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STATE REGULATION OF FIXED CAPITAL REPRODUCTION IN UKRAINE USING TAXONOMIC ANALYSIS METHODOLOGY

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Abstract
This scientific article is concentrated on the issues of evaluation of effectiveness of state regulation of the fixed capital reproduction in Ukraine using the methodology of taxonomic analysis. The study of modern economic literature has shown that scientists-economists have studied and explained numerous indices that allow evaluate the present day state of reproduction of the fixed capital.
The authors propose their own approach to evaluation of effectiveness of state regulation of the fixed capital reproduction through the prism of the fixed capital reproduction process. That is, the authors made a detailed description of specific indices of effectiveness at certain stages of the process of reproduction of the fixed capital, which is presented in the summary table. Comprehensive effectiveness of state regulation of the fixed capital reproduction is determined using an integrated index that characterizes effectiveness of state regulation of the fixed capital reproduction using the method of taxonomic analysis applied for multidimensional economic concepts that are described by a considerable number of indices.
Calculations proved instability of the taxonomic indices during the study period which, according to the authors, indicates a decline in the efficiency of reproduction processes connected with reproduction of the fixed capital in Ukraine.

Key words: *fixed capital, integrated taxonomic index, reproduction effectiveness, reproduction of fixed capital, state regulation, taxonomic analysis.*
JEL Codes: *C02; M48.*

Introduction

Both, in theory and in practice of state regulation of the fixed capital reproduction one of the most important issues is determination of the criteria of its effectiveness. According to the authors of this study, the criteria of effectiveness are the major distinguishing particularities and the determining measure of the probability of knowing the essence of the processes connected with reproduction of the fixed capital.

Examining the origin of the term "effectiveness" we found, that it comes from the Latin "effectus", which means effect, result of a particular cause or action. In a general

sense, the effect is the result achieved as a consequence of any event. In the present day economic literature, effectiveness is a measure of the rational use of various resources for the achievement of goals set forth at both, the macro- and micro-levels. Although there are approaches according to which the concepts of "effect" and "effectiveness" are synonymous. Thus, particularly, the collective of authors headed by M. Lapyhin understands effectiveness (Lapyigin, 2005) as:

– a specific result (effectiveness of some action);

– conformity of the result or a process to the maximum possible, ideal or planned;

– functional diversity of systems;

– numerical characteristics of satisfactory functioning;

– probability of efficiency of the set objectives and functions;

– ratio of the actual effect to the required (standard) effect.

Of interest from the standpoint of our research is the approach of S. Yashin, who identifies the following approaches to understanding the concept of effectiveness:

1) effectiveness is considered as a relative index (resource or target effectiveness). These are all kinds of profitability;

2) effectiveness is determined through the profitability methods that produce absolute values of indices. These approaches use the discounted cash flow method, capitalized cash flow method, payback period method, calculation of the project break-even point;

3) effectiveness is determined through the profitability methods, but is calculated as a relative index – method of profitability index (return index) and project profitability, method of internal rate of return (internal revenue rate, profitability rate, return on investment);

4) effectiveness is considered as an individual set of financial and non-financial indices of the enterprise (balanced system of indices) (Yashin & Puzov, 2005).

In general, effectiveness is determined by way of comparison of the obtained results with the expended resources. The value obtained is the basis for evaluation of the practicability of measures, including those connected with reproduction of the fixed capital. Proceeding from the above said, *effectiveness of state regulation of the fixed capital reproduction* can be determined by the following formula:

$$\textit{Effectiveness of state regulation} = \frac{\textit{Effect (result) of state regulation}}{\textit{Expenses for state regulation}} \quad (1)$$

As we can see from the above formula, effectiveness of state regulation of the fixed capital reproduction in a formalized form is a relative value. If we include all resources with which reproduction of the fixed capital is made in the denominator of this formula, the numerator will include the results of these investments. In this case the issue of demarcation of the concepts of “effectiveness” and “efficiency” becomes especially important. This is explained by the fact that the use of a system of efficiency indices resolves the problem of identification of expenses connected with state regulation of the fixed capital reproduction and allows to use on a wider scale non-financial indices to characterize functioning of the state. Solution of this problem envisages a study of ideas of various scientists about these concepts (see Table 1).

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Table 1. Comparison of the concepts of "effectiveness" and "efficiency" (Source: Tischenko, Kizim & Dogadaylo, 2005)

Author	Interpretation of the concept	
	"effectiveness"	**"efficiency"**
E. Dolan	choice of the right goals on which all energy of the enterprise is focused	achievement of the set goals with the least costs and mistakes
P. Drucker	consequence of what "the necessary things are created correctly"	consequence of what "the necessary, correct things are created"
D. Khan	ability to do correctly what is planned	ability to plan correctly what to do
M. Mescon, M. Albert, F. Hedoury	internal effectiveness, cost effectiveness best of all evaluating the use of resources	external effectiveness, evaluating achievement of goals of the enterprise reflecting not only cost effectiveness, but characterizes relationships with external environment
A. D. Sheremet, R.S. Saifulin	a complex category characterized by efficiency of the enterprise and profitability of its capital, resources or products	a value characterizing the degree of business activity of the enterprise
Yu.V. Perevalov, I. E. Himadi, V.V. Dobrodey	a mixed concept what should be considered in two aspects 1) efficiency 2) cost effectiveness	degree of achievement of the main set goals, characterized by quantitative indices showing the goals without taking into account the cost effectiveness of their implementation
V.V. Kovalev	relative index that correlates the obtained effect with the costs or resources used to achieve this effect, one of the indices of evaluation financial and economic activity	value that reflects the profitability, dynamism of achievement of goals, effectiveness of the use of economic potential, situation in the securities market

The table below shows that some authors in their works equate the concepts of "effectiveness" and "efficiency", which in our opinion is explained by the characteristics of economic systems in which the above said scientists conducted their research. To eliminate the controversial issue of equating the concepts of "effectiveness" and "efficiency", we support those scientists who believe that the most exhaustive definition of these concepts is given in ISO:9000:2000 standard, according to which effectiveness is the ratio between the achieved results and resources used, and efficiency is the degree of implementation of the planned activities and achievement of the planned results (Klymash, 2009).

Besides, complexity of study of the problem is that today there are no clear recommendations as to what number of criteria should be used to characterize both, effectiveness of state regulation in general and state regulation of the fixed capital reproduction in particular. The most common, in this case, is the point of view presented by L. Dmitrichenko and according to which the criterion of effectiveness has to show the need for state regulation, its optimal limits, and the real effect of state influence on the socio-economic processes (Dmitrichenko, 2001). In general, agreeing with this point of view, it would be worth pointing out that the processes connected with reproduction of the fixed capital usually serve as a catalyst for the development of social production, productive forces, etc. However, we do not agree with the view that the only criterion of effectiveness of state regulation of the fixed capital reproduction is the GDP index, as the same value of GDP can be achieved by using the fixed capital varying in structure, volume and quality.

We are of the opinion that the criterion of the effectiveness of state regulation of the fixed capital reproduction are directly connected with the stages of the reproduction process. Besides, insufficiency and scarcity of resources for the fixed capital reproduction encourage systematization of indices that would, on the one hand, characterize effectiveness of state regulation of the fixed capital reproduction, and on the other hand would determine priority objectives along this avenue.

The complexity of formation of criteria for effectiveness of state regulation of the fixed capital reproduction, in our opinion, is caused by the following factors:

– firstly, state regulation, depending on the circumstances, is a factor of direct or indirect influence on the process of reproduction of the fixed capital;

– secondly, effectiveness of state regulation of the fixed capital reproduction to a great extent depends on the related trends of the state policy connected with the improvement of fixed assets and development of scientific and technological process;

– thirdly, the concurrence of interests at the macro- and micro-levels where on the one hand there are enterprises as the owners of the fixed capital, and on the other hand – the state, which is both the owner and buyer of the fixed assets.

Proposed methodology

On the strength of the above, we believe that effectiveness of state regulation of the fixed capital reproduction is a system-based category that expresses the value of sufficiency of the fixed assets in quantitative and qualitative characteristics at macro- and micro-levels. Although the approach of scientists to this issue is ambiguous. Thus, the vast majority of them have a strong belief in the use of a system of physical and cost indicess (Poddjerjoghin, Bilyk & Burjak, 2005). The others suggest using one generalizing index of economic effect (Pidlisecjkyj, 2003). In our opinion effectiveness of state regulation of the fixed capital reproduction at the macro-level can be determined by one generalizing index, the basis for calculation of which is a complex system of indices of the effectiveness of reproduction processes at the micro-levels, i.e. stages.

Macroeconomic effectiveness of state regulation of the fixed capital reproduction has to be evaluated by the separate stages resulting from the essential difference in their time duration and the movement of forms of the fixed capital value and in general depending on the impact on the stability of economic growth in the country. For that purpose in the USA they use the “index of reproductive reserve of the fixed capital”. This index is calculated as the ratio of actual accrued depreciation in the cost of products sold to the initial cost of fixed assets. According to some economists, in essence, this index is a key index of effectiveness of the fixed capital reproduction and the assessment of state influence on it. However, its calculation under present day conditions is hardly probable, as the official statistics does not provide information on the share of depreciation in the cost of the products sold.

We support the opinion of scientists (Onufrieva, 2006) who believe that introduction into practice of state regulation of the index of reproductive reserve of the fixed capital will allow to objectively assess, coordinate and control the intra-phase and inter-phase state of the reproduction processes in sectoral, object-oriented and temporal sense. Proceeding from the level and dynamics of this parameter in conjunction with the operating indices, it is possible to elaborate appropriate government measures that would prevent a variety of negative processes connected with reproduction of the fixed capital.

As for domestic practice, as noted above, economic science does not have a clearly defined system of indices for the assessment of effectiveness of state regulation of the fixed capital reproduction. Though in order to study

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the process of exploitation of basic capital and its interaction with other factors of production, it has developed and substantiated economic and mathematical models based on the application of the production function. The list of these models includes:

– Leontiev's model, formed on the basis of three factor production functions and with whose aid it is possible to set a limited economic resource that determines possible volume of production;

– linear two-factor model that allows to determine proportions of increasing output of products taking into account the increase of the involved production resources;

– power model, based on the Cobb-Douglas production function, that allows to confirm the fact that the use of each additional unit of production resource with the invariability of the other leads to a reduction in the growth of manufactured product;

– the model based on the power production function, that allows to implement the principle of increasing production effectiveness depending on its scale;

– dynamic model based on the Solow production function, that allows to trace the impact of scientific and technological progress on increasing output of products. This model shows that the volumes of output increases even when the amount of resources used remains unchanged.

In this scientific article we offer our own method of assessing effectiveness of state regulation of the fixed capital reproduction on the basis of two approaches –*economic and financial*. The essence of ***economic approach*** is in evaluation of the state regulation of the fixed capital reproduction at the stages of the reproduction process with a certain set of indices that complement each other and producing the summary index. At the base of our considerations we hold the thesis, that only by having systematized the system of indices of effectiveness of state regulation of the fixed the capital reproduction by stages it is possible to characterize it objectively and comprehensively and propose a generalizing parameter.

Thus, in our opinion, effectiveness of state regulation of the fixed capital reproduction at the stage of "Introduction of fixed capital" is measured by way of comparing the costs connected with its formation and the results, i. e. the volume of production. The main indices here are indices of *capital productivity, capital intensity and capital-labor ratio*; at the stage of "Productive use" **–** *coefficient of productiveness of capital resources* (rates of return on fixed assets functioning); at the stage of "Reproduction" **–** coefficients of dynamics, renewal, retirement and cumulative reproduction.

The most important index that characterizes the effectiveness of use and reproduction of the fixed capital from the standpoint of state regulation at the stage of "Introduction of fixed capital" is the capital productivity, the inverse of which is capital intensity (Table 2). At present time, capital productivity is defined as the value of gross output at comparative prices to the average annual cost of the fixed capital. It shows the amount of products obtained from each hryvnia of the fixed capital. Fully agreeing with the formula of this index, it would be worth to note the following:

Table 2. Indices of the effectiveness of state regulation of the fixed capital reproduction (Source: compiled by the author)

#	Indices	Characteristic of index	Standard
Stage «Introduction of fixed capital»			
1	*Capital productivity*	Gross product value at comparative prices / Average annual cost of fixed capital	Increase
2	*Capital intensity*	Average annual cost of fixed capital / Gross product value	Reduction
3	*Capital-labor ratio*	Average annual cost of fixed capital / Average number of registered personnel	Increase
Stage «Productive use of fixed capital»			
4	*Coefficient of productive use of fixed capital*	Profit from operating activities / Average annual cost of fixed capital	Increase
Stage «Reproduction of fixed capital»			
5	*Increase rate*	Fixed capital formation / Fixed capital value as of beginning of the year	Increase
6	*Coefficient of renewal*	Value of introduced fixed capital / Average annual cost of fixed capital	Increase
7	*Retirement rate*	Value of retired fixed capital / Average annual cost of fixed capital	Increase
8	*Coefficient of cumulative reproduction*	Value of fixed capital Received during the year / Fixed capital value as of beginning of the year	Increase

• the use of this formula leads to obtaining the result through the use of only fixed capital, although for the manufacture of products other resources are used as well with the balance of which changes in the costs of one of them in value terms leads to changes in the sales in the same proportion;

• the use of the average annual cost of capital in the formula leads to the following paradox. If acquisition of new fixed assets does not occur, then due to depreciation their value is constantly falling, which in its turn leads to an increase in capital productivity. This is illogical, because fixed assets are aging, and the return on them increases. Elimination of this shortcoming is possible by way of using the initial cost of fixed capital instead of the average cost.

Effectiveness at the stage of "Productive use of fixed capital" is determined by comparison of the results of this use and costs. For this purpose, the most accessible and at the same time, in our opinion, objective from the standpoint of state regulation is the "coefficient of productive use of fixed capital", which is defined as the ratio of profit from operating activities to the average annual cost of the fixed capital (Skvorcov, 2003). In some sources, this index is known as the "rate of return".

Effectiveness at the stage of "Reproduction of the fixed capital" is determined by way of comparison of the volumes of the fixed assets involved. It is appropriate for this to use the coefficients of dynamics, retirement and renewal. The growth

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index reveals the rate of increase or decrease in the value of the fixed capital.

The coefficient of cumulative reproduction makes it possible to judge which share of the newly introduced fixed assets is used for the simple reproduction and which for the expanded reproduction.

Thus, if the fixed capital received during the year is equal to the fixed capital retired during the year, then only a simple reproduction of the fixed capital is ensured. If the fixed capital received during the year is greater than the fixed capital retired during the year, then only an expanded reproduction of the fixed capital is ensured.

We propose to determine the general effectiveness of state regulation of the fixed capital reproduction using an integrated index that characterizes the effectiveness of state regulation of the fixed capital reproduction using the ***method of taxonomic analysis*** developed by Vyacheslav Plyuta (Plyuta, 1989). The argument in favor of using this method, in our opinion, is that it works with multidimensional economic concepts, that are described by a considerable number of indices.

Result analysis and discussion

The use of the method of taxonomic analysis will allow solve the problem of streamlining the multidimensionality of such a category as the effectiveness of state regulation of the fixed capital reproduction in relation to the standard reference vector. We are convinced that application of the taxonomy method to evaluate effectiveness of state regulation of the fixed capital reproduction is a new technique in scientific exploration of this issue.

Using formulas of Table 2 we shall present the said indices we have calculated (Table 3), that will be used to calculate taxonomic index of effectiveness of state regulation of the fixed capital reproduction.

Table 3. System of indices of effectiveness of state regulation of the fixed capital reproduction (Source: calculations by the authors)

Years	Capital productivity	Capital intensity	Capital-labor ratio (million UAH / pers.)	Coefficient of productive use of fixed capital	Increase rate	Coefficient of renewal	Retirement rate	Coefficient of cumulative reproduction
2010	0,143	7,002	0,347	0,002	1,04	0,071	0,020	0,043
2011	0,154	6,498	0,385	0,009	1,06	0,020	0,013	0,271
2012	0,142	7,020	0,475	0,004	1,06	0,021	0,026	0,050
2013	0,135	7,407	0,539	-0,002	1,05	0,016	0,044	0,060
2014	0,100	10,044	0,761	-0,043	1,00	0,009	0,017	0,022
2015	0,187	5,337	0,465	-0,049	1,02	0,028	0,061	0,067
2016	0,249	4,014	0,502	0,004	1,02	0,025	0,034	0,063
2017	0,316	3,164	0,479	0,003	1,02	0,021	0,051	0,062
2018	0,321	3,115	0,587	0,002	1,01	0,020	0,065	0,064

Taxonomic index is calculated by the classical algorithm of taxonomic analysis (Ayvazyan, Bajaeva & Staroverova, 1974) (Fig. 1): formation of the observations matrix, standardization of the values of elements of the observations matrix, formation of the reference vector, determination of the distance between individual observations and the reference vector, calculation of the taxonomic coefficient.

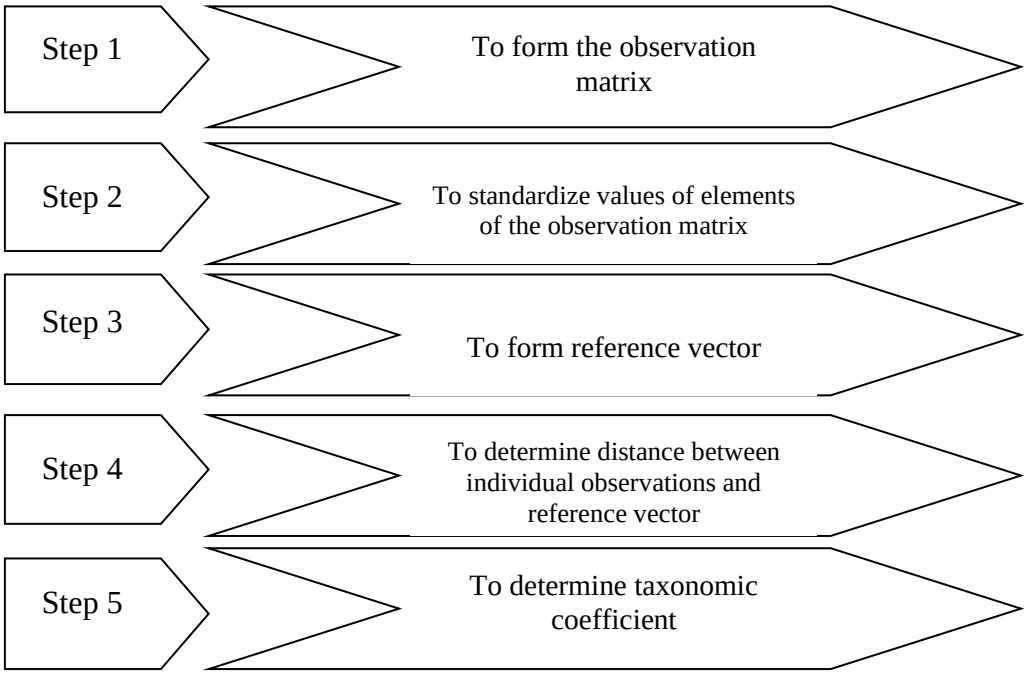

Fig 1. Algorithm of taxonomic analysis characterizing effectiveness of state regulation of the fixed capital reproduction (Source: compiled by the author)

To form a matrix of observations, we use formula 1 and indices of Table 3, that characterize effectiveness of state regulation of the fixed capital reproduction.

$$X_{mn} = \begin{pmatrix} X_1 \\ X_2 \\ \dots \\ X_i \\ \dots \\ X_m \end{pmatrix} = \begin{pmatrix} x_{11} & x_{12} & x_{13} & \dots & x_{1j} & \dots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \dots & x_{2j} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ x_{i1} & x_{i2} & x_{i3} & \dots & x_{ij} & \dots & x_{in} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & x_{m3} & \dots & x_{mj} & \dots & x_{mn} \end{pmatrix} \quad (2)$$

We shall form the observations matrix *(X):*

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$$X = \begin{matrix} 0{,}143 & 7{,}002 & 0{,}347 & 0{,}002 & 1{,}04 & 0{,}071 & 0{,}020 & 0{,}043 \\ 0{,}154 & 6{,}498 & 0{,}385 & 0{,}009 & 1{,}06 & 0{,}020 & 0{,}013 & 0{,}271 \\ 0{,}142 & 7{,}020 & 0{,}475 & 0{,}004 & 1{,}06 & 0{,}021 & 0{,}026 & 0{,}050 \\ 0{,}135 & 7{,}407 & 0{,}539 & -0{,}002 & 1{,}05 & 0{,}016 & 0{,}044 & 0{,}060 \\ 0{,}100 & 10{,}044 & 0{,}761 & -0{,}043 & 1{,}00 & 0{,}009 & 0{,}017 & 0{,}022 \\ 0{,}187 & 5{,}337 & 0{,}465 & -0{,}049 & 1{,}02 & 0{,}028 & 0{,}061 & 0{,}067 \\ 0{,}249 & 4{,}014 & 0{,}502 & 0{,}004 & 1{,}02 & 0{,}025 & 0{,}034 & 0{,}063 \\ 0{,}316 & 3{,}164 & 0{,}479 & 0{,}003 & 1{,}02 & 0{,}021 & 0{,}051 & 0{,}062 \\ 0{,}321 & 3{,}115 & 0{,}587 & 0{,}002 & 1{,}01 & 0{,}020 & 0{,}065 & 0{,}064 \end{matrix} \quad (3)$$

As the developer of this method notes, the elements of this matrix are indices expressed in units of measurement. However, any index reflects only certain aspects of the category under the study, while a comprehensive description envisages the use of a system of indices, that in the opinion of M. Repin have the following particularities: 1) comprehensiveness of quantification of phenomena; 2) organic relationship of individual indices, and these are they, that turn a group of indices into a single set of characteristics of a complex phenomenon or process (Ayvazyan, Bajaeva & Staroverova, 1974). It is exactly the definition of the object of study and the establishment of its purpose that are the main criteria that determine this system of indices. However, following the algorithm of taxonomic analysis, further calculations require standardization that allows to reduce the units of measurement to a non-dimensional value in the range of [0; 1], i.e., to equalize the characteristic values (Sablina & Telichko, 2009). The significance of this step is that standardization allows to avoid discrepancies with the units of measurement because elements of the observation matrix can be expressed in units of measurement specific for each characteristic. To achieve this, we shall determine the mean value of each index (Table 4).

Having determined the mean values of indices, we standardize values of the matrix elements of using the following formula:

$$Z_i = \frac{X_i}{\overline{X_i}}, \quad (4)$$

Table 4. Mean values of indices for calculation of taxonomic coefficient of effectiveness of state regulation of the fixed capital reproduction (Source: calculations by the authors)

Index	Mean value
Capital productivity	0,194
Capital intensity	5,956
Capital-labor ratio	0,504
Coefficient of productive use of fixed capital	- 0,008
Increase rate	1,031
Coefficient of renewal	0,026
Retirement rate	0,037
Coefficient of cumulative reproduction	0,078

where Z_i – standardized value of index *i*;
X_i – value of index *i* in the observations matrix;

$\overline{X_i}$ – mean value of index *i.*

Matrix of standardized values *(Z)* will have the following pattern:

$$Z = \begin{matrix} 0{,}73669 & 1{,}17569 & 0{,}68789 & -0{,}25714 & 1{,}00862 & 2{,}76623 & 0{,}54381 & 0{,}55128 \\ 0{,}79336 & 1{,}09106 & 0{,}76322 & -1{,}15714 & 1{,}02802 & 0{,}77922 & 0{,}35347 & 3{,}47436 \\ 0{,}73154 & 1{,}17871 & 0{,}94163 & -0{,}51429 & 1{,}02802 & 0{,}81818 & 0{,}70695 & 0{,}64103 \\ 0{,}69548 & 1{,}24369 & 1{,}06850 & 0{,}25714 & 1{,}01832 & 0{,}62338 & 1{,}19637 & 0{,}76923 \\ 0{,}51517 & 1{,}68646 & 1{,}50859 & 5{,}52857 & 0{,}96983 & 0{,}35065 & 0{,}46224 & 0{,}28205 \\ 0{,}96337 & 0{,}89612 & 0{,}92181 & 6{,}30000 & 0{,}98922 & 1{,}09091 & 1{,}65861 & 0{,}85897 \\ 1{,}28277 & 0{,}67398 & 0{,}99515 & -0{,}51429 & 0{,}98922 & 0{,}97403 & 0{,}80769 & 0{,}80769 \\ 1{,}62793 & 0{,}53126 & 0{,}94956 & -0{,}38571 & 0{,}98922 & 0{,}81818 & 1{,}38671 & 0{,}79487 \\ 1{,}65369 & 0{,}52303 & 1{,}16366 & -0{,}25714 & 0{,}97953 & 0{,}77922 & 1{,}76737 & 0{,}82051 \end{matrix} \quad (5)$$

The next step of the above algorithm is formation of the reference vector, which envisages the division of all variables into stimulators and destimulators. The basis of this division is the characteristic effect of each index on the level of the object under study. Stimulators are indices whose increase shows improved overall performance of the object of study (for example, capital productivity, return on assets, turnover ratio), and destimulators, on the contrary, show a deteriorated performance (for example, depreciation coefficient, retirement rate, duration of one turnover of floating assets).

We shall count as *stimulators*, that is, indices whose growth has a positive effect on the overall effectiveness of reproduction of the fixed assets, capital productivity, capital-labor ratio, coefficient of productive use of fixed capital, increase rate, renewal rate and coefficient of cumulative reproduction. We shall count as *destimulators* capital intensity and retirement rate.

Division of the attributes into stimulators and destimulators is the basis for the construction of the reference vector. For this purpose it is necessary to choose the highest values of stimulators and the lowest values of destimulators from values of the matrix attributes for the entire period under study respectively. Elements of this vector have coordinates and are formed from the values of indices using the formula:

$$Z_{oi} = max\ Z_{ij}\ (stimulator)$$
$$Z_{oi} = min\ Z_{ij}\ (destimulator) \quad (6)$$

Proceeding from that, reference vector (P_0) has the following coordinates:

$$P_0 = (1{,}654;0{,}523;1{,}509;6{,}300;1{,}028;2{,}766;0{,}353;3{,}474) \quad (7)$$

The next step in the algorithm of determining taxonomic index is determination of distance between separate observations and the reference vector. This distance is calculated using the formula

$$C_{i/o} = \sqrt{\sum_{j=1}^{m}(z_{ij} - z_{oj})^2} \quad (8)$$

where Z_{ij} – standardized value of *j-th* index in period *i;*

Z_{oj} – standardized value of *j-th* index in reference vector.

After finding the above said distance, calculate the following necessary indices, namely root-mean-square deviation from this distance and the norm setting of distances (remoteness) of each unit of the aggregate from the "reference" point using the following formulas:

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$$\overline{C_o}=\frac{1}{m}\sum_{i=1}^{m} C_{io} \quad (9)$$

$$S_o = \sqrt{\frac{1}{m}\sum(C_{io} - \overline{C}_o)^2} \quad (10)$$

$$C_o = \overline{C}_o + 2S_o \quad (11)$$

The obtained distances serve as the initial values used in the calculation of taxonomy:

$$d_i = \frac{C_{io}}{C_o} \quad (12)$$

Taxonomic index itself *(K_i)* shall be determined using the formula:

$$K_i = 1 - d_i, \quad (13)$$

Values of the taxonomy coefficient for 2010–2018 calculated using the above formula are shown in Table. 5.

Table 5. Values of taxonomy coefficient characterizing general effectiveness of state regulation of the fixed capital reproduction in 2010–2018 (Source: calculations by the authors)

Years	Taxonomy coefficient K_i	Intermediate calculations				
		d_i	$C_{i/0}$	$\overline{C}_o$	S_o	C_o
2010	0,249	0,751	7,316	6,725	1,511	9,746
2011	0,197	0,803	7,821			
2012	0,205	0,795	7,745			
2013	0,269	0,731	7,125			
2014	0,549	0,451	4,392			
2015	0,640	0,360	3,509			
2016	0,223	0,777	7,576			
2017	0,225	0,775	7,554			
2018	0,231	0,769	7,491			

We shall show changes in taxonomic coefficient over time characterizing general effectiveness of state regulation of the fixed capital reproduction in 2010–2018 in Fig. 2.

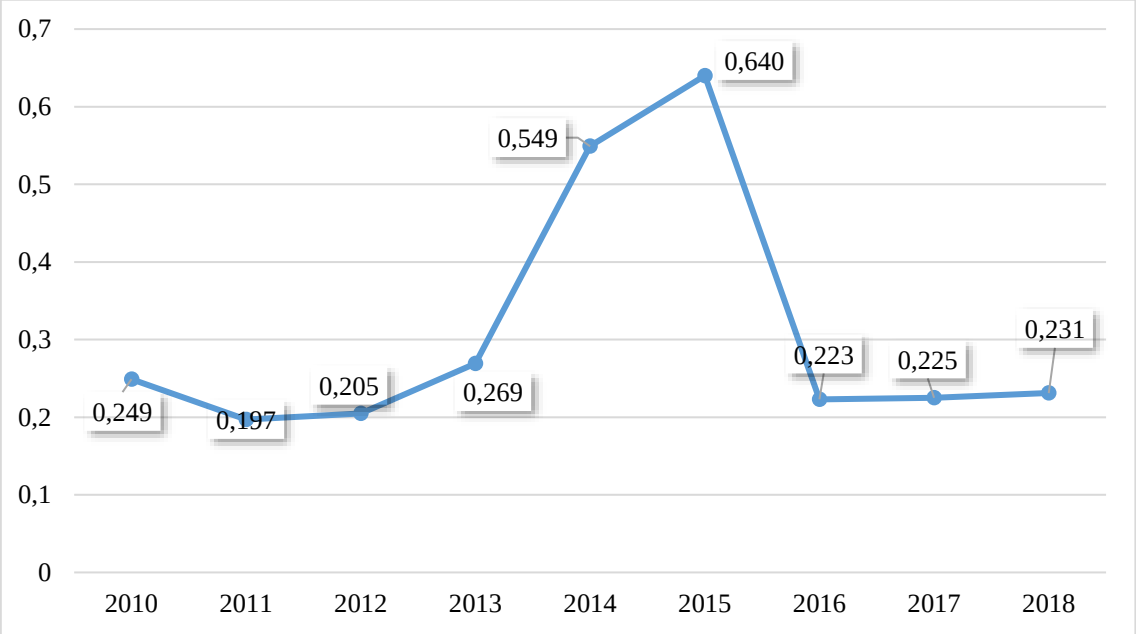

Figure 2. Changes over time in taxonomic index of effectiveness of state regulation of the fixed capital reproduction in 2010–2018 (Source: calculations by the authors)

As shown in Fig. 2 above, taxonomy coefficient was unstable during the analyzed period. Interpretation of this indicator is made in conformance with the following logic: the closer is the level of relevant component to the unit, the better is the situation towards state regulation of the fixed capital reproduction. Our study confirms that in 2015 this index was the highest and attained the value of 0.640, and in 2016-2018 it declined. This indicates a declining effectiveness of reproduction processes connected with reproduction of the fixed capital. To prevent further decline, there is a need to develop effective managerial decisions connected with reproduction of the fixed capital.

Conclusion

The conducted scientific research dealing with the problem of effectiveness of state regulation of the fixed capital reproduction in Ukraine using the method of taxonomic analysis allowed to draw the following conclusions:

1. A review of modern economic literature has shown that to date scientists have studied and explained a great number of indices that allow to evaluate the state and reproduction of the fixed capital (Cherep, 2009; Rep'jakhovsjka, 2013; Solomko, 2012; Stratijchuk & Boghacjka, 2013). At the same time, a considerable curtailment of the role of state regulation and financing of reproduction processes, lack of stability, development of globalization processes in the economic system of the state necessitates improvement and critical analysis of the system of indices, which was developed mainly during existence of the administrative-planned economic system.

2. The most important indices characterizing the state of reproduction of the fixed capital are indices of their movement and renewal that include the coefficients of renewal, growth, liquidation, depreciation, adaptability (Rep'jakhovsjka, 2013; Anas, Subaeva, Nurullin & Aleksandrova, 2018; Brovko & Ghalaghan, 2017; Gulamov, 2019). The argument in favor of these indices is that they characterize composition and structure of

the fixed assets and represent their dynamics in a certain period of time.

3. The quality and volume of renewal of the fixed assets are insufficient to ensure the desired pace and development of domestic economy of Ukraine. For most branches and sectors of the Ukrainian economy, the pressing task is a practically entire renewal of production capacities on a modern technological basis.

4. The use under modern conditions of certain indices for evaluation of effectiveness of state regulation of the fixed capital reproduction is insufficient. The main reason of this, in our opinion, is disputability and inconsistency of these indices. The way out of this situation is calculation of an integrated index, namely, the index of taxonomic analysis (Fedorova, Razzhivin, Zamkovoy, Potapova, Nikonorova & Maymina, 2017; Plyuta, 1989) that allowed to combine individual indices and became an exponent of comprehensive evaluation of state regulation of the fixed capital reproduction. Taxonomic index calculated in this scientific article shows a reduced effectiveness of reproduction processes connected with reproduction of the fixed capital.

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