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RESEARCH ARTICLE

On Prognosis of Forecast Technique of Replacement of Old Products (Innovative Technologies) by New Products (Innovative Technologies)

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ABSTRACT

In this paper, the prognosis and analysis of the process of the replacement of new lines of innovative products must take into account the capacity of the market, the possible demand for different versions of the product, the presence in the market of competing products – analogs, the proximity of the market to saturation, etc. In this paper, an approach of analysis of the replacement of new lines of innovative products (innovative technologies), recommendations for replacement of line of old products on line of new products (innovative technologies) has been introduced.

Key words: Analytical approach for analysis, model for prognosis, replacement of new lines of innovative products

INTRODUCTION

In modern economic theory, scientific and technological progress is considered as one of the relevant factors of long-term economic growth. The impact of scientific and technological progress on a particular sector of the economy is manifested in the creation of new products that have important competitive advantages over existing ones or in the modification (modernization) of already produced products. Often, new products are based on new (innovative) technologies. However, technological superiority requires timely modernization of production and training of personnel, that is, significant financial and organizational investments. At the same time, the abandonment of the transition to innovative technologies can lead to tangible losses of market positions or even to a complete cessation of activities. At present, one of the important examples of markets characterized by the displacement of some products by others, more attractive from a technological point of view, is the market of information and telecommunication technologies (market of data transmission services). Most data service providers are now faced with the question of the degree of market saturation and prospects for its development; this question is also relevant in the light of the emergence of new mobile data technologies, etc.[1-9]

The aim of this work is to formulate and analyze the model of the dynamics of the replacement of new lines of innovative technologies, taking into account the capacity of the market, the possible demand for various products, the presence of competing products on the market, the proximity of the market to saturation, etc.

METHOD OF SOLUTION

In this work, to analyze the change of generations of innovative technologies, we adapt the model of Lottky-Volterra.[10,11]

$$\begin{cases} \dfrac{dN_1(t)}{dt} = r_1\left[1-\dfrac{1}{K_1}N_1(t)-\dfrac{\gamma_1}{r_1}N_2(t)\right]N_1(t) \\ \dfrac{dN_2(t)}{dt} = r_2\left[1-\dfrac{1}{K_2}N_2(t)-\dfrac{\gamma_2}{r_2}N_1(t)\right]N_2(t) \end{cases} \quad (1)$$

Where, K_1 and K_2 are the market capacity for the number of two products: $N_1(t)$ and $N_2(t)$,

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respectively; r_1 and r_2 are the coefficients of growth of the quantity of products; g_1 and g_2 are the characteristics of competition between two products. Initial conditions for the functions $N_1(t)$ and $N_2(t)$ could be written as

$$N_i(0) = \hat{N}_i. \quad (2)$$

To simplify of analysis of the considered of replacement of new line of products let us transform the Equation (1) to the following form

$$\begin{cases} \dfrac{d N_1(t)}{d t} = r_1 N_1(t) - \dfrac{r_1}{K_1} N_1^2(t) - \dfrac{\alpha_1 r_1}{K_1} N_1(t) N_2(t) \\ \dfrac{d N_2(t)}{d t} = r_2 N_2(t) - \dfrac{r_2}{K_2} N_2^2(t) - \dfrac{\alpha_2 r_2}{K_2} N_1(t) N_2(t) \end{cases} \quad (1a)$$

where $\alpha_i = \gamma_i K_i / r_i$. Farther, we will determine the solution of the above system of equations as the following power series

$$N_i(t) = \sum_{j=0}^{\infty} \alpha_i^j N_{ij}(t), \text{ i =1 or 2.} \quad (3)$$

Substitution of these series into Equation (1a) at both values of number of products i (i=1 or 2) gives a possibility to obtain following equations for the functions $N_{ij}(t)$

$$\frac{d N_{10}(t)}{d t} = r_1 \left[N_{10}(t) - \frac{1}{K_1} N_{10}^2(t) \right],$$

$$\frac{d N_{20}(t)}{d t} = r_2 \left[N_{20}(t) - \frac{1}{K_2} N_{20}^2(t) \right]; \quad (1b)$$

$$\frac{d N_{11}(t)}{d t} = r_1 N_{11}(t) \left[1 - 2 \frac{N_{10}(t)}{K_1} \right] - \frac{2 r_1}{K_1} N_{10}(t) N_{20}(t)$$

$$\frac{d N_{21}(t)}{d t} = r_2 N_{21}(t) \left[1 - 2 \frac{N_{20}(t)}{K_2} \right] - \frac{2 r_2}{K_2} N_{10}(t) N_{20}(t); \quad (1c)$$

$$\frac{d N_{12}(t)}{d t} = r_1 N_{12}(t) - r_1 N_{12}^2(t)$$

$$- \frac{2 r_1}{K_1} N_{10}(t) N_{12}(t) - \frac{2 r_1}{K_1} N_{11}(t) N_{20}(t)$$

$$\frac{d N_{22}(t)}{d t} = r_2 N_{22}(t) - r_2 N_{22}^2(t)$$

$$- \frac{2 r_2}{K_2} N_{20}(t) N_{22}(t) - \frac{2 r_2}{K_2} N_{21}(t) N_{10}(t); \quad (1d)$$

Initial conditions for the functions $N_{ij}(t)$ could be written as: $N_{i0}(0) = \hat{N}_i$; $N_{ij}(0) = 0$, $i \geq 1$, $j \geq 1$.

Solution of the above equations by standard approaches[12] gives the following result

$$N_{10}(t) = \frac{K_1 \hat{N}_1 e^{r_1 t}}{K_1 \hat{N}_1 e^{r_1 t} - \hat{N}_1 + K_1},$$

$$N_{20}(t) = \frac{K_2 \hat{N}_2 e^{r_2 t}}{K_2 \hat{N}_2 e^{r_2 t} - \hat{N}_2 + K_2}; \quad (4a)$$

$$N_{11}(t) = \frac{2 r_1}{K_1} \exp\left\{ \int_0^t \left[2 \frac{N_{10}(\tau)}{K_1} - 1 \right] r_1 \tau \, d\tau \right\}$$

$$\int_0^t N_{10}(\tau) N_{20}(\tau) \exp\left\{ \int_0^\tau \left[2 \frac{N_{10}(u)}{K_1} - 1 \right] r_1 u \, du \right\} d\tau$$

$$N_{21}(t) = \frac{2 r_2}{K_2} \exp\left\{ \int_0^t \left[2 \frac{N_{20}(\tau)}{K_1} - 1 \right] r_2 \tau \, d\tau \right\}$$

$$\int_0^t N_{10}(\tau) N_{20}(\tau) \exp\left\{ \int_0^\tau \left[2 \frac{N_{20}(u)}{K_2} - 1 \right] r_2 u \, du \right\} d\tau; \quad (4b)$$

$$N_{12}(t) = \left\{ \frac{1}{K_1} N_{10}(t) - \frac{1}{2} - r_1 \sqrt{\frac{8}{K_1} N_{11}(t) N_{20}(t) - \left[1 - \frac{2}{K_1} N_{10}(t) \right]^2} \right\} \times$$

$$tg\left\{ \frac{t r_1}{2} \sqrt{\frac{8}{K_1} N_{11}(t) N_{20}(t) - \left[1 - \frac{2}{K_1} N_{10}(t) \right]^2} \right\} \quad (4c)$$

$$N_{22}(t) = \left\{ \frac{1}{K_2} N_{20}(t) - \frac{1}{2} - r_2 \sqrt{\frac{8}{K_2} N_{21}(t) N_{10}(t) - \left[1 - \frac{2}{K_2} N_{20}(t) \right]^2} \right\} \times$$

$$tg\left\{ \frac{t r_2}{2} \sqrt{\frac{8}{K_2} N_{21}(t) N_{10}(t) - \left[1 - \frac{2}{K_2} N_{20}(t) \right]^2} \right\}$$

In this paper, these required quantities of products $N_1(t)$ and $N_2(t)$ framework the considered approach. The approach is usually enough good approximation to obtain to make qualitative analysis and obtain some quantitative results. The

results of analytical calculation have been checked by comparison with the results of numerical simulation.

DISCUSSION

In this section, we will analyze the dynamics of the replacement of lines change of innovative technologies depending on the market parameters (market capacity, possible demand for various products, etc.). Figure 1 shows the dependence of the quantity of the products on time at various values of the market capacity. The increasing of the curve numbers corresponds to the increasing of market capacity. From this figure, it follows that the decrease in market capacity leads to a more rapid saturation with an increase in the number of products. Figure 2 presents the dependence of the quantity of products on time at different values of its initial quantity. Increasing of curve number corresponds to the increasing of the initial quantity of products, which leads to an increasing of initial quantity of products with an earlier achievement of the saturation of the market. Figure 3 illustrates the dependence of the quantity of product on time at different values of the growth factor of its quantity. The increasing of number of the curve corresponds to the increase in the value of the growth factor of the number of goods. From Figure 3, it follows that an increase in the value of the growth factor of the number of product leads to an increase in the number of product with an earlier achievement of the saturation of the market. Figure 4 shows that dependence of the quantity of products on

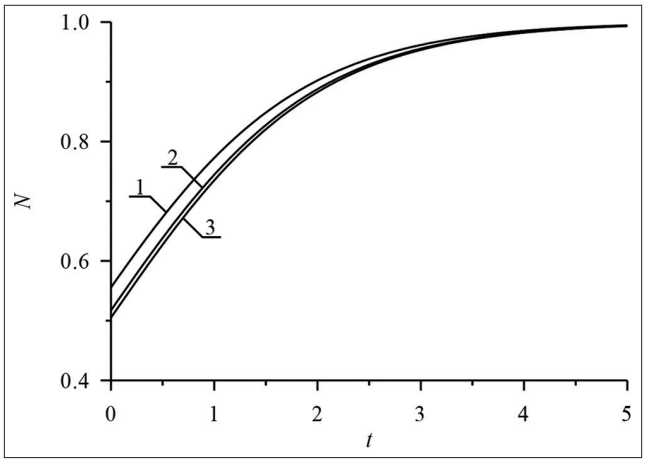

Figure 1: Dependence of quantity of product on time for different values of market capacity. The increase in the curve number corresponds to the increase in market capacity

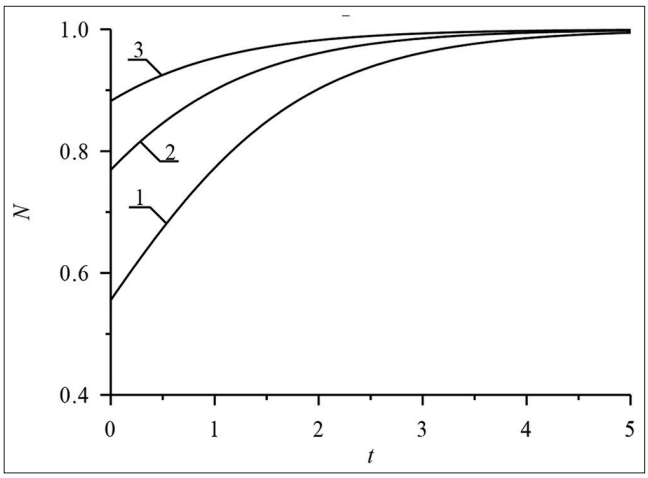

Figure 2: Dependence of the quantity of product on at different values of its initial quantity. Increasing of curve number corresponds to increasing of initial quantity of the product

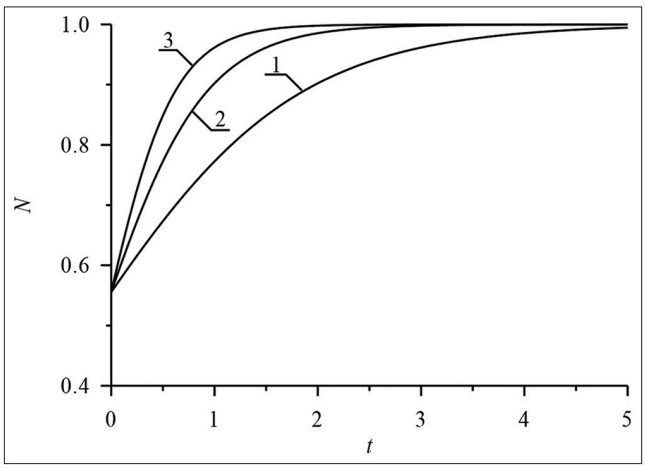

Figure 3: Dependence of quantity of product on time at different values of the coefficients of the growth in the number of product. The increasing of curve number corresponds to the increasing of growth coefficients of the quantity of product

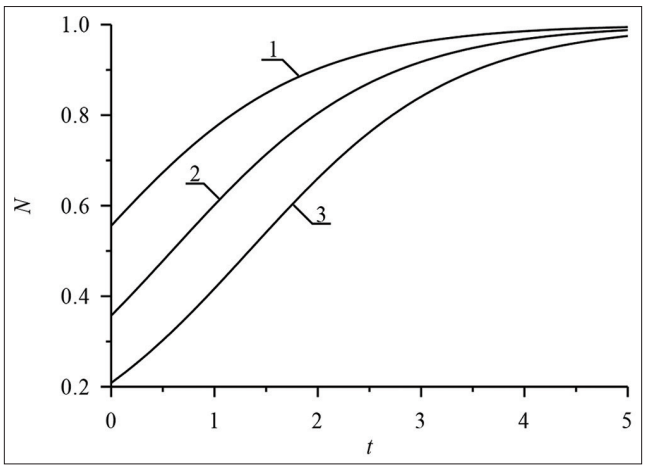

Figure 4: Dependence of quantity of product on time at different values of the characteristics of its competition with another product. The increasing of curve number corresponds to the increasing of values of the characteristics of the competition of the product with another product

time at various values of the characteristic of its competition with other products is presented. The increasing of curve number corresponds to the increasing of the value of the characteristics of the competition of the considered product in comparison with another product. From this figure, it follows that an increase in the competition of the considered product with other products can lead to a decreasing of product in a market. At the same time, the opposite effect is possible, which leads to a change in the values of the corresponding product.

CONCLUSIONS

In this paper, we introduce an analytical approach for analysis of the replacement line of product process. Using the approach, we analyzed the dependence of the above process on different parameters.

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