OPERATIONAL (ECONOMIC) RISK

T. PĂZITOR, Transilvania University of Braşov, traian_c2005@yahoo.com

Abstract: The paper deals with the economic risk. The phrase economic risk is the expression of profit variability as compared to the mean return of the last financial years under pressure from economic and social conditions.
The financial diagnosis of risk is concerned with the measurement of the variability in the results of the company upon modification of the volume of activity of the company (turnover and structure of its fixed and variable expenditure), and modification of the structure of (equity and borrowed) capital and the variability in the solvency and capacity of the company to honour, when due, its obligations towards third parties.
In conclusion, the economic risk is nothing else than the expression of the incapacity of the company to timely adapt, at the smallest cost and with the least effort, to the variations in the economic climate.

Key words: operation risk, breakeven, result, effect.

1. CONTENTS OF THE ECONOMIC (OPERATIONAL) RISK

In a broad sense, the phrase economic risk is the expression of profit variability as compared to the mean return of the last financial years under pressure from economic and social conditions.
Given that return analysis and risk analysis are two interdependent aspects, return can only be assessed against the risk carried by the return-generating activities. Such risk affects the return of the economic assets in the first place and of the invested capital in the second place. Therefore, it can be approached both from the perspective of the company, in its capacity of organizer of the production process driven by an intention to increase the holdings of the owners and properly remunerate the production factors, and from the perspective of foreign financial investors, interested in making the best investment on a financial market comprising several return sectors and various risk degrees.

The financial diagnosis of risk is concerned with the measurement of the variability in the results of the company upon modification of the volume of activity of the company (turnover and structure of its fixed and variable expenditure), and modification of the structure of (equity and borrowed) capital and the variability in the solvency and capacity of the company to honour, when due, its obligations towards third parties. Considered as a whole, the activities of any company, irrespective of their nature, entail three risks derived from the following aspects:
- operation (economic)
- financing (financial)
- bankruptcy

The situation of the company shall be rated positive if, from its financial diagnosis it follows that the return is such as to cover the risks taken by the investors (shareholders and lenders) through the allocation of their capitals to the assets of the company.
Succinctly defined as profit sensitivity, the economic (operational) risk represents the potential losses the holdings, interests and entrepreneurial activity are exposed to, entailed by force majeure circumstances (such as acts of God, damage, and the like) and the incapacity of the company to adapt in time and at the smallest cost to background variations (e.g. increase in energy price, wage increases, competition, technological changes).

The economic risk provides a forecast and assessment of the possibility of an inefficient result or even of losses. After all, the economic risk is nothing else than the expression of the incapacity of the company to timely adapt, at the smallest cost and with the least effort, to the variations in the economic climate.
When it comes to projects, the operational risk is the expression of the vulnerability of the project to conjectural modifications of its circumstances and hypotheses, brought about by technical advances, market uncertainty, and social and political instability (crises, unemployment, strikes, etc.) throughout the operational period.

2. OPERATIONAL RISK ANALYSIS METHODS

2.1.Break-even analysis

Risk does not depend only on general factors (sale price, cost, and turnover) but also on the structure of costs, and their behaviour against the volume of activity, respectively. The structure of expenses, and especially the sharing out into fixed expenses and variable expenses depending on the turnover, exercises an essential impact on return. All this information regarding expenses and income can be aggregated into a model enabling the identification of the particular level of production at which profit is zero and wherefrom the activity of the company becomes profitable. Such point is called break-even point or critical point.

A critical point is that level of production / activity pertaining to a fiscal year, where operating costs are equal to takings.

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It is calculated as physical or value units (break-even point) and can be completed with a more efficient concept: flexibility.

Irrespective of the calculation modality, production expenses must be broken down as variable (proportional to the volume of activity) and fixed, element which makes the analysis more difficult, since no such classification can be found in the accounting documents.

Variable expenses are directly proportional to the production level and generally refer to: raw materials and direct materials, wages of the directly productive personnel, etc.

Fixed expenses are independent of the level of the activity, are made to ensure a normal running of the company, being paid even in the absence of a turnover (water, electricity, upkeep, administrative staff, amortization expenses etc.). This classification needs considering from a temporal perspective, as in the long term all expenses are deemed variable and only in the short term part of them are variable and part fixed.

The operational risk is especially dependent on the amount of fixed expenses, the same amount of fixed expenses being much better absorbed by a higher turnover. The importance of the fixed expenses cannot be assessed and expressed as an absolute value, but only against the margin generated by the company, as there are sectors, such as that of services, where the „turnover / purchase" ratio is very high, therefore fixed expenses are much more easily absorbed through the turnover.

The critical point analysis (break-even point, standstill, balance point) features differentiations in the case of mono-productive companies as compared to companies manufacturing a varied range of products.

For mono-productive companies, the break-even point is determined on the basis of two hypotheses, namely:

- a unit variable cost (v) constant against the increase in the volume of production. This means that, irrespective of the physical volume of sold production (Q), variable expenses per product unit are constant but the total volume of the same varies instead (VE)
  VE = v x Q
- the hypothesis of constancy of the unit sale price (p) irrespective of the volume of sold physical products (Q). In other words, the market absorbs the entire production at the same price:
- T = p x Q

Based on these hypotheses, the linear break-even point represents the physical volume of the sold production covering the overall expenses (fixed expenses + variable expenses), and the operational result is null, being calculated by the following formula:

$$Q_{BP} = \frac{FE}{p - v} \quad (1)$$

where:

Q_{BP} = physical volume of the production sold to reach the break-even point (BP);

p – v = unit margin over variable expenses (M_{VE}) or the gross margin accrued on product unit

$$Q_{BP} = \frac{FE}{M_{VE}} \quad (2)$$

The graphic representation of the break-even point in the case of mono-productive companies is shown in figure 1.1.

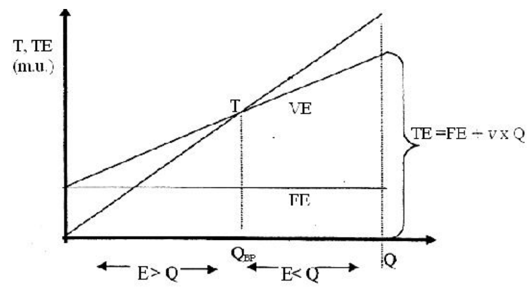

Fig. 1.1. Linear critical point

The graph in figure 1.1. gives the manager the possibility to analyze profit stability. The following conclusions are reached:

- In Q_{BP} the company has neither profit nor loss. The closer the company is to its critical point, the higher the instability of profit. When the activity level expressed by the turnover (T) is close to the critical point, a small variation in the turnover brings about a high variation in profit.
- When Q< Q_{BP} costs exceed the turnover, and the company is working at a loss.
- When Q > Q_{BP} costs are being compensated by a turnover sufficiently high as to yield profit. The higher the production (Q) is as compared to this critical point, the more profit shall increase including the gross unit margins related to additional sales (fixed expenses are have already been absorbed by the sales achieved up to the zero point).

In order to determine the break-even point as value units, in the case of mono-productive companies the break-even point expressed as physical units (Q_{BP}) is multiplied by the unit sale price (p) according to the following formula:

$$p \text{ x } Q_{BP} = \frac{FE}{M_{VE}} \text{ x } p$$
$$T_{BP} = Q_{BP} \text{ x } p \quad (3)$$

where: p – sale price

T_{BP} – turnover corresponding to the break- even point

M_{VE} = p – v (margin of the unit variable cost).

For the units manufacturing and marketing a varied range of products, the value break-even point for the entire activity of the company, established on the basis of the profit and loss account, features the following pattern:

$$T_{BP} = \frac{FE \text{ (absolute)}}{rv} \quad (4)$$

where rv – the weight of variable expenses in the turnover (rv = VE/T)

2.2. Methods based on the break-even point pattern

The assessment of the operational risk starting from the break-even point pattern can be achieved by three methods:

- on the basis of the degree of exploitation of the production capacity corresponding to the critical point, which directly expresses the operational risk (R_{BP}):

$$R_{BP} = \frac{T_{BP}}{T_{real}} \times 100 \qquad (5)$$

The higher this ratio is, the higher the risk, and vice versa.

- based on the security index (I_S), which highlights the security margin of the company:

$$I_S = \frac{T_{real} - T_{BP}}{T_{real}} \qquad (6)$$

The higher the index, the higher the security margin of the company and a high I_S indicates a low operational risk.

- through an indicator of the position to the break-even point:

$$\alpha = T_{real} - T_{BP} \text{ or } \alpha' = \frac{T_{real} - T_{BP}}{T_{BP}} \qquad (7)$$

where

α - absolute position to the break-even point

α' – volatility coefficient.

The absolute position (α) also known as absolute flexibility is indicative of the ability of the company to adapt its production to market demand. It is desirable that this indicator be as high as possible, in order to point out a high flexibility of the company, and a low operational risk, respectively.

The relative position indicator (α'), also called volatility coefficient, has high values when there is a minimum risk. It has the same informational value as the absolute flexibility.

Based on statistical research, it was concluded that, depending on the position of turnover to the critical point, we can be talking about the following states characteristic of a company:

- the unstable state determined by situations when the turnover is situated by up to 10% above the break-even point.
- the relatively stable state, determined by situations when the turnover is by 10-20 % higher than the break-even point
- the comfortable state, determined by situations when the turnover is by more than 20 % higher than the break-even point.

The above discussion on the break-even analysis was based on simple equations and graphs with rectilinear representations, which involves the following premises: (1) prices are constant; and (2) once the fixed costs are established, the unit variable costs are also constant. These hypotheses are often reasonable for companies with a well-established position on the market and mature markets, but they do not generally apply to newly-established small business, created to place on the market new goods or services.

If we adopt the idea of non-linearity between variable expenses and turnover, it will be observed that there are several break-even points. In such cases, a non-linear analysis of the break-even point is required.

This non-linear variation in production costs and sales determines two critical points (figure 1.2). In the non-linear pattern presented hereinafter, the sale price can have a decreasing evolution as compared to the turnover, the increase in the volume of sales being achieved through increasingly discounts. The variation in turnover determines a decrease in expenses over the first segment of the variation interval (BP1, BP2) and a marked increase over its last segment.

Under these circumstances, two break-even points shall result (BP1 and BP2). Between the two critical points, it is obvious that the activity of the company is profitable. It is estimated that the highest return is obtained when the turnover (Q_{opt}) is situated in a point where the marginal cost is equal to the marginal income. In the graph, the gradient of the curve of total costs (tg α) corresponds to the marginal cost, and that of the total income measures the marginal income.

The marginal cost is the expression of the increase in the total cost required to obtain the last product, or series of products.

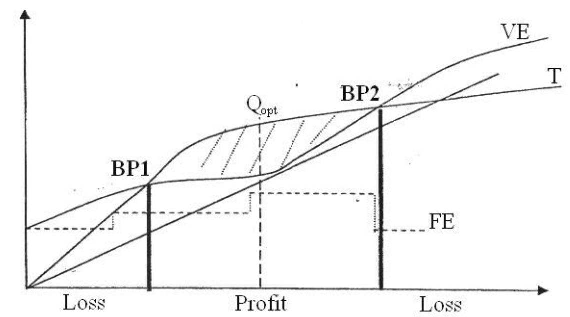

Fig. 1.2. Non-linear critical point

The gradient of the total cost curve, representing the derivative of the production cost function against production, corresponds to the marginal cost (C_m):

$$C_m = \frac{dTC}{dQ} \qquad (8)$$

However, there is not only a marginal cost which corresponds to each production unit, but also a marginal cost and a marginal income obtained from the sale of the last production unit. The marginal income (V_m), being a derivative of total takings (T) against sold quantity, measures the gradient of the total income curve.

$$V_m = \frac{dT}{dQ} \qquad (9)$$

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When the two gradients become identical, the deviation between the two curves shall be maximal and the total profit (P_t) shall reach the maximum value in point Q_{opt}. The total profit can be calculated by the following formula:

$$P_t = T \text{ corresp. } Q_{opt} – TC \text{ corresp. } Q_{opt}$$

The analysis of the linear break-even point provides interesting management information from the perspective of economic calculation, but less pertinent under the aspect of the economic reality, considering that it supposes a limited demand at a fixed price and also constant return, and the horizon it considers is short and does not generate modifications in the structure of production.

Despite all these limitations, the break-even point calculation can be used by the company management for the following reasons: it provides information on the minimum level of activity required to obtain profit; it is an useful instrument in decision-making related to investments for new products, and investments of the modernization or extension of the company; it offers explanations regarding the deviations between forecasts and achievements.

2.3.Sensitivity of the result in relation to the activity level

The measure of the risk is given not only by the distance to the critical point, but also by the rapidity in reaching the critical point which is pointed out by the operational leverage, which is a component of the global risk.

The global risk of the company is an expression of the sensitivity of the net result (operating profit) in relation to turnover and is expressed as a global flexibility coefficient CF_g (also called Degree of Combined Leverage: DCL), interpreted as the product of other three coefficients:

$$CF_g = \frac{\frac{\Delta R_n}{R_{n0}}}{\frac{\Delta T}{T_0}} = \frac{\frac{\Delta R_n}{R_{n0}}}{\frac{\Delta R_i}{R_{i0}}} \text{ x } \frac{\frac{\Delta R_i}{R_{i0}}}{\frac{\Delta R_e}{R_{e0}}} \text{ x } \frac{\frac{\Delta R_e}{R_{e0}}}{\frac{\Delta T}{T_0}} = CF_3 \text{ x } CF_2 \text{ x } CF_1 \quad (10)$$

To this effect, the following mode of formation of the net result is considered:

Turnover:

- Operating expenses (fixed and variable)

= Operating result (R_e)

- Financial expenses

= Current result before tax (R_i)

- Income tax

= Net result (R_n).

The flexibility coefficient ((CF_1) also called operating leverage coefficient (degree) (DOL) measures the sensitivity of the operating result to the variation in turnover, and is based on the classification of company expenses into fixed (or structural) and variable (or operational).

$$\text{a) } DOL = \frac{\Delta R_e / R_{e0}}{\Delta T / T_0} \quad (11)$$

$$\text{b) } DOL = \frac{T}{T - T_{BP}} \quad (12)$$

A smaller DOL indicates the fact that the activity of the company is less risky. The higher DOL than 1, the more profit yielding is the increase in turnover, and the activity riskier. According to the cost-volume-profit analysis, DOL can be determined depending on the margin on variable expenses (M_{VE}) and the volume of activity (Q):

$$\text{c) } DOL = \frac{M_{VE}}{R_e} = \frac{T - VC}{T - VC - FC} \quad (13)$$

The flexibility coefficient CF_2, also called Degree of Financial Leverage (DFL), is the expression of the sensitivity of the current result before deduction of the income tax (R_i) to a prior modification of the operating result (R_e).

$$DFL = \frac{R_e}{R_e - E_{fin}} = \frac{\Delta R_i / R_i}{\Delta R_e / R_e} \quad (14)$$

where $R_i = R_e - E_{fin}$, and $\Delta R_i = \Delta R_e$.

The flexibility coefficient CF_3 measures the sensitivity of the net result (R_n) to the variation in the current result before tax (R_i).

$$CF_3 = \frac{\frac{\Delta R_n}{R_n}}{\frac{\Delta R_i}{R_i}} = \frac{\frac{\Delta R_i (1 - i)}{R_i (1 - i)}}{\frac{\Delta R_i}{R_i}} = \frac{\Delta R_i (1 - i)}{R_i (1 - i)} \text{ x } \frac{R_i}{\Delta R_i} = 1 \quad (15)$$

where i = income tax rate.

It can be observed that CF_3 has no impact on the coefficient of global flexibility. Given that CF_3 = 1, the combined leverage degree (DCL), reflects the accounting measure of the global risk, and appears as a combination of the operating leverage with the financial leverage.

DCL = DFL x DOL.

By taking into account financial expenses, which at a given activity level are deemed fixed, it is possible to determine a global break-even point enabling an analysis of the financial risk

3. PRACTICAL WORK

3.1. Risk analysis based on a non-linear break-even point

Waste Containers Incorporated (WCI) is a company created in 1989 having as object of activity the design and manufacture of cylindrical containers used to the storage of dangerous biological residues in hospitals, clinics and medical practices in Toronto Region. Mary Puffer, founder and chairman of the board of directors of WCI, realized since the beginning of the 1980s that human tissues containing cancerous cells, materials contaminated through infections diseases and other specific hospital waste represented a more and more acute problem. With financial support from a few doctors, members of the teaching staff of the University of Toronto and the staff of various hospitals, Puffer started to experiment a new

system of collection and storage of this waste, which consisted of a cylindrical container in which the waste was placed together with an acid solution and then sealed. In 1991, Puffer perfected the cylindrical containers, tested them for leakage and storage efficiency, patented them and secured from the competent authorities of the province the approval to use the same.
The problem she and those who provided her with financial support were faced with was the devising of the best production plan and marketing strategies.
First, Puffer realized that the waste domain was a highly competitive sector, that their patented system was more efficient for some clients and less efficient for others, and that any of the clients would buy more cylinders if these were sold at a smaller price. She also realized that if the price remained constant, the total income would linearly increase with the increase in production (in which case the representation of the break-even point would be linear). However, if a smaller price per product unit is necessary in order to sell a higher number of products, p should decrease with the increase in Q, wherefrom a curvilinear graph of total income would result.
Puffer also reached the conclusion that unit variable costs would not remain constant. First, if only a few pieces of the respective product are manufactured, the workers will not be efficient, as they lack experience, there would be no discounts on the purchase price of raw materials on account of the small quantities purchased, and so on and so forth. Thus, as production would increase from the lowest level, costs would decrease. In other words, there would be scale saving. On the other hand, should it come to very large volumes of production, it would be necessary to hire new workers, inefficient considering their lack of experience, the activity would have to be organized in two or three shifts, overtime would have to be paid and the equipment would be exploited at such a rate that there would be frequent breakdowns and repairs would be expensive. Thus, beyond a certain point in production, costs will start to increase at a rapid pace and there would be scale non-saving. Considering the circumstances, WCI prepared two production and marketing strategies (Tables 1.1. and 1.2.):
Plan A: start from relatively low fixed costs (an initial capital of 2 million dollars), and relatively high variable unit costs, for any level of the production volume.

Table 1.1. Plan A (Low operating leverage)

Units	Unit price (USD)	Total income	Variable unit cost	Total variable costs	Fixed costs	Total costs	Profit
0	13,20	0	0,00	0	100	100	-100
25	10,00	250	10,00	250	100	350	-100
50	9,00	450	7,00	350	100	450	0
75	8,00	600	5,33	400	100	500	100
100	7,20	720	5,00	500	100	600	120
125	6,40	800	4,92	615	100	715	85
150	5,85	878	5,27	791	100	891	-13
175	5,40	945	6,00	1050	100	1150	-205
200	4,90	980	7,50	1500	100	1600	-620

Plan B started from higher fixed costs (5 million dollars), and lower unit variable costs determined by the high degree of technological equipment enabled by the initial investment.

The total income curve is the same for both plans, as clients generally do not care how the respective containers are being manufactured, as long as they comply with the high quality specifications.

Table 1.2. Plan B (High operating leverage)

Units	Unit price (USD)	Total income	Variable unit cost	Total variable costs	Fixed costs	Total costs	Profit
0	13,20	0	0,00	0	200	200	-200
25	10,00	250	12,50	300	200	500	-250
50	9,00	450	7,50	375	200	575	-125
75	8,00	600	5,73	430	200	630	-30
100	7,20	720	4,60	460	200	660	60
125	6,40	800	3,92	490	200	690	110
150	5,85	878	3,53	530	200	730	148
175	5,40	945	3,54	620	200	820	125
200	4,90	980	3,70	740	200	940	40

When Puffer represented graphically all these factors, she obtained an S-shaped curve of total costs, as shown in figure 1.3 (Plan A) and figure 1.4 (Plan B), respectively.

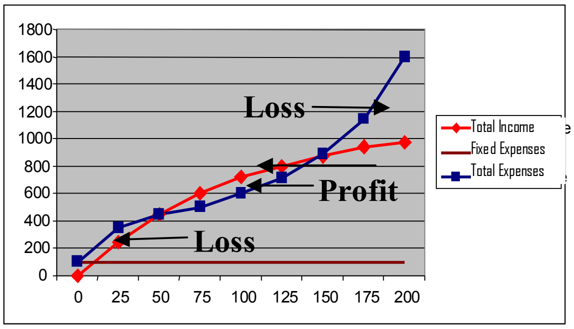

Fig. 1.3 Plan A

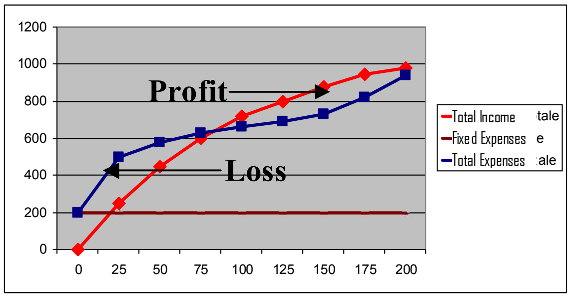

Fig. 1.4. Plan B

Which plan was the best?

Plan A, which featured a low degree of operating leverage, featured a break-even point at a lower level than that of plan B (50.000 units as compared to 82.500 units). Moreover, plan A would have required a production capital of only 2 million dollars, while plan B would require 5 million dollars to the same effect. However, plan B would yield a higher profit than A, namely USD 148.000 $ as compared to USD 120.000, in the production volume point yielding maximum profit. The return rate of the invested capital would have been mainly the same for both plans, again considered from the perspective of the production volume point yielding maximum profit.

During the first meeting of Puffer with the members of the board of directors of WCI, most of them were in favour of plan A, mainly because they felt it presented a smaller degree of risk due to a low break-even point.
One of the members of the board of directors asked if Puffer could lay sets of probabilities for various sales

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(expressed as products units) as if that was feasible, then it would be possible to calculate the profits forecasted for each of the two plans. Anyway, it turned out that Puffer was not convinced that it was possible to apply, in that case, a distribution of probabilities, on account of the variation in the price of sale with the number of sold units. It was agreed that the best estimate of the profits for each level of sales income were the values entered in the column headed Profit in tables 1.1 and 1.2. At that point, everybody agreed that plan A was the best and that it should be adopted.

At the end of the meeting, Puffer mentioned rumour had it that Retrot Industries (RI), a national-scale company and the leading manufacturer of medical waste collection and storage system planned to penetrate the market of cylindrical containers, but that if WCI started the production, RI could be prevented from entering said market.

If WCI had implemented plan A, it would have manufactured 100.000 cylindrical containers and would have sold them at a price of USD 7,20 a piece. But this would have given RI the chance to enter the market, build up a type B manufacture capacity, and subsequently set a market price of $ 5,85 or $ 4,90 a piece. WCI would have had to come up with a reaction to this price. At that point, the total demand would have been of 200.000 units, and it was supposed that such demand would have been equally satisfied by WCI and RI (therefore they would have supplied 100.000 units each time). Under these circumstances, the situation of WCI would be as follows:

- total income from 100.000 units x $ 4,90 / unit = $ 490.000 and
- total costs for 100.000 units x $ 5,00 / unit + $ 100.000 = $ 600.000.

It appears that actually it would have sustained a loss of $ 100.000.

We must also point out that WCI would not have covered even its variable costs, in which case it would have been better to shut the factory to limit the losses to $ 100.000.

RI, on the other hand, would have sustained losses, but it would have at least covered its variable costs, so it would have continued to manufacture. If WCI had shut the factory, RI would have cornered the whole market and could have increase the prices, manufacture more and make considerable profit

It thus became obvious that under such circumstances, the greatest danger was to opt for building a small manufacturing capacity with high variable costs, as this strategy would have permitted another company to penetrate the market, build a higher and more efficient manufacturing capacity, set a lower price for the same type of product and thus take WCI out of the respective market.

3.2. Assessment of the operational risk based on the degree of operating leverage

Three companies are manufacturing the same type of product sold at the same price (p) of EUR 1000. Company A owns a small percentage of automated equipment, wherefrom it results a low level of fixed expenses. Company B employs automated equipment in an average proportion, and company C is highly automated. The fixed expenses (FE) and variable cost (v) corresponding to each company are set forth in table 1.3.

Table 1.3.

	Company A	Company B	Company C
FE (thousand euros)	30.000	60.000	90.000
v (euros/piece)	2.250	1.800	1.500

Requirements:

1. Calculate the critical point and the degree of operating leverage – DOL for the variation in sales from 100.000 to 200.000 pieces;
2. Analyze the risk associated to each company, by explaining the values corresponding to the two indicators.

Solution:

Table 1.4 presents the results of the calculation of the total expenses and income corresponding to the quantity of 20.000, 100.000 and 200.000 product pieces.

Table 1.4.

Q	TE = FE + v*Q (thousand euros)			TI = Q*v (thousand euros)		
	A	B	C	A	B	C
20.000	75.000	96.000	120.000	60.000	60.000	60.000
100.000	255.000	240.000	240.000	300.000	300.000	300.000
200.000	480.000	420.000	390.000	600.000	600.000	600.000

Based on the total income and expenses, the operating result and the average unit costs were determined (according to table 1.5).

Table 1.5.

Q	Ores = TI – TE (thousand euros)			Average unit cost = TE/Q (thousand euros)		
	A	B	C	A	B	C
20.000	-15.000	-36.000	-60.000	3750	4800	6000
100.000	45.000	60.000	60.000	2550	2400	2400
200.000	120.000	180.000	210.000	2400	2100	1950

Using the calculation formulae of the critical point (expressed in physical units) and those of the DOL, the values in table 1.6 are obtained.

$$Qcrt = \frac{FE}{p - v} \qquad DOL = \frac{\Delta R_e / R_e}{\Delta T / T} \tag{16}$$

Example for company A:

$$Qcrt.A = \frac{30.000.000}{3.000 - 2.250} = 40.000 \text{ pieces}$$

$$DOL_A = \frac{(120.000 - 45.000)}{45.000} : \frac{(600.000 - 300.000)}{300.000} = 1,67$$

The results corresponding to the three analyzed companies are set forth in Table 1.6.

Table 1.6.

		A	B	C
Qcrt.	Pieces	40.000	50.000	60.000
DOL		1,67	2,00	2,50

From the perspective of the critical point, the higher it is, the riskier the position of the company, (company C, followed by B and A). A smaller DOL is indicative of the fact that the activity of the company is less risky, company A, in our case.

The higher DOL than 1, the more profit yielding is the increase in turnover, and the activity riskier. This is the case of company C. Thus, for company C, a 20% increase in sales entails an increase by 2,5 * 20 % = 50 % of the operating result.

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