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EL Pankratov
1. Nizhny Novgorod State University, 23 Gagarin Avenue, Nizhny Novgorod, 603950, Russia
2. Nizhny Novgorod State Technical University, 24 Minin Street, Nizhny Novgorod, 603950, Russia

Corresponding Author:
EL Pankratov
1. Nizhny Novgorod State University, 23 Gagarin Avenue, Nizhny Novgorod, 603950, Russia
2. Nizhny Novgorod State Technical University, 24 Minin Street, Nizhny Novgorod, 603950, Russia

An approach to maximize profit: Accounting of changing of prices

EL Pankratov

Abstract
This paper presents an analytical approach for estimation of maximum value of profit of an enterprise with account several types of products. Profit maximization gives a possibility to take into account changing of price of products on the market. As an example we consider estimation of profit for the accounting of three types of products. But the introduced approach gives a possibility to change number of products, if necessary.

Keywords: Maximization of profit, accounting of changing of price

Introduction
Necessity to obtain the maximum value of profit leads to the necessity to obtain an optimal production plan for the available stocks of resources [1, 2]. Changing of market situation leads to changing of prices depending on the volume of available products on the market [3-5]. In this situation during solving the problem of obtaining of maximal value of profit, the market reaction to the release of a new batch of products in the form of a change in prices for the manufactured products should be taken into account (i.e. feedback must be taken into account). The considered relation could be taken into account in the profit function as the dependence of the prices of products on their quantity. In this paper we introduced an approach for estimation of the maximum value of the profit of an enterprise that produces several types of products. As an example, the estimation of profit for estimation of three types of products was considered. But the introduced an approach gives the possibility, if necessary, to change number of products.

Method of solution
Now let us analyze the profit of the enterprise on the basis of studying the following profit function

$$L=p_1(x_1)\,x_1+p_2(x_2)\,x_2+p_3(x_3)\,x_3. \quad (1)$$

Here x_i is the quantity of the i-th product released; $p_i(x_i)$ is the price of the i-th product as a function of its quantity on the market. In this paper, let us consider as an example the simplest dependence of the price of a product on its quantity $p_i(x_i) = a_i - b_i x_1 - c_i x_2 - d_i x_3$. The dependence gives a possibility to take into account the dependence of the price of the product on its quantity and to take into account, that i-th product could be sell with pair of j-th product or as an alternative to i-th product. At the same time, the considered model is the simplest, which makes it possible to decrease volume of calculations. Framework this paper we will consider some limitations. One of these limitations shows that the maximum volume of products at the start of the sale is fixed: for example, the volume of the storage is limited

$$e_1x_1+e_2\,x_2+e_3\,x_3=f_1. \quad (2a)$$

And (this ratio shows that the minimum volume of products has been reached, from which starting own production or supply of products from outside)

$$e_4x_1+e_5\,x_2+e_6\,x_3=f_2. \quad (2b)$$

Next, consider the maximization of profit within a mathematically standard procedure. In the first stage, we write the Lagrange function [6].

$$L=p_1(x_1)\, x_1+p_2(x_2)\, x_2+p_3(x_3)\, x_3+\lambda_1(e_1x_1+e_2 x_2 +e_3 x_3-f_1)+\lambda_2(e_4x_1+e_5 x_2 +e_6 x_3-f_2), \tag{3}$$

where λ_i are the Lagrange multipliers, which are an auxiliary parameter. Further, the maximum value of profit is determined in the framework of the standard procedure for determining of conditional extremum [6], i.e. the extremum (in this case, the maximum) of the profit function (1) with conditions (2). As a result of the calculations, we obtain the coordinates of the required maximum

$$x_{1opt}=\alpha_1/\alpha,\ x_{2opt}=\alpha_2/\alpha,\ x_{3opt}=\alpha_3/\alpha, \tag{3a}$$

Where

$$\alpha = e_4\left(e_2\{(b_3+d_1)(e_2e_6-e_5e_3)+e_1[2d_3e_5-e_6(c_3+d_2)]+e_4[e_3(c_3+d_2)-2d_3e_2]\}-\right.$$
$$-e_3\{(e_2e_6-e_3e_5)(b_2+c_1)+e_1[e_5(c_3+d_2)-c_2e_6]-e_4[e_3c_2-e_2(c_3+d_2)]\})-e_5(e_1\{e_1[2d_3e_5-$$
$$-e_6(c_3+d_2)]+(e_2e_6-e_3e_5)(b_3+d_1)+e_4[e_3(c_3+d_2)-2d_3e_2]\}-e_3\{2b_1(e_2e_6-e_5e_3)+e_1\times$$
$$\times[e_5(b_3+d_1)-e_6(b_2+c_1)]+e_4[e_3(b_2+c_1)-e_2(b_3+d_1)]\})+e_6(e_1\{(b_2+c_1)(e_2e_6-e_5e_3)+$$
$$+e_1[e_5(c_3+d_2)-e_6(c_3+d_2)]+e_4[c_2e_3-e_2(c_3+d_2)]\}-e_2\{e_1[e_5(b_3+d_1)-e_6(b_2+c_1)]+2b_1\times$$
$$+2b_1(e_2e_6-e_5e_3)+e_4[e_3(b_2+c_1)-e_2(b_3+d_1)]\}),\ \alpha_1=a_5(\{e_2(e_2e_6-e_5e_3)(b_3+d_1)+e_1\times$$
$$\times[2d_3e_5-e_6(c_3+d_2)]+e_4[e_3(c_3+d_2)-2d_3e_2]\}-e_3\{(b_2+c_1)(e_2e_6-e_3e_5)+e_1[e_5(c_3+d_2)-$$
$$-c_2e_6]+e_4[c_2e_3-e_2(c_3+d_2)]\})-e_5(a_4\{(b_3+d_1)(e_2e_6-e_5e_3)+e_1[2d_3e_5-e_6(c_3+d_2)]+$$
$$+e_4[e_2(c_3+d_2)-2d_3e_2]\}-e_3[a_1(e_2e_6-e_3e_5)+e_1(a_2e_6-a_3e_5)+e_4(a_2e_3-a_3e_2)])+e_6\times$$
$$\times(\{(b_2+c_1)(e_2e_6-e_5e_3)-e_1[c_2e_6-e_5(c_3+d_2)]+e_4[c_2e_3-e_2(c_3+d_2)]\}-e_2\{a_1(e_2e_6-$$
$$-e_3e_5)+e_1(a_3e_5-a_2e_6)+e_4(a_2e_3-a_3e_2)\}),\ \alpha_2=e_4(f_1\{e_1[2d_3e_5-e_6(c_3+d_2)]+(b_3+d_1)\times$$
$$\times(e_2e_6-e_3e_5)+e_4[e_3(c_3+d_2)-2d_3e_2]\}-[a_1(e_2e_6-e_3e_5)+a_2(a_2e_6-a_3e_5)-(a_2e_3-a_3e_2)\times$$
$$\times a_3]\,e_3)-f_2(e_1\{(b_3+d_1)(e_2e_6-e_3e_5)+e_1[2d_3e_5-e_6(c_3+d_2)]+e_4[e_3(c_3+d_2)-2d_3e_2]\}-$$
$$-e_3\{2b_1(e_2e_6-e_3e_5)+e_1[e_5(b_2+c_1)-e_3(b_3+d_1)]+e_4[e_3(b_2+c_1)-e_2(b_3+d_1)]\})+e_6([(e_2e_6-$$
$$-e_3e_6)a_1+e_1(a_2e_6-a_3e_5)+e_4(a_2e_3-a_3e_2)]\,e_1-f_1\{e_1[e_5(b_3+d_1)-e_6(b_2+c_1)]+[(b_2+c_1)\times$$
$$\times e_3-e_2(b_3+d_1)]\,e_4+2b_1(e_2e_6-e_3e_5)\}),\ \alpha_3=e_4(e_2[a_1(e_2e_6-e_3e_5)+e_1(a_3e_5-a_2e_6)+$$
$$+e_4(a_2e_3-a_3e_2)]-a_4\{(e_2e_6-e_3e_5)(b_2+c_1)+e_1[c_2e_6-e_5(c_3+d_2)]+e_4[e_2(c_3+d_2)-c_2e_3]\})-e_5(e_1\times$$
$$\times[a_1(e_2e_6-e_3e_5)+e_1(a_3e_5-a_2e_6)+e_4(a_2e_3-a_3e_2)]-a_4\{e_1[e_6(b_2+c_1)-e_5(b_3+d_1)]+2b_1\times$$
$$\times(e_2e_6-e_3e_5)+e_4[e_3(b_2+c_1)-e_2(b_3+d_1)]\})+a_5(e_1\{e_1[e_5(c_3+d_2)-e_6c_2]+(e_2e_6-e_3e_5)\times$$
$$\times(b_2+c_1)+e_4[c_2e_3-e_2(c_3+d_2)]\}-e_5\{e_1[e_5(b_3+d_1)-e_6(b_2+c_1)]+2b_1(e_2e_6-e_3e_5)+$$
$$+e_4[e_3(b_2+c_1)-e_2(b_3+d_1)]\}).$$

These coordinates are the volumes of products corresponding to the maximum profit of the enterprise.

Discussion

In this section we analyze the results, which were obtained in the previous section. Figures 1-3 show several typical dependences of the profit function (1) on the volume of output products x_i for different values of parameters. In these cases, there is an explicit maximum of the considered function.

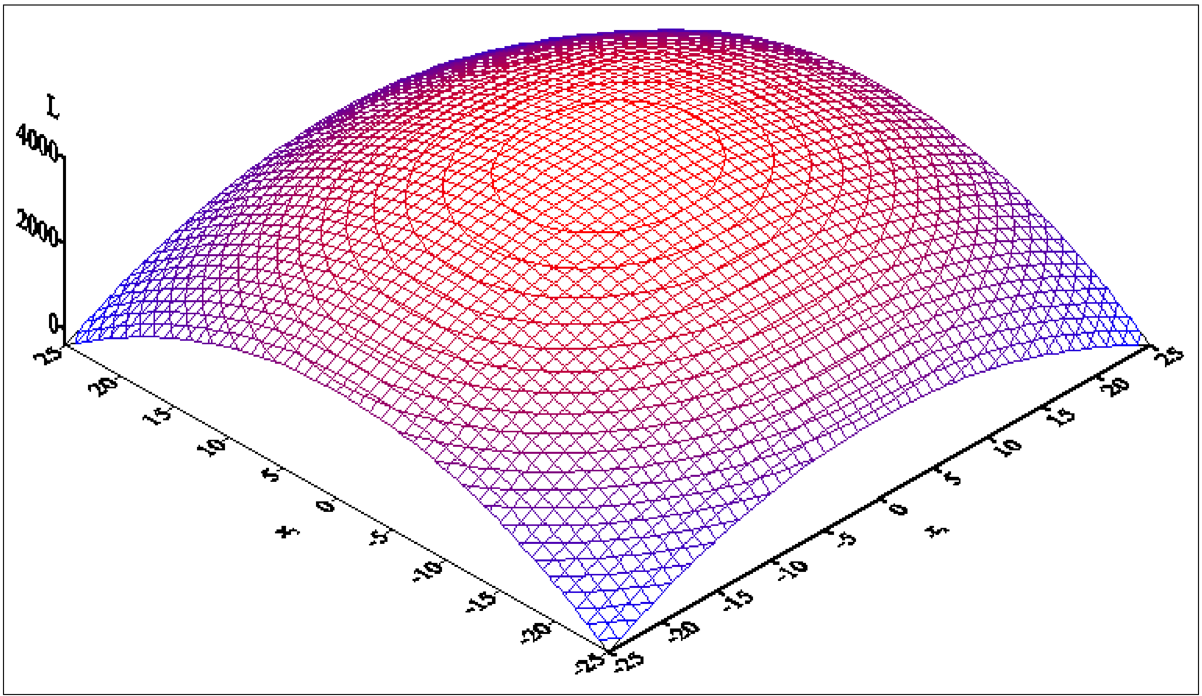

Fig 1: Example of the dependency of the profit function on the output production volumes x_1 and x_2

Next, we will consider dependences of the optimal values of the volume of manufactured products x_{iopt} on several parameters. Several typical dependences of this volume on the parameters e_i are shown on Fig. 4. Several typical dependences of this volume on the parameters a_i, b_i and d_i are shown in Figs. 5, 6 and 7, respectively.

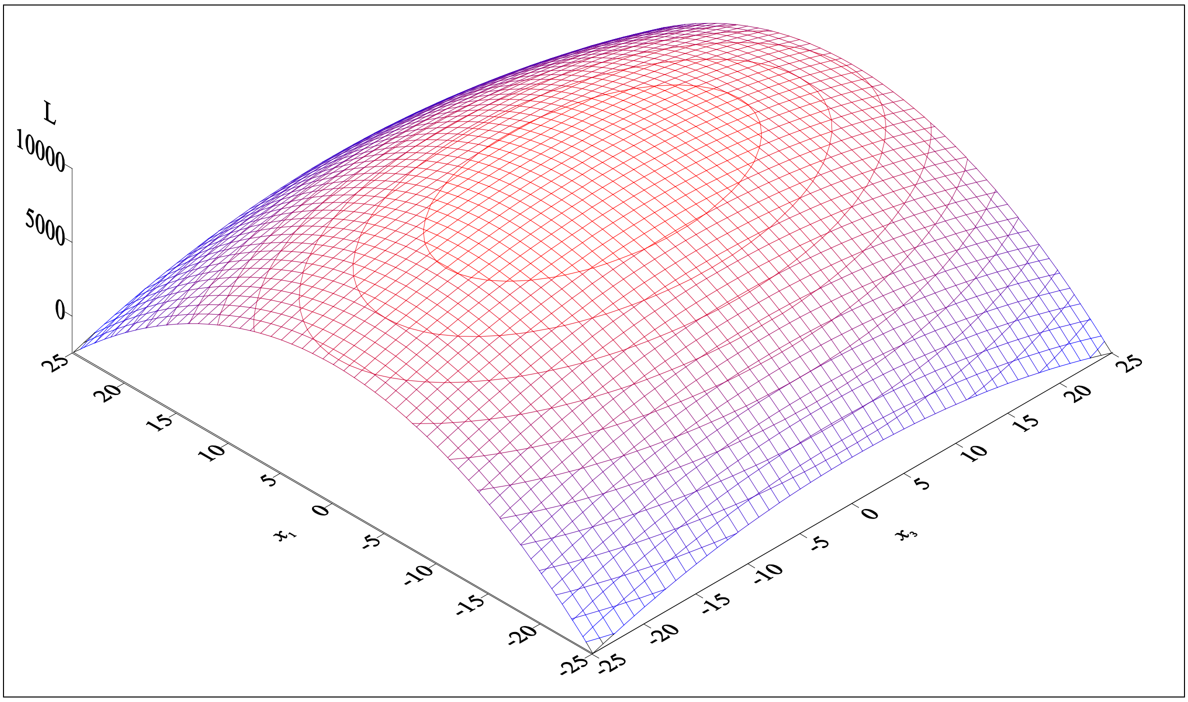

Fig 2: Example of the dependency of the profit function on the output production volumes x_1 and x_3

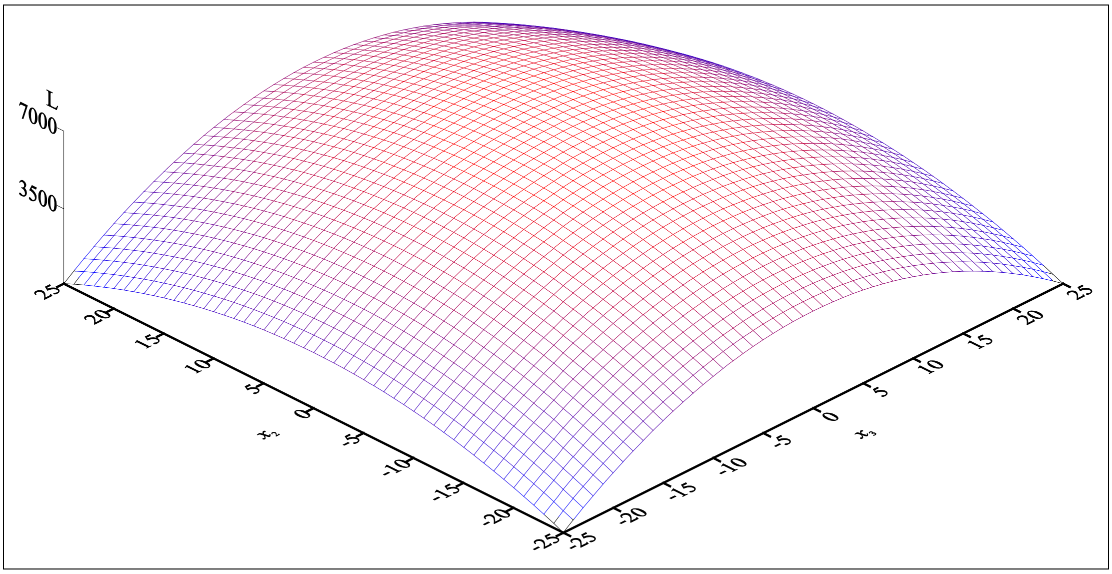

Fig 3: Example of the dependency of the profit function on the output production volumes x_2 and x_3

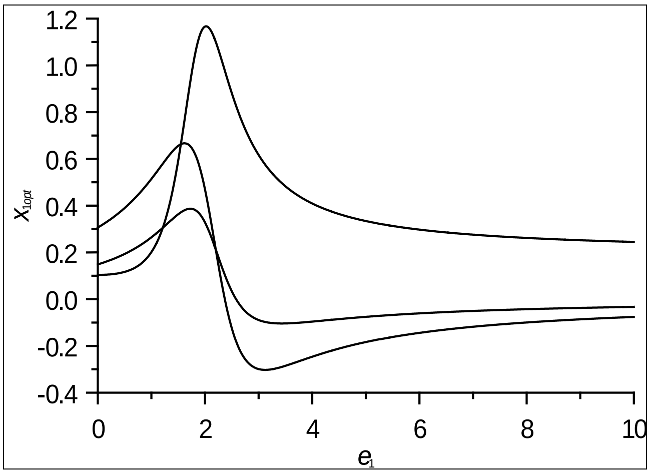

Fig 4a: An example of dependence of the optimal value of the volume of manufactured products on the parameter e_1

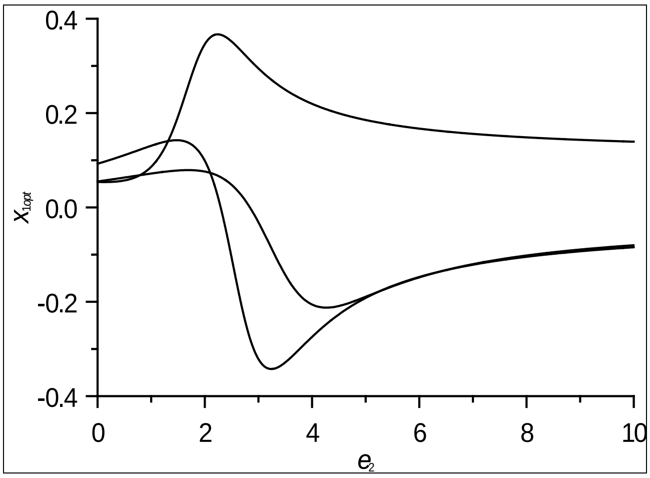

Fig 4b: An example of dependence of the optimal value of the volume of manufactured products on the parameter e_2

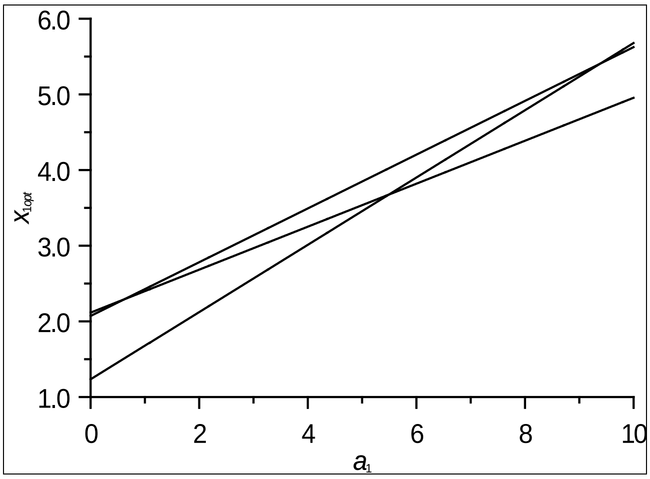

Fig 5a: An example of dependence of the optimal value of the volume of manufactured products on the parameter a_1

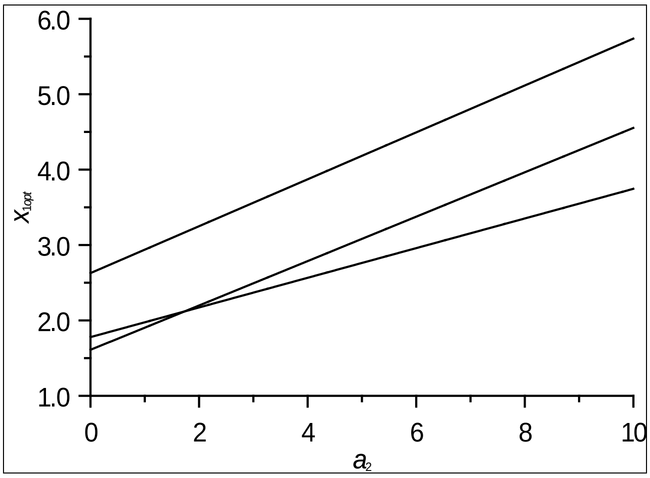

Fig 5b: An example of dependence of the optimal value of the volume of manufactured products on the parameter a_2

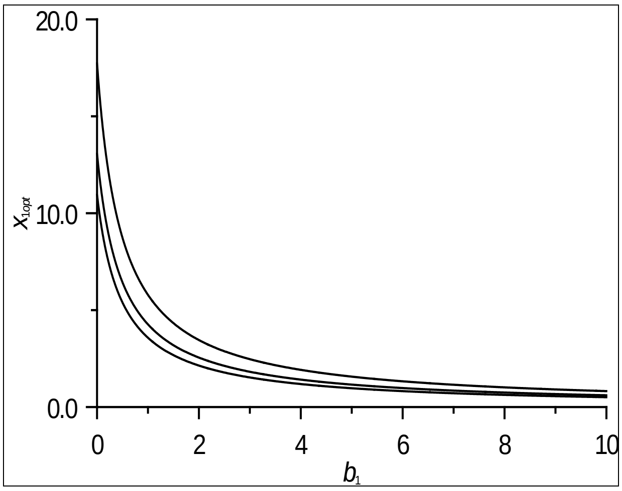

Fig 6a: An example of dependence of the optimal value of the volume of manufactured products on the parameter b_1

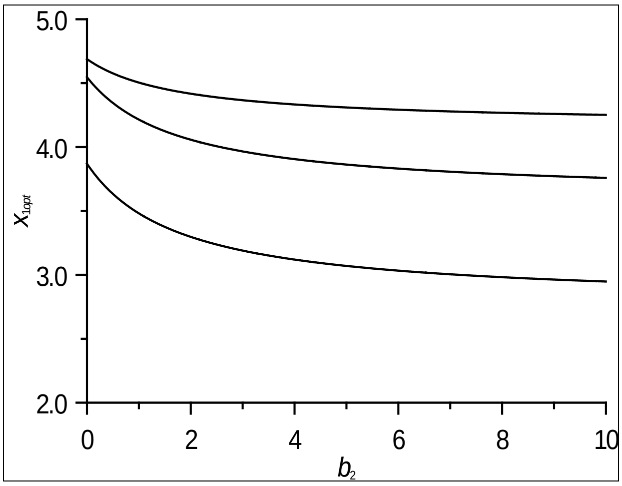

Fig 6b: An example of dependence of the optimal value of the volume of manufactured products on the parameter b_2

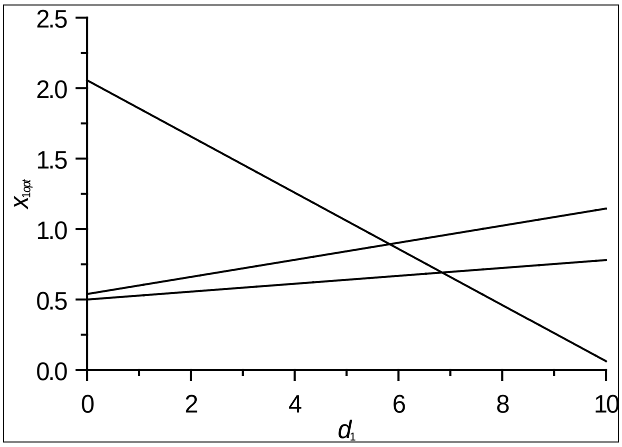

Fig 7*a*: An example of dependence of the optimal value of the volume of manufactured products on the parameter d_1

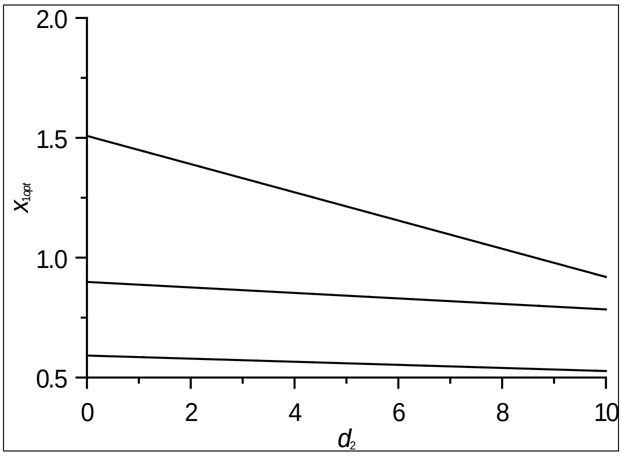

Fig 7*b*: An example of dependence of the optimal value of the volume of manufactured products on the parameter d_2

Conclusion

In this paper we introduce an approach of maximization of profit of an enterprise with account of conditions of existing constraints. The approach is considered on the example of three products, but it is possible to consider another quantity of products.

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