Innovative Approach to Evaluation of the Decoupling Phenomena in Making Decision on Investment of Agro-Business

Alla Tkachenko, Nataliia Levchenko, Tatyana Pozhuieva, Nataliia Chupryna

Abstract— The author's suggestions for improving the method of assessing the effectiveness of the implementation of state environmental policy of the country by supplementing the list of common environmental performance indicators, indicators of the decoupling phenomenon, which are based on indicators of economic growth in both the country as a whole and individual industries are presented in the article. Implementation of these proposals in practice will ensure that the government makes clear and prudent decisions about increasing agricultural production, saving the environment and using natural resources to meet the modern needs of mankind and the interests of future generations in food security, safety and health.

Keywords: decoupling, impact decoupling, resource decoupling, gross agricultural production

I. INTRODUCTION

In the face of aggravated global food and climate change problem, intensifying the search for ways to solve them for the agrarian business of Ukraine with its powerful potential and favourable natural and climatic conditions opens ample opportunities. Therefore, agrarian business should be recognized as one of the most promising areas of business in Ukraine in the light of these problems. Therefore, a number of strategic documents and regulations have been adopted in order to make the country a strong and independent government of Ukraine that creates the foundations for the economic development of agricultural production. Among them, special attention is paid to "Agrostrategy-2030", which is expected in the next decade to create Ukraine a world food supermarket and an organic hub [1].

Today, Ukraine is in the first place in the world food market in sunflower oil, fourth in corn and barley, fifth in wheat, and so on. [2]. According to the results of 2018, the share of agricultural production in GDP is over 10%. According to estimates by experts of the Ukrainian Institute of the Future (UIF) and Latifundist Media, it is expected to increase to 17% in the next decade, with an increase in GDP

by $ 80 billion and an increase in budget revenues by $ 15 billion [1].

However, it should be remembered that the increase in agricultural production is accompanied by environmental threats, which requires the government to ensure a balanced environmentally-oriented development of agrarian business, and thus to meet the interests of future generations in food security and reduce environmental sustainability.

It is possible to estimate the rate of depletion of an ecosystem with the increase in agricultural production due to the effect of decoupling (from English *decoupling* is demarcation, separation, separation, disruption of communication) [13], which undoubtedly makes the study of the method of its assessment quite relevant.

II. METHOD

Construction of statistical data on capital investment dynamics due to correlation-regression analysis and output of gross output of agricultural non-linear multiple dependence of CO_2eq emissions into the atmosphere from stationary sources of pollution of agribusiness.

III. LITERATURE REVIEW

For the first time, the concept of "decoupling" was used by the Organization for Economic Co-operation and Development (OECD) in the program document "An Environmental Strategy for the First Decade of the 21st Century" (2001), and meant a disconnect between "negative environmental impact" and "economic benefits" [13]. It has been used to this end in Thematic Strategy on the sustainable use of natural resources (2005) [18] and in Roadmap to a Resource Efficient Europe (2011) [15].

However, with the Assessment of resource efficiency indicators and targets (Final report - 2012) [5] and with the launch of the UNEP Decoupling Natural Resource Use and Environmental Impacts from Economic Growth [8] report, the concept of "decoupling" has become more widely interpreted, namely as a key principle of the inconsistency of traditionally formed interconnected processes of development of economic growth, volumes of consumed natural resources and pollution of the environment, which provides for meeting the growing needs of society while minimizing the consumption of natural capital [8].

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In domestic practice, the concept of "decoupling" is not widely used because of the meagre amount of its studies. And so, interpretations of its content component by domestic scholars mainly rely on the etymology of the borrowed English-speaking term (Table 1):

Table 1: Interpretation of the definition of "decoupling"

Author	Content component
Barzhyna A. [3]	decoupling is the phenomenon of the difference between economic growth and reducing the pressure on the environment
Vatchenko O. Svystun K. [6]	decoupling is breaking the link between the growth of economic volumes or rates and the increase in volumes or rates of exploitation of resources or harmful anthropogenic load on the environment and human health
Veklych O. Danylyshyn B. [7]	decoupling is a process of sustained long-term, projected and managed mismatch in economic growth trends, consumption of natural resources and environmental pollution at all stages of the life cycle.
Zabelyna Y. [9]	decoupling implies an increase in output while reducing environmental pressure on the environment
Kokovskyi L. [11]	decoupling is the delimitation of the use of natural resources from economic growth and the delimitation of the environmental impact through the use of resources
Litvak S., Litvak O. [12]	decoupling is an economic phenomenon that reflects the capacity for economic growth, which is not accompanied by increased environmental pressures
Sotnyk M.I., Kulyk L.A. [16]	decoupling is the phenomenon of the gap between economic development and the degree of anthropogenic impact on the environment
Tur O. [17]	decoupling is a strategic basis for developing a green economy that improves people's well-being and social justice while significantly reducing environmental risks and resource consumption

The results of the examination of the definitions of "decoupling" indicate that the domestic economic literature so far lacks generalized approaches to substantiate the content of this concept.

IV. RESULT AND DISCUSSION

The most accurate and complete interpretation of it is considered to be an eco-centric approach, which focuses primarily on the environmental component of economic growth, which is primarily related to the human impact on the environment and the conservation of natural resources. Therefore, according to the eco-centric approach under "decoupling" it is necessary to understand changes in the level of existing (expected) environmental threats as a result of economic growth (Fig. 1):
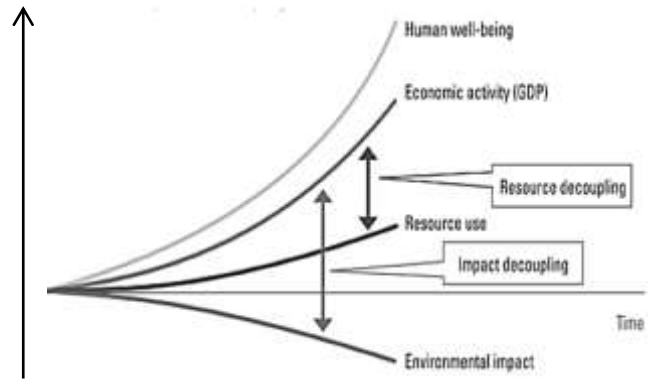

Figure 1: Graphic representation of decoupling in nature load and nature capacity
Source: [8]

Environmental threats according to the results of economic growth are dual and therefore characterized by:

resource decoupling – decoupling on the nature capacity of production (level of use in the production of natural resources);

impact decoupling – decoupling by naturally loaded (the level of impact of production on the environment [12].

Therefore, the Decoupling Index and Decoupling Factor are proposed to evaluate the decoupling effect according to the OECD methodology:

$$\text{Decoupling Index} = \frac{\left(\dfrac{EP}{DF}\right)_{ending}}{\left(\dfrac{EP}{DF}\right)_{beginning}}, \qquad (1)$$

$$\text{Decoupling Factor} = 1 - \text{Decoupling Index} \qquad (2)$$

Where:

EP (*environmental pressure*) – an indicator of anthropogenic pressure on the environment (or the amount of consumed resource),

DF (*driving force*) – economic growth indicators that are typically reflected through macroeconomic indicators, in particular gross domestic product (hereafter GDP), gross value added (hereinafter referred to as GVA) in the ending and beginning periods research [8].

With this method, we have the opportunity to evaluate the decoupling phenomenon in the whole country, and therefore to determine its position in the international rankings of global indices, which should be considered positive. However, this technique is not perfect.

Therefore, it is not without drawbacks. And the most significant of these is the lack of ability to assess the phenomenon of decoupling in the sectors of the national economy, which is, first of all, an obstacle to making clear and prudent, both tactical and strategic decisions by the government to prevent environmental threats, improve the environment and the restoration of natural resources.

We consider it is necessary to expand the list of economic growth indicators by supplementing it with indicators: gross output (at constant prices for a certain year) of a certain industry, net value added, net profit, etc. in order to be able to estimate decoupling in the sectors of the national economy.

Let's analyze accompanying the decoupling phenomenon in the increase of the gross production of agricultural production in Ukraine during 2009-2018 according to the table. 2 and make sure that the given proposals are appropriate.

Table 2: Dynamics of indicators of economic growth and environmental threats in the agricultural production of Ukraine during 2009-2018 [2]

Years	The output at constant prices mln. UAH	Emissions of pollutants into the atmosphere, thousand	Emissions of CO_2 into the atmosphere, thousand tons	Waste generation, thousand tons	Disturbance of agricultural land,	Fresh water intake, million m³
2009	197935.9	61.0	566.4	2761.4	0.6	2580
2010	187526,1	71.0	718.1	8357.7	0.3	2565
2011	225381,8	72.7	790.5	12218	0.3	2889
2012	216589,8	80.0	673.4	10199	0.6	3107
2013	246109,4	89.8	974.1	10311	0.4	3427
2014	251427,2	77.0	775.9	8451.4	0.1	3932
2015	239467,3	77.7	1110	8736.8	0.1	2989
2016	254640,5	81.6	878.5	8715.5	0.3	3156
2017	249157,0	80.3	1099	8432.3	0.2	3196
2018	269408.1	82.1	1178	5968.1	0.3	3227

For calculations we use the following notation:

V - the volume of gross agricultural production (at constant 2010 prices), million UAH;

E_{c1} - indicator of emissions of pollutants into the atmosphere, thousand tons;

E_{c2} - indicator of CO_2-eq emissions into the atmosphere from stationary sources of pollution, thousand tons;

E_{c3} - waste generation, thousand tons;

E_{c4} - arable land, thousand hectares;

E_{c5} - fresh water intake, million m³.

Hence the Decoupling Index is similar to the formula (1):

$$\text{Decoupling Index}(Ec_i, V) = \frac{K_{Eci}}{K_v}, \quad (3)$$

Where:

K_{Eci} – the chain rate of growth of environmental threats;

K_V - Chain growth rates of gross agricultural output (at constant 2010 prices);

t - year.

Here from:
$$K_{Eci} = E_{ci}(\%) - 100, \quad (4)$$
$$K_v = V_t(\%) - 100, \quad (5)$$

Where:

E_{ci}, V_t – the chain growth rate of the corresponding indicator:

$$E_{ci} = \frac{y_t}{y_{t-1}} \cdot 100 \qquad V_t = \frac{y_t}{y_{t-1}} \cdot 100, \quad (6)$$

Where:

y_t - the value of the corresponding indicator in the reporting year,

y_{t-1} – the value of the corresponding indicator in the previous year.

The Decoupling Factor calculation method does not need to be changed, and therefore this indicator must be calculated by the formula (2).

3pollutant emissions into the atmosphere K_{Ec1}, and the chain growth rates of agricultural output (at constant 2010

prices) presented in Table 2, we analyze the decoupling indices, which are summarized in Table 3 and in Fig. 2:

Table 3: Dynamics of indicators decoupling effects of pollutant substances

Years	K_{GP}, %	K_{PS}, %	Decoupling Index	Decoupling Factor
2010	-5.2591	16.3934	-3.1171	4.1171
2011	20.1868	2.3943	0.1186	0.8813
2012	-3.9009	10.0412	-2.5740	3.5740
2013	13.6292	12.25	0.8988	0.1011
2014	2.1607	-14.253	-6.5967	7.5967
2015	-4.7568	0.9090	-0.1911	1.1911
2016	6.3362	5.0193	0.7921	0.2078
2017	-2.1534	-1.5931	0.7398	0.2601
2018	8.1278	2.2415	0.2757	0.7242

Source:[own calculations]

The conducted calculations make it possible to state that during the period studied economic growth in agribusiness is caused by the use of extensive factors of the development on the basis of outdated resource and consuming technologies, the use of which is a significant eco-destructive factor, which shows the obvious need to reduce the negative impact on the environment [16].
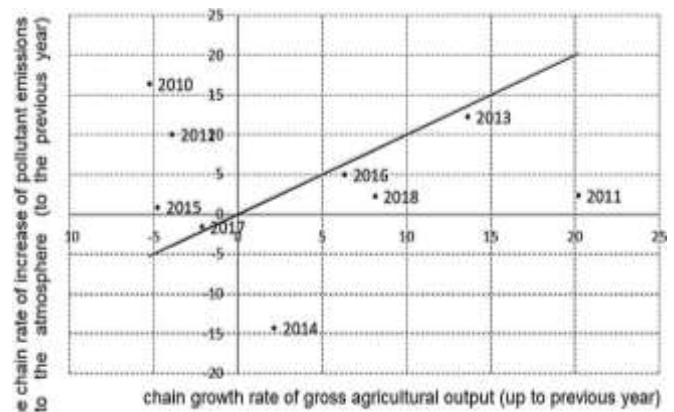

Figure 2: Dynamics of indicators decoupling effects of pollutant substances
Source: [own calculations]

By analogy with the study of the previous indicator, according to the results of the comparison of the chain growth rates of CO_2-eq emissions into the atmosphere from stationary sources of pollution K_{c2} and the chain growth rates of the gross agricultural output (at constant prices in 2010) K_{v1}, it was established that during 2009-2018, CO_2-eq emissions into the atmosphere from stationary sources of pollution are prone to reduction (Table 4 and Figure 3):

Table 4: Dynamics of indicators decoupling the impact of emissions CO_2-eq into the atmosphere from stationary sources of pollution

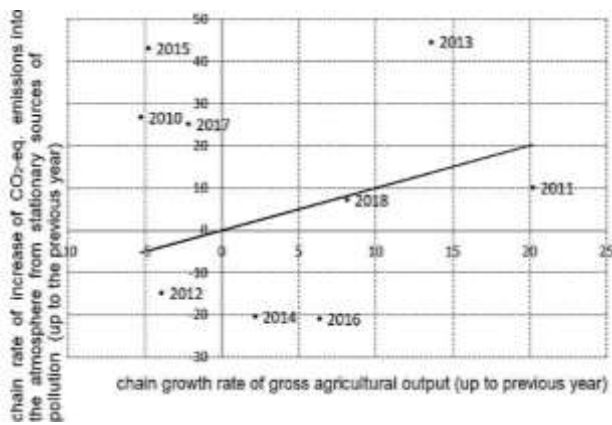| Years	K_{GP}, %	K_{PS2}, %	Decoupling Index	Decoupling Factor
2010	-5.2591	26.783	-5.0926	6.0926
2011	20.1868	10.082	0.4994	0.5005
2012	-3.9009	-14.813	3.7973	-2.7973
2013	13.6292	44.653	3.2763	-2.2763
2014	2.1607	-20.346	-9.4166	10.416
2015	-4.7568	43.111	-9.0630	10.063
2016	6.3362	-20.884	-3.2960	4.2960
2017	-2.1534	25.190	-11.697	12.697
2018	8,1278	7,1922	0,8848	0,1151

Source:[own calculations]

Figure 3: Dynamics of indicators decoupling the impact of emissions CO_2-eq into the atmosphere from stationary sources of pollution
Source:[own calculations]

The impact of waste generation on the eco-system with an increase in the volume of grosses of agricultural output by comparison of indicators K_{c3}, and K_{v1}, and is much lower than in the previous calculations, as evidenced by the calculations presented in Table 5 and Figure 4:

Table 5: Dynamics of indicators decoupling the impact of waste generation

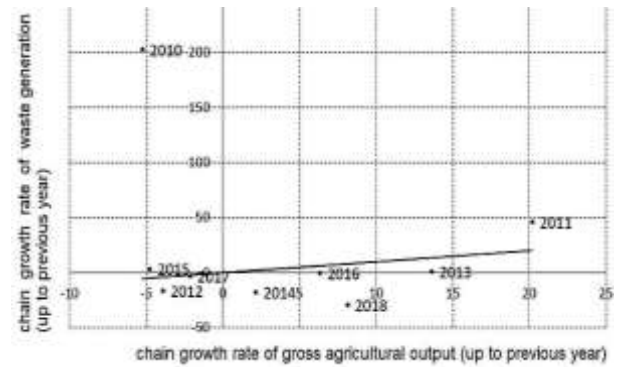| Years	K_{GP}, %	K_w, %	Decoupling Index	Decoupling Factor
2010	-5.2591	202.66	-38.534	39.534
2011	20.1868	46.193	2.2882	-1.2882
2012	-3.9009	-16.522	4.2355	-3.2355
2013	13.6292	1.1000	0.0807	0.9192
2014	2.1607	-18.041	-8.3496	9.3496
2015	-4.7568	3.3769	-0.7099	1.7099
2016	6.3362	-0.2437	-0.0384	1.0384
2017	-2.1534	-3.2493	1.5089	-0.5089
2018	8.1278	-29.223	-3.5954	4.5954

Source: [own calculations]

Figure 4: Dynamics of indicators decoupling the impact of waste generation
Source:[own calculations]

In turn, the comparison of the chain growth rates of agricultural disturbance volumes K_{c3} to the chain growth rates of gross agricultural output (at constant 2010 prices) K_{v1}, the results of which are presented in Table 6 and Figure 5, make it possible to ensure that the Government provides a saving attitude to agricultural land:

Table 6: Dynamics of indicators decoupling the impact of disturbance volumes of agricultural land

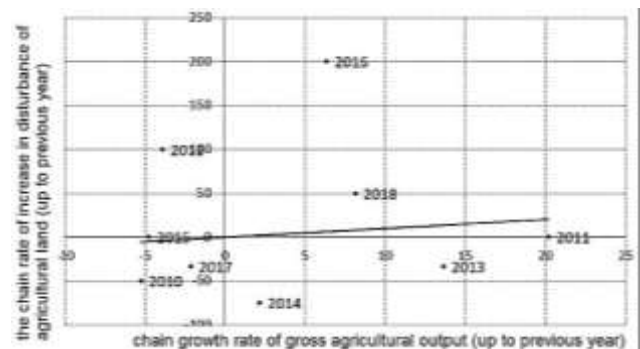| Years	K_{GP}, %	K_{AL}, %	Decoupling Index	Decoupling Factor
2010	-5.2591	-50	9.5071	-8.5071
2011	20.1868	0	0	1
2012	-3.9009	100	-25.6348	26.6348
2013	13.6292	-33.333	-2.4457	3.4457
2014	2.1607	-75	-34.7102	35.7102
2015	-4.7568	0	0	1
2016	6.3362	200	31.5645	-30.5645
2017	-2.1534	-33.333	15.4791	-14.4791
2018	8,1278	50	6,1516	-5,1516

Source:[own calculations]

Figure 5: Dynamics of indicators decoupling the impact of disturbance volumes of agricultural land
Source:[own calculations]

Attitudes to freshwater intake are characterized by comparisons of indicators K_{c5} and K_{v1}, the results of which indicate that during the period studied the decoupling phenomenon indicates the need for increased attention to the rational use of freshwater (Table 7 and Figure 6):

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Table 7: Dynamics of indicators decoupling the impact of fresh water intake volumes

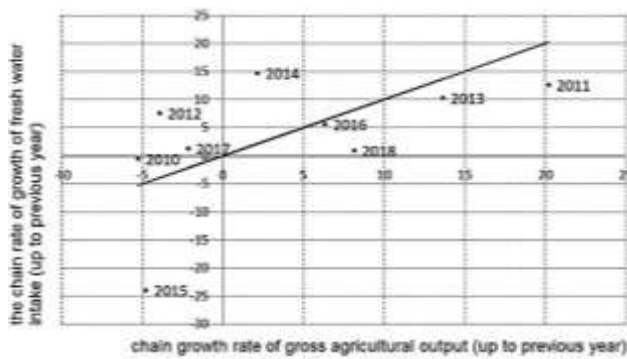| Years	K_{GP}, %	K_{AL}, %	Decoupling Index	Decoupling Factor
2010	-5.2591	-0.5813	0.1105	0.8894
2011	20.1868	12.631	0.6257	0.3742
2012	-3.9009	7.5458	-1.9343	2.9343
2013	13.6292	10.299	0.7556	0.2443
2014	2.1607	14.735	6.8198	-5.8198
2015	-4.7568	-23.982	5.0417	-4.0417
2016	6.3362	5.5871	0.8817	0.1182
2017	-2.1534	1.2674	-0.5885	1.5885
2018	8.1278	0.9699	0.1193	0.8806

Source:[own calculations]

Figure 6: Dynamics of indicators decoupling the impact of fresh water intake volumes
Source:[own calculations]

The change in the volume of gross agricultural production is undoubtedly the capital investment aimed at expanding, updating and modernizing the material and technical base of the agricultural business. Therefore, multiple nonlinear dependences are constructed according to the results of correlation-regression analysis of statistics of dynamics of capital investments and output of agricultural production, as well as CO_2-eq emissions into the atmosphere from stationary sources of pollution:

$$Y = 642,47 - 59732,25 \cdot x_1^{-0.5} + 1,34 \cdot x_2^{0.5}, \quad (7)$$

Where:

Y – CO_2-eq emissions into the atmosphere from stationary sources of pollution, thousand tons,

x_1 - capital investment, mln. UAH;

x_2 - gross agricultural output (at constant 2010 prices), mln. UAH.

Multiple nonlinear regression coefficients after initial linearization were found by the generalized least squares method in the matrix form.

The schedule of dependence of CO_2-eq emissions into the atmosphere on the volume of capital investments in the agrarian business of Ukraine and the volume of gross agricultural production (at constant prices in 2010) is presented in Table 8 and Figure 7.

The obtained coefficient of determination of the model R^2 = 0,71 approaches 1, which indicates sufficient density between the variables.

Table 8: Dependence of CO_2-eq emissions into the atmosphere on the volume of capital investments in the agricultural business
Source:[own calculations]

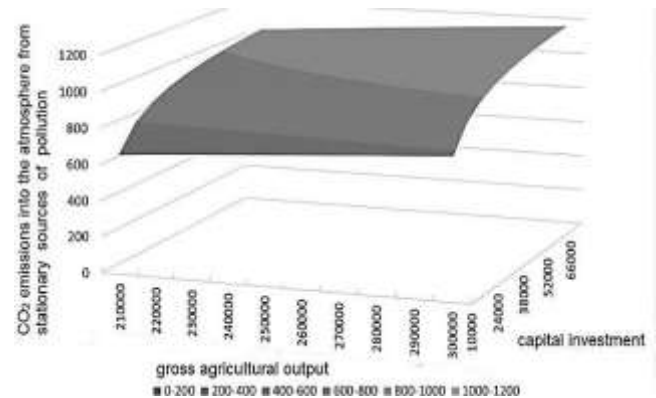| Years	CO_2 emissions, thousand tons	Capital investment, mln. UAH	Gross production, mln.UAN
2009	566.4	8237.9	197935.9
2010	718.1	10817.7	187526.1
2011	790.5	16140.9	225381.8
2012	673.4	18564.2	216589.8
2013	974.1	18175	246109.4
2014	775.9	18388.1	251427.2
2015	1110.4	29309.7	239467.3
2016	878.5	49660	254640.5
2017	1099,8	63400,7	249157,2
2018	1178,9	65059,4	269408,1

Figure 7: Dependence of CO_2-eq emissions into the atmosphere on the volume of capital investments in the agricultural business
Source:[own calculations]

The calculated value of the Fisher coefficient according to the sample data $F = 8,47$, the critical value of the Fisher coefficient $F_{kr} = 4,74$ according to degrees of freedom $k_1 = 7$, $k_2 = 2$ and the level of significance $\alpha = 0,05$.

Check according to the Fisher criterion $F > F_{kr}$ showed that with a probability of 95% can be considered is likely to suggest that the proposed mathematical model is adequate to the statistical data and its application is expedient in assessing environmental threats based on economic growth.

In particular, with the expected increase in capital investment in the volumes foreseen by "AGRO-STRATEGY – 2030" to the level of UAH 72.3 billion, the volume of gross agricultural production (at constant 2010 prices) is expected to increase to 293.1 billion UAH and CO_2-eq emissions into the atmosphere from stationary sources of pollution – up to 1143.5 thousand tons.

For fixed projected volume of gross output of agricultural production (at constant 2010 prices) 293.1 billion UAH a graph of the effect of capital investment in the agrarian business on CO_2-eq emissions into the atmosphere from stationary sources of pollution has been constructed (Fig. 8).

The reliable zone for this regression is constructed for the significance level $\alpha = 0,05$, the critical value of the Student's coefficient according to the table of values is equa $t_{kr} = 2,365$. That is, for the prediction value, the confidence interval for the prediction, calculated with reliability $p = 95\%$, is the lower

bound of the confidence zone of regression Y=504,21, and the upper bound of the confidence zone of regression Y=1782,82.
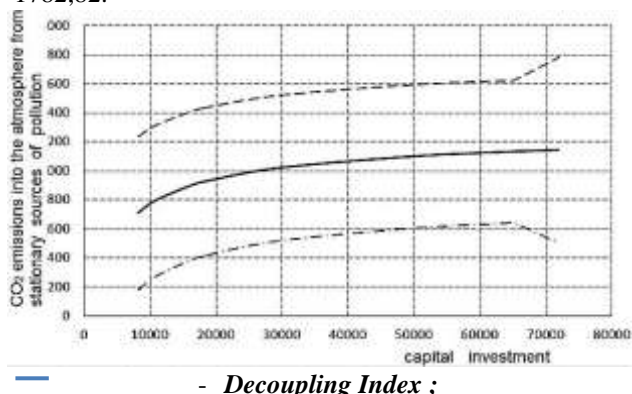
— *Decoupling Index ;*
— *The upper bound of the confidence zone of regression*
— *The lower bound of the confidence zone of regression*
Figure 8: Graph of dependence of the impact of capital investments in the agrarian business on CO_2-eq emissions into the atmosphere from stationary sources of pollution
Source: [own calculations]

V. CONCLUSIONS

Thus, according to the results of the conducted research, we come to the conclusion that the list of indicators of the evaluation of the implementation of the state environmental policy, defined by the Law of Ukraine "On Basic principles (strategy) of the state environmental policy of Ukraine for the period up to 2030" from February 28, 2019 No. 2697-VIII [14] needs to be complemented by indicators of a decapitation phenomenon based on the economic growth of both the country as a whole and individual industries, which will enable the government to make clear and well-balanced decisions to increase production, saving attitude to the environment and natural resources to meet current needs of humanity and interests of future generations in the food supply, safe and healthy environment.

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