KAPITEL 5 / *CHAPTER 5* [5]
CONTEMPORARY DISCOURSE AND MODELS OF MECHANISMS FOR INVESTING OF SUSTAINABLE INDUSTRIAL DEVELOPMENT IN REGIONS

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Introduction

In the conditions of dynamic progress of the economy, the solution of the development problems is gaining more attention, its relevance every day and the practical significance. This also applies the industry as one of the bases, leading types of activity for the national economies. At the same time, the entire are irreplaceable, relevant and for the integral components of industry directly. Therefore, the current state, vectors and forms, methods and prospects etc. for the sustainable development of industry respectively and vice versa are actively discussing today, tomorrow and always at various levels, in particular at the meso-level of economy.

5.1 Analysis of publications and previously unsolved parts of the problem of discourse and mechanisms for capitalizing of sustainable industrial development

As noted by [1], market value of industry, the assets depend on the values of the efficiency of use the tangible and intangible assets – the important generators of stable and growing of cash flows. In the assessment process, ability to successfully implement strategies, presence of external factors widely characterizing markets is taken into account [1; 2]. In long term, the value of assets is criterion for the optimal functioning and level of sustainable development of industry. In turn, the assessment of the market value of industry in the regions is justification the value of industrial production assets at the meso-level, purposeful, orderly process of establishment in monetary terms with mandatory expert consideration of effects number of factors in the time of competitive

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condition [4].

At the same time, the authors [3; 7; 10] noted the next: cost management to ensure increase in long term allows identifying the optimal strategic guidelines, the directions of sustainable development, developing systems of the measures for organizing the implementation of a set task. Proper analysis of literary sources [2; 4; 9] showed that in past decade many publications has appeared, on the pages of which attention was devoted to study and solution problems of the cost management of business entities in the industry. For example, according to the information provided from the columns [1; 5; 10], the issues of evaluating investment objects were dealt with by such known economists in the world of economics, founders of classical school and innovators of economic theory, with whom we are familiar and so well-known from the rank of higher education, as: Adam Smith, Alfred Marshall, Allais Maurice, Alvin Roth, Arthur Berns, Bertil Ohlin, Cyril Northcote, Friedrich Behrens, Gill Berman, Henri Simon, Joseph Stiglitz et al. But, unfortunately, the specificity of conditions and current state of development of the investment market of countries, such as Ukraine, do not yet allow for sufficiently effective use world experience in investment support, especially for machine industry, in the systems for ensuring sustainable development of industry in the regions.

In the field of investment support the development of industry in Ukraine and abroad, in the author's opinion, it was worth highlighting, first of all, scientific works of the galaxy of representatives of the NAS of Ukraine that are quite well-known, no less significant. Among them are Oleksandr Amosha, Borus Burkynskuy et al. The analysis of some literary sources of [1; 2; 5; 6; 10] allow to assert their achievements, for the most parts, were devoted to various aspects and kaleidoscope of the issues of theory and methodology, also applied investment of domestic industry at different levels of structural analysis of economic processes (in particular, through the prism of individual or spectrums of the types of industrial activity), in colorful contexts of development of the economy. But, very often in many respects, for example, such as [1; 2; 5; 6; 10] and, unfortunately, also often in sources [3; 7; 9], the international approaches which are not preventively and properly adapted to the modern realities of

development Ukrainian investment market, to ensure the sustainable development of industry, including the macro-level of economy, were used for those purposes.

Therefore, "no sufficient research base, practical experience of…companies in investment sector have not been taken into account" [2, p. 43]. Moreover, according to the authors [4], insufficient attention has been paid so far to research the issues, solving problems of investing in the real sector, opportunities and needs of insiders has not always been taken into account. It is obvious that further attention, additional disputes require the issue of forming, implement a policy of sustainable development of industry in the regions on the basis of restitution and mechanisms adequate to the market situations which are designed to stimulate increase in the values of indicators of investment activity and the capitalization of sustainable development, innovative attractiveness of industrial production, the shares of industry in the gross added value of national economies (especially in the light of above and other circumstances) etc.

5.2 The purpose of research the discourse and mechanisms for capitalizing of sustainable industrial development in regions

This is determent the potential and real opportunities for ensuring sustainable development of industry in the regions. The general goal set, among the other things, necessitates the need to with emphasize on:

a. Develop the theoretical and methodological principles for assessing the state of depreciation of tangible assets;

b. Determine the relationships and interdependencies, establish the possibilities and strength of the impact of their depreciation on economic mechanism, the effects of assessing the value of assets using tools and functional potential of restitution, as well as capitalization models in the system of ensuring the sustainable development of industry in the regions;

c. Build the mathematical models of economy mechanism, the use of which will make it is virtually impossible to achieve the state of depreciation of assets which can really has the destructive (detrimental) impact at industry in the regions.

5.3 The methods of economy science research the discourse and mechanisms for capitalizing of sustainable industrial development in regions

The object of scientific research is process of ensuring sustainable development of industry through the prism of the regional economy, while the subject – facts and prospects of development of industry in the regions. Also, in process of determining opportunities for its kind of development interdisciplinary methods, comprehensive approach was used. The main methodological bases were scientific achievements in the economy theory and industry.

5.4 The results of research the discourse and mechanisms for capitalizing of sustainable industrial development in regions

In the author opinion, the sustainable development of industry in the regions – type of progress that is focused on ensuring the modernization of industrial products at the level of the regional economy in real-time range by reducing energy, resource and labor intensity, the duration of technological processes and cycles of industrial production, integrating production processes and service, after-sales service for the consumers of products and increasing its environmental safety. The modernization of products is nothing else than effect, consequence of increasing the efficiency of management systems, functioning and development of various economic entities. So, we are not only talking about the search for and the implementation of opportunities to modernize the technological characteristics of products, but also the need for much more thorough specification, detailing of concepts, content of development process of industrial manufacturers in accordance to modern industrial paradigms of policy.

The main imperative for organizing sustainable development of industry in the regions is principle of refusing use the tangible and intangible assets that do not meet the progressive modern conditions for formation of market relations in the world and are therefore incapable of any way ensuring increase in the level of competitiveness of industrial products.

The presence of the different types of fixed assets in the regional industry, at the same time, characterized by the levels of depreciation, requires average assessment of level of depreciation of fixed assets as a whole. Such assessment allows, in particular, to identifying the general picture of the level of depreciation of the entire set of fixed assets and to find out what extent this level of depreciation affects the efficiency of industry in the regions.

Obviously, there is certain level of depreciation of fixed assets in the regional industry that can be quite considered as detrimental for future operation. The precise formulation of detrimental level of the depreciation of fixed assets (or DLDFA) of industry in regional concepts requires the introduction of certain restrictions and assumptions relating to main items of the ability of regional industry to:

a. Ensure the volume of results from operating activities (revenue and profits) in the future at the level least as high as the current one and reproduction of fixed assets in order to achieve the requirements for the future parameters of activities solely at the expenses of own sources of the funds in the regional industry, i.e. without use additional funds received or contributions to increase authorized capital;

b. Operate for unlimited period of time.

If existing the depreciation level of fixed assets is not great with existing internal capabilities in the regional industry regarding the simple restitution of fixed assets, it would not to ensure that fulfillment of three requirements listed above. Then value of the level of depreciation will not be the detrimental, although at a certain level it may cause concern among insider' industrial enterprises. In this regard, it is also necessary to introduce and quantitatively characterize of normal level of depreciation of fixed assets in the regional industry concepts. If at least one of the three requirements listed above is not met for the regional industry, then DLDFA of industry in the regions can't be considered satisfactory.

From considerations it is follows that in the context of the problem posed and necessary to solve tasks:

1. To develop the methodological principles for determining degree of DLDFA of industry in the regions which the level of depreciation refers to normal;

2. To determine the impact of DLDFA of industry in the region on mechanism and results of assessing its value as holistic complex using the capitalizing income;

3. To form the organizational and economic mechanisms that would allow the regional industry to timely avoid DLDFA exceeding its normal value.

Thus, in view of the above, we shall distinguish main types of depreciation of fixed assets in the regional industry, according to its level:

a. Permissible (to ensure the simple restitution of fixed assets in the regional industry using only the future flow of depreciation deductions for their renovation);

b. Determinable (not be able to carry out the simple restitution of fixed assets in the regional industry when using future flows of profit and depreciation deductions).

Derived DLDFA of industry in the regions can be distinguished in these ways:

1. Low (not exceeds value of the normal level of DLDFA);

2. Average (the value of the permissible level is less than the DLDFA);

3. High (the value is equal to or exceeds the DLDFA of industry in the regions).

At a given time, depending on the low, medium and high levels of DLDFA of industry in the regions action to normalize derived these levels would be different if levels are:

a. Low (can use only a depreciation deduction to ensure the simple restitution of fixed assets of industry in the regions);

b. Average (to ensure simple restitution of production potential must, in addition to depreciation deductions, use part of future profit in order to implement measures to renew the fixed assets in the regional industry and task is to determine the size of this part of profit, its change over time);

c. High – the industry of regions has such base options: either to intensify the process of investing own sources of funds in renewal of production apparatus (in this case the volume of DLDFA of industry in the regions will normalize over time due to decommissioning of obsolete assets, but the simple restitution will not be achieved); the sources of funds to attract of external sources are additional contributions to authorized capital (in particular the bank loans) in order to capitalization large-scale programs of renewal fixed assets in the regional industry.

In order to determination the parameters of DLDFA of industry in the regions it is first necessary to establish how the level of depreciation was calculated in every one of a particular case. So, at the same time, the most possible cases of determining DLDFA of industry in the regions are the following values:

1. Market (ratio of the market value of DLDFA of industry in the regions to the market initial value of assets);

2. Actual of operating time (ratio of actual time worked from the moment of putting of fixed assets in the regional industry during operations to duration of the effective functioning of industrial enterprises).

First of all, we propose to consider the first case of measuring the DLDFA of industry in the regions examining this case of separate element of its assets with subsequent extrapolation results obtained to entire set of fixed assets of industry in the regions industry. Therefore, industry in the regions will have time to accumulate amount of funds for timely replacement of fixed assets at the expense in the net cash flow from operations during time remaining before termination of operation if the left side of the condition (1) [3; 7; 10] is modified to as follow and met

$$\beta(1+\gamma)^{\gamma} = \alpha = \left[\beta(1+\gamma)^{\delta}\right] \rightarrow min, \quad (1)$$

where α – the cost element of fixed assets of industry in the regions, monetary units (m.u.);

β – the residual value of fixed assets of industry in the regions which has been in the operation a year (m.u.);

γ – the industrial enterprises annual average standard discount rate, the fractions of a unit;

δ – the effective service life of the element of fixed assets of industry in the regions, years.

DLDFA of national industry in the regions at market value is determined by the next formula:

$$\varepsilon = \left[\frac{1-\beta}{\alpha}\right] \rightarrow max, \quad (2)$$

where ε – DLDFA of industry in the regions at the market value.

Then, according to formula (1), the value of DLDFA of industry in the regions is

determined by the expressions (3) and (4)

$$\epsilon = \left[1 - \left(\frac{\beta}{\alpha}\right)\right] \rightarrow max; \quad (3)$$

$$\epsilon = \left[1 - (1+\gamma)^{\delta}\right] \rightarrow max, \quad (4)$$

where ϵ – the value of DLDFA of industry in the regions.

In the terms of economical and math analysis, the conditions (3) and (4) can be presented by the following formula:

$$\epsilon = \left[1 - \left(\theta^{\delta\gamma}\right)\right] \rightarrow max. \quad (5)$$

If we shall indicate the number of years left to operate the item of fixed assets of industry in the regions as expression (6)

$$\delta_1 = [\delta - n] \rightarrow max, \quad (6)$$

where δ_1– the ordinal numbers of years left to the operate items of fixed assets of industry in the regions, we can also establish such dependencies that follow directly from the next formulas:

$$\gamma = \left[\left(\frac{1}{\delta_1}\right)\theta_1\left(\frac{1}{(1-\epsilon)}\right)\right] \rightarrow min; \quad (7)$$

$$\delta_1 = \left[\left(\frac{1}{\gamma}\right)\theta_1\left(\frac{1}{(1-\epsilon)}\right)\right] \rightarrow max. \quad (8)$$

The visualization and quantitative illustration of the dependencies (3–5) is given in the Table 1 respectively.

Table 1 - Adaptive identification of indicators values of the DLDFA of Ukrainian industry in the regions during 2015–2024[1]

Indicators	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	2	3	4	5	6	7	8	9	10	11
ADR[2]	DLDFA									
0.05	0.04	0.09	0.13	0.18	0.22	0.25	0.29	0.32	0.36	0.39
0.06	0.05	0.11	0.16	0.21	0.25	0.3	0.34	0.38	0.41	0.45
0.07	0.06	0.13	0.18	0.24	0.29	0.34	0.38	0.42	0.46	0.5
0.08	0.07	0.14	0.21	0.27	0.32	0.38	0.42	0.47	0.51	0.55
0.09	0.08	0.16	0.23	0.3	0.36	0.41	0.46	0.51	0.55	0.59
0.1	0.09	0.18	0.25	0.32	0.39	0.45	0.5	0.55	0.59	0.63
0.11	0.1	0.19	0.28	0.35	0.42	0.48	0.53	0.58	0.62	0.66
0.12	0.11	0.21	0.3	0.38	0.45	0.51	0.56	0.61	0.66	0.69
0.13	0.12	0.22	0.32	0.4	0.47	0.54	0.59	0.64	0.68	0.72
0.14	0.13	0.24	0.34	0.42	0.5	0.56	0.62	0.67	0.71	0.75
0.15	0.13	0.25	0.36	0.45	0.52	0.59	0.65	0.69	0.74	0.77
0.16	0.14	0.27	0.38	0.47	0.55	0.61	0.67	0.72	0.76	0.79
0.17	0.15	0.28	0.39	0.49	0.57	0.63	0.69	0.74	0.78	0.81
0.18	0.16	0.30	0.41	0.51	0.59	0.66	0.71	0.76	0.8	0.83
0.19	0.17	0.31	0.43	0.53	0.61	0.68	0.73	0.78	0.81	0.85
0.2	0.18	0.32	0.45	0.55	0.63	0.69	0.75	0.79	0.83	0.86
0.21	0.18	0.34	0.46	0.56	0.65	0.71	0.77	0.81	0.84	0.87
0.22	0.19	0.35	0.48	0.58	0.66	0.73	0.78	0.82	0.86	0.88

Indicators	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	2	3	4	5	6	7	8	9	10	11
0.23	0.2	0.36	0.49	0.6	0.68	0.74	0.8	0.84	0.87	0.89
0.24	0.21	0.38	0.51	0.61	0.69	0.76	0.81	0.85	0.88	0.9
0.25	0.22	0.39	0.52	0.63	0.71	0.77	0.82	0.86	0.89	0.91
DLDFA	ADR									
0.5	0.69	0.34	0.23	0.17	0.13	0.11	0.09	0.08	0.07	0.06
0.53	0.75	0.37	0.25	0.18	0.15	0.12	0.1	0.09	0.08	0.07
0.55	0.79	0.39	0.26	0.19	0.15	0.13	0.11	0.09	0.08	0.07
0.58	0.86	0.43	0.28	0.21	0.17	0.14	0.12	0.1	0.09	0.08
0.6	0.91	0.45	0.3	0.22	0.18	0.15	0.13	0.11	0.1	0.09
0.63	0.99	0.49	0.33	0.24	0.19	0.16	0.14	0.12	0.11	0.09
0.65	1.04	0.52	0.34	0.26	0.21	0.17	0.15	0.13	0.11	0.1
0.68	1.13	0.56	0.37	0.28	0.22	0.18	0.16	0.14	0.12	0.11
0.7	1.2	0.6	0.4	0.3	0.24	0.2	0.17	0.15	0.13	0.12
0.73	1.3	0.65	0.43	0.32	0.26	0.21	0.18	0.16	0.14	0.13
0.75	1.38	0.69	0.46	0.34	0.27	0.23	0.19	0.17	0.15	0.13
0.78	1.51	0.75	0.5	0.37	0.3	0.25	0.21	0.18	0.16	0.15
0.8	1.6	0.8	0.53	0.4	0.32	0.26	0.22	0.2	0.17	0.16
0.83	1.77	0.88	0.59	0.44	0.35	0.29	0.25	0.22	0.19	0.17
0.85	1.89	0.94	0.63	0.47	0.37	0.31	0.27	0.23	0.21	0.18
0.88	2.12	1.06	0.7	0.53	0.42	0.35	0.3	0.26	0.23	0.21
0.9	2.30	1.15	0.76	0.57	0.46	0.38	0.32	0.28	0.25	0.23
0.93	2.65	1.32	0.88	0.66	0.53	0.44	0.37	0.33	0.29	0.26
0.95	2.99	1.49	0.99	0.74	0.59	0.49	0.42	0.37	0.33	0.29
0.98	3.91	1.95	1.3	0.97	0.78	0.65	0.55	0.48	0.43	0.39

1. Generalized results of mathematical modeling of the technological process of calculating indicator values and computer processing of experimental data. 2. ADR – the industrial enterprises annual discount rate.

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In turn, systematized results of calculations the indicator value of the remaining period of the operating time with DLDFA of industry in the regions by dependency (6) are shown in the Table 2.

Table 2 - Adaptive identification of indicators value of the remaining operating time include DLDFA of Ukrainian industry in the regions during 2015–2024[1]

DLDFA	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	ROT[2]									
1	2	3	4	5	6	7	8	9	10	11
	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.23
0.5	13.86	9.9	7.7	6.3	5.33	4.62	4.08	3.65	3.3	3.01
0.53	15.1	10.79	8.39	6.86	5.81	5.03	4.44	3.97	3.6	3.28
0.55	15.97	11.41	8.87	7.26	6.14	5.32	4.7	4.2	3.8	3.47
0.58	17.35	12.39	9.64	7.89	6.67	5.78	5.1	4.57	4.13	3.77
0.6	18.33	13.09	10.18	8.33	7.05	6.11	5.39	4.82	4.36	3.98
0.63	19.89	14.2	11.05	9.04	7.65	6.63	5.85	5.23	4.73	4.32
0.65	21	15	11.66	9.54	8.08	7	6.18	5.53	5	4.56
0.68	22.79	16.28	12.66	10.36	8.76	7.6	6.7	6	5.43	4.95
0.7	24.08	17.2	13.38	10.95	9.26	8.03	7.08	6.34	5.73	5.23
0.73	26.19	18.7	14.55	11.9	10.07	8.73	7.7	6.89	6.23	5.69

DLDFA	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	ROT[2]									
0.75	27.73	19.8	15.4	12.6	10.66	9.24	8.15	7.3	6.6	6.03
0.78	30.28	21.63	16.82	13.76	11.65	10.1	8.91	7.97	7.21	6.58
0.8	32.19	22.99	17.88	14.63	12.38	10.73	9.47	8.47	7.66	7
0.83	35.44	25.31	19.69	16.11	13.63	11.81	10.42	9.33	8.44	7.7
0.85	37.94	27.1	21.08	17.25	14.59	12.65	11.16	9.98	9.03	8.25
0.88	42.41	30.29	23.56	19.28	16.31	14.14	12.47	11.16	10.1	9.22
0.9	46.05	32.89	25.58	20.93	17.71	15.35	13.54	12.12	10.96	10.01
0.93	53.19	37.99	29.55	24.18	20.46	17.73	15.64	14	12.66	11.56
0.95	59.91	42.8	33.29	27.23	23.04	19.97	17.62	15.77	14.27	13.02
0.98	78.24	55.89	43.47	35.56	30.09	26.08	23.01	20.59	18.63	17.01

1. Generalized results of mathematical modeling of the technological process of calculating indicator values and computer processing of experimental data. 2. ROT – the remaining operating time.

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As follows from data of the Tables 1–2, in the general case, there is no constant of the value of DLDFA of industry in the regions, that is, even with the high level of depreciation, for example, much more than 90 per cents, under a certain conditions the level of depreciation is not detrimental, because for this the years left to operate these items of fixed assets in the regional industry and industrial enterprises annual discount rate must be large enough.

So, t would be noted that the value of the DLDFA of industry in the regions significantly depends on how the value of the net cash flow from the operation of given element of fixed assets in the regional industry are distributed during the period of operation time. The list of the characteristics of distribution may be significantly different for different types of elements of fixed assets in the regional industry.

In order to the scientific results of the studies [1; 2; 3; 7; 9; 11; 13; 14], values of DLDFA of industry in the regions at the end of clearly defined period of time – year, decade etc., the last year has not to be no less than, but not way the detrimental, it is sufficient if the conditions (9) and (10) is met

$$\left[\frac{\left(\frac{\mu}{(1-\varepsilon)}\right)\theta_1^{\gamma\delta}}{\left(\left(\theta_1^{\gamma\delta}\right)-1\right)}\right] > \vartheta; \quad (9)$$

$$\left[\left(\left(\frac{1}{\gamma}\right)\theta_1\left(1+\left(\frac{\vartheta}{\mu}\right)\left(1-\left(\theta_1^{-\gamma\delta}\right)\right)+\theta_1^{-\gamma\delta}\right)\right)\right] > \mu, \quad (10)$$

where ϑ and μ – the indicators value of the net cash flow from the operation of fixed assets of industry in the regions during the first and the following years, m.u.;

ε – DLDFA of industry in the regional industry at the end of the second (and or the last) year of two periods of time.

Thus, this example illustrates the fact – there is not certain determined the value of DLDFA of industry in the regions. Given the trend of the different changes the value of the net cash flow from the operation of fixed assets of industry in the region throughout the period of time, there is fairly long time for the effective service life the element of fixed assets of industry in the regions if the depreciation levels of approaching unity can be, theoretically, non-detrimental.

Now we disseminate the obtained results of calculation of the value of the DLDFA of industry in the regional industry only for the case of entire set of fixed assets of industry in the regions. So, it will not be detrimental if the following inequality holds:

$$\left[\sum \frac{\rho}{(1+\gamma)\rho}\right] > \pi, \quad (11)$$

where π – the total residual value of fixed assets of industry in the regions, m.u.;

ρ – the indicator value of the initial cost of fixed assets of industry in the regions which have been in operation year left before it ends (m.u.).

If we taking into account generalized results of research [1; 3; 10], expression (11) for regional industry can be presented in the form of the next formula:

$$\left[\tau\left(\sum \frac{\sigma}{(1+\gamma)\rho}\right)\right] > \pi, \quad (12)$$

where τ – the total residual value of the initial cost of fixed assets of industry in the regions, m.u.;

σ – the indicator value of the share of fixed assets of industry in the regions which has been in using (or operation) year left before it ends in the total value of the initial cost of fixed assets.

Accordingly, the value of DLDFA of industry in the regions, then the entire set of these assets will correspond as conditions (13)

$$\left[1 - \left(\sum \frac{\sigma}{(1+\gamma)\rho}\right)\right] > \varphi, \quad (13)$$

where φ – the value of DLDFA and the entire set of fixed assets of industry in the regions.

From the event of estimating the indicator value of DLDFA of industry in the regions at the market value let is move on to the case of provision estimating the level

of depreciation of its assets based on the useful (effective service) life the element of assets and consider the separate element of fixed assets of industry in the regions.

At the same time, it is worth recalling the following fact: value of DLDFA of industry in the regions significantly depends on how the values of the net cash flow from the operation of fixed assets are distributed over of operating time.

It is obvious that one of the most favorable theory, methodological and practical events – the indicator value of the net cash flow from the operation of given element of fixed assets in the regional industry, remain unchanged and turns to 0 (or negative) immediately after end of the operating time. It is latter case characterizes limiting situation and, therefore, the condition of DLDFA of industry in the regions obtain the basis of the consideration will also be limited. The last are obtained the maximum limits of the DLDFA of industry in the regions. In author opinion, the maximum limit of the DLDFA of industry in the regions must have satisfy to the conditions (14–15) and equalities (16–17)

$$\left[\frac{\alpha_1\left(1-\left(\frac{1}{\theta^{\gamma\delta}}\right)\right)}{\gamma}\right] \rightarrow opt; \quad (14)$$

$$\left[\frac{\alpha_1(\theta^{\gamma\delta}-1)}{\gamma}\right] \rightarrow opt; \quad (15)$$

$$\left[\frac{\alpha_1(\theta^{\gamma\delta}-1)}{\gamma}\right] = \left[\frac{\alpha_1(\theta^{\gamma\delta}-1)}{\gamma}\right]; \quad (16)$$

$$\left[1-\left(\frac{1}{\theta^{\gamma\delta}}\right)\right] = [\theta^{\gamma\delta}], \quad (17)$$

where α_1 – the annual value of the net cash flow from the operation of given element of fixed assets in the regional industry that distributed over of operating time, m.u.

Thus, it is expected step that from the expression (16) obtain the equality (18)

$$\beta_1 = \left[\left(\frac{1}{\gamma\delta}\right)\theta_1\left(2-\left(\frac{1}{\theta^{\gamma\delta}}\right)\right)\right] \rightarrow min, \quad (18)$$

where β_1 – the maximum limit (upper bound) of DLDFA of industry in the regions.

Another one visualization and quantitative illustration of the dependency (17) is given in the Table 3.

In turn, quantitative illustration of the compliance with the dependence of (18) is given in the Table 4.

Table 3 - Adaptive identification of indicators value of time reserves for the effective functioning of tangible assets of Ukrainian industry in the regions during 2015–2024*

ROT	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	ADR									
1	2	3	4	5	6	7	8	9	10	11
	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.23
0.5	13.86	9.9	7.7	6.3	5.33	4.62	4.08	3.65	3.3	3.01
0.53	15.1	10.79	8.39	6.86	5.81	5.03	4.44	3.97	3.6	3.28
0.55	15.97	11.41	8.87	7.26	6.14	5.32	4.70	4.2	3.8	3.47
0.58	17.35	12.39	9.64	7.89	6.67	5.78	5.1	4.57	4.13	3.77
0.6	18.33	13.09	10.18	8.33	7.05	6.11	5.39	4.82	4.36	3.98
0.63	19.89	14.2	11.05	9.04	7.65	6.63	5.85	5.23	4.73	4.32
0.65	21	15	11.66	9.54	8.08	7	6.18	5.53	5	4.56
0.68	22.79	16.28	12.66	10.36	8.76	7.6	6.7	6	5.43	4.95
0.7	24.08	17.2	13.38	10.95	9.26	8.03	7.08	6.34	5.73	5.23
0.73	26.19	18.7	14.55	11.9	10.07	8.73	7.7	6.89	6.23	5.69
0.75	27.73	19.8	15.4	12.6	10.66	9.24	8.15	7.3	6.6	6.03
0.78	30.28	21.63	16.82	13.76	11.65	10.09	8.91	7.97	7.21	6.58
0.8	32.19	22.99	17.88	14.63	12.38	10.73	9.47	8.47	7.66	7
0.83	35.44	25.31	19.69	16.11	13.63	11.81	10.42	9.33	8.44	7.7
0.85	37.94	27.1	21.08	17.25	14.59	12.65	11.16	9.98	9.03	8.25
0.88	42.41	30.29	23.56	19.28	16.31	14.14	12.47	11.2	10.1	9.22
0.9	46.05	32.89	25.58	20.93	17.71	15.35	13.54	12	11	10
0.93	53.19	37.99	29.55	24.18	20.46	17.73	15.64	14	12.7	11.6
0.95	59.91	42.8	33.29	27.23	23.04	19.97	17.62	15.8	14.3	13
0.98	78.24	55.89	43.47	35.56	30.09	26.08	23.01	20.6	18.5	17

Generalized results of mathematical modeling of the technological process of calculating the indicator values and computer processing of experimental data.

Grouped by the author

Table 4 - Adaptive identification of dependence of the maximum limit of DLDFA on ROT and ADR of Ukrainian industry in the regions during 2015–2024[1]

ADR	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	ROT									
	5[2]	8	10	13	15	20	25	30	35	40
1	2	3	4	5	6	7	8	9	10	11
0,05	0.98	0.81	0.78	0.72	0.64	0.57	0.48	0.38	0.26	0.12
0,06	0.90	0.78	0.71	0.66	0.59	0.52	0.44	0.35	0.24	0.11
0,07	0.80	0.70	0.64	0.59	0.52	0.47	0.39	0.31	0.22	0.10
0,08	0.65	0.57	0.52	0.48	0.42	0.38	0.32	0.25	0.18	0.08
0,09	0.50	0.44	0.40	0.37	0.33	0.29	0.25	0.20	0.14	0.06
0,1	0.38	0.33	0.30	0.28	0.25	0.22	0.19	0.15	0.10	0.05
0,11	0.30	0.26	0.23	0.22	0.19	0.17	0.15	0.12	0.08	0.04
0,12	0.24	0.21	0.19	0.18	0.16	0.14	0.12	0.10	0.07	0.03
0,13	0.21	0.18	0.17	0.15	0.14	0.12	0.10	0.08	0.06	0.03
0,14	0.19	0.17	0.15	0.14	0.12	0.11	0.09	0.07	0.05	0.02
0,15	0.18	0.16	0.14	0.13	0.12	0.10	0.09	0.07	0.05	0.02
0,16	0.17	0.15	0.13	0.12	0.11	0.10	0.08	0.07	0.05	0.02
0,17	0.16	0.14	0.13	0.12	0.11	0.10	0.08	0.06	0.04	0.02
0,18	0.16	0.14	0.13	0.12	0.10	0.09	0.08	0.06	0.04	0.02
0,19	0.16	0.14	0.12	0.11	0.10	0.09	0.08	0.06	0.04	0.02

ADR	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	ROT									
	5[2]	8	10	13	15	20	25	30	35	40
1	2	3	4	5	6	7	8	9	10	11
0,2	0.15	0.13	0.12	0.11	0.10	0.09	0.07	0.06	0.04	0.02
0,21	0.15	0.13	0.12	0.11	0.10	0.09	0.07	0.06	0.04	0.02
0,22	0.15	0.13	0.12	0.11	0.10	0.09	0.07	0.06	0.04	0.02
0,23	0.14	0.13	0.11	0.11	0.09	0.08	0.07	0.06	0.04	0.02
0,24	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.04	0.02
0,25	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.05	0.04	0.02

1. Generalized results of mathematical modeling of the technological process of calculating indicator values and computer processing of experimental data. 2. The years.

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So, as evidenced from given data in the Table 3–4, maximum limit of DLDFA of industry in the regions decreases with increase industrial enterprises annual discount rate and duration of the effective service life the element of fixed assets in the regional industry.

At the same time, as in the case of assessing DLDFA of industry in the regions based at the market value, in the case of assessing DLDFA of industry in the regions based on the operating time, there are no certain constants for limiting value of the detrimental level of their depreciation.

It is obvious that sustainable development of industry in the regions seeks at least not reduces the volume level of the production potential and are interested in not reach the critical (possible detrimental) level of depreciation of these assets under any lists, the rows of conditions. At the end, it must implement reasonable depreciation policy, take into account the need of periodic renewal of fixed assets in the regional industry when distributing profit to the goals of accumulation and (or) consumption.

We propose to consider establishing much lower estimate of the magnitude of the DLDFA of industry in the regions as the optimization vectors of realization the competitive advantages of sustainable development of industry in the regions.

The first optimization vector and accordingly first hypothesis assume that the valuation of the DLDFA of industry in the regions is carried out with use income approach. Last approach, as are known from [1; 2; 3; 7; 10–15], implies discounting the value of the net cash flow from each individual operation of given element of fixed assets in the regional industry.

In view of aforementioned conditions, the valuation of the DLDFA of industry in the regions expected through conducting calculations of the initial cost of fixed assets of industry in the regions will be rather precisely determined via one of the next formulas:

$$\gamma_1 = \left[\sum_{i=1}^{i} \frac{\gamma_i}{(1+\gamma)^i}\right] \rightarrow min; \quad (19)$$

$$\gamma_1 = \left[\sum_{i=1}^{n} \frac{\gamma_1}{(1+\gamma)^i}\right] \rightarrow min, \quad (20)$$

where γ_1 – DLDFA of industry in the regions, m.u.;

γ_i – the indicators value of the net cash flow from the individual operation of given element of fixed assets in the regional industry, m.u.;

$i \in \delta \in \delta_1$ – the number of years of the effective operation the item and service life of fixed assets of industry in the regions.

Then, the residual value of the element of fixed assets of industry in the regions which has been in operation a year will be calculate by the following formulas:

$$\beta_2 = \left[\frac{\gamma_{i_n}}{(1+\gamma)^{i_n-n}}\right] \rightarrow max; \quad (21)$$

$$\beta_2 = \left[\sum_{i_1}^{i_n} \frac{\gamma_i}{(1+\gamma)^{i_n-n}}\right] \rightarrow max; \quad (22)$$

$$i_1 = [1 + i_n] \rightarrow max, \quad (23)$$

where β_2 – the value (or weight) of residual value of the element of fixed assets of industry in the regions which has been in operation a year, m.u.;

γ_{i_n} – the net cash flow from the individual operation of given element of fixed assets in the regional industry for at least a year, m.u.;

i_n – the number of years of the effective operation the item and the service life of assets of industry in the regions for at least a year plus necessary period of time, days;

n – the time lag of the effective operation the item and service life of fixed assets of industry in the regions (per month, quarter, year etc.);

i_1 – the period of time of the effective operation the item and the service life of fixed assets of industry in the regions (with necessary period of time), days.

The suitability and the residual value of DLDFA of industry in the regions which has been in operation for at least a year will be quite determined by the following formulas:

$$\alpha_2 = \left[\frac{\beta_2}{\alpha}\right] \rightarrow min; \quad (24)$$

$$\beta_3 = [1 - \alpha_2] \rightarrow min; \quad (25)$$

$$\beta_3 = \left[1 - \left(\frac{\beta_2}{\alpha}\right)\right] \rightarrow min, \quad (26)$$

where α_2 – the value of suitability of the DLDFA of industry in the regions which has been in operation for at least a year, m.u.;

β_3 – the residual value of the DLDFA of industry in the regions which has been in operation a year, m.u.

The second optimization vector and the additional (so-called reserve) hypothesis assume – the net cash flow from the operation of given element of fixed assets in the regional industry all over the years is non-increasing value. At the same time, the fixed assets at the expense in the value of the net cash flow from operation during the time remaining before the termination of operation or, otherwise, in operation for at least a year, that is, properly speaking, the annual value of the net cash flow from the operation of given element of fixed assets in the regional industry over of operating time does not increase compared to previous years.

In author opinion, it is worth noting: both of the above hypotheses seem quite realistic for further considering opportunities and implementation in practice. In addition, it would be noted, that for the most of fixed assets the service life exceeds much more than one decade (at least, first of all, this is relevant for Ukraine, but although far away not only and always for it), and the industrial enterprises annual discount rate are not less than zero point one tenth per year.

Given the above, it can be stated with complete confidence that whatever the trend of the net cash flow from the operation of given element of fixed assets in the regional industry during over the period of time, in the case when service life exceeds decade and the industrial enterprises annual discount rate, by the way, are not less than one tenth fractions of a unit, the residual value of the DLDFA of industry in the regions mainly corresponds to the values into much more than over forty per cent annually. Among other things, this is a clear indication that the depreciation of fixed assets of industry in the regions more forty per cent will not be detrimental level of it.

If whatever the trend of the net cash flow from the operation of given element of

fixed assets in the regional industry for at least a year, the periods of time service life and appropriately the industrial enterprises annual discount rate, the indicator values of suitability DLDFA of industry in Ukranian regions which has been in operation for at least a year, then it will be correspond to the following inequality and conditions totally:

$$\left[\frac{\left(1-\left(\frac{1}{(1+\gamma_3)^{n_i}}\right)\right)}{\left(1-\left(\frac{1}{(1+\gamma)^{i_n}}\right)\right)}\right] \leq \alpha_2; \quad (27)$$

$$\alpha = \left[\sum_{i=1}^{i_n} \frac{\gamma_n}{(1+\gamma)^i}\right] \rightarrow min; \quad (28)$$

$$\alpha = \left[\left(\frac{\gamma_n}{\gamma}\right)\left(1-\left(\frac{1}{(1+\gamma)^{i_n}}\right)\right)\right] \rightarrow min; \quad (29)$$

$$\alpha_2 = \left[\sum_{i=1}^{i_n} \frac{\gamma_m}{(1+\gamma)^i}\right] \rightarrow min; \quad (30)$$

$$\alpha_2 = \left[\left(\frac{\gamma_m}{\gamma}\right)\left(\frac{1}{(1+\gamma)^{i_n}}\right)\right] \rightarrow min, \quad (31)$$

where n_i – the value of the gap indicator of time of the effective operation the item and the service life of fixed assets of industry in the regions with consideration the number of years of operations at least period of time, days;

i_n – the least period of time of the effective operation the item and the service life of fixed assets of industry in the regions (days, months, years etc.);

γ_n – average assessment of the annual value of the net cash flow from the individual operation of given element of fixed assets in the regional industry, m.u.;

γ_m – average assessment of the annual value of net cash flow from the depreciation of the entire set of given remain element of fixed assets in the regional industry, m.u.

Otherwise, if we imply that the inequalities (32) and (33) are met

$$[\gamma_n] \geq [\gamma_m]; \quad (32)$$

$$\left[\frac{\gamma_m}{\gamma_n}\right] \leq 1, \quad (33)$$

then the indicator value of suitability of the DLDFA of industry in the regions which has been in operation for a year we shall respond to the next expressions:

$$\alpha_2 = \left[\frac{\frac{\gamma_m}{\gamma}\left(1-\left(\frac{1}{(1+\gamma)^{n_i}}\right)\right)}{\frac{\gamma_n}{\gamma}\left(1-\left(\frac{1}{(1+\gamma)^{i_n}}\right)\right)}\right] \rightarrow min; \quad (34)$$

$$\left[\frac{\gamma_m}{\gamma_n}\right]\left[\frac{\left(1-\left(\frac{1}{(1+\gamma)^{n_i}}\right)\right)}{\left(1-\left(\frac{1}{(1+\gamma)^{i_n}}\right)\right)}\right] \leq \left[\frac{\left(1-\left(\frac{1}{(1+\gamma)^{n_i}}\right)\right)}{\left(1-\left(\frac{1}{(1+\gamma)^{i_n}}\right)\right)}\right]. \quad (35)$$

If whatever the trend of the net cash flow from the operation of given element of fixed assets in the regional industry for at least a year, the periods of time of their service life and appropriately the industrial enterprises annual discount rate that is, according to the economic and math contents of the equality (5), closely correlated with the indicator value of suitability of the detrimental level of depreciation of these assets which has been in operation for at least a year, then the value of the latter, at the same time, will be corresponds to the inequality (36)

$$\left[\frac{1}{(1+\gamma)^{\gamma_m}}\right] < \gamma_1. \quad (36)$$

Since the indicator annual value of suitability of the DLDFA of industry in the regions which has been in operation for at least a year will be much detrimental if the entire flows are compounded by the industrial enterprises annual discount rate at the end of the period of time of their service life, is less than the full real, original cost. However, in the author opinion, the procedure of compounding can be carried out something differently.

So, in the case, when discount the net cash flow from the operation of given element of fixed assets in the regional industry for at least a year at the beginning of the periods of time and appropriately results of such discounting will be the residual value of the element of fixed assets in the regional industry which has been in operation for at least a year, compound all of previously received discounted value together at the end of the least periods of time of the effective operation the item and the service life of fixed assets of industry in the regions.

Then, considering that, if the conditions (37) and (38) are met

$$[\beta_2(1+\gamma)^{\gamma_m}] < \alpha_2; \quad (37)$$

$$\left[\frac{1}{(1+\gamma)^{\gamma_m}}\right] < \gamma_1, \quad (38)$$

obtained indicators value of suitability of the DLDFA which has been in operation for at least a year can have detrimental effect at the industrial enterprises in regions.

And now, from the inequality (25), it follows that

$$\left[\gamma_1\left(1-\left(\frac{1}{(1+\gamma)^{\gamma n}}\right)\right)\right] \le \left[1-\left(\frac{1}{(1+\gamma)^{\gamma m}}\right)\right]; \quad (39)$$

$$\left[\frac{1}{(1+\gamma)^{\gamma m}}\right] \le \left[1-\left(\gamma_1\left(1-\left(\frac{1}{(1+\gamma)^{\gamma n}}\right)\right)\right)\right]. \quad (40)$$

Simultaneously, on the other hand, the economic and mathematical contents of the expression (35) is valid, in fact, when the condition of the inequality (41), usually, is satisfied as

$$\left[\frac{1}{(1+\gamma)^{\gamma n}}\right] < \gamma_1. \quad (41)$$

The following necessary and the important step – to combine the expression (40) with the inequality (41) into the form of a chain of the expressions (42)

$$\left[\frac{1}{(1+\gamma)^{\gamma n}}\right] \le \left[1-\left(\gamma_1\left(1-\left(\frac{1}{(1+\gamma)^{\gamma m}}\right)\right)\right)\right] < \gamma_1. \quad (42)$$

From a chain of the inequalities (42) we obtain that

$$\left[1-\left(\gamma_1\left(1-\left(\frac{1}{(1+\gamma)^{\gamma n}}\right)\right)\right)\right] \le \gamma_1; \quad (43)$$

$$\left[\frac{1}{\left(2-\left(\frac{1}{(1+\gamma)^{\gamma n}}\right)\right)}\right] \le \gamma_1, \quad (44)$$

and consider the right-hand side of listed the expression (44) into the form of already known function (45)

$$(1+\gamma)^{\gamma n}. \quad (45)$$

As we can see, the function (45) is function with monotonically decreasing – it means: as usually, the minimum value of the right-hand side of the inequality (44) will be obtained if the function (45) heading to infinity; hence, in this case, minimum value of the right-hand side of the expression (44) transforms into the next formula:

$$\left[\lim_{(1+\gamma)^n\to\infty}\left(\frac{1}{\left(2-\left(\frac{1}{(1+\gamma)^n}\right)\right)}\right)^m\right] \to 0.5. \quad (44)$$

The generalization of the results of multi-criteria analysis, system modeling and vector optimization of the DLDFA of industry in the regions allows stating that it would be noted – for the most of industries the average service life of fixed assets in Ukrainian regions exceeds twenty years. Thereby, under such conditions, the value of

the right-hand side of the equality (24) will not exceed values of zero point five tenth and therefore DLDFA of industry in the regions which does not exceed forty six per cent will not be the detrimental for Ukrainian industries.

Conclusions

Summary of scientific results obtained allow drawing the following conclusions:

a. Evolutionary or revolutionary increase value of the levels of competitiveness of industry, in particular, at the meso-level is the number of strategically important challenges and therefore systemic task. Fulfilling task by increasing the added value and the level of efficiency of the infrastructure through balanced mass involvement of not only cheap, but also very qualified labor in combination with other measures will ensure systematically synergistic sustainable development of industry in the regions. In the lists of measures, extremely special attention would be paid, for example, to the formation of a policy of sustainable development of industry in the regions on the base of reproduction and applied mechanisms adequate to the market situations. It would be noted that the use of a policy in conjunction with corresponding models of mechanisms can encourage an increase in the level of structural rationalization and much more efficient use the material assets in production;

b. Was determined the potential and actual (or real) opportunities for sustainable development of industry in the regions with emphasize on: develop the theoretical, methodological principles for assessing state of depreciation of the tangible assets of industry in the regions; determine the relationships and interdependencies, establish the possibilities and strength of the impact of depreciation on economy mechanisms, effects of assessing the value of assets use the tools and functional potential of the restitution, as well as capitalization models in the system of ensuring the sustainable development of industry in the regions; build mathematical models of mechanisms using of which will make virtually impossible to achieve the state of depreciation of assets that can has the detrimental impacts at industry in the regions;

c. Was formed a policy of the sustainable development of industry in the region on the basis of restitution, economy mechanisms that adequate to market situations and which are designed to ensure the next stimulation of increases to the investment

activity, and innovative attractiveness of industry etc.;

d. Where presented the methodological principles of state economy diagnostics of depreciation the tangible assets of national industry; generalized results of analysis relationships, interdependencies, possibilities and strength influence of depreciation the assets at mechanisms, the effects of determining the value of assets through using the tools and the functional potential of restitution, the mathematical models of the direct capitalization in the system of ensuring sustainable development of industry; built the mathematical models of mechanisms on the basis of taking into account the influences of the time lags using of which will actually make it impossible for the assets to achieve state that will destructively for industry in the regions.

e. Was presented the methodological approaches to involve the formation policy of the sustainable development of industry in the regions on the basis of restitution will allow to the optimize depreciation of tangible assets of industry at the meso-level with built the models of economy mechanisms of the development capitalization by determine the detrimental and standard indicator values of the depreciation of fixed capital of industry in the regions;

f. The standard indicator values of the depreciation of fixed capital of industry in the regions focused on the ensuring easy playback and which generally involves the use of the depreciation of fixed capital of industry in the regions for the capitalization of renovations; in turn, the detrimental does not even include easy playback. In the case of assessing the state of depreciation of the tangible assets of industries in the regions at the market values and taking into account the time lags of the effective operation of fixed assets there is no certain constant limiting the DLDFA of industry at the meso-level of Ukrainian economy.

The prospects for further scientific research may concern the formulation of relevant methodical recommendations for implementation a policy of the sustainable development of industry in the regions on the basis of restitution and the economy mechanisms that adequate to market situations which are designed to ensure the next stimulation of increases investment activity, innovative attractiveness of the industrial production, as well as the share in the gross added value of the national economy.