Strategies based on the quantitative global analysis of the concurrent position function

Strategii bazate pe analiza cantitativă globală a funcţiei de poziţie concurenţială

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Abstract

The paper shows an original model describing in mathematical language the way in which the concurrent position of the product considered varies in time [0,T]. The model starts from Arthur D. Little model consisting of a qualitative analysis of the various activities of the company depending on the maturity of the business scope and the position among the competitors of the company in its business scope.

Keywords: *concurrent position, illusory area, unacceptable area, natural development area*

Rezumat

În lucrare se prezintă un model original care descrie în limbaj matematic modul în care variază în timp poziţia concurenţială a produsului considerat pe intervalul de timp [0,T]. Modelul porneşte de la o modelul Arthur D.Little care constă într-o analiză calitativă a diverselor activităţi ale firmei în funcţie de maturitatea domeniului de activitate şi poziţia concurenţială a firmei în domeniul ei de activitate..

Cuvinte-cheie: *poziţie concurenţială, zonă iluzorie, zonă innaceptabilă, zonă de dezvoltare naturală*

JEL Classification: C65, M21

Arthur D. Little (ADL) model shows a qualitative analysis of the various activities of the company depending on the maturity of the business scope and the position among the competitors of the company in its business scope. The problem, which occurs is how to describe in mathematical language at least the way one of these characteristics generically called y (t), varies in time. To be more specific, we have chosen *y (t)* as being the concurrent position of the company during the period of launching and then during the period of producing currently a single product. The knowledge of the variation of the function *y (t)* helps very much the strategy of the management of the company during a later period or during the period under discussion.

If we think the investments are a function of time, *I (t),* we will be able to change "in real time" the way of their direction, so that during certain periods they are accelerated (for example, reaching the maturity) or delayed (for example, the period of natural decline of the concurrent position leading to the need of changing radically the technological parameters of the product in cause).

We will call lifetime of a product of the company the period of time elapsed between its launch on the market (we will always consider the same market on which several economic units operate producing the same type of products) until the moment were the concurrent position becomes "weak".

We will consider the time represented on the axis of the x-coordinate and the concurrent position on the axis of the y-coordinate.

We will mean by the concurrent position *y (t)* a numerical quantity depending on time t, which reflects the position our company ranks on a scale were the lowest value corresponds to the value of that quantity for the "weakest" company operating on the market given and the highest value corresponds to the value of that quantity for the strongest company operating on the same market.

We will divide the lifetime of a product $[0,T]$ researched in four sub-periods:

1) period of starting, $[0,T_0]$, (here $0=T_{-1}$ by definition)
2) period of increase, $[T_0,T_1]$,
3) period of maturity $[T_1,T_2]$,
4) period of decline $[T_2,T]$, (here $T=T_3$, by definition) (see Fig. 1)

On the axis of the concurrent position we will delimit 5 subintervals:

i) marginal concurrent position $[0,C_1]$, (here $0=C_0$ by definition)
ii) weak concurrent position $[C_1, C_2]$,
iii) favorable concurrent position $[C_2, C_3]$,
iv) strong concurrent position $[C_3, C_4]$,
v) dominant concurrent position $[C_4, C_5]$, (see Fig.1)

Numbers T_0, T_1, T_2, T and C_1, C_2, C_3, C_4, C_5 are fixed by the management of the company depending on numerous objective or subjective factors upon which we will not insist here.

A large rectangle appears in fig. 1, $[0,T]\times[0,C_2]$ hereinafter referred as *compared domain of existence* of the product which "survives" on the competition market. This large rectangle is divided at its turn in 20 sub-rectangles $[T_{i-1},T_i]\times[C_j,C_{j+1}]$, where $i\in\{0,1,2,3\}$ and $j\in\{0,1,2,3,4\}$.

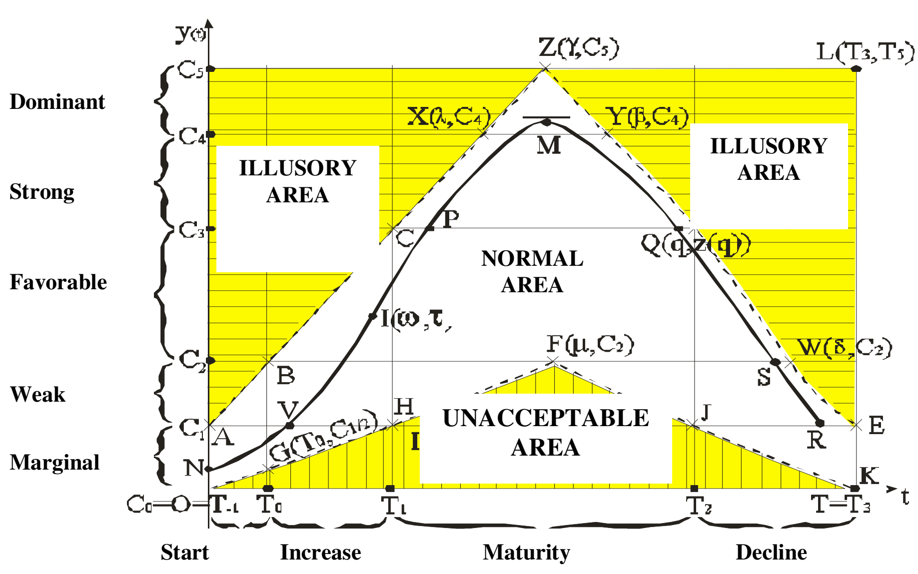

Figure 1. Concurrent position curve

The large rectangle is divided in 3 sub-domains or areas. The first area (hachured) is called "*illusory area"* and is delimited by the polygon contour line $ZC_5C_4C_3C_2C_1ABC\times Z$ and by *ZYDWELZ*, where the coordinates of the points which are not picks of sub-rectangles are given by the following formula:

$$\alpha = T_1 + \frac{T_2 - T_1}{3} = \frac{2T_1 + T_2}{3}$$

$$\gamma = \frac{T_1 + T_2}{2}$$

$$\beta = T_1 + \frac{2}{3}(T_2 - T_1) = \frac{T_1 + 2T_2}{2}$$

$$\delta = T_2 + \frac{T_3 - T_2}{2} = \frac{T_2 + T_3}{2}$$

We called the above area as illusory area because it is less probable that a point on the diagram of the function $y = y(t)$ exists in this area. For example, it is hard to believe that during the increase period $t \in T_0, T_1$ to have $y(t) \in [C_3, C_4]$ that is the product ranks in a strong concurrent position. All the same, we may say, there is a little probability (it is impossible in fact) that during the decline period (small sales, etc.), $t \in [T_2, T_3]$ to have $y(t) \in [C_4, C_5]$, that is the product ranks in dominant concurrent position.

The second area (hachured) limited by the polygon contour line de $0T_0T_1T_2T_3YFGHO$, where $\mu = \frac{T_1 + T_2}{2}$, was called "unacceptable area" because, if a point on the concurrent position function diagram $(t, y(t))$ were in this area urgent measures should have been taken by the management of the company, because the concurrent position of the curve dropped in a dead area and if it continues to be there in time, the product shall have to be withdraw from the market, because its maintaining on the market would bring big losses to the producer.

As consequence, the diagram of the concurrent position function must be in the not hachured area in fig. 1, called by us "*natural development area*". We have represented in fig. 1 the diagram of concurrent position with an uninterrupted thick line *NVIPMQSR*.

The analytic study of the concurrent position function (original mathematic model)

This function will represent a general trend of the evolution of the concurrent position of the product considered on the time interval *[0,T]*. Usually (Pecican 2006) these logistic curves are designed mathematically by an exponential function like $y(t) = \frac{a}{1 + e^{b-ct}}$, where *a, b, c,>0* are positive parameters which must be determined.

However, this exponential expression does not harmonize with the reality, it harmonizes only during the starting and increase periods (and possibly very little during the maturity period). In our case the formula will design the curve N, V, I (see fig. 1.). The point of inflexion *I* of this last curve has a special importance, because it marks the place on the curve where the "childhood" in the evolution of the product ends, the place where the investments played a major part in launching and promoting this product. After this place it follows the efficiency of the sales of this products return the costs of the investments made. Most of the time T_1 is indicated as the limit between the period of increase and the period of maturity, equals ω, that is *I* to be on the line $t = T_1$. But we can express ω depending on *a,b,c* parameters because ω is the sole solution of the equation

$y''(t) = 0$, where

y'' Is the second derivative of the concurrent position function y.

Because $y'(t) = c\,a\,e^{b-ct}\left(1 + e^{b-ct}\right)^{-2} > 0$ and

$$y''(t) = a\,c^2\,e^{b-ct}\left(1 + e^{b-ct}\right)^{-3}\left(e^{b-ct} - 1\right),$$

we find that the sole solution of the equation $y''(t) = 0$ is $\omega = \frac{b}{c}$.

A simple calculation shows that $y\left(\frac{b}{c}\right) = \frac{a}{2} = \tau$.

If we impose the condition that $\omega = T_1$ we will find the first restriction *a,b,c*:

(1) $\frac{b}{c} = T_1$

Another condition may be obtained from the "initial condition".

(2) $y(0) = \frac{a}{1+e^{b}} = y$ (*y* is calculated or specified)

The value of y_0 as well as the value $y_1 = y(T_0)$ shall have to be specified by the management of the company. One must consider that $y_1 \in \left[C_1/2, C_1 \right]$.

Thus we obtain the third restriction:

(3) $\frac{a}{1+e^{b-cT_0}} = y_1$

We find *a,b,c* from the relations (1), (2) and (3), as depending of y_0, y_1, T_0 and T_1.

The problem put at present is to give an analytical description of the remaining curve *IPMQSR*. In order to design this we will use an entire rational function of 2 degree:

$z(t) = A1t^2 + B1t + C1$,

where *A1, B1, C1* are following to be determined.

We will impose a condition of "levelness" to the joint between the two curves $y(t)$ and $z(t)$, respectively, in $t = T_1$. The first condition occurs naturally imposing as curve $z = z(t)$ to pass through $t = T_1$:

(4) $A1 \cdot T_1^2 + B1 \cdot T_1 + C1 = y_1$

From the real need as in $t = T_1$ to occur not "a corner" on the curve of concurrent position we will ask that $y'(T_1) = Z'(T_1)$, that is

(5) $2A1 \cdot T_1 + B1 = c\,a\,e^{b-cT_1}\left(1+e^{b-cT_1}\right)^{-2}$

The third condition occurs from the "desire" of delaying as much as possible the decline period of the product. We consider, the best is that the management of the company to prescribe the time *t=q* when the curve pass through the line $y = C_3$, that is the place where the concurrent position passes from the "strong" area in the favorable area. That is, the management must not wait for "a miracle" of rectification or of rejuvenation of the sales of this product, except the case of accidents on the market of other companies, which cannot be estimated from the beginning. The natural restriction will then occur:

(6) $A1 \cdot q^2 + B1 \cdot q + C1 = C_3$

The linear system formed by the equations (4), (5) and of (6) is compatible and is determined (in variables *A1, B1, C1*) because $q \neq T_1$ (from simple intuitive reasons, $P \neq Q$!).

In conclusion, if the management of the company, based on remarks and economic calculations related to the evolution of the market for the product is launches, prescribes the values T0, T_1, y_0, y_1 and *q,* with the help of the formula (1)-(6), it may find accurately the concurrent position curve of the product under discussion, for its entire lifetime, *[0,T]*. This curve may be "improved in real time" by allocating additional investments or by introducing a newer technique. In fact, the input parametersT_0, T_1, y_0, y_1 and *q* will be changed. For example, with larger fixed funds one can increase y_0. But its increase becomes artificial if it exceeds the value C_1. The additional investments shall be entered as "losses" in this last case. All the same, one can artificially decrease T0 and T_1 by additional investments. These will not always lead to the increase of the period of maturity *[T1,* T_2*]*, so they will not necessarily delay the decline of the product. Avery delicate matter is the one of the increase q, beyond the point *K*, that is *Q* is on the right of *D* on the line $y = C_3$. This may be done with high expenses, usually not justified and which do not do but to prolong the lifetime of an obsolete product from the market viewpoint. It is preferred to launch a new product (even if it does not differ from the previous one) to the artificial and even not profitable improvement of the old product.

We see in this last discussion how important is the concurrent position curve from the strategy of a company. Finding it on mathematical way is simple and may be even designed automatically by diagram software of modern computers.

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