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A MODEL OF MANAGEMENT OF TARGETTED CAPITAL STRUCTURE OF A COMPANY

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Abstract. In the paper a methodology of control of the capital structure of a company by the optimal targetted control of some specialized coefficients is given.

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The managers of large companies – providers of electricity and telecommunication to the population, caring for incessant work, seek how to reduce the business risk of the company to zero, which depends on the share of fixed costs out of the total costs. The business risk of a company is a threat of decreasing the future income of the company, depending on a number of factors.

The long term efficient activity might be in contradiction with the short term maximization of shares' price. In this regard state authorities demand from such

companies to take out licences issued by special commissions at the Congress, Parliament or Government for the emission of long term stocks. At the same time these commissions monitor the capital structure of such companies by statistical reports.

Except troubles about low debts, managers strive for low costs, choosing such capital structure which could minimize the capital expenditure and which couldn't threaten the solvency of the company. The coefficient **Sk**, which characterizes the capital structure, is determined as a proportion of the value of the company's debt to the value of its assets and the main parameter of the structure is **EBIT**, the net earnings of the company before tax and payment of interest rates on credits and loans. Sometimes the concept of capital structure includes a long term debt, as well as the proportion of preference to ordinary shares.

If the fixed costs are too high, even a lesser fall in sales could decrease the coefficient **EBIT**. The higher the fixed costs of a company are, the higher the business risk is.

The factors, influencing the capital structure are known, they are as follows:

- sales stability
- the structure of assets, convenient for issuing of stocks
- the share of the fixed costs in the total costs
- the high rate of growth of a company, always depending on explicit capital
- small loans in the prosperous companies and large ones in the unsuccessful firms.

It is accepted to speak of companies having high fixed costs as of companies having **high operational leverage**, which characterizes the use of the fixed capital.

High operational leverage means that minor changes of the amount of sales lead to a considerable change of the profits.

The fixed costs are determined by technology. For instance, electrical and telecommunications companies have high fixed costs, connected with the amortization of the equipment.

The so-called **financial leverage**, together with the **operational leverage**, is of great importance to the solution of the problem with the targetted capital structure of the company, which characterizes the use of stock with fixed earning, such as bonds, preference shares, etc.

The determination of the targetted capital structure is connected with some of dificulties such as:

- determination of the exact influence of the **finincial leverage** on the proportion **Pm/EPS**, which, as it is known, is reverse to the value of the capital structure, where **Pm** is the market price per share, **EPS** is the earning per share;
- if the company is closed down and the shares are not freely sold, the question of the expected price of shares makes no sense at all;
- very often it is difficult to prove, that the chosen capital structure is the optimum one.

Practically, the size of the rate of interest per share depends on the amount of debt. The more bills of payment a company sells, the higher is the proportion of debts to assets and the lower is the coefficient of the rate of discharge (the proportion of **EBIT** to the total sum of rates of interests paid on stocks). At that the earnings per share **(EPS)** are determined by the formula

EPS=(amount of realizations - fixed costs - direct costs - payment on credits) (1-corporative tax rate)/the amount of shares in circulation=

$$=(EBIT - I)(1 - t)/N,$$

where **I** are payments on credits, **N** is the amount of shares in circulation, **t** is the corporative tax rate.

It is also known that the higher the corporative tax rate is, the more advantages take firms from the use of the debt.

Many companies are able to control the capital structure at the cost of technological policy. For instance, the automated production has high fixed but low direct costs.

If a company has considerable fixed costs, the point of profitableness is plased relatively high on the vertical axis of **"profits and loss"** coordinates. At that even minor changes of the level of sales influences considerably the profit. The **financial leverage** acts analogically: the higher it is the greater the amount of profitable sales is.

The coefficient of the operational leverage (DOL) is determined as profit flexibility at fixed costs to the amount of manufactured products. Applying the general formula of flexibility we could present

$DOL=\Delta Q(P-V)/[Q(P-V)-F] : \Delta Q/Q=Q(P-V)/[Q(P-V)-F].$

Another formula is also correct

$DOL=Q(P-V)/[Q(P-V)-F]=(S-QV)/(S-QV-F).$

where **Q** is amount of manufactured products; **P** is the average costs of sales; **V** are the direct costs per unut product; **F** are the total fixed costs; **S=PQ** is the amount of sales in cash; **QV** are the total direct costs.

The coefficient of the financial leverage (DOFL) is the proportion of profit flexibility per share of the company **(EPS)** to the value of the net profit before payment of interests rates and tax **(EBIT)**.

In accordance with that definition we obtain a chain of equalities :

$EPS=(EBIT-I)(1-t)/N,$

that is why

$\Delta EPS=\Delta EBIT(1-t)/N$,

$\Delta EPS/EPS=\Delta EBIT/(EBIT-I)$,

that is why

$DOFL=EBIT/(EBIT-I)$.

The financial leverage helps for the management of a company, when it is not in a position to create **the operational leverage**.

Except **DOL** and **DOFL**, **the generalized coefficient of leverage (CLE)** is widely used, determined as follows

$CLE=DOL.\ DOFL=(EBIT+F)/(EBIT-I)$.

If a company has **high operational and financial leverages**, even minor fluctuations of the amount of realization lead to considerable fluctuations of profit per share.

The concept of generalized leverage allows to determine the influence of capital structure on the profit. For instance, a decision to obtain a new equipment by issuing bonds, and thus increasing the debt (manipulation with one **DOL** coefficient) could result in a decrease of sales by 10% and in a decrease of the level of profit by 50%, at the same time when a different manipulation with the **DOL** and **DOFL** coefficients could result in a decrease of the profit by only 20%.

From all this follows, how important it is to have methodics for the management of the capital structure as a result of optimum targetted control with the coefficients **DOL** and **DOFL**. At that **DOL** is connected with the fixed costs and the production activities, while **DOFL** characterizes the use of the debt in the capital structure (the higher the debt is, the higher **DOFL** is). Besides, **DOFL** increases both **EPS** and the degree of risk of stock. The risk of shares and bonds of a company increases with the increase of proportion **debt/assets**, which leads, by analogy, to the same results for the size of interest rate on the debt and the required size of profit.

For the application of **a highly technological conflict approach** to the problem of the management of the leverage it is important to know that the leverage creates two opposite effects: its increase helps for increasing of the profit per share, which leads to higher price per share, and at the same time, to increasing of the part of the risk, which decreases the price per share. The capital structure **debt/assets** throws off the balance between these two trends. This structure could be calculated theoretically. But by the present moment, the process of approximations to quasioptimum structure have been done autonomously: managers have analysed the clearing effect of various capital structures, market consultants have analysed the stability of the sales, and the final targetted capital structure has been rather a result of personal experience and instruction than of precise methods.

Together with that such methodics could be developed with the help of **market competitive strategies**. Let us turn to its development.

Let us introduce

lnCLE=y , then y=lnDOL+lnDOFL ,

where the symbol **ln** denotes a natural logarithm. If we denote

X1=lnDOL/y ,

X2=lnDOFL/y

and require the increase of **CLE** in the interval of simulation [0,T], (T>2), in the form of a differential equation

dy/dt=*a*y(X1+X2)

with a positive parameter ***a*** (which is determined below) and if the requirements about functionals

$$Ji = \int a y(1 - Xi)\, dt, \quad i = 1,2,$$

to acquire in [0, T] the highest values, if possible, then in the state of balance [2] the equation

$$dy/dt = ay\left(X1^N + X2^N\right)$$

will be fulfilled, where $X1^N$, $X2^N$ **are the market competitive strategies** ([1-5]), determined by the formula

$$Xi^N(t) = \left\{Xi(0),\quad t \le ti^X;\ \min\left(Xi(0), Xi(T)\right),\ t > ti^X\right\}$$

with temporary affixes of switching over the branches of strategies in the points

$$ti^X = T - 1/a\left(1 - Xi^N(T)\right),$$

$$a = M1\sum\left(1/\left(1 - Xi^N(T)\right)\right)^2 /T/(M1-1)/\sum\left(1/\left(1 - Xi^N(T)\right)\right), M1 = T/2.$$

By analogy, if there is a tendency to a decrease of **CLE**, the requirements

dy/dt=by(1 – X1 – X2)

will be fulfiled, where **b** is a parameter, analogical to **a**; the integrals

$$Ij = \int byXjdt,\ j = 1,2,$$

if possible are maximum in [0,T], then in the state of balance we obtain

$$dy/dt = by\left(1 - X1^N - X2^N\right),$$

where

$$Xi^N(T) = \left\{Xi(0),\ t \le ti^X;\quad \max\left(Xi(0), Xi(T)\right),\ t > ti^X\right\}$$

with temporary affixes of switching over brances of strategies in the points

$$ti^X = T - 1/bXi^N(T),\quad i = 1,2,$$

and

$$b = M1\sum\left(1/\left(Xi^N(T)\right)\right)^2 / T /(M1-1)/\sum(M1-1)/\sum\left(1/\left(Xi^N(T)\right)\right)$$

Finally we have

$$y(t)=\begin{cases} y0\exp\left[a\left[\sum Xj(0)\,tj^X+\sum Xj^N(T)\,\left(T-tj^X\right)\right]\right], & \text{a tendency to increasing;}\\ y0\exp\left[b\left[T-\sum Xi(0)\,\tau i^X-\sum Xi^N(T)\left(T-\tau i^X\right)\right]\right], & \text{a tendency to decreasing.}\end{cases}$$

It ramains to note that for the determination of the strategies $Xi^N(T),\quad i=1,2,$ the targetted functional F_0 should be given. Types of functionals could be different depending on the strategy of the company in the interval of similation. For instance, it could be required, that at the end of interval [0, T]

$Q \equiv Qt = \text{const},$

that is why

$S \equiv St = QtP = \text{const},$

and the company could have a large debt in the form of credit **I**, the payments on which in the point **T** will be **It,** which gives

$$F_0 = (I - It)^2 + (S - St)^2 \to \min\left(X1^N(T), X2^N(T)\right).$$

It remains to say, that a number of dependences allows to express F_0 in terms of **DOL**, **DOFL**, and therefore the managements $X1^N(T), X2^N(T)$.

Indeed

$$Sk = (Pm / EPS)^{-1},$$
$$EPS = (EBIT - I)(1 - t) / N,$$
$$DOL = (EBIT + F) / EBIT,$$

$$DOFL = (EBIT)/(EBIT - I),$$
$$t = 1 - EPS.N/(EBIT - I),$$
$$I = F(DOFL - 1)/DOFL/(DOL - 1),$$
$$S = [DOL(F + QV) - QV]/(DOL - 1),$$

where **Sk** is the capital structure of the company; **Pm** is the market price per share; **EPS** is the earning per share; **t** is the corporative tax rate.

Finally, we obtain for the given example

$$\mathbf{F_0 = \{F(DOFL - 1)/DOFL/(DOL - 1) - It\}^2 +}$$
$$\mathbf{+ \{[DOL(F + QV) - QV]/(DOL - 1) - St\}^2 \rightarrow}$$
$$\mathbf{\rightarrow \min(X1^N(T), X2^N(T)).}$$

Minimization $\mathbf{F_0}$ is recommended to be done by **the method of generalized gradient descent** [2–4], already approbated in similar problems.

References

[1] **Bokov, V.**, Prognosis of matrix of economical branches links in the state of progressing market relatons, Proceeding of the International conference: Economy and Higher School Menagement, Krasnogorsk, 1992.

[2] **Bokov, V., S. Bilchev**, Prognosis of Samuelson-Solow's Optimal curve: Differential game of Stakelberg-Nash, Scientific works of Angel Kanchev Higher Technical School, Vol. XXX, Ser. 8: Physics, Mathematics and Informatics, Rousse, Bulgaria: Angel Kanchev Higher Technical School Press, 1994, 8-15.

[3] **Bokov, V., S. Bilchev**, Prognosis of Philip's optimal curve for application in economical models, Proceeding of XXIV Spring conference of the Union of

Bulgarian Mathematicians in Svishtov: Mathematics and Educations in Mathematics, April 4-7, 1995, Sofia: Bulgarian Academy of Scienes Press, 1995, 360-369.

[4] **Bokov, V., S. Bilchev**, A model of evolution without crisis of connected diversified systems: approach of Shumpeteroskey, Scientific works of Angel Kanchev University of Rousse, Vol. XXXVII, Ser. 8: Physics, Mathematics and Informatics, Rousse, Bulgaria: Rousse University Press, 1999, 65-70.

[5] **Kouznetzova, E.**, (ed.), Financial management of a company, 1995.

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