

Simulation Depending Profitability of Sales Variable Costs on Forming Functions Marginal Profit Enterprise in Reengineering



Tetiana Bludova, Svitlana Usherenko, Larisa Hromozdova, Nelina Khamska, Olena Shaposhnik

Abstract: The article defines the concept of "variable costs", describes the value of variable costs in the formation of marginal income of the enterprise and proposes a model of costing products with allowance for variable costs investigated in terms of re-engineering internal business processes. It is established that when classifying costs by product types or cost carriers, cost grouping is carried out according to production volume. The American and French models of variable and fixed income financial statements are presented. There are some controversial issues when using margin calculations. The article deals with Bernoulli differential equation, which describes the economic process of formation of sales. Functional dependence of sales on variable sales costs is considered. The dependence of the marginal income of the enterprise on variable costs is also mathematically substantiated. The maximum value of the marginal income of the enterprise is found with the optimal value of the level of sales, which depends on the variable costs. It is shown that the rate of change in marginal revenue is inversely proportional to the difference between the average price of the nomenclature of products produced and its average cost. A differential equation system is considered, the solution of which is the optimal value of the sales function, which is related to the maximum value of the marginal revenue, depending on the variable costs of the sales function. The formula of profitability of the sales function from variable costs is deduced. It is shown that the optimal value of the sales function, which is achieved with the maximum value of the marginal revenue of the enterprise, can be obtained through a statistical study of the level of consumer demand, which determines the level of sales that the company could obtain in the case of approaching at additional variable costs, calculating the value of the maximum possible level sales of the enterprise, which depends on the market share in the field of market relations, as well as on the volume of production.

Keywords: re-engineering, variable costs, sales, profit margin, Bernoulli equation, sales profitability.

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I. INTRODUCTION

Today, enterprise reengineering requires modern methodological approaches for its implementation [11]. This leads to the revitalization of business processes in the enterprise, which leads to cost optimization and increased marginal revenue. At the same time, reengineering applies to all internal business processes of an enterprise operating in an innovative direction. In determining the profitability of an enterprise as an integral part of its financial condition, the first is the calculation of the volume and dynamics of profit, which is defined as the financial result of the enterprise and is formed by reducing the total income from the sale of products (goods, works, services) by the amount of production costs [1, 10]. The classification of costs is carried out on different grounds and is a prerequisite for the proper organization of planning, accounting and cost calculation of products, and also allows to use cost-effective ways of grouping costs in the practice of economic activity [2, 10, 11].

Costs are grouped according to their cost objectives. When classifying costs by product type or cost carrier, cost grouping is performed according to production volume. Accordingly, the costs of the enterprise are divided into variables (conditional variables) and fixed [3, 11]. Allocation of fixed and variable costs, along with their division into relevant and irrelevant, marginal and average, valid and possible, creates for the management of the enterprise a sufficiently comprehensive information base for making appropriate management decisions, implementation of production planning of the enterprise (production volume and pricing) [4, 5, 11].

Variable costs are costs that are directly proportional to the change in the capacity utilization rate or sales volume of the enterprise, but the proportion of which per unit of output remains unchanged [5, 6, 7, 11]. Depending on the degree of the ratio of variable costs and changes in output, the variable costs are divided into proportional, progressive and degressive. For the mathematical expression of this relationship, the cost response factor (K), which is determined by the formula, is used:

$$K = \frac{\% \text{Cost changes}}{\% \text{Changes in production volume}} \quad (1)$$

Depending on the value of the response coefficient of the cost of change in production, they are divided into: 1) constant ($K = 0$); 2) depressive ($0 < K < 1$); 3) proportional ($K = 1$); 4) progressive ($K > 1$).

Graphically, the dependence of cost behavior on changes in production volume can be represented as follows (Fig. 1):

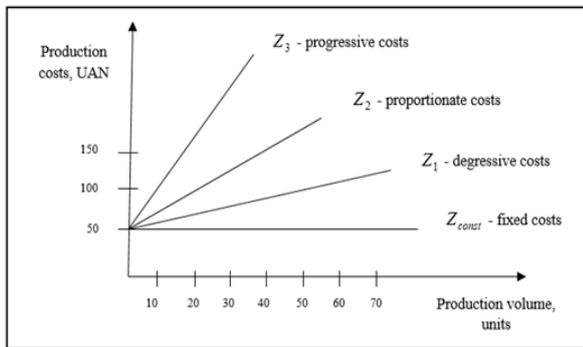


Fig. 1. The relationship between the cost and output of the enterprise

Source: Developed by author based on [2, 10]

It should be noted that the grouping of costs by elements is unchanged for enterprises of any industry, so it is a sound basis for the formation of financial and statistical reports on production costs. Despite its informative nature, the cost structure of an enterprise cannot fully meet the needs of management, such as obtaining information on costs by their intended purpose, place of origin, as well as determining the cost of certain types of products. In this regard, costs are grouped by costing items that can be set by the enterprise on its own, based on its accounting policies and individual features of technology and production organization [8, 14, 15].

The use of costing items allows an enterprise to determine the purpose of individual types of costs, calculate them by structural units, determine the dependence of their volume on the activities of each unit, etc. Thus, costing allows you to more objectively reflect costs depending on their place in the production process and the value in the enterprise.

The separation of costs into fixed and variable assumes that the variable costs of production include direct costs of raw materials, electricity, wages of employees of the enterprise, part of the variable costs of sales of goods and services, as these cost items change depending on changes in the volume of production. The composition and structure of variable costs depends on the nature and conditions of production, the ownership of the enterprise, the ratio of material and labor costs, etc. [9, 11]. The calculation of production costs by the elements of fixed and variable costs is carried out in accordance with the current legislation of Ukraine using cost-oriented methods as the basic economic category.

II. METHODOLOGY

In the practice of calculating the cost of production of an enterprise, there are two main approaches to accounting costs related to cost: the method of accounting for full costs and the method of accounting for incomplete costs. The full costing and costing method is quite effective, but it cannot be used to make short-term management decisions. In order to avoid the error of displaying all items of cost of production, methods of

accounting and costing of production at incomplete costs are used.

It is worth noting that the methods of costing based on variable costs only, unlike full costing methods, involves calculating the cost of sales on the basis of only variable costs and accordingly determines not the profit but the marginal revenue, which is a kind of contribution fixed costs of the enterprise and profit from them. Another important difference between incomplete costing is that it does not include both operating and fixed costs in the cost process.

One such method, based on the separation of costs into fixed and variable costs, costing only with variable costs, as well as the analysis of different levels of cost of production, is the method of direct costing. It is this method, like the rest, based on variable, direct costs, that sets the lower boundary of the selling price of the enterprise's products.

Direct-costing assumes that fixed costs are accounted for in separate accounts, depending on the direction of their use and are written off at the end of the reporting period to the account of the financial results of the enterprise. Thus, the direct-costing system directs the accounting of the enterprise to the process of sale of products, and its basic accounting principles correspond to the tasks of market analysis and determining its place of enterprise [8, 9, 10, 11, 12].

The practical significance of the results from the use of the direct-costing system is greatly increased due to the fact that when using this costing method, the statement of financial results contains at least two sections: the first reflects the profit margin (the difference between the income from sales of products and variable costs), the second - the operating profit (loss) of the enterprise (the difference between marginal revenue and fixed costs) [10, 11]. This approach to the calculation of the financial result of the enterprise makes it possible to calculate the profitability of production and sales of products.

III. RESULTS

Variable and fixed costs involve two financial reporting models: US and French. In Fig. 2 presents a block diagram of

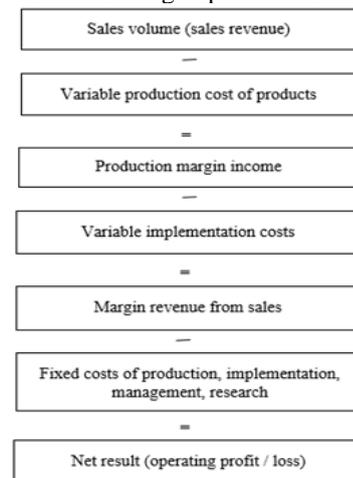


Fig. 2. The American model of determining the enterprise financial result



Source: Developed by author based on [4]
the American model of the main stages in determining the financial result.

The French model envisages such stages of enterprise net profit formation, which are presented in Fig. 3. Figures 2 and 3 suggest that the French net profit / loss model excludes a detailed description and division of variable costs into production and commercial costs and does not provide for the determination of production marginal revenue. In practice, the use of full costing is likely to make erroneous management decisions, as it is often felt that fixed costs behave as variables. However, the assumption that there is no reaction of all fixed costs to the decision-making process is rather conditional, ie it is acceptable only in the short term. Here are some issues when using margin calculus:

- 1) it is not always possible to accurately divide all enterprise costs into variables and fixed ones;
- 2) marginal costing is practically impossible to use when a small fraction of costs are variable (which is typical of modern industrial technologies) [7].

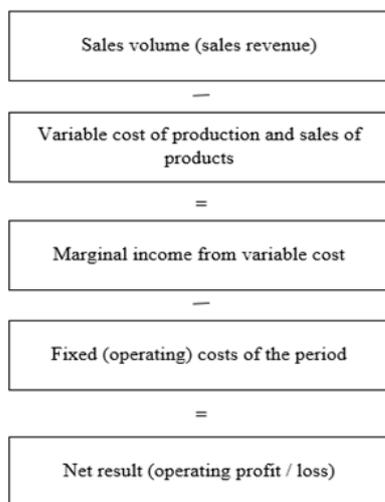


Fig. 3. The French model for determining the financial result of an enterprise

Source: Developed by author based on [7]

Therefore, the cost-effectiveness of implementing a direct costing system in Ukraine consists of its use in integrated accounting systems, ie the possibility of combining direct costing with the elements of national regulatory cost accounting and costing. The latter can significantly improve the process of controlling the costs of the enterprise and managing the cost of its products.

Consider the functional dependence $y(x)$ of sales y on the variable cost of sales x . Variable overhead costs include costs for maintenance and production management, which change almost directly in proportion to changes in production. Such expenses are written off at the end of the month for production cost.

In [6, 8, 9, 11] Bernoulli differential equation is described, which describes the economic process of sales formation:

$$\frac{y'}{y} = \frac{1}{v} \frac{y_M - y}{y_M}, \quad y(0) = y_0, \quad (2)$$

where y_M - the maximum possible sales;

$y(0) = y_0$ - initial level of sales;

v - the level of consumer demand, which sets the level of sales that the company could receive in the case of approaching y_M at additional variable costs.

Economically, this equation is the equilibrium between average sales and under-sales of the enterprise, which is adjusted by the level of consumer demand for the enterprise's products.

After the transformations, we find the solution of the Bernoulli differential equation (2) or the sales function of the enterprise depending on the variable costs in the following form [6, 8]:

$$y = \frac{y_M}{1 + ae^{-\frac{x}{v}}}, \quad a = \frac{y_M - y_0}{y_0} \quad (3)$$

Geometrically, the solution (3) is represented as a logistic curve (Fig. 4) [9,12]

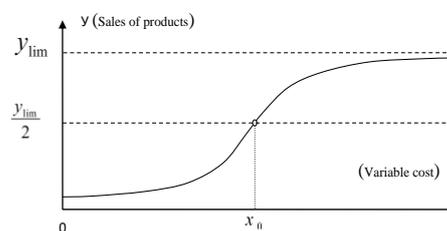


Fig. 4. Logistic curve of sales of enterprise products, depending on the variable costs

Source: Developed by author based on [8, 9, 10, 11]

Let us form the function of marginal income as the difference between the income from the sale of products and the variable costs of the enterprise - $R(x)$:

$$R(x) = (p_r - c)(y - y_0) - x, \quad (4)$$

where - p_r the cost of goods produced;

c - cost of production;

x - cost of variable costs of sales.

Note that sales costs include the following costs associated with the sale (sale) of finished goods, goods, works, services:

- 1) the cost of packaging materials in the warehouses of finished goods, repair of packaging;
- 2) remuneration and commissions to sellers, sales agents and employees of sales units;
- 3) marketing costs;
- 4) costs for pre-sale preparation of goods;
- 5) the cost of business travel for employees engaged in the sale of products;
- 6) costs of maintenance of fixed assets, other non-current tangible assets, related to the sale of products, goods, works, services (operating lease, insurance, depreciation, repair, heating, lighting, security);
- 7) costs for transportation, transshipment and insurance of finished goods, freight forwarding and other services related to transportation of products in accordance with the terms of the contract;
- 8) the cost of warranty repair and warranty service;
- 9) other costs associated with the sale of products, goods, works, services.

Note that in formula (4), the first addition expresses the income from the sale of products of the enterprise.

Find the maximum value of the marginal revenue of the enterprise with the optimal value of the level of sales in, which depends on the variable costs. To do this, we find the first derivative of the margin income function:

$$R'(x) = (p_r - c)y' - 1 = 0 \Rightarrow y' = \frac{1}{pr - c} \quad (5)$$

Thus, the rate of change in margin income is inversely proportional to the difference between the average price of the nomenclature of products produced and its average cost.

Let us write a system of differential equations, the solution of which is the optimal value of the function $y(x)$, which is associated with the maximum value of the marginal revenue, depending on the variable costs x of the sales function $y(x)$:

$$\begin{cases} \frac{y'}{y} = \frac{1}{v} \frac{y_M - y}{y_M} \\ y' = \frac{1}{pr - c} \end{cases} \quad (6)$$

We define the function of margin income in the form

$$R = (p_r - c)(y_{opt} - y_0) - x_{opt} \quad (7)$$

Therefore, the optimal value of sales of the enterprise with the maximum value of its profit margin will be described by the equation:

$$\frac{1}{(p_r - c)y} = \frac{1}{v} \frac{y_M - y}{y_M} \quad (8)$$

From here we have:

$$y^2 - y_M \cdot y + v \cdot \frac{y_M}{p_r - c} = 0 \quad (9)$$

The solutions of the equation are as follows

$$y_{1,2} = \frac{1}{2} (y_M \pm \sqrt{y_M^2 - v \cdot \frac{4y_M}{p_r - c}}) \quad (10)$$

Equations exist if the discriminant is positive and they determine the optimal values of the sales function $y(x)$ with the maximum value of the margin income. Thus, we have the optimum value of the sales function in the form

$$y_{opt} = \frac{1}{2} (y_M \pm \sqrt{y_M^2 - y_M \cdot \frac{4v}{p_r - c}}) \quad (11)$$

Divide left and right parts (11) by y_M , we have solutions of system (6) in dimensionless form:

$$\frac{y_{opt}}{y_M} = \frac{1}{2} (1 \pm \sqrt{1 - \frac{4v}{y_M(p_r - c)}}) \Rightarrow \frac{1 - \left(\frac{2y_{opt}}{y_M} - 1\right)}{4} = \frac{v}{y_M(p_r - c)}, \quad (12)$$

or

$$\frac{y_M(p_r - c)}{v} = \frac{4}{1 - \left(\frac{2y_{opt}}{y_M} - 1\right)^2} \quad (13)$$

On the other hand, the solution of the differential equation of system (6) is also true for optimal values:

$$y_{opt} = \frac{y_M}{1 + a \cdot e^{-\frac{x_{opt}}{v}}}, \quad a = \frac{y_M - y_0}{y_0} \quad (14)$$

From equation (14) we express x_{opt} through y_{opt} :

$$x_{opt} = v \ln \left(a \cdot \frac{y_{opt}}{y_M - y_{opt}} \right) \quad (15)$$

Rewrite the formula (15) in dimensionless form:

$$\frac{x_{opt}}{v} = \ln \left(a \cdot \frac{\frac{y_{opt}}{y_M}}{1 - \frac{y_{opt}}{y_M}} \right) \quad (16)$$

Determine the profitability of variable costs:

$$rent = \frac{R_{opt}}{x_{opt}} = \frac{(p_r - c)(y_{opt} - y_0)}{x_{opt}} - 1, \quad (17)$$

or, given (16), we rewrite formula (17) as:

$$rent = \frac{y_M(p_r - c)}{v} \frac{\left(\frac{y_{opt}}{y_M} - \frac{y_0}{y_M}\right)}{\ln \left(a \cdot \frac{\frac{y_{opt}}{y_M}}{1 - \frac{y_{opt}}{y_M}} \right)} - 1 \quad (18)$$

In formula (18) we substitute instead of the first factor of formula (13), we obtain:

$$rent = \frac{4}{1 - \left(2 \frac{y_{opt}}{y_M} - 1\right)^2} \frac{\left(\frac{y_{opt}}{y_M} - \frac{y_0}{y_M}\right)}{\ln \left(\left(1 - \frac{y_0}{y_M}\right) \frac{\frac{y_{opt}}{y_M}}{1 - \frac{y_{opt}}{y_M}} \right)} - 1 \quad (19)$$

Enter the notation:

$$x = \frac{y_{opt}}{y_M}, \quad y = \frac{y_0}{y_M} \quad (20)$$

Then formula (19) will look like:

$$rent = \frac{4}{1 - (2x - 1)^2} \frac{(x - y)}{\ln \left((1 - y) \frac{x}{1 - x} \right)} - 1 \quad (21)$$

or

$$rent = \frac{x - y}{(x - x^2) \ln \left(\frac{x(1 - y)}{1 - x} \right)} - 1 \quad (22)$$

Thus, formula (22) is a formula for the profitability of the sales function against variable costs.

Therefore, the optimum value of sales (7), which is achieved with the maximum value of the marginal revenue of the enterprise, can be obtained through a statistical study of the level of consumer demand, which determines the level of sales that the enterprise could obtain in the case of approaching y_M at additional variable costs, calculating the value of the maximum possible the level of sales of the enterprise, which depends on the market share in the field of market relations, as well as the volume of production. Therefore, the study requires an analysis of the average price of the product and its cost.



In fact, reengineering an enterprise's business processes enhances existing business processes to increase efficiency and flexibility.

Therefore, reengineering is an analysis of the current state of the enterprise. In this context, it is important to study the formation of marginal income of the enterprise and, from a mathematical point of view, the creation of an income function, depending on the variable costs of the enterprise. This makes it possible to improve the efficiency and excellence of work, which is consistent with the overall strategy of the company.

IV. RESULT

In today's environment, classic transactional marketing is no longer sufficient for any business to function successfully. Priority direction of the enterprise development is support of long-term, reliable communications with business partners, formation of the circle of loyal consumers and formation of marketing of relations [12, 13].

Modeling of priority directions of development of qualitative relations in vertical supply channels becomes of some importance and relevance. In order to achieve effective interaction between the two parties, the benefits of the partnership must be taken into account. In this context, a significant aspect of the interaction between the manufacturer and the intermediary as participants in the marketing channel is the interaction, which can be considered as:

- training of personnel, which helps to achieve high sales results;
- creation of a complex joint product with special financing conditions;
- production of joint advertising materials, joint mailings and PR-actions;
- participation in exhibitions and conferences.

Such business relationships are based on trust, convenience and promise. The result of this approach for marketing channel participants is:

- an opportunity to offer the retailer a real way of financing its activities, which is one of the competitive advantages in the conditions of intense struggle for the customer;
- increase of sales volume and expansion of the retailer of its customer base;
- receiving full and prompt payment for the goods being sold;
- expansion of the product line at the expense of quality financial product and various joint programs;
- reducing marketing and advertising costs through joint promotion with the manufacturer;
- reduction of the manufacturer's costs for the operation through the use of the developed scheme of interaction.

V. CONCLUSION

We emphasize that enterprises use business process reengineering to reduce costs by speeding up enterprise information flows. Through business process reengineering, the operation of an enterprise becomes more efficient and modern, leading not only to its efficiency but also to an increase in marginal revenue. Thus, the reengineering process is an effective tool for an enterprise operating in the field of market competitive relations for a successful long-term

enterprise development strategy.

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