Montenegrin Journal of Economics

Vol. 15, No. 2 (2019), 071-079

Assessment of the Balance of Economic Entities' Activity at Different Life Cycle Stages

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ARTICLE INFO

Received December 11, 2018
Revised from December 27, 2018
Accepted January 25, 2018
Available online June 15, 2019

JEL classification:

O12, Q01.

DOI: 10.14254/1800-5845/2019.15-2.6

Keywords:

assessment,
systemic balance of economic entities,
resource-based approach,
life cycle,
golden ratio,
Fibonacci numbers.

ABSTRACT

The development of world and national economies in present-day conditions is characterized by multiple transition processes accompanied by both local and global crises. Such economic performance demonstrates contradictions in the modern economic theory and the need for a new economic paradigm with research tools which would be suitable both to describe organizations, environments, processes and projects in a consistent manner and analyze specific features of their interaction in the economy. The system economic theory developed under the guidance of G.B. Kleiner, which can be used for systemic balanced economic management at macro-, meso- and microeconomic levels is analyzed. Deeper insight into theoretical and methodological provisions of systemic balanced management of economic entities at the microeconomic level (plants). The studies were conducted on the basis of the system life cycle concept using such scientific methods as analysis and synthesis, abstraction, generalization, analogy. The resource-based economic analysis (its theoretical and methodological provisions were developed by authors of this article and tested on economic entities of various hierarchical levels) was used as an alternative to the method for assessing the degree of balance of the structure of economic entities, used in the system economic theory. It is concluded that methodological provisions of the resource-based economic analysis may be used not only to determine but also predict the balance of systemic structure of the plant by changing the amount of consumed resources and their returns.

INTRODUCTION

It is estimated that, to date, the economic theory as scientific basis for making management decisions at all levels of the economy is in a protracted crisis. Various theoretical and methodological approaches are proposed to overcome this crisis. We adhere to the systemic economic theory developed under the guidance of G. Kleyner (2017), which aims to provide system-balanced economic management at the macro-, meso-, and microeconomic levels. The scheme or the image of stable interaction between four different types of systems (project, object, environment, process) serves as structural basis for economic stability at all levels. The balance of the economic system is characterized by commensurability, proportionality of the structural components of the economic system, ensuring its stable performance at various stages of the life cycle.

The life cycles of economic entities have been actively studied since the 60s of the last century. Their results differ not only in assessment of the number of life cycle stages but also in the indicators characterizing these stages. Life cycle models of economic entities compared in researches conducted by J. Galbraith (1982), D. Miller et al. (1984), B. Wernerfelt (1985), S. Hanks et al. (1993), E. L. Black (1998), I. Adizes (2015), H. Jaafar et al. (2015) and G. Shirokova (2009) showed that these models contain three to nine development stages. The indicators characterizing these stages differ and do not have quantitative assessment, which make it impossible to uniquely identify the stages and therefore ensure balanced development of the economic entities..

1. TRADITIONAL EVALUATION OF LIFE CYCLE STAGES

Lessons learned made it possible to regulate a number of provisions related to the use of the concept of the life cycle of economic entities, including life cycle notions (IEEE 15288-2015 - ISO/IEC/IEEE International Standard - Systems and software engineering -- System life cycle processes), life cycle stages (ISO/IEC 15288:2002 System engineering — System life cycle processes) in the national standards of the Russian Federation. According to IEEE 15288-2015 "*Each system has a life cycle. The life cycle can be described using an abstract functional model which represents understanding of needs of the system, its implementation, operation, development and decommissioning. The system develops through its life cycle* ...". The stages and outcome of actions performed and managed by organization’s specialists using system life cycle processes for these stages, are regulated, but smaller steps of life cycle stages are not uniquely defined since there are no regulated methods for their quantitative assessment. For example, the authors of this article divided “production” stage into such steps as birth, growth, maturity, aging, but in the paper of G. Kleyner (2015) these steps are called formation, growth, maturity, decline, recovery.

The studies have shown that interests of the stakeholders at different life cycle stages change, which makes it difficult to choose criteria for evaluating individual stages on the basis of a single methodological framework and leads to their diversity.

For example, N. Rozanova and A. Kataykina (2012) believe that identification of a stage of the life cycle of economic entities implies assessment of the following aspects: cash flows (operational, investment, financing cash flows), volume of sales, sales growth, profit, profit growth, amount of financial leverage, financing structure. Judging by the content, the authors consider the stage of production, which, according to their interpretation, consists of the following stages: appearance on the market, growth, maturity, decline. We draw attention to such findings of these authors as the need to identify the general viability indicator of economic entities, and the conclusion that available studies on correlation of financial indicators and life cycle stages do not yet represent a mature theory or model that could be used as scientific basis for managing economic entities.

The papers of I. V. Ivashkovskaya et al (2013) state: "*The classical criteria for assessing business growth of a company and its movement along the life cycle path usually include such indicator as growth rate of business (operating) activity, which, in general and with a certain degree of conventionality, is equated to changes in the gross sales proceeds. This assumption is conditional because the very concept of company’s business growth is a relative value, since it can be compared at once with several criteria such as economy (market) development dynamics, growth rate of the industry in general, growth rates of certain industry segments, etc*.". We focus on the fact that the rates of change of individual indicators are analyzed. At the same time, the authors point out that the rate of change in the volume of business activity cannot be a clear-cut criterion explaining the behavior and dynamics of business. It is proposed to consider liquidity, investment risk, company's market value as additional characteristics of development over the life cycle, which requires the quality of capital of economic entities to be assessed and measured at different stages of the life cycle. A specific weight value is set to each of the parameters selected and presented for further analysis. This weight value determines significance of this parameter and the degree of its influence on the business growth indicator at a certain step of the "production" stage of the life cycle of an economic entity, i.e. there is an expert assessment. Then, indices are calculated for each parameter. These indices are expressed as product of the specific weight and the actual value of the analyzed parameter. The sum of these indices allows an integral value of the growth factor related to a specific period of the life cycle of the economic entity, to be calculated.

There are not enough studied approaches, i.e. there are no threshold values of indicators characterizing individual stages of the life cycle and no methodology that allows applying the considered methods to economic entities of other hierarchical levels.

2. SUGGESTED HYPOTHESES

In order to mitigate the above mentioned shortcomings, the authors suggest a number of hypotheses:

- Classification of economic entity lifecycle stages is determined by the type of economic development (intensive, extensive, intermediate values);
- The type of economic development is established based on dynamics of the result and consumed resources, i.e. share of intensive and extensive factors in result achievement;
- The quantitative assessment during classification of economic development types is established in accordance with the golden ratio or Fibonacci sequence.

3. ASSESSMENT OF LIFECYCLE STAGES BASED ON THE SUGGESTED HYPOTHESES

The classification criteria of development characteristics based on the suggested hypotheses (1, 2) is the type of economic entity's (enterprise's) economic development which is determined by the dynamics of sales volume (production volume), consumed resources and their efficiency. There are two extreme development types: intensive and extensive; their combinations result in intensive-extensive (more than 50% influence of intensive factors) or extensive-intensive (more than 50% influence of extensive factors) development types. This approach can be viewed as the traditional one.

Intensification of the use of resources under conditions of expanded reproduction was discussed as early as in the 19th century. The existence of extensive and intensive types of expanded reproduction was pointed out by C. Marx (1955-1974) who wrote that as viewed by the society, extensive production growth involved only "growth of production field", whereas intensive production growth implied "use of more efficient means of production". In modern days, the research on intensification of economic development is reflected not only in the works of scientists working on the resource theory, but also in various publications by academicians such as A. I. Anchishkin et al. (1987) and A. I. Notkin (1982). Issues related to intensification of the use of resources at different hierarchy levels of economic entities brought to practical implementation were studied by many scientists. The following conclusion made by S. B. Barngolts et al. (2003, p. 20) remains relevant even today: "*... analysis has turned to solving the tasks of resource use optimization and became the basis ... for intensification of the production process and marshalling of interchangeable resources*".

The type of economic development of an economic entity (results of activity) with regard to the type of resources in question is determined by the dynamics of the volume of results, consumed resources and their efficiency, i.e. is a generalization of the concept of production function consisting in representation of the regular dependence between the parameters of activity results, used resources (factors) and intensity of their use. This representation can be formulated as follows:

$Y_i = X_i k_i$, (1)

where Y_i – result of economic entity's activity;

i – order number of the resource used to obtain the result;

X – volume (quantity) of the resource used (quantitative index);

k – intensity of the resource use (qualitative index).

The share of extensive (using the quantitative factor) and intensive (using the qualitative factor) factors in obtaining the result is calculated by the index method of deterministic factor analysis as demonstrated in another work of the authors dealing with the assessment of development sustainability at the macro level (Endovitsky et al., 2018). In their papers, the authors point out that as opposed to the traditional approach, the quantitative assessment of the classification of economic development types obeys the rule of golden ratio and catastrophe theory (Endovitsky et al., 2017). This conclusion was validated by the statement made by the scientists of V. A. Trapeznikov Institute of Control Sciences: "*... when assessing economic efficiency and solving issues related to sustainable development of systems, it is expedient to use the golden ratio principle*[1]" (Prangishvili,2003). Another graphic observation on this topic was made by E. M. Soroko (2012): "*The ideas of harmony and its measure, the golden ratio of 0.618, have been agitating man's intellectual faculties for more than three and a half thousand years*".

Offset of the extreme points from the traditionally accepted 100% influence of a factor is confirmed by scientists representing other branches of knowledge, namely, scientific schools led by V. I. Arnold (1990), A. N. Dmitievskii et al. (2014), A. V. Zhirmunsky and V. I. Kuzmin (1990), I. V. Prangishvili (2003) and others.

Table 1. Classification of economic development types

Boundaries of variation of intensive factors		Production development type
Traditional approach	The golden ratio	
Less than 0 %	Less than 14 %	Extensive
0–50%	14–37%	Extensive-intensive
51–100 %	38–62 %	Intensive-extensive
More than 100 %	More than 62 %	Intensive

Source: authority on

[1]The golden ratio is the number found by dividing a line in to two unequal parts soth at the ratio of the entire line(1) to its longer part (x) is the same as the ratio of the longer part (x) to the shorter part (1–x): $\frac{1}{x} = \frac{x}{1-x}$.

The positive root of the equation is equal to the golden proportion: $\tau = \frac{1+\sqrt{5}}{2} \approx 1{,}618$.

This number builds the dynamic model of the golden ratio principle:

$1 = \tau^{0} = \tau^{-1} + \tau^{-2} = 0{,}618 + 0{,}382;$

$0{,}382 = \tau^{-2} = \tau^{-3} + \tau^{-4} = 0{,}236 + 0{,}146$ (A. Stakhov, A., 2018).

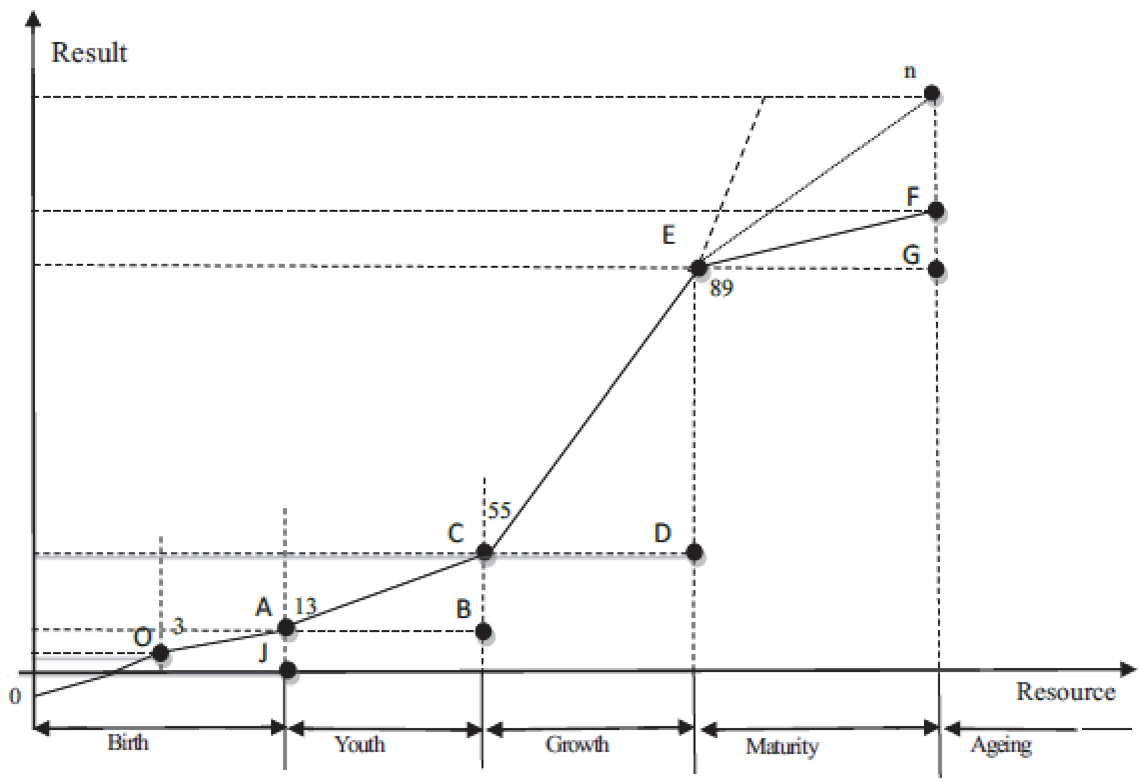
The specified boundaries (62%, 38%, 14%) were taken as criteria for the assessment of economic development types and justified by the authors in (Endovitskiy, 2017).

Classification of the types of economic development (the traditional approach vs the golden ratio principle) is shown in Table 1.

Development of economic entities is represented by life cycle curve (see Figure 1). The Figure 1 suggests that the nature of the life cycle curves (angle of inclination with respect to the axis “resource”) depends on the change of the result of the functioning of the company. As the indicator "result" here is introduced "sales volume", which is one of the main the indicator of organic growth in a company in Russian and foreign scientific research (Delmar, 1997; Rozanova and Kataykova, 2012; Adizes, 2015).

In Figure 1 the life cycle curve is presented using piece wise linear functions. For example, on the growth stage section CE as the ratio of the result DE to the quantity of resource CD shows resource efficiency, i.e. result per unit of resource consumption. The higher the result, the steeper the section representing the efficiency, i.e. the more intensive the resource use per unit of result, leading to relative conservation of resources.

Figure 1. A company’s life cycle curve represented by piecewise linear functions
(3, 13, 55, 89 share of intensive factors in the result)



Source: authority on

If the result represents the revenue and the life cycle stage is characterized by the cost of resources, then the pattern of the curve represents the dynamics of revenue (main financial resource) over the given life cycle stage. The higher the share of intensive factors, the more efficient the resource use, constituting the basis for life cycle stage classification.

Today special attention is given to creation of high-technology workplaces characterized by transition from Industry 3.0 to Industry 4.0, i.e. fastest possible time to serial production of goods.

Ray Kurzweil (2012) points out: "... *acceleration affects every process that is influenced by evolution in data processing. That is why we are observing acceleration in biological evolution and a similar (but much faster) acceleration in technological evolution* ...". In pre-production engineering, serial production is preceded by a pilot batch and a validation batch. We assume that the pilot batch is accompanied by the extensive type of economic development and the validation batch should include some elements of intensification. This condition is satisfied by the classification of life cycle stages using the Fibonacci sequence[2] which is closely related to the golden ratio. Let us modify the classification of economic development types, linking it to the production development type and using the Fibonacci numbers as the basis (Table 2 and Figure 1).

Table 2 Correlation between economic development types and intensification of resource use (based on the Fibonacci numbers)

Production type				
Pilot batch	Validation batch	Serial production		
Boundaries of variation of intensive factors				
Less than 3	3–13	13.1–55	55.1–89	More than 89
Production development type				
Extensive	Extensive-intensive-		Intensive-extensive	Intensive
Life cycle stage				
birth/ageing		youth/ageing	growth/maturity	growth

Source: authority on

The Fibonacci numbers are viewed as numbers characterizing system sustainability and harmony. Yu. A. Urmantsev (2009, p. 69) points out: "In the second half of the 20th century the Fibonacci numbers and the golden ratio find use in almost all branches of science and arts". This tendency is also noted by I. V. Prangishvili (2003), A. P. Stakhov (2009; 2018) and other scientists.

4. METHODS FOR ASSESSING ENTERPRISE SYSTEM BALANCE

Let us consider methods for assessing the system balance of enterprise subsystems.The following subsystems constitute the structural basis for stable interaction at the micro-level of the "enterprise" object system:

- object–structural units;
- infrastructure-environmental – enterprise institutes, regulations, social climate among the co-workers;
- production-operational – business processes, repeatable standard procedures;
- innovation – various innovations, organizational or technological novelties.

Naturally, at different life cycle stages these subsystems will have a different impact on enterprise development and will themselves have different levels of development. Nevertheless, it is stated in work by G.B. Kleyner (2015, p. 183): "*The ideal configuration of system structure exists*

[2] Discovered in the 13th century by an Italian mathematician Leonardo of Pisa, also called Leonardo Fibonacci. The Fibonacci sequence is a series of numbers where every number after the first two is the sum of the two preceding ones, e.g. 0 1 1 2 3 5 8 13 21 34 55 89 etc. The ratio of adjacent numbers within the sequence tends to the golden ratio: 89:55 ≈ 55:34 ≈34:21≈ 1.618.

when all system constituents are equally expressed. … Strategically, not a single system constituent should dominate over the others… ."

Methods for assessing enterprise system balance employ internal analysis based on management accounting data and external analysis based on financial accounting. Internal analysis to assess subsystem proportions is conducted on the basis of statistical data describing personnel's use of working time or data on the composition of enterprise personnel belonging in the corresponding subsystem (finding the weight of each subsystem). This approach uses methods that are similar to those used by I. V. Ivashkovskaya et al. (2013).

Let us consider indices (Table 3) used in the external analysis of enterprise system structure:

- net sales are used to assess the consolidated financial result of the enterprise considered as an object type system;
- fixed assets value is used to assess infrastructure-environmental subsystems;
- fixed assets in use are used to assess production-operational subsystems but, since these data are excluded from reporting, the assessment is performed on the basis of current assets (with the exception of short-term financial investments and cash);
- intangible assets, financial investments and free cash are used to assess innovation subsystems.

Table 3. Assessment of subsystems of enterprise structure

Subsystems	Subsystem targets	Performance indicators	Model of the dependence of the resulting indicator on performance indicators
Object	Maximize net sales	Net sales	Revenue dynamics
Infrastructure-environmental	Provide the production with fixed assets in the use to reach the object subsystem target	Fixed and environmental assets	Fixed Asset Turnover Ratio = net sales / average fixed and environmental assets
Production-operational	Maintain continuity of production processes to reach the object subsystem target	Current assets (with the exception of cash and cash equivalents)	Current Asset Turnover Ratio = net sales / average current assets (with the exception of free cash and cash equivalents)
Innovation	Ensure innovation and sustainability of company's development by creating new products and business processes	Intangible assets, financial investments, free cash and cash equivalents	Intangible Assets Turnover Ratio = net revenue / average intangible assets, financial investments, free cash and cash equivalents

Source: authority on

The degree of enterprise system balance is determined by the strength of bonds between enterprise subsystems and the system balance index (Kleyner; 2015, p. 197).

As an alternative to the above-described procedure for assessing the balance of enterprise system structure, we suggest using the resource-oriented economic analysis in accordance with the theoretical and methodological provisions developed by the authors and tried out at the micro-, meso- and macro-economic levels (Babicheva et al., 2018; Endovitsky et al., 2017; 2018).

At the enterprise level, the object subsystem is characterized by revenue, which, as it was discussed above, is affected by factors characterizing other subsystems. The algorithm for assessing the impact of each subsystem on the object is implemented as follows:

- Formula (1) is used to build factor models in order to assess the impact of quantitative (volume of resource) and qualitative (intensity of resource use) on the result (revenue). The models are shown in Table 2;
- The method of deterministic factor analysis is used to assess the impact of all factors on the result. The share of impact of intensive factors on the result serves as the basis for determining the position of subsystems being analyzed on the life cycle curve (Figure 2);
- The degree of balance can be not only analyzed, but also predicted by modifying the volume of consumed resources and their efficiency. The models (30 models) characterizing dependence of enterprise revenue on the efficiency of use of different resources have been developed, tried out at real-world enterprises and described in various papers by the authors.

CONCLUSION AND FINDINGS

The studies have shown that systemic balanced management in the economic theory requires development of methods and models allowing balanced development of economic entities at different stages of their life cycle to be assessed.

To assess the balance of development of economic entities quantitative indicators and models showing dependence of the resulting indicator on factors characterizing efficiency of resource use both by the entities themselves and individual subsystems have been developed. The quantitative assessment of the types of economic development of each subsystem is made on the basis of the resource-oriented approach in accordance with the golden proportion or Fibonacci numbers, which allows determining threshold values to describe the position of subsystems and economic entities on the life cycle curve. The developed methods make it possible not only to assess but also predict the balance of subsystems of economic entities.

ACKNOWLEDGMENT

The paper is supported by a grant of Russian Foundation for Basic Research (Project No. 16-06-00390 A).

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