Маркетинг

UDC 339.138

Chunikhina Tetiana
PhD in Economics, Associate Professor
State University of Trade and Economics
Чуніхіна Тетяна Сергіївна
кандидат економічних наук, доцент
Державний торговельно-економічний університет
ORCID: 0000-0002-1386-6706

Chernyshov Oleksandr
Candidate of Economic Sciences, Associate Professor
National Aviation University
Чернишов Олександр Юрійович
кандидат економічних наук, доцент
Національний авіаційний університет
ORCID: 0000-0003-0422-2252

Liganenko Iryna
PhD in Economics, Associate Professor
Danube branch
Private joint-stock company "Higher educational institution
"Interregional Academy of Personnel Management"
Ліганенко Ірина Віталіївна
кандидат економічних наук, доцент
Придунайська філія
ПрАТ «ВНЗ «Міжрегіональна Академія управління персоналом»
ORCID: 0000-0003-0716-289X

Kubai Oksana
Candidate of Economic Sciences, Associate Professor
Vinnytsia National Agrarian University
Кубай Оксана Григорівна
кандидат економічних наук, доцент
Вінницький національний аграрний університет
ORCID: 0000-0001-5099-489X

THE VARIATION MODELING OF THE MARKETING PRICING STRATEGIES OF THE INDUSTRIAL ENTERPRISE
ВАРІАЦІЙНЕ МОДЕЛЮВАННЯ МАРКЕТИНГОВИХ СТРАТЕГІЙ ЦІНОУТВОРЕННЯ ПРОМИСЛОВОГО ПІДПРИЄМСТВА

Summary. *The main purpose of the article is to substantiate the optimal pricing strategy using a modified econometric model, to develop an algorithm for modeling the price of industrial products and to determine the projected sales volumes at the initial stage of market entry. The methodological basis of the study was the scientific provisions on the need for the process of developing a pricing strategy, the importance of which is especially great, given that the competent justification of the price level determines the profitability of the enterprise and its financial stability, its competitive position and the effectiveness of the leading marketing strategy. The Rogers variational model was modified for new product positions, and the model was empirically tested on an analytical product sample. The practical importance is based on the possibility of forecasting and analytical support for the introduction of new product groups by the enterprise to the market and the calculation of the optimal parameters of the pricing strategy. A mechanism for constant updating of the parameters of the proposed analytical model and*

changing the price policy accordingly has been formed. The work forms an applied model of choice and economic feasibility of the optimal pricing strategy of an industrial enterprise. Future research should focus on developing an appropriate diffusion model that incorporates the impact of competition in forming optimal pricing.

Key words: *marketing activity, pricing strategy, product group, econometric model of choice.*

Анотація. *Основною метою статті є обґрунтування оптимальної цінової стратегії з використанням модифікованої економетричної моделі, розробка алгоритму моделювання цін на промислову продукцію та визначення прогнозованих обсягів продажів на початковому етапі виходу на ринок. Методологічною основою дослідження послужили наукові положення про необхідність процесу розробки цінової стратегії, важливість якої особливо велика, враховуючи, що грамотне обґрунтування рівня цін визначає прибутковість підприємства і його фінансову стійкість, його конкурентну позицію і ефективність провідного маркетингу стратегія. Варіаційна модель Роджерса була модифікована для нових позицій продукту, і модель була емпірично протестована на аналітичному зразку продукту. Практична значимість заснована на можливості прогнозування та аналітичної підтримки виведення підприємством на ринок нових товарних груп і розрахунку оптимальних параметрів цінової стратегії. Сформовано механізм постійного оновлення параметрів запропонованої аналітичної моделі та відповідної зміни цінової політики. В роботі сформована Прикладна модель вибору та економічної доцільності оптимальної цінової стратегії промислового підприємства. Майбутні дослідження повинні бути*

зосереджені на розробці відповідної моделі розповсюдження, яка враховує вплив конкуренції при формуванні оптимального ціноутворення.

Ключові слова: *маркетингова діяльність; цінова стратегія; товарна група; економетрична модель вибору.*

Introduction. The leading role of the price is increasing, especially in the conditions of formation of market economy. The choice of the optimal price strategy is an important and very difficult task for the management of companies in present's unstable market conditions, with a decrease in consumer activity. The search for sound management decisions is complicated by many factors of the internal and external environment and requires a well-grounded algorithm of actions. The management process is a series of interrelated analytical procedures and solutions that allow the company to consistently move towards the achievement of its strategic goal.

The scientific problem is that the existing pricing methods for a new product are inaccurate, and in practice there are almost no statistical, economic, mathematical and optimization methods for pricing a product when it enters the market. When planning strategic activities, an important role is played by the process of pricing a new product that the company wants to bring to the market. In a market economy, the rules and patterns of behaviour are imposed from above by economic agents are, on the one hand, non-viable, because they cannot precisely correspond to the real conditions of each enterprise, on the other hand, the entrepreneur cannot act in a stereotyped manner, since he is forced to solve individual problems of a particular production.

Literature review. A significant number of scientific works [1, 6, 13, 18] are devoted to the problems of development of pricing policy and strategy of the enterprise in market conditions. But not all aspects of this complex problem are

sufficiently covered. Developing an appropriate pricing strategy for a new product is a very difficult and important task, because it includes a complex dynamics associated with the distribution of the product in a particular market. Thus, a number of researchers [1, 7, 12, 17] are exploring the optimal pricing policy based on the model as a basis. Because this model does not contain a variable price, the researchers first had to include the price in the model, and then get the optimal pricing policy of the enterprise. A thorough analysis of the sources [8, 11, 19] indicates that establishing the optimal price path should be largely based on a sales growth model. However, in the real world of the market, we do not often find new products that have this pricing model.

Methodology. Diffusion models of scientific research describe the appearance of a new product on the market, characterizing its distribution using the s–curve. The class of diffusion models is quite wide and agrees well with practice. E. Rogers' model describes the diffusion of new products, its essence is as follows. Let there be some market where a new product (product or service) is appeared, which has no analogues and, accordingly, competition from other products [16]. This product creates a new demand, there is a certain number of people who want to buy this product or have already made a purchase. Then a certain percentage of customers who commit the act of buying in the point in time described by the formula (Eq. 1):

$$\frac{f(t)}{1-F(t)} = p + qF(t)$$
$$F(t) = \int_0^T f(t)dt \quad (1)$$

where f (t) – percentage of customers making a purchase at the time t or, in other words, the function of the density distribution of buyers over time;

F (t) – percentage of customers who bought the product before time t or, in other words, the distribution function of buyers over time

p – coefficient of innovation or the coefficient of external influence;

q – coefficient of imitation or the coefficient of internal influence.

Results. The model assumes that every act of purchase occurs either under the influence of advertising and the media (this category of customers is called innovators) or under the influence of the opinion of people who have already made a purchase (this category of buyers is called imitators) [14]. Thus, the probability of making a purchase (the left part of the formula (1), firstly, depends on the external influence (advertising, media), which is taken constant and expressed by the coefficient of external influence, and secondly, depends on the influence of the social system itself, which is increasing as the number of people who have already made a purchase increases (the effect is assumed to be proportional (the internal impact factor) of that number) [2]. The parameters p,q can best be estimated according to the expression of the number of purchases n(t) at the time t from the next formula (Eq. 2):

$$n(t) = \alpha_0 + \alpha_1 N(t) - \alpha_2 N^2(t) \quad (2)$$

where m – is the number of potential customers of the product (potential demand), then mf(t) = n(t) is a number of purchases at a certain period of time t. Similarly, mF(t) = N(t) – is the number of people who have already purchased the product. From equation (2) we can estimate the parameters p,q, forming a regression model of the following form (Eq. 3):

$$n(t) = \alpha_0 + \alpha_1 N(t) - \alpha_2 N^2(t) \quad (3)$$

where $\alpha_0 = p \times m; \_ \alpha_1 = q - p; \_ \alpha_2 = -\frac{q}{m}$

We'll use this model to find diffusion parameters for individual segments of the industrial products market.

To build econometric models for a wide range of enterprise products, a function is formed in the application software environment "MATLAB", that

created the necessary models, rejected the insignificant and those that contradict the formulation of the model and the conditions of its variables. The appropriate of the models is verified by the formula $F_{pr} > F_{eor}$ with coefficients α_0, α_1, α_2, that correspond to the necessary conditions and assumptions of the model that are $p,q,m>0$. The inadequacy of 3% of the constructed estimates of the model is explained by specific factors, the influence of that was not taken into account in the given base model, that investigated the presence of products in the market. Thus, on the basis of the introduced econometric models and the indicators p,q,m are obtained from them, the average parameters for the segments were found, which are given in Table 1.

Table 1

Diffusion coefficients for different groups of commercial products of the enterprise (calculation model)

Product group designation	p	q	m
Z1	0,018	0,055	7586,32
Z2	0,011	0,256	520,06
Z3	0,003	0,153	1524,28
Z4	0,002	0,136	1808,53
Z5	0,001	0,047	3427,54
Z6	0,011	0,090	3408,45
Z7	0,007	0,141	506,20
Z8	0,003	0,026	18095,36
Z9	0,009	0,121	2639,26
Z10	0,008	0,151	2083,01
Z11	0,007	0,162	343,45
Z12	0,010	0,096	402,68
Z13	0,001	0,060	21282,90
Z14	0,015	0,350	107,53
Z15	0,008	0,151	2083,01

Source: calculation authors

For 15 selected product groups, the variation indicators were calculated, in particular the standard fallibility (Eq. 4):

$$\delta = \sqrt{\frac{1}{n} = \sum_{i=1}^{n} (x_i - \bar{x})^2}$$
$$V = \frac{\delta}{\bar{x}} \quad (4)$$

The coefficient of variation will be especially informative. This indicator allows us to analyze the percentage fallibilities of the parameters calculated for individual product groups relative to the average for the therapeutic group. These indicators are shown in Table 2.

Table 2

Indicators of variation of parameters p,q for different groups of commercial products of the enterprise (calculation model)

Product group designation	δp	Vp, %	δq	Vq, %;
Z1	0,00282	15,4	0,000611	1,06
Z2	0,00189	17,82	0,015612	6,08
Z3	0,00040	15,42	0,006701	4,36
Z4	0,000082	4,3	0,009702	7,13
Z5	0,000075	7,83	0,0072	15,21
Z6	0,000402	3,64	0,016230	17,90
Z7	0,00060	8,61	0,008211	5,76
Z8	0,000130	4,31	0,0050013	18,80
Z9	0,001441	15,49	0,014991	12,24
Z10	0,000241	3,11	0,012111	7,79
Z11	0,000981	13,51	0,0320	19,32
Z12	0,000075	0,75	0,0081111	8,41
Z13	0,00010	11,20	0,012012	17,18
Z14	0,002910	20,69	0,005177	1,45
Z15	0,000891	11,42	0,024014	15,67

Source: calculation authors

Fallibilities from the average value for groups of commodity products of the enterprise were insignificant and amounted less than 20%, that allows us to estimate the average values of the diffusion parameters for product segments, as the corresponding situation is observed in the distribution of individual positions of

these groups of commodity products of the enterprise when they are brought to market. We'll analyze the obtained results relatively to the found parameters. The largest values of the coefficients of innovation (external influence) were found in the following product groups of the enterprise: Z12 (p = 0,010), Z2 (p = 0,011), Z6 (p = 0,011), Z14 (p = 0,015), Z1 (p = 0,018). In fact, the buyers of the products of these groups may be a small number of consumers, but they consistently buy or order them and form a demand for it. Therefore, the external impact factor plays no decisive role in the distribution of the product group at the launch stage. Marketing activities for these product groups are not decisive and have an indirect impact on distribution at the introduction stage [4]. Basically, this list includes groups with inelastic market demand. All these attributes influence the company's marketing activities, such as price cuts or product promotions through advertising.

Based on the research, an algorithm for setting prices for industrial products was formed. Consider the steps to determine the necessary parameters and modeling the optimal price path. Let's start with the fact that the company is going to introduce, first of all, a new product for the market, that has certain improved characteristics. The company has to do the following:

1. To identify a product group that includes a certain assortment item. If a narrower segment of products can be substitutes for a given product, then define it.

2. To analyze analytical data on the introduction of new or similar competitive products to the market in this group (segment) in recent years. Construct each of them based on the Rogers econometric model. Select only significant models in which the hypothesis of adequacy and those in which the obtained coefficients correspond to the content of the model is justified. Analyze the obtained parameters *p,q,* calculate the indicators of variation, discarding those commodity items that have a significant fallibilities from the average for the commodity group (segment) [15]. Calculate the average values of the diffusion

coefficients of the model that remained based on those product groups. In a detailed analysis, it is possible to select from the analytical data on new commodity items only those that, in its fundamental differences, resemble this product and make a sample on their basis, while calculating the average diffusion coefficients.

3. To calculate the point of maximum sale *T** according to the Rogers model, that is based on the analytical data of the product group.

4. According to the obtained diffusion coefficients, choose the marketing activities that will be optimal for certain types of products. Mention the main ones in the Table 3.

Table 3

Marketing activities in the field of pricing in accordance with the ratio of coefficients p,q (analytical parameters)

Ratio	Low indicator value p	High indicator value p
High value q	- a reduced price that will grow rapidly to a certain point; - work with sales representatives in the field of industrial marketing.	- reduced price, that will continue to grow to a certain point; - introductory advertising at the launch stage.
Low value q	- the price that is reduced during the subsequent phases of the life cycle; - advertising for target segments; - work with sales representatives in the field of industrial marketing.	- monotonous falling price policy; - constant supporting advertising, if the product group has a wide segment of consumers; - advertising support.

Source: designed by the authors

5. Evaluation of the competitive environment of the product group, the selection of competitive segments and substitute products. Analyzing their prices by comparing the benefits of a new product [5]. Setting the starting price according to the real competitive advantages and advantages regarding the positioning of commodity positions in the market.

6. Build a modified Rogers price diffusion model on the sample of historical data of new types of industrial products in the target segment. Determine the

parameters of diffusion p,q,β, select the averages sample and build a model for a particular segment.

7. Focusing on the price diffusion index b, calculate the transition points for the discount r^*. Determine $(Pr(0)(1- r^*)T^*$ and compare with the net cost. $(Pr(0)(1- r^*)T^* > c$, then we can set $r > r^*$, for which $-\beta r > 1$, that means that a monotonous price reduction policy will be optimal. If $(Pr(0)(1- r^*)T^* < c$, then we need to set $r < r^*$, for which $-\beta r < 1$, which determines the optimal price policy, as a policy of rise-and-fall, at which prices rise to the point $t1^*$, and then fall according to the selected discount r. For this policy, determine the point $t1^*$.

8. If the analytical data is not enough or lacking at all, it is necessary to do all the actions specified in the previous paragraphs for the collected data on their own product. We can do this on the basis of 6 monthly observations. With each subsequent observation it is necessary to recalculate the parameters of the model and adjust them.

9. After launching a product, it is necessary to collect statistics on sales and changes in product prices and build appropriate Rogers models: a generalized and modified pricing strategy [9]. Analyze fallibilities from the model based on historical data and correct it according to real data. It can be concluded that there is no information about the existing products in the segment, nor specific data about the new product, which are taken separately, is not enough to take as a basis for parameterization of the diffusion model. Therefore, we assume that more adequate estimates will have a model that uses data from both sources. That is, taking into account both analytical and data on certain commodity positions, we choose the intermediate solution in which: only some segment parameters are considered for a specific product, they are "free"; these parameters are not overestimated at the initial stage of the introduction of a new product, and only when more data on diffusion become available.

Conclusions. The industrial enterprise tries to form an optimal price policy in relation to the product that it wants to bring to the market, based on the diffusion (distribution) of the product in the segment, as well as any that operates in the market. The existing diffusion models were evaluated and some of them were modified. Among the analyzed pricing models for the new product, the corresponding to the needs of the industrial enterprise is highlighted and is based on statistical data that are formed on the results of economic activity. The model has been modified, thus changing it to the features of the world market of industrial goods, taking into account the specifics of marketing activities that attract to promote the product and the specifics of the competitive environment. The main factors of influence on individual product groups were also determined in order to predict their main indicators, that influence the decision of choosing a pricing strategy for a new product group.

Practical results of the research are formed for their further use in bringing industrial products to the market. In particular, it was noted that a lower initial price would be offered if the initial price sensitivity was higher. The dependence of the choice of price policy on the coefficient of internal influence q, which is also determinative of the price diffusion coefficient β, on the basis of which the transition points for discounts r^* are revealed.

The clear algorithm for choosing the price policy of the enterprise for a new product was formed, that combines the using of analytical data on new products of the segment introduced earlier and data on the market launch. It was found that the diffusion model is sensitive to the amount of data and the parameters change with each subsequent observation, so it is important to recalculate and adjust the corresponding diffusion coefficients in the process of distribution of commercial products.

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