit from the entire range: W:=12000

The final optimal value of the nomenclature volume: $xx_j := X_j \frac{W}{Y(X)} h_j$

xx^T:=(189.555 291.052 174.638 145.463 545.679 242.478)

The cost of the entire nomenclature

$fff1 := \sum_j \frac{A1_j X_j}{h_j}$ *ST0:=fff1(xx)* *ST0=2.619x10*^{4}

Cost permissible for the organization: ST:=20000

ERR:=if(ST>ST0, “profit can be increased”, “profit is unattainable”)

ERR=“profit is unattainable”

$E := \frac{ST}{ST0}$ $xx_j := xx_j E$

xx^T=(144.779 222.301 133.386 111.102 416.781 185.201)

Total profit: $\sum_j xx_j B_j$=1.415x10^4

The initial data of the problem are vectors *A* and *B*, respectively, of the cost and profit of a unit of goods, the amount of fixed profit from the entire range (the number 12000 in the given listing) and the unit vector *c*. The result of the program is the number of product units for each nomenclature (vector xx).Since the value of the function *f*(*X*) and the profit *Y*(*X*) depend linearly with each other, the value *f*(*X*) in the program can be set arbitrary (in our example, the number 100 is taken).

The algorithm should be checked if the total cost of the specified limit is exceeded. If this cost is higher than the limited one, then it is concluded that it is impossible to determine the item for the profit specified in the task. If the total cost is lower than the limited one, if desired, it is possible to increase the profit by recalculating the item at the limited cost, as is done in the above listing.

The proposed method for determining the nomenclature completely eliminates the zero volume of goods for any nomenclature. At the same time, for a given value of profit, the item is selected taking into account the consumer's rights to pay the minimum amount for it. With a different algorithm for choosing the nomenclature, the most likely outcome is the disappearance of cheap but low-profit goods from the market [12].

In the proposed method, there is a possibility of introducing non-unit powers of X_j into the functions $f(X)$ [13]. From a profit and price point of view, this makes no economic sense. However, a lower value of this degree automatically underestimates the volume of goods for a given nomenclature. Such an opportunity can be used when forcibly promoting some product to the market (degree greater than 1 in the above listing) or withdrawing a product from the market (degree less than 1). A necessary condition in this case is the condition that the total degree of all is equal to one X_j (in the above listing it is 6 * (1/6)):

$$f(X) = (X_1^{0.2} X_2^{1} X_3^{2} X_4^{3} X_5^{0.5} X_6^{0.6})^{1/7.3}$$

As you can see from the example, the total power $f(X)$ in brackets is 7.3 and up to one it is compensated by the corresponding power outside the brackets. The powers at X_j are set in the vector c, which is expedient to take proportional to the profit. The meaning of the damping coefficients of the vector c is reduced to the following: with $c = 0.2$ - this is a fivefold forced reduction in the output of the nomenclature; with $c = 5$ – five-fold forced promotion of the release of the product nomenclature. If we assume that any item with a profit less than the maximum will be restrained in the release of the nomenclature, then the calculation of the nomenclature restraint vector c will be carried out *as* follows:

$$as := \max(B) \qquad c_j := \frac{B_j}{as}$$

Listing of the proposed calculation algorithm is presented below:

ORIGIN:=1

Profit from unit: B:=$(10\ 12\ 21\ 4\ 5\ 14)^T$ Item unit cost: A:= $(23\ 15\ 25\ 30\ 8\ 18)^T$

Size of vectors B and A: n:=rows(B) j:=1..n

Nomenclature containment vector:

as:=max(B) $c_j := \frac{B_j}{as}$ cn:=$\frac{1}{\sum c}$

The vector of the lot size reduced to the same profit: $h_j := \frac{as}{B_j}$

Item batch cost: $A1_j := A_j h_j$ Nomenclature function: $f(X) := [\prod (X_j)^{c_j}]^{cn}$

Initial starting value of the item volume: $X_j := 1$

Function of the total cost of the entire item: $fff(X) := \sum_j A1_j X_j$

Profit from whole range: $Y(X) := \sum_j B_j\ X_j$

Given

The base value of the item function: f(X)=100 X>0

The function of minimizing the total cost of the entire item

X:=Minimize(fff,X)

X^T=(53.055 117.888 214.966 6.536 38.219 155.861) Y(X)=8542

Planned profit from the entire range: W:=12000

The final optimal value of the nomenclature volume: $xx_j := X_j \frac{W}{Y(X)} h_j$

xx^T=(156.513 288.582 301.98 48.201 225.494 281.689)

The cost of the entire nomenclature

$ff1 := \sum_j \frac{A1_j X_j}{h_j}$ *ST0:=fff1(xx)* *ST0=2.38x10⁴*

Cost permissible for the organization: ST:=20000

ERR:=if(ST>ST0, "profit can be increased", "profit is unattainable")

ERR="profit can be increased"

$E := \frac{ST}{ST0}$ $xx_j := xx_j E$

xx^T=(131.532 242.522 253.781 40.508 189.503 236.729)

Total profit: $\sum_j xx_j B_j$=1.398x10^4

The effectiveness of such promotion of a product on the market for the consumer is attractive in that even with a rigid withdrawal of goods, the method does not give zero volume for this type of product and this leaves a chance for a product with a low cost to hold out on the market. On the other hand, the forced promotion of goods with a high value to the market will be restrained by the release of goods of a different range. In the latter case, it is necessary to forcibly set the value c_j> 1 according to the given nomenclature *j*.

The proposed algorithm for forming the nomenclature gives a result only with positive values of profit. Moreover, with positive values of profit, there will be a large error in the calculation results if the maximum value of the profit exceeds the minimum by about ten times. In these cases, it is necessary to set a fixed total cost of the item, and to carry out optimization by ensuring maximum profit [14]:

ORIGIN:=1

Profit from unit: B:=$(10\ -1\ 21\ 4\ 5\ 14)^T$ Item unit cost: A:= $(23\ 15\ 25\ 20\ 8\ 18)^T$

Size of vectors B and A: n:=rows(B) j:=1..n

Nomenclature containment vector:

as:=max(A) $h_j = \frac{as}{A_j}$ $B1_j := B_j\ h_j$ sas:=max(B1) $c_j := \frac{B1_j}{sas}$ cn:= $\frac{1}{\sum c}$

Nomenclature function: $f(X) := \left[\prod (X_j)^{c_j}\right]^{cn}$

Initial starting value of the item volume: $X_j := 1$

Function of the total cost of the entire item: $fff(X) := \sum_j A_j X_j$

Profit from whole range: $Y(X) := \sum_j B1_j X_j$ Z(X):=$\frac{fff(X)}{Y(X)}$

Given

The base value of the item function: f(X)=10 X>0 Y(X)>0

The function of minimizing the total cost of the entire item

X:=Minimize(Z,X)

X^T=(3.823 1.007x10^{-6} 10.916 0.13 10.697 11.316)

Y(X)=658.603

Planned profit from the entire range: W:=10000

The final optimal value of the nomenclature volume: $xx_j := X_j \frac{W}{Y(X)} h_j$

xx^T =(63.091 2.548x10^{-5} 165.743 2.477 507.508 238.639)

Resulting profit

$Y(X) := \sum_j B_j X_j$ Y(xx)=1.0x10^4

There is a price maintenance strategy that has a direct impact on the price. Maintaining the price level consists in specifying prices by suppliers, above or below which other channel members are not allowed to sell their products. The main reasons for using this strategy are:

- maintaining resale prices discourages the sale of goods at reduced prices, reducing the ability of competing dealers to use the services provided by other participants for free;
- using their monopoly power in this region, dealers raise the price above the competitive level to the detriment of the interests of the manufacturer and the consumer, indicating the maximum price level, the price can be maintained at a competitive level;
- a manufacturer can increase the trade markup for advertising support and the invention of its brand, it is possible to provide discounts to offset costs and other costs to ensure competition with other brands.

In cases where the seller offers a lower price to one buyer for the same product than to another, we can say the seller provides one of them with a certain monetary reward.

In practice, such discrimination carries a lot of meaning. By using segmented pricing, management minimizes the need for compromise. Low price sensitivity buyers who require expensive service or are poorly served by competitors can charge more than high price sensitivity buyers who are cheaper to service or are well served by competitors. This discrimination increases sales and increases profitability.

The proposed methodology for the formation of the nomenclature to a large extent supports this strategy for the formation of prices, since in the interactive mode it allows, by changing prices, to form the range of goods in the optimal mode. Considering the fact that in many sectors of the economy the nomenclature of goods is regulated and constitutes one of the factors in the formation of marketing channels [15], the method of forming the nomenclature using the nomenclature function can provide an additional factor in maintaining the company's image in the eyes of consumers.

The proposed mathematical models in the work are implemented in Mathcad, but they can be implemented in Excel using the “Search for a solution” service [16, 17].

Conclusions

1. This article describes the method for defining the nomenclature without direct programming can be implemented only by means of MathCad.
2. Research has shown that the volume of the nomenclature changes in proportion to the required profit relative to the calculated profit for the fixed value of the nomenclature function.
3. As expected, the value of the optimal volume of the nomenclature essentially depends on the degrees at Xi in the nomenclature function.
4. A negative value of the specific profit gives a value close to zero in the optimal stock vector in the corresponding position.

The proposed nomenclature function makes it possible to exclude zero values of the nomenclature, which corresponds to the strategy of ensuring the nomenclature assortment of goods [18]. The methodology provides for two optimization options: cost and profit. In practice, the calculation is performed for these two options and then the most appropriate option is selected. The methodology can be supplemented with calculations for the integer variant of the commodity nomenclature units. The article does not provide explanations of the aspects of the algorithms, since these explanations are made directly in the programs on MathCad. It is assumed that the reader is familiar with programming in Mathcad. The listings given in the article are fully debugged algorithms in Mathcad.

References

1. Information systems and technologies in economics and management / under. ed. V.V. Trofimova. - M .: Higher education, 2006.
2. Naumov A. N., Quality of management of the XXI century // Management today, 2003, №6, p. 2–5.
3. Vasilevskaya I. V. Innovation management.– Moscow, Rior Publ.,2017. 480 p.
4. Crassus M. S., Chuprynov B. P. Mathematical methods and models for undergraduates in economics - M.-St.Petersburg : Peter, 2006.
5. Vlasova E. V., Glinkin E. I. Evaluation of efficiency by standardized measurement measures // Bulletin of TSU, 2017, v. 22, no. 2. - p. 51–57.
6. Kudryavtseva L. B., Kolmakova L. I. Basic concepts in the cloud of assortment policy // Bulletin of modern science, 2015, 10 (3). - pp. 35–37 of modern science, 2015, 10 (3). - p. 35–37.
7. Rusmevichientong P., Topaloglu H. Robus assortiment optimisation i revenue management the multinomial model// Operations Research, 2012, 60(4) – p. 865–882.
8. Hotomtseva, M. A., Berestneva, N. O. Workshop on the discipline "Economic and mathematical methods and models" - Minsk: MITSO, 2006.
9. Vlasova E. V., Glinkin E. I. Evaluation of efficiency by standardized measurement measures.Vestnik TGU [TSU Bulletin], 2017, vol. 22, issue 2, pp. 51–57

10. Domanova Yu. A., Chernyak A. A., Chernyak Zh. A. Mathematics based on Mathcad, general course - St. Petersburg, BHV, 2004.

11. Mathematics for economists based on MathCad / A. A. Chernyak [and others] - St. Petersburg: BHV-Petersburg, 2014.

12. Differentiation Strategy With a Product Life Cy cle Focus. Available at: https://bizfluent.com/facts-6802144-application-differentiation-business.html (accessed 26.09.2017).

13. Crawley M. J. Statistics: an introduction using R. – Wiley, 2014. – 354 p.

14. Novikov V. A., Vankovich G. R. Calculati on of commodity classifications according to the criterion of cost. – Economics and Management, 2014, no. 1 (37), pp. 15–21.

15. Stern L. Marketing channels - M., Williams, 2002.

16. Karlberg K. Business analysis using Excel. M .: Williams, 2019. 576 p.

17. Kremer N. Sh., Putko B. A., Trishin I. M., Friedman M. N. Operations Research in Economics: a Textbook for the Academic Bachelor's Degree. – Moscow, Izdatel'stvo Yurayt Publ., 2014. 438 p.

18. Ishchenko A. Assortment policy // Exclusive marketing. - 2011, 2.- p. 345-349.

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