DETERMINANTS OF CORPORATE VALUE IN MINING

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ABSTRACT. *The nature of value and objectives of investment expenses are analysed and a proposition is made that they functionally depend solely on two main factors - the stochastic vectors of expected future revenues from sales and expected operating profits. This proposition enables us to claim that the free cash flows and value of enterprises ultimately depend only on these two factors and cost of capital since capital expenditures can be expressed as a function on expected sales and operating profit.*

Key words: *discounted cash flow (DCF), value, valuation, determinants of value*

ДЕТЕРМИНАНТИ НА СТОЙНОСТТА В МИННОДОБИВНИТЕ ПРЕДПРИЯТИЯ

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РЕЗЮМЕ. Анализира се естеството на стойността и целите на инвестиционните разходи и се прави предположение, че те функционално зависят единствено от два основни фактора - стохастичните вектори на очакваните бъдещи приходи от продажби и очакваните оперативни печалби. Това предложение ни позволява да твърдим, че свободните парични потоци и стойността на предприятията в крайна сметка зависят само от тези два фактора и цената на капитала, тъй като капиталовите разходи могат да бъдат изразени като функция от очакваните продажби и оперативната печалба.

Ключови думи: сконтирани парични потоци, стойност, оценяване, детерминанти на стойността

Introduction

Businesses including mining companies invest for two main reasons.

First, investment is needed to replace worn-out or defective equipment, machinery, facilities, buildings and infrastructure. These investments are usually called capital expenditures and are caused by the continuous depreciation of fixed or non-current assets. Secondly, investments are made for the commissioning of new equipment, machinery, facilities and buildings in order to initiate new projects or activities such us prospecting or development of mines or increase production capacity of existing mines, the main motivation being rooted in reducing long-term production costs, increasing competitiveness and increasing and maintaining profitability and respectively the volume of activity.

The subject of the study are the determinants of value, in view of presenting them in functional dependence on them. Our ultimate goal is to eliminate investment costs from the circle of exogenous factors that determine free cash flows, and hence the present value of investment in real production assets.

Reduction of the factors determining cash flows can be achieved only if we demonstrate that they are functionally dependent on other factors, namely sales and operating margin, which in relation to the invested capital determine the efficiency (turnover) of capital, its return and ultimately the value cdreation and value.

The economic literature abounds in research on the determinants of value, and our interest is the stage of the theoretical development of neoclassical synthesis in this problem area and its subjection to a series of empirical tests. The fundamental theoretical formulations by Jorgenson (1963), Brainard and Tobin (1963; 1968), and Tobin (1969) set the stage with the definition of the indicator Q as a ratio between the market value of an enterprise and the cost of its assets, used as an indicator for future investment opportunities. This construction was further developed by Hayashi (1982) and generally demonstrates that if an enterprise can change the volume of fixed assets involved in production without additional costs (friction), then the decision on how much capital to use is a static solution in which equilibrium is achieved when the proposed return on the application of capital is equal to its price, or Q = 1. The investment decision becomes an even more interesting dynamic problem when the expectations for the future investment opportunities determine the current investment costs in the conditions of difficult and expensive readjustment of the amount of engaged fixed assets and impossibility for immediate change. And this is especially true in mining where the majority of investment once made is irreversible and capacity cannot be easily changed at all.

Research over the past six decades has focused on two main operational difficulties - the cost of readjustment and the irreversibility of investment, as well as the financial difficulties associated with raising capital from external sources. Irreversibility has been studied in the context of the toolbox of real options by Dixit and Pindyck (1994) within the framework of uncertainty. The friction of attracting capital from external sources is also based on the empirically demonstrated link between internal free cash flows and investment costs. It was initially considered by Fazzari, Hubbard and Petersen (Hayashi, 1992) and has been the subject of active scientific discussion, such as the one of Erickson and Whited and Alti (2003) who argue that the marginal coefficient Q is the only determinant of capital expenditures and any deviation is due to either empirical errors or incorrect specification of the applied model.

Without qualifying previous research, the present study leaves aside the issues of restructuring costs, irreversibility and financial constraints and focuses on the Q factor as a reliable indicator of the range of investment opportunities of a company and tries to find a way to establish the determinants of value, to reduce them to the ultimate ones, and to express the amount of investment required solely on the basis of the factors that predetermine Q and value.

To identify and analyse the determinants, we use as a basis a simplified model with elements of randomness to determine the value of a hypothetical enterprise by the method of discounted cash flows (DCF) (Sarastov et al., 2021). This includes only the significant and ultimate determining factors. It distinguishes and discerns between valuation parameters that are subject to uncertainty (risk) and those that are deterministic, either due to their nature and structure or subject to managerial decision making. This discerning classification is based on and applies the criterion of degree of control by the management of the enterprise. For example, the price of a product or service produced and sold under the conditions of ideal competition depends mainly on the market. The management cannot independently determine a specific price level, but in the best case can set a probabilistic space in which this value should occupy values. The case with the volume of sales is similar.

The effect of these two factors manifested in the model are considered random within certain limits and are modelled as such. The authors of this model argue that "in contrast, the amount of investment in fixed assets is largely subject to managerial discretion and we can consider the value of this parameter as subject to determination and set a specific amount." In the present text, we argue that this determination is weak and does not relate to the size of the undertaking, but rather to the decision whether or not to make them, which is based on the expectations for the Tobin limit factor Q. In terms of time positioning, these costs should also precede the expected activity they generate.

Let us assume that there are attractive investment opportunities and Q>1. This means that the present value of the expected cash flows from the future activity is greater than the investment costs required for it or there are monopoly or quasi-monopoly rents that allow the company to realise positive economic added value for a certain period of time. These rents in mining can be due to advantageous concession rights, royalty costs or exclusive access to knowledge and technology, as well as to geographical and other natural or social resources. The expected realisation of the rental advantage leads us to the ensuing expected future sales of goods or services. Their actual delivery execution requires production capacity, which in turn implies the necessary investments or capital expenditures. This line of thought leads us to define the following statement.

Statement 1: The expected future sales predetermine the volume of capital expenditures required to acquire the necessary production capacity. And this is especially true in mining, where we have a substantial lead-time of investments which results in the hysteresis of their roll out.

Production capacity could be described by a standard production function, such as the one proposed by Jorgenson (1963), thus defining operating margin or operating profit. In the face of future uncertainty, this feature should include the necessary elements of randomness as we demonstrate in the present text. The production function sets the relationship between the investment cost of the required production capacity and the expected effect of it, incorporating both economic and purely physical parameters and arguments. This logic in turn leads us to:

Statement 2: The expected profitability of sales and productivity or return of investment costs completely determine the amount of capital employed that a business including mining can feasibly sustain.

Since capital expenditures are made on the basis of managerial discretion, usually made once in a time at the outset of a mining project or at clearly defined subsequent stages for capacity expansion, it is necessary to break them down into periods (annuity) to achieve quantitative relation and comparability with the parameters of the production function and their inclusion in an extended version.

By no means do we rule out the discretion of the company's management to undertake an investment or not, when, and in what way. Our statements 1 and 2 show that these decisions, however, largely depend on what is necessary for the expected volume of the activity and what this activity can sustain or afford, taking into account the expected profitability, which can be fully covered by the Tobin Q factor.

Let's define the following two functional dependencies:

$C_i^{min} = \Phi\ (E\ (S_1) \dots E\ (S_i)),\ i = 1 \dots T$ which sets the minimum necessary investments for the expected sales, for a foreseeable period of time with horizon T.

$C_i^{max} = \Psi\ (E\ (m_1) \dots E\ (m_i)),\ i = 1 \dots T$ which sets the maximum capital employed which, given the expected profits, for the foreseeable period of time with horizon T, the activity can afford to bear with a sufficient degree of probability.

This can be defined as a standard growing perpetuity function of the following type:

$$C_i^{max} = \frac{E(NOPLAT)}{r^* - g} = \frac{E(S_i)E(m_i)}{r^* - g}$$

where, NOPLAT is the net operating profit after tax and $r^*$is the required return on capital also known as the alternative costs of capital.

Let's look at the following two cases:

(1) If $C_{min}<C_{max}$, the investment in question is profitable and assumes Q>1 as demonstrated in Fig. 1:

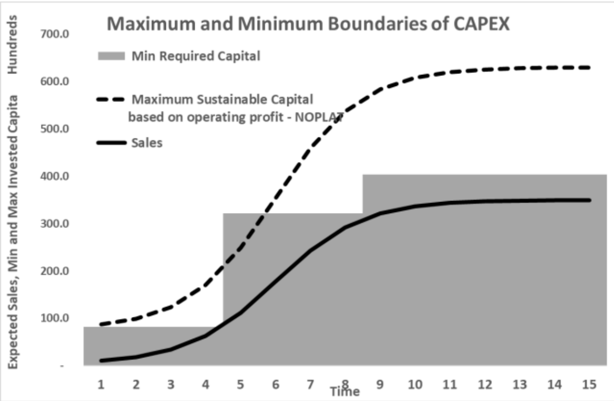

Fig. 1. Boundaries positioned for NPV>0 and Tobin' Q>1

(2) If $C_{min}>C_{max}$, then the investment in question is economically unviable, as the required investment is larger than what the activity can afford and assumes Q<1 as shown in Fig. 2.

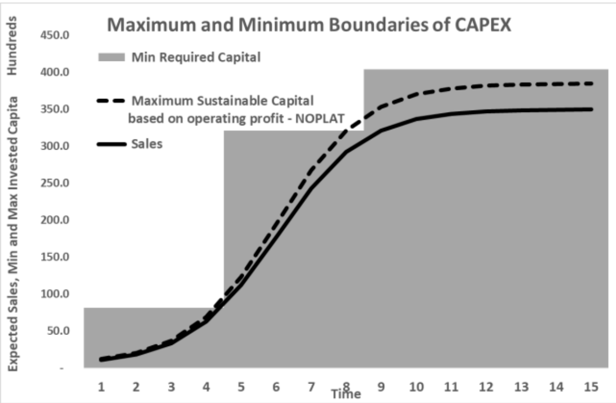

Fig. 2. Boundaries positioned for NPV<0 and Tobin's Q<1

It should be firmly stated that is possible for the functions Φ (.) And Ψ (.) To be defined and specified in various ways, which take into account the possible trajectories of realisation of the future and the sequence of realisation of the future states into which the uncertainty about future leads us. They may also take into account different horizons, factoring in the expected feasibility or sustainability of newly committed funds and capacity acquired as a result of related investment.

We have offered an example specification for C_i^{max}. C_i^{min} depends more on engineering mining considerations which prevail in assessments of investments and value in mining. Nevertheless we do not want to firmly offer a specific function definition or specification, as we prefer to work with the most general case.

Let us now define the function

$$c = \Xi\ (\Phi\ (.), \Psi\ (.))$$

Again, we do not offer a specification, as we want to look at the problem in the most general case.

We use a dynamic model of the enterprise over time, which is described by a system of equations containing deterministic and random variables as well as constant parameters under certain restrictive conditions. Sales, operating profits and sequentially functionally derived free cash flows take the form of a random processes.

Our ultimate goal is to show that the value of an enterprise depends only on the expected sales and operating profit and their probabilistic profile.

Model Description

We follow Sarastov et al. (2012) and model the enterprise as a system of dependent random processes and deterministic quantities in time for the period $[t_0, t_n]$, where t_0 is the last reporting period, and t_i for $i \in [1, n]$ and $n \in N$, is the i-th forecast period. We work with discrete random processes and continuous random variables. This is appropriate because in practice the planning and reporting of the activity is done in periods and not continuously over time.

We define the value of the enterprise as the sum of the present value of the free cash flows (F_i) discounted at discounted rates r_i for the periods $t_1, t_2, \ldots, t_n$ and the present value of free cash flows beyond the horizon t_{n+1}, set as the perpetuity of the following formula:

$$\boldsymbol{V} = \sum_{i=1}^{n} \frac{\boldsymbol{F_i}}{(\boldsymbol{1}+\boldsymbol{r_i})^i} + \frac{\boldsymbol{F_{n+1}}}{\boldsymbol{r_{n+1}}(\boldsymbol{1}+\boldsymbol{r_i})^n} \quad (1)$$

When defining the free cash flows for each of the periods i = 1,2,…, n, we follow the methodology of Copeland (1995):

$$F_i = N_i - C_i - \Delta W_i + D_i \quad (2)$$

where:

F_i is the free cash flow;

D_i are the depreciation costs;

$N_i = (P_i - D_i)(1-T)$ is the taxed operating profit after taxes or NOPLAT, as explained above

T is the tax rate

P_i is operating profit before taxes and depreciation;

C_i are capital investments;

ΔW_i is the change (investment) in net working capital W_i-W_{i-1}.

Let S_i denote the sales, as S_0 are the sales for the initial, last realised and reported period, and S_i, i = 1,2,…, n are the forecast sales for the future periods from t_1 to t_n.

We assume that the scale of activity represented by the amount of sales revenue (S) is decisive for each of the quantities on the right side of the equation (2). Therefore, these values can be represented as functionally dependent on sales revenue. We assume that these functional dependencies are linear of the following type:

$P_i = m_i S_i$, where mi is the operating margin, (3)

$C_i = c_i S_i$, c_i is the capital investment ratio, (4)

$D_i = d_i S_i$, d_i is the depreciation rate, (5)

$W_i = w_i S_i$, and w_i is the working capital investment ratio. (6)

Therefore, cash flows can be represented as a function of sales revenue (S_i), operating profitability ratio (m_i), depreciation ratio (d_i), capital investment ratio (c_i) and working capital ratio (w_i) as substitutable (3) - (6) in (2):

$$F_i = m_i(1-T)S_i + d_i T S_i - c_i S_i - (w_i S_i - w_{i-1} S_{i-1}) \quad (7)$$

Revenues from sales can be presented as a time series in which:

$$S_i = S_{i-1} * (1+g_i),\ i = 1,2,3,\ldots,n \quad (8)$$

where g_i is the increase or decrease of sales in the respective period. The intuitive justification for the above is that, in practice, the sales for each period differ, but not by much, from those in the previous period. The basis for the projection is S_0, the last reference value that we consider known because it is realised, not expected.

We can assume that the working capital ratio is a constant value, $w = w_1 = w_2 = \ldots = w_n$.

After simplifying (7) and replacing (8) in it follows:

$$F_i = S_i\left[(1-T)m_i - w_i + d_i T - c_i + \frac{w_i}{1+g_i}\right] \quad (9)$$

Given (8), the following formula is valid:

$$S_i = S_0 \prod_{j=1}^{i}(1+g_j) \quad (10)$$

Therefore:

$$F_i = S_0\left[(1-T)m_i + d_i T - c_i - w_i \frac{g_i}{1+g_i}\right] \prod_{j=1}^{i}(1+g_j) \quad (11)$$

Thus, the defined cash flows in each period are placed in functional dependence on the sales from the last reported period S_0 and on the product of their periodic changes g_i for all previous project periods and the current period t_i, multiplied by the margin for operating profitability for the period, reduced by the coefficient of corporate tax (T), to which are added non-cash expenses and capital investments.

Now we can eliminate c_i in (11) the capital investment ratio by taking into account the earlier defined *c = Ξ (Φ (.), Ψ (.))*.

Therefore:

$$F_i = S_0[(1-T)\ m\_i + d\_i\, T - \ \Xi_i(\Phi_i\,(.), \Psi_i\,(.)) - w\_i\ \ g\_i/\,(1 + g\_i\,)] \prod_{j=1}^{i}(1+g_j) \quad (12)$$

We have demonstrated how the capital investment ratio *c* can be defined by expected sales and expected profitability, fully within the framework of the Tobin-Q ratio. Thus, we can eliminate the capital investment ratio *c* as a separate ultimate factor and present the free cash flows F and value V through (1) as solely functionality dependent on $E(S_i)$ and $E(m_i)$.

This is demonbstrated in (13) below

V=

$$\sum_{i=1}^{n}\left\{\frac{S_0\left[(1-T)m_i + d_i T - \ \Xi_i(\Phi_i\,(.), \Psi_i\,(.)) - w_i \frac{g_i}{1+g_i}\right]\prod_{j=1}^{i}(1+g_j)}{(1+r_i)^i}\right\} + \frac{S_0\left[(1-T)m_{n+1} + d_{n+1} T - \ \Xi_{n+1}(\Phi_{n+1}\,(.), \Psi_{n+1}\,(.)) - w_{n+1}\frac{g_{n+1}}{1+g_{n+1}}\right]\prod_{j=1}^{n+1}(1+g_j)}{r_{n+1}(1+r_i)^n} \quad (13)$$

In (13), we demonstrate how the value represented by cash flows depends solely on the profitability expectations $E(m_i)$ and the volume of activity represented by sales expectations $E(S_i)$.

We leave out the possibility for subsequent factor decomposition of the sales of production volume at an average price, as this would complicate the presentation without introducing additional benefits from the point of view of the task. Such a presentation would require separate assumptions for the development of prices and volumes, as well as the relationship between these two quantities, which according to economic theory is different for specific goods and markets and depends on the elasticity of supply and demand.

We intuitively assume that the change in sales g_i and the operating profitability m_i are random discrete processes. The remaining variables on the right-hand side of (12) are taken as deterministic variables. The latter condition can be released. In the specific reproduction of the model, we will even place the additional restriction that they are constant parameters close to their long-term historical averages. This condition gives only ease of implementation, but can also be released. Thus, we set in the model the assumption that the investment process in the enterprise, as well as the management of working capital, will be determined by the success of the activity, namely the profitable realisation of the produced goods and services.

Conclusion

We identified and defined the determinants of capital expenditures reducing them to the expected sales and expected profitability and eliminating the exogeneity in determining their size. Thus, we eliminated them from the free cash flow and ultimately present value functions.

Our claim, therefore, is that capital expenditures will be performed only if they can be placed and determined in functional dependence on the scale of activity (i.e. sales) and their profitability (operating margin). The requirements for the former are strictly smaller than the latter, or put otherwise, what the activity can afford to sustain with a sufficient degree of probability.

The model used demonstrates the validity of these statements and is based on the normative economic theory and mainly on Jorgenson and Tobin. When experimenting with the model, the resulting return distributions are normal. The model behaves similarly at other arbitrary levels of deterministic quantities. Due to its simplicity and software application in a spreadsheet, the model can be used relatively easily to validate statements and those similar to those set forth herein.

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