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OPTIMIZATION OF QUALITY WITH COST FUNCTIONS AND THE MARKET PRICE

В статті розглядається вирішення проблеми конкурентоспроможності вітчизняної продукції на внутрішньому та світовому ринках, що є головним завданням державної політики на шляху до національного відродження. Створення методів оптимізації витрат виробника на виготовлення конкурентоспроможної продукції повинно бути головним вектором сучасної економічної стратегії національного виробництва. Пропонується математична модель з чисельним розв'язком задачі оптимізації. Функція прибутку виробника досліджується за допомогою регресійного рівняння. Запропоновані методи дозволяють визначити економічно оптимальне зростання якості продукції.

Ключові слова: рівень якості продукції, математичні моделі, функція прибутку виробника.

В статье рассматривается решение проблемы конкурентоспособности отечественной продукции на внутреннем и мировом рынке, что является главным заданием государственной политики на пути к национальному возрождению. Создание методов оптимизации затрат производителя на изготовление конкурентоспособной продукции должно стать главным вектором современной экономической стратегии национального производства. Предлагается математическая модель с численным решением задачи оптимизации. Функция прибыли производителя исследуется с помощью регрессионного уравнения. Предложенные методы позволяют определить экономически оптимальное увеличение качества продукциию

Ключевые слова: уровень качества продукции, математические модели, функция прибыли производителя.

The article considers the problem of competitiveness of domestic products in home and world markets, which is the main task of the state policy towards national revival. The creation of methods of optimization cost producer in the production of competitive products should be the main vector of the current economic policies of national production.A mathematical model with the numerical solution of the optimization problem is investigated. Manufacturer's profit function is studied using a regression equation. The proposed methods allow to determine the economically optimal increase in product quality.

Keywords: level of product quality, mathematical models, manufacturer's profit function.

A decision of problem of competitiveness of domestic industrial products at the home and world markets is the main task of public policy on a way of national revival. Economic aspect is the main from many other achieving high quality commodities problem aspects because quality is not an aim itself that is caused by the reproductive process of competitive production development that is possible only in a case when a commodity brings income for its producer and when quality of competitive good achieves by the most economic way. Creation of optimization methods of producer charges to make competitive products must be the main vector of modern economic strategy of national production on a way of the sphere of the World Trade Organization.

It seems that consistent market demand and stable economic position of producer is determined by the high level of good quality, planed up in a project. But a real situation which is folded under influence of number of external and internal factors is considerably more difficult [1, 2].

To the most strongly influencing external factors belong: sale market conjuncture, presence f competitors and tax policy. Influence of internal factors which determine producer charges: human factor [3], perfection of technological process, quality management process dynamic, damages and losses is important [4].

The main vector of economic strategy of producer is getting of maximal income that, as known, is a difference between the volume of sales and volume of costs. The level of good quality, mainly, determines both the constituents: the volume of sales and volume of charges, because quality is such a feature of good characterized from point of market value and is achieved, as a rule, by loosening of production costs.

The aim of this study is a product quality optimization.

The increase of quality level, unconditionally, conduces for multiplying of demand and income while the proper increase of price will not stop this process. Decline of quality level, accompanied by price reducing, can also cause demand boom by a "cheap billow" until market will not react on an true producer by decrease in demand and his income will not decline automatically [5].

Models and results

Thereby, income is a multiply function of quality level, loss amount and market price that could be describe with functional

$$I(Q, M, n, S_{pr}) \to \max \qquad (1)$$

Q – integral quality level; M – market price of one good; n – sales in units of production; S_{pr} – producer's costs.

Changes of economic features in the phase of market overturn of products takes place in relation to the project level of quality. The change in model quality which produces serially in the process of market overturn substantially does not touch on the project value of quality index, but touches, for example, on additional services, change of guarantee service terms, form, package and other secondary indexes of quality that allows to provide an income of enterprise for a long time under conditions of high level of good qualities.

Picture 1 shows the known graphic model of product quality management that does not have analytical features (parameters) in the phase of market overturn according to functions of producer costs S_{pr} and market value M^p_{pr} [7]. Unlike the known models the best standard of competitor was taken as a base standard which has competitor's charges S_{com}, market value (price) M^p_{com}.

Diminishing of quality level from value Δq_{opt} to value q_1 causes the corresponding reduction in costs on a value A that leads to decline of market value $B > A$. Increase of the level of quality from value Δq_{opt} to value q_2 causes increase of manufacturer costs to value in point to q_3 that more than corresponding increase in market value D. In both cases the manufacturer does not get maximum possible income. The choice of value Δq_{opt} requires a numeral or analytical decision.

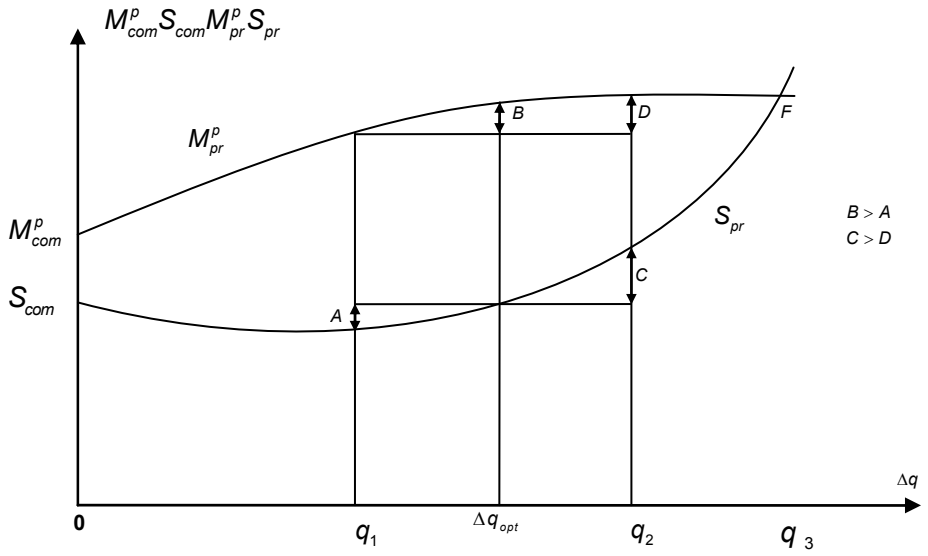

Fig. 1. Graphic model of strategy of market products pricing by enterprise-manufacturer with variation of quality level

Synthesis of mathematical models of optimum quality and their decisions

The existent methods of analytical modeling of market situation and computer models of market demand don't have a practical value because they are burdened by superfluous large errors. We developed the economic-mathematical methods of quality management that should be defined as theoretic-empiric ones. The sense their empiric content is that market demand is determined by statistical treatment of results of sales of experimental parties of manufacturer goods, quality and price of which is varied. Their theoretical content creates methodologies of determination of optimum level of quality which corresponds a maxim income [8].

The important feature of the developed models is their ability to define the dynamics of process of forming of necessary level of quality, consequently, to carry out the prediction of minimum time during which it is necessary to supply products with the new optimum level of quality to the market. This period of time shouldn't override time of decrease of market value till the critical value which corresponds the decline of income to zero.

Model with analytical solution

A market situation is determined by changeability of conjuncture, tax policy and many other factors which present it as extraordinarily difficult object of mathematical modeling. Let's take into account that the constituents of market price are determined, mainly, by the level of quality of good, because a level of quality is a description of good both from point of properties of consumers and from point of necessary achieved producer charges. Thus a maximum of producer charges is some optimum level of quality according to his economic and technical possibilities. Its analytical determination was unknown till nowadays.

Let's take to account such increase of charges of manufacturer that is connected with upgrading quality compared to a base model. Let's represent curve of costs function $\Delta S(\Delta q)$ increase displaced from increase of generic quality variable Δq to beginning of co-ordinates in form of

$$\Delta S(\Delta q) = S_b \exp\,(\alpha\,\Delta q - 1), \qquad (2)$$

where S_b is a manufacturer's base model costs.

On a Picture 2 function (2) is presented by the theoretical line of regression which determined, for example, under LSM from the array of empiric data about the charges of producer on making tentative parties of goods.

Increasing of a market price from a value Δq expressed by a next function

$$\Delta M(\Delta q) = M_{\lim}\,[1 - \exp(-b \cdot \Delta q)], \qquad (3)$$

where $M_{\lim} = \lim f(\Delta M)$ is a boundary value of market price, $\Delta q \to \Delta q_{\lim}$ proper to boundary by technical possibility maximizing of generalized index of quality $\Delta q_{\lim}$.

Let's determine a value $M_{\lim}$ by solving of the following system of equations

$$\left.\begin{aligned} \Delta M_1 &= M_{\lim}\,[1 - \exp\,(-b\Delta q_1)], \\ \Delta M_2 &= M_{\lim}\,[1 - \exp\,(-b\Delta q_2)], \\ \Delta M_3 &= M_{\lim}\,[1 - \exp\,(b \cdot \frac{\Delta q_1 + \Delta q_2}{2})] \end{aligned}\right\} \qquad (4)$$

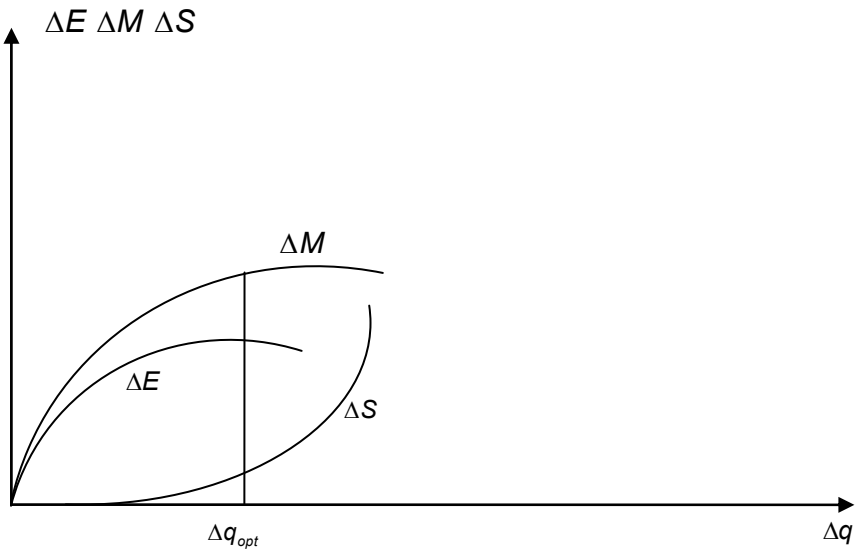

Fig.2. Graphic explanation of conduct of function of income of producer

$$M_{\lim} = \frac{\Delta M_1 \cdot \Delta M_2 - \Delta M_3^2}{\Delta M_1 + \Delta M_2 - 2\Delta M_3} \quad (5)$$

Let's accept $y = M_{\lim} - \Delta M$ and linearise it:

$$\ln y = \ln M_{\lim} - b\Delta q \quad (6)$$

According to least-squares method let's determine the parameter of regression.

Thus, all variables in right part of equation (3) are set.

Let's present the change of income of producer by expression

$$\Delta E(\Delta q) = M_{\lim} - M_{\lim} \exp(-b\Delta q) - S_b \exp(\alpha\Delta q) + S_b. \quad (7)$$

Now a value Δq_{opt} can be defined analytically [8]:

$$\Delta q_{opt} = \frac{\ln M_{\lim} - \ln S_b}{\alpha + b}.$$

Conclusions

Thus, the quality metering methods of optimization of economic strategy of commodity producer were developed in the phase of market overturn of the products let out by him, which allow to solve the problem of choice of modernized model quality level multiplying according to good of serial issue, to get the maximal value of income in the conditions of its destabilization by revolting market factors. If a commodity producer has information about economic and quality metering features of competitor products, the task of economic optimization of multiplying the level of quality of serial good concerning the level of quality of good of competitor becomes more common for analytical solution.

Computer models of market situation in the segment of commodity producer through the great number of influencing factors usually have large errors of sales volumes prediction. The offered methods have considerably accuracy due to the offered mechanism of receipt of statistical array of data about the market price of experimental portion of goods, the quality level of which is varied by producer according to a serial sample or sample of competitor. An involved feed-back is called "market – commodity producer – market" and must be high-dynamic, because the methods of optimization of market strategy of commodity producer couldn't be realized. Otherwise, high speed of reaction of commodity producer on market conjuncture is needed by producing and sales of experimental parcel with different gradation of their quality. Economic optimum increase of goods quality could be solved with high accuracy according to described methods.

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