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ECONOMIC-MATHEMATICAL MODELS OF DYNAMICS OF CIRCULATING ASSETS OF PRODUCER

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Abstract: the economic-mathematical model of producers behavior, which consists of a system of differential equations, describing the dynamics of circulating assets and dynamics of the market price of the product is proposed in the article. The model is implemented on practical data and the results are analyzed for the stability.

The behavior of the producer considerably is defined by market structure in which he offers the goods. We will consider the competitive market as strongly nonequilibrium open system. Despite considerable interest of scientists, nevertheless there are actual researches of mechanisms of establishment of the equilibrium price in the markets, in particular, under the influence of self-organizational processes. Complexity of such system and limitation in application of analytical methods at her research allows to pass to numerical models.

Now the wide experience of studying of economic systems from a position of the theory of nonequilibrium systems is saved up. Works of the famous foreign scientists, in particular in economy are fundamental: H. Haken, I. Prigogine, Yu. Loskutov, S. Kurdyumov, .G. Malinetskii and others.

We will consider mathematical behavior model of the producer taking into account market mechanisms of self-organization by economic methods. We will take the model offered in works D. S. Chernavsky with coauthors as a basis [1, 2]. Let the firm produce the uniform production which price is established as equilibrium on the basis of balance of supply and demand. N - number of consumers of production, S – consumers income, τ - the duration of the production cycle, $\tilde{p}$ - cost of production, δ - share of current assets which goes on a covering of variable expenses, κ - the constant expenses which aren't depending on quantity of the production, $Q\left(\frac{S}{p}\right)$ - function of demand depends on the income S relation to price p.

Then the equation of dynamics of current assets of the enterprise M can be written:

$$\frac{dM}{dt} = -\frac{M\delta}{\tau} + NQ\left(\frac{S}{p}\right)\cdot p - \kappa = -\frac{M\delta}{\tau} + Nq\left(1 - \frac{p}{p_{cr}}\right)\cdot p - \kappa . \qquad (1)$$

And the equation of change of market price of in time is presented to a formula (2) as a difference of supply and demand on goods, that is dynamics of the price depends on excess demand or the offer:

$$\frac{dp}{dt} = \gamma\left\{-\frac{M\delta}{\tau\tilde{p}} + Nq\left(1 - \frac{p}{p_{cr}}\right)\right\}. \qquad (2)$$

We realize model (1) - (2) on the real data obtained from financial statements of “Svitoch” confectionery.

As a result the model is:

$$\begin{cases} \dfrac{dM}{dt} = -3M + 12\left(1 - \dfrac{p}{6}\right)p - 4 \\ \dfrac{dp}{dt} = 3{,}5\left(-M + 12\left(1 - \dfrac{p}{6}\right)\right) \end{cases} . \qquad (3)$$

We investigate system (3) on stability [3, 4]. Having equated the right part of system to zero, we will find its stationary points:

$$\begin{cases} -3M+12\left(1-\frac{p}{6}\right)p-4=0 \\ 3{,}5\left(-M+12\left(1-\frac{p}{6}\right)\right)=0 \end{cases}$$

$$\begin{cases} -3M+12p-2p^2-4=0 \\ -M+12-2p=0 \end{cases}$$

$$\begin{cases} -3M+12p-2p^2-4=0 \\ M+2p=12 \end{cases}$$

From the second equation of system defines M:

$M=12-2p$

We will substitute in the first equation of system:

$$-3(12-2p)+12p-2p^2-4=0$$

$$-36+6p+12p-2p^2-4=0$$

As a result we will receive a quadratic equation, we will solve by finding of a discriminant:

$$-2p^2+18p-40=0$$

$$D=324-4\cdot(-2)\cdot(-40)=324-320=4$$

$$p_1=\frac{-18+2}{2\cdot(-2)}=\frac{-16}{-4}=4 \qquad p_2=\frac{-18-2}{2\cdot(-2)}=\frac{-20}{-4}=5$$

$$M_1=12-8=4 \qquad M_2=12-10=2$$

Two stationary points with coordinates are the decision of system т. A (4;4) i т. Б(2;5).

To investigate behavior of system in the vicinity of stationary points, it is necessary to study its behavior at small shifts in the vicinity of these points. It is realized through linearization of system in the vicinity of special points. We will find derivatives $f'_M=-3;\; f'_p=12-4p;\; g'_M=-3{,}5;\; g'_p=-7.$

According to the obtained data, calculations by means of a package of the MatLAB application programs, it is possible to draw conclusions: the point of A (4, 4) means that at market price of 4 UAH the firm will receive growth of current assets of 4 thousand UAH. The type of behavior of the enterprise in the vicinity of this point steady knot, means that all a phase trajectory meet in that point; the point of B (2, 5) means that at market price of 5 UAH the firm will receive growth of current assets of 2 thousand UAH that it is less, than in the previous case.

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