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Methods for Determining Barrier Values of Economic Indicators

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Abstract: The article discusses the determination of barrier values of economic indicators. In the practice of financial and economic analysis, there is often a need to determine the barrier (threshold, critical, maximum permissible) value of a certain parameter. Therefore, examples of solving problems using the barrier or critical point method are considered. Shown by the barrier value of a parameter is meant its value, the excess of which leads to a positive or, conversely, negative final economic result within a certain production or financial system.

Key words: Break-even point, production volume, profit size, price of products, total cost, cost of manufactured products.

Introduction

The barrier value of a parameter is understood as its value, the excess of which leads to a positive or, conversely, negative final economic result which in a certain production or financial system. For example, if we are talking about determining the volume of production of a product, then its threshold value is the volume of output at which the profit received is zero. Exceeding this volume gives a profit, production in a smaller volume turns out to be unprofitable. Similar and many other problems similar in general formulation are solved using the barrier or break-even point method.

To begin with, let us consider the simplest and very conditional version of the static formulation of the problem, which is usually resorted to when explaining the essence of the method. Let it the necessary to find the threshold volume of production of one type of product, provided that all the quantitative dependencies necessary for the analysis are described by linear expressions, in other words, linear model.

To write such a model, we will accept the following notations:

Q-production volume;

F-constant production costs, costs that do not depend on the volume of output;

C-variable, or proportional costs (per unit of production);

p-unit price;

S-is the total amount of costs;

V-cost of manufactured products;

P-profit before taxes;

The variables Q, F, S, V, p

Are defined for the same time interval, usually one year.

First, let's find the cost of manufactured products and the corresponding amount of costs

$$V = pQ \quad (1)$$
$$S = F + cQ \quad (2)$$

We obtain the required critical production volume or barrier point based on the equality of the cost of manufactured products and amount of costs:

$$V = S$$

It is the equality of two dissimilar economic indicators, each of which is a function of one controlб that underlies the barrier point method.

Let's denote the barrier output as Q_k, then using (1) and (2) we get

$$pQ_k = cQ_k + F$$

Thus,

$$Q_k = \frac{F}{p-c} \quad (3)$$

As you can see, the higher the size of fixed and variable costs, the greater the critical production volume. Profit (before taxes) by definition will be

$$p = V - S = (p - c)Q - F \quad (4)$$

A graphic illustration of the problem statement and its solution is shown in Fig.1. The solution is located at the intersection point of two lines, one of which characterizes the dynamics of costs (S), the other-the change in income (V) as output increases. Production volumes that are less than the critical Q_k will lead to losses. Exceeding this volume dives profit. The higher the size of fined and variable costs, the greater the critical production volume.

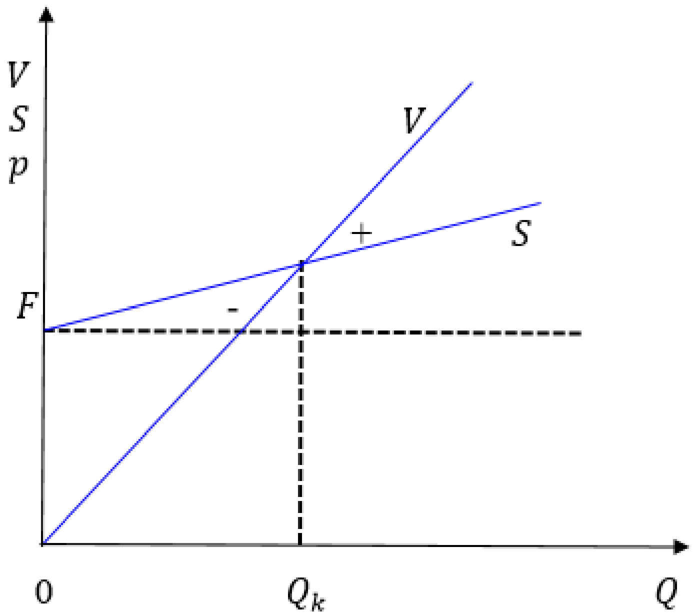

Fig.1.

Example - 1. Expected that $p = 100, c = 40, F = 120$

$$Q_k = \frac{120}{100-40} = 2, P = (100 - 40) \cdot 2\text{=}120$$

A graphical representation of the problem conditions and its solution is presented in Fig.2.

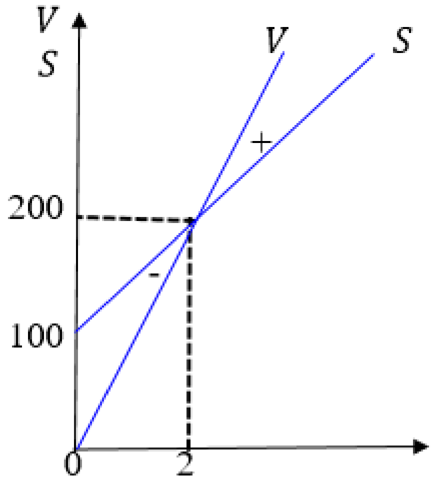

Fig.2.

The above allows us to formulate a general definition as a method of barrier value of a control variable based on the equality of two competing functions of this variable.

Barrier release of products

Let us limit ourselves to two of the possible formulations of the problem. To begin with, let the cost of production be a linear function of output, and the costs of production be described by a nonlinear, monotonically growing function. In other words, it is assumed that unit costs decrease as production scale increases, and the unit price does not change. This combination of costs and product costs is presented in Fig.3.

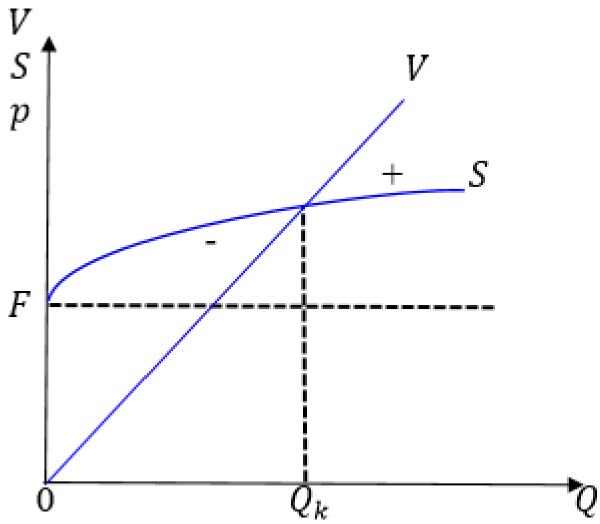

Fig.3.

$V = pQ, \quad S = F + cQ^{\alpha} \quad 0 < \alpha < 1$

The difference between competing functions at the barrier point is zero;

$pQ_k - cQ_k^{\alpha} - F = 0.$

The solution, us we see, comes down to finding the root of this equation.

Example - 2. Initial data: $F = 120, p = 100, c = 40, \alpha = 0{,}5$

Accordingly, we have

$100Q_k - 40Q_k^{0,5} - 120 = 0$ or

$5Q_k - 2Q_{10}^{0,5} - 6 = 0$

$Q_{10}^{0,5} = x$

$5x^2 - 2x - 6 = 0$

The positive root is 1,314.

Thus, $Q_k = 1{,}314^2 \approx 1.73$.

Let's move on to a combination of two nonlinear dependencies. For example, let both functions be parabolas of the second degree (Fig.4).

Then
$V = AQ^2 + BQ, S = CQ^2 + DQ + F$

Where A, B, C, D are parameters of the parabolas.

Profit depending on the level of output will be

$P = (A - C)Q^2 + (B - D)Q + F$ (5)

The barrier output volume is found as the root of the quadratic equation

$(A - C)Q_k^2 + (B - D)Q_k - F = 0$

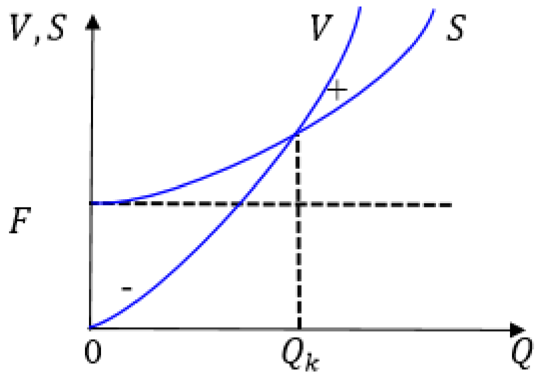

Fig.4.

Under certain conditions, it is possible to calculate the volume of output that maximizes the margin (we denote it as Q_m). To do this, as is known, it is enough to find the derivative of the profit function and equate it to zero. In the case when profit is described by expression (5), we find

$Q_m = \frac{D-B}{2(A-C)}$ (6)

As we ca see, the position of the maximum point is completely determined by the parameters of the corresponding parabolas. Moreover, the necessary condition for the existence of a maximum is the following relations: $D > B, A > C$. If $B > D$

and $A > C$ then profit grows monotonically with increasing output.

Barrier indicators in financial analysis

Let's start by solving a simple problem that illustrates the capabilities of the method in solving some problems of finance and credit.

Suppose it is necessary to choose one of two options for cash receipts, differing in amounts and terms: $S_1 > S_2, n_2 > n_1$(otherwise the task does not make economic sense)

It is logically justified to base the choice on a comparison of modern revenue values. Thus, the outcome of the choice depends on the expected market level of interest rates. The barrier in the problem under consideration is the rate at which both options turn out to be equivalent.

Let's consider a solution method for two options for calculating modern values using simple bet we have the following equality of modern values:

$\frac{S_1}{1+n_1 i_k} = \frac{S_2}{1+n_2 i_k}$ (7)

and for a complex let:

$S_1(1+i_k)^{-n_1} = S_2(1+i_k)^{-n_2}$ (8)

In both equalities, i_k means the value of the barrier rate. Having solved (7) for the desired rate, we obtain

$i_k = \frac{S_2 - S_1}{S_1 n_2 + S_2 n_1}$ (9)

The last expression implies a necessary condition for the existence of a barrier rate

$S_1 n_2 > S_2 n_1$ or $S_1 > S_2 \frac{n_1}{n_2}$

A graphical illustration of the solution is presented in Fig.5.

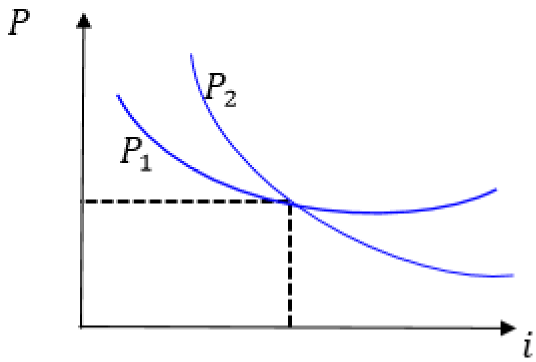

Fig.5.

As can be seen from the figure, if the expected rate level is less than the barrier rate, then option S_2 is preferable for the recipient of the money, but if the market rate is greater than the barrier rate, then the alternative option should be chosen.

Example - 3. Let's compare two payment options with parameters: $S_1 = 1{,}2; S_2 = 1{,}25$; $n_1 = 8$; $n_2 = 12$ (payment terms are indicated in months). Firs let's check: if $S_1 > 1{,}25 \cdot \frac{8}{12} \approx 0{,}83$, therefore, a solution exists. Next we get

$i_k = \frac{S_2 - S_1}{S_1 n_2 + S_2 n_1} = \frac{1{,}25-1{,}2}{1{,}2\cdot\frac{12}{12} - 1{,}25\cdot\frac{8}{12}} = \frac{0{,}05}{0{,}17} \approx 0{,}294$, or 29,4%

Thus, at a market rate that is less than 29,4%, a more distant payment is preferable for the money, all other things being equal. Let's move on to determining the barrier value of a complex bet. Based on (8) we find

$$(1+i_k)^{n_2-n_1} = \frac{S_2}{S_1},$$

where

$$ln(1+i_k) = \frac{ln\left(\frac{S_2}{S_1}\right)}{n_2 - n_1}$$

$$i_k = e^{\frac{ln\left(\frac{S_2}{S_1}\right)}{n_2-n_1}} - 1$$

Example - 4. There are two options for payment for goods upon delivery. Cost and delivery time: $S_1 = 1$; $S_2 = 1{,}5$; $n_1 = 1$; $n_2 = 2{,}4$ (terms are measured in years). The buyer needs to choose the purchase option, provided that the period is not decisive, in other words, he should focus only on the amount of payments. We find the value of the barrier rate at which the discounted costs will be the same:

$$ln(1+i_k) = \frac{ln\left(\frac{S_2}{S_1}\right)}{n_2 - n_1} = \frac{ln1{,}5}{1{,}4} \approx 0{,}2893$$

$$1 + i_k = e^{0{,}2893}, i_k = 0{,}335$$

Barrier points of release-financial approach to their determination

Let's imagine that a project is being developed to create an enterprise for the production of some new type of product. Product output is planned for "n"

Years in equal volumes per year. As for costs, their division into constant and variable, proportional to production output, is maintained. Current costs and revenues from product soles can be represented in the form of payment flows. Here, two competing approaches to determining barrier output are possible.

In the first, which will conventionally call accounting, investments are not taken into account directly; they are taken into account through depreciation charges. In the second, financial approach, investments play a key role-they act as an independent factor-while depreciation is not taken into account in current expenses. As we can see, both methods avoid double counting in relation to investment costs.

Both methods are used in practice, but they give different results. Let's start with the accounting approach, according to which it is necessary to determine the minimum volume of output at which the costs will pay off. Let's find the profit margin for a particular year:

$$P = pQ - (f + d + cQ) \ (10)$$

Where p and c have the same meaning as above, $f -$ is the fixed costs for the year, $d -$ is the amount of depreciation write-offs for the same period ($d = const$).

Let PV be the operator for determining the modern value of the corresponding flow of payments. The modern value of the flow of variable and fixed costs, which includes depreciation charges, in this case will be:

$$PV(f + d + cQ) = (f + d + cQ)V^{0,5} + \cdots + (f + d + cQ)V^{t-0,5} =$$

$$= (f + d + cQ)a_{n;i}(1 + i)^{0,5} \ (11)$$

where

$$a_{n;i} = \frac{1 - (1+i)^{-n}}{i}, V = (1+i)^{-1}$$

In turn, the modern cost of receipts is found as

$$PV(pQ) = pQV^{0,5} + pQV^{1,5} + \cdots + pQV^{n-0,5} = pQa_{n;i}(1+i)^{0,5} \ (12)$$

From equality

$$(f + d + cQ_k)a_{n;i}(1+i)^{0,5} = pQ_k a_{n;i}(1+i)^{0,5}$$

from here

$$Q_k = \frac{f + d}{p - c}$$

Let us now assume that all specific characteristics involved in the calculation change over time, i.e. instead of p, c, f, d we have p_t, c_t, f_t, d_t. Variable parameters are probably more adequate to reality.

Conclusion

Note that until recently the barrier point method was used, so to speak statically. Economic indicators were considered within one, relatively short period. Recently, this method has been extended to payment flows covering a number of consecutive time intervals. In these cases, with the help of discounting, the most important factor began to be taken into account-time (namely, the timing of investment and the timing of return on investment). The article discusses the simplest and very conditional version of the static formulation of the problem, which is usually resorted to when explaining the essence of the method.

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