Approaches to the Formation of a Theoretical Model for the Analysis of Environmental and Economic Development

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Abstract:

The paper considers the influence of economic development factors on the state of the environment. The subject of the research is the processes of improving the sustainable development (SD). A theoretical model for analysis of environmental and economic development was worked out based on the existing methods and a more comprehensive presentation of information on the parameters of SD. Possibilities of achieving the Environmental Kuznets Curve as the conditions for the SD improvement are determined. A minimum condition to guarantee the nonavailability of deterioration in the SD was determined to overcome the point of maximum pollution. This point describes emissions of pollutants, taking into account the accumulation effect of the pollution, which can be observed from the moment of exceeding of the assimilation potential of the environment. Proposed approaches were applied to the development analysis relative to the environmental component, the case of carbon dioxide (CO2) emissions in Ukraine. Accordingly, Ukraine has a predominantly positive trend towards the SD relative to the environmental component. This trend is partly supported by predominant decrease in specific CO2 emissions per unit of output in the economy. On the other hand, there was a significant increase in the concentration of Ukraine's CO2 emissions in the atmosphere, despite the fact that the overall level of emissions has decreased. Therefore, overcoming the tendency of increase in the concentration of pollution requires a significant increase in the environmental effects of economic activities and the coordination of actions on the international level.

Keywords: sustainable development (SD); environmental and economic development; the Environmental Kuznets Curve (EKC); greenhouse gases; carbon dioxide (CO2); economic growth.

JEL Classification: E01; Q53; Q54; Q56

Introduction

A new surge of the research into the theory of economic development aimed at identifying new determinants of growth does not allow us to make an unambiguous conclusion about a sufficient interest in the environmental factors. Most of the research works are aimed at finding these determinants in an indicator known as the Solow Residual. In some empirical studies, the dependence named the Environmental Kuznets Curve or EKC became widespread. However, the results of the works aimed at identifying the impact of economic growth on the sustainable development indicators relative to the ecological component do not prove the conclusions based on the analysis of exclusively theoretical models. As the analysis of research works aimed at identifying and studying the EKC has shown, many proposed approaches diverge in results and do not provide comprehensive information on the dynamics of an influence of the economic development factors on the quality of environmental components.

The purpose of this paper is to analyze the influence of the economic development factors on the state of the environment, to construct a comprehensive model of environmental and economic development based on the integration of available approaches and a more comprehensive presentation of the information on the sustainable development parameters.

1. Literature Review

Dependence of the level of income on the quality of the environment was first considered in 1971, in the research work of Ruttan (1971). It states that the higher the level of well-being, the lower the elasticity of demand for income on material consumption and services. On the contrary, the higher the level of well-being, the higher the elasticity of demand for the environmentally sound living conditions. Further studies were conducted by Antle and Heidebrink (1995). The authors concluded that the demand for "clean air" starts increasing when the level of income reaches a certain value.

In 1991, the scientists first empirically established a systematic relationship between per capita income and quality of the environment, which was later called the Environmental Kuznets Curve. Since that time, this method has actually become the standard for determining the level of the environmental development of a state. Grossman and Krueger (1991) carried out one of the first studies in this area. The research showed that the values of some important indicators of the quality of environmental components improve along with the growth of household incomes and the level consumption.

The EKC became widely used in the research after its popularization by the World Bank (1992) in the "World Development Report". In the report, a special attention was paid to the fact that along with the growth of incomes, the demand for improving the quality of the environment in the form of investments will grow. In addition, Stokey (1998) suggested that an economic system itself should generate the creation of an inverse U-shaped consistent pattern between income and environmental quality by means of changing the structure of supply and demand with Adam Smith's invisible hand.

A possibility of reducing the EKC trajectory in developing countries is shown in the research works of the scientists Dasgupta et al. (2002); the statistics show that the EKC trajectory for the same kinds of the environmentally destructive effects is lower in developing countries than in developed countries. This may happen due to the fact that developing countries are now more aware of the possible negative consequences of the environmentally destructive activities, whereas developed countries did not have such information.

A work of the scientists Li et al. (2007) presents a comprehensive analysis of the research on the EKC concept for various types of the environmentally destructive activity. As a result, the researchers identified the following forms of the correlation between the state of the environment and the level of economic development (in parentheses there is the number of proved dependencies): monotonous growth (22), monotonous decline (20), reverse U-shaped curve (333), U-shaped curve (25), N-shaped curve (27), weak correlation (124), absence of correlation (37). In general, only 57% of studies confirm the existence of EKC in its classical form, and in 21% of the studies, the connection is very weak. Researchers De Bruyn et al. (1995) indicate that the curve of the correlation between the pollution and the economic growth has a wave pattern. It is logical to assume that the forms of correlation in the Li et al. (2007) work can be the parts of the wave trajectory and are caused by insufficient information about the phenomena being studied. Furthermore, the correlation between the economic growth and the environmental quality was also investigated by Apergis and Payne (2010), who examined the cause-and-effect relationship between CO2 emissions, energy consumption and real output. Kaika and Zervas (2013) presented the evolution of the EKC concept. Ben Jebli et al. (2016) studied the relationship between the GDP growth, development of alternative energy and the environmental consequences. Stern (2017) explored the alternative and convergent approaches to the EKC. Zoundi (2017) examined the impact of short-term and long-term renewable energy impacts on CO2 emissions. Costanza and Daly (1992), Voronenko et al. (2017), Kattumuri (2017) dealt with the impact of consumption of natural resources on the sustainable development. Shkarupa et al. (2016), Sotnyk (2012), Kovalov et al. (2017) dealt with the impact of ecological modernization, dematerialization and tourism respectively on the sustainable development.

2. Methodology

This study is not aimed at proving the objectivity of existence of the EKC. Instead, we believe that the existence of an EKC is a necessary condition for improving the sustainable development. Thus, it becomes necessary to determine the ways of achieving it. To this end, a comprehensive model of the environmental and economic development was designed based on the integration of available approaches and a more comprehensive presentation of information on the parameters of the sustainable development.

In the designed model, a time factor is provided by determining the indicators of the level of pollution and the economic development in the form of appropriate dynamic functions. To simplify the model of environmental and economic development, the level of economic development refers to the level of output in the economy. Gross Domestic Product can be used as an indicator for the calculation. The correlation between the level of pollution and the economic development in the model is determined by decomposition of the following indicators:

$$E(t)=Q(t)\cdot E(t)/Q(t), \quad (1)$$

where $E(t)$ is the pollution level, $Q(t)$ is the level of output in the economy, $E(t)/Q(t)$ is the specific pollution (ecological destructiveness) of production.

Differentiating and logarithmizing the Eq. (1) we obtain a relationship between the absolute and specific indicators:

$$\frac{\Delta E}{E} = \frac{\Delta Q}{Q} + \frac{\Delta(E/Q)}{(E/Q)}, \qquad (2)$$

where ΔE/E, Δ(E/Q)/(E/Q) are the rates of increase in absolute and specific pollution values, respectively; ΔQ/Q is the rate of growth in output, which determines the rate of economic growth.

Sustainable development and cumulative effect do not ensure the statement and solution of the society's problems. Sustainable development implies common directions for solving the problems without a clear statement of the problems themselves. The cumulative effect is an indicator that characterizes the state of the environment and can be used to state the problem, without suggesting a way to solve it.

Nowadays, the cumulative effect occurs so often in time and densely in space that restoration of the initial state of the environment can no longer be achieved solely by means of assimilation potential of the natural environment. This effect is described by the level and direction of changes in the state of the system, while the state of the system is already different from the natural one. To account for the processes of accumulation and absorption of greenhouse gases in the atmosphere, a liability index is used. It considers this aspect by applying the approach proposed by Siegenthaler (1983) to assess the accumulated volume of carbon dioxide in the atmosphere. This approach in the form of a complex model that takes into account the oceanic and biospheric absorption processes of hydrocarbon emissions resulting from the anthropogenic activity was simplified and became a formula for finding the amount of CO2 in the atmosphere. Estimation of CO2 retained in the atmosphere is carried out according to the Eq. (3):

$$CO_{2,r} = CO_{2,0} \cdot \left(0{,}3e^{\left(-\frac{t}{7}\right)} + 0{,}34e^{\left(-\frac{t}{71}\right)} + 0{,}36e^{\left(-\frac{t}{815}\right)}\right), \qquad (3)$$

where $CO_{2,r}$ is the volume of CO2 held in the atmosphere in the *t*-th year after the emission, thousand tons; $CO_{2,0}$ is the volume of emissions in the previous period, thousand tons; t is a period, years.

In general, if a determination of the level of contamination requires consideration of accumulation and absorption of the results of the eco-destructive effects, we propose to calculate it according to the Eq. (4):

$$E(t) = \sum_{t=t_0}^{t_n} f(E_t; t_n - t), \qquad (4)$$

where E(t) is the pollution level in the period t; *f* is a function that reflects the dependence of the level of pollution on the effects of accumulation and absorption over time; t_n is a current period; t_0 is the horizon of retrospection; t_n - t is the period from the moment of pollution to the calculation.

Currently, various special indicators are used to analyze the sustainability of the development relative to CO2 emissions. Among them are production-based CO2 productivity (i.e., CO2 generated per unit of CO2 emitted in production) and demand-based CO2 productivity, proposed by OECD (2014). In addition, the streaming data is also used in the form of absolute values. We have developed an additional indicator for these purposes, which takes into account the losses from carbon dioxide emissions and characterizes the carbon productivity of the economy, based on the features of estimating the sustainable development. The developed indicator is a specific value of the country's economic performance per unit of carbon dioxide emissions from the fossil fuel use and cement production. At the same time, the economic performance in the form of a gross domestic product is corrected by the losses from these carbon dioxide emissions, as emissions into the environment lead to economic losses. Carbon dioxide damage is estimated at 20 US $ per ton of carbon dioxide (World Bank, 2016).

The indicator of the gross domestic product per unit of carbon dioxide emissions, adjusted by damages from carbon dioxide emissions, per year is calculated by the Eq. (5):

$$AEO = (GDP – DE)/E, \qquad (5)$$

where AEO is the indicator of adjusted economic output per unit of carbon dioxide emissions, US$ per metric ton; GDP is the gross domestic product at market prices, US$; DE are the damages from carbon dioxide emissions, US$; E are the carbon dioxide emissions, metric ton.

The values of the AEO indicator will be 20 US$ less than the values of the production-based CO2 productivity.

3. Case studies

Nowadays, the main arguments explaining the nature of the Environmental Kuznets Curve are as follows: technological improvement of production systems, excluding negative factors of influence; introduction of less material-intensive and energy-intensive technologies; raising public awareness of the impact of pollution on the well-being and health; increase of the elasticity of demand for "clean air"; liberalization of international trade relations; development of the open political systems.

Among the critical arguments about the EKC, the following points are highlighted: consequences of the environmental degradation cannot cause significant damage to the economic entities, and degradation of the environment cannot stop the economic growth and affect the well-being of people in the future; the structure of environmentally destructive effects is changing with the economic growth, which creates a false impression of reduction in the pollution level; the EKC is a consequence of liberalization of the international trade, when developed countries are able to reduce a negative load on the environment and transfer it to developing countries.

The development of a comprehensive ecological and economic model is conditioned by the determination of a number of shortcomings inherent in the available models. We suggest they are as follows:

• Lack of a comprehensive analysis of the quantitative and qualitative characteristics of the studied processes. In determining the "pollution–economic growth" correlation, absolute (quantitative, extensive) as well as relative (qualitative, intensive) indicators can be taken into account. Often values of the natural logarithms of the studied indicators are also used. First, a separate analysis of the absolute and relative values does not allow making a comprehensive analysis of the dynamics of environmental and economic factors, and second, it does not allow comparing the data of various studies.

• The rebound effect is not taken into account. The rebound effect develops when the high-quality environmental improvement and optimization of the environmental management processes lead to an increase in the absolute scale of the environmentally destructive activity.

• The accumulation and absorption of the results of the environmentally destructive effects by the natural systems are not taken into account. There is a law of chain-based anthropogenic connections and processes. It states that there are anthropogenic streams formed within the framework of natural and technical geo-systems, which have the opportunity to interact such a way that their summation causes a cumulative effect prompting an increase in the scale of spreading the anthropogenic changes in the environment. Consideration of this factor makes it possible to improve the accuracy of calculations, to anticipate the long-term consequences of the environmentally destructive effects.

• Only unlimited economic growth is provided for. The "pollution–economic growth" correlation does not describe the nature of change in economic indicators, suggesting only their permanent growth. An economic decline or stagnation is not taken into account.

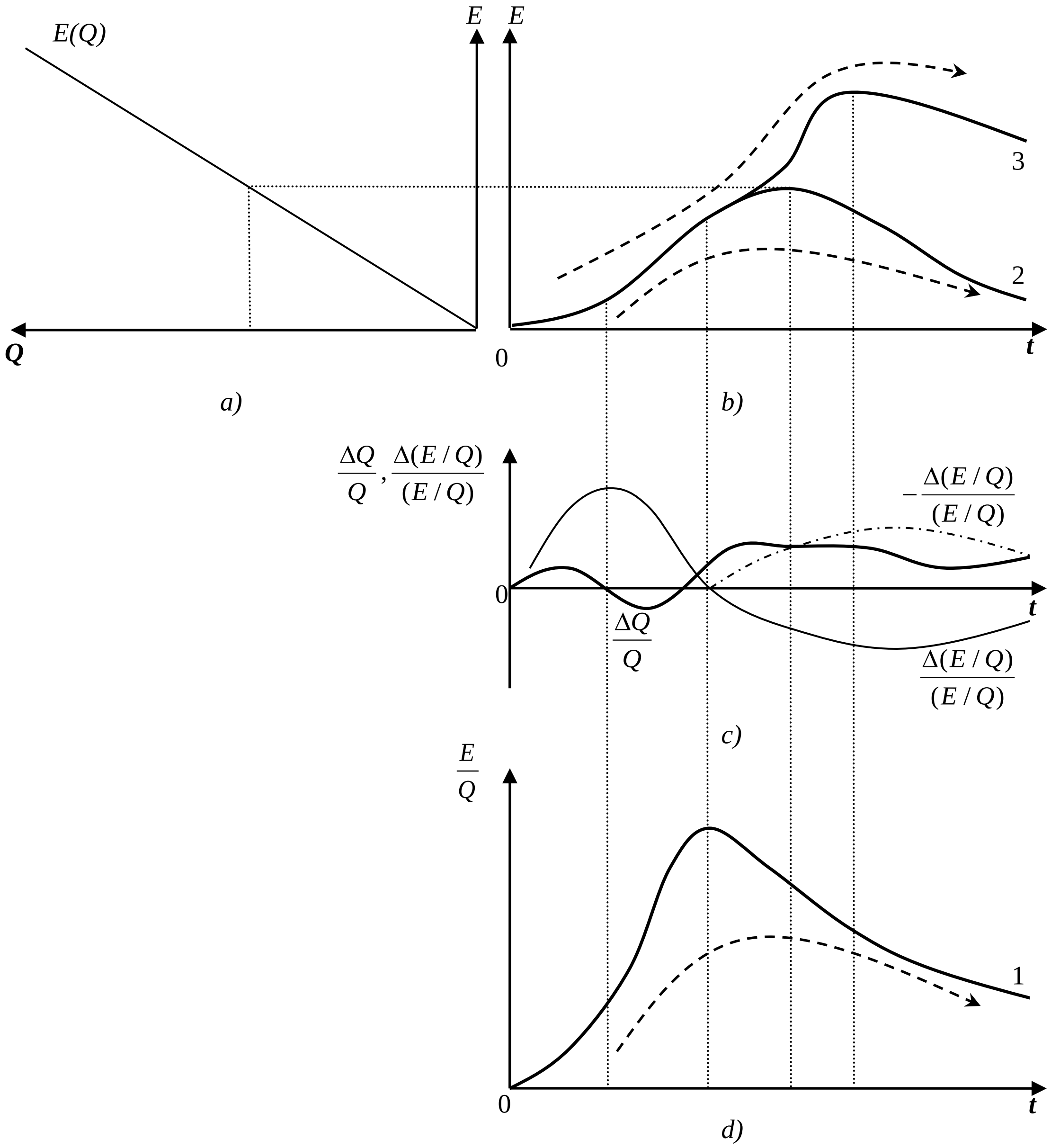
• There is no timing of the researched indicators. The EKC in its classical form takes into account only the indicators of economic growth and the influence factors. This significantly reduces the value of the results obtained.

• Necessary conditions for the existence of the EKC in its classical form have not been formulated. Besides, the reverse U-shaped character of the correlation, determined on the statistical indicators for many countries is a desirable development trajectory.

The relationship between researched values presented in Eq. (1), (2), and (4) determines the model of ecological and economic development, which is graphically presented in Figure 1. In this model, three curves (No 1, 2, 3) determine the correlation in the "economic growth–state of the environment" system within the framework of the EKC concept. As the graph shows, achieving the maximum and reducing the trajectory of the EKC No 1 is not a sufficient condition for the further nonavailability of an increase in the pollution level if the rate of output growth will outstrip the rate of decrease in the specific pollution. It means that the condition following from the Eq. (2) is satisfied Eq. (6):

$$\frac{\Delta Q}{Q} > - \frac{\Delta(E/Q)}{(E/Q)}. \tag{6}$$

Figure 1. A theoretical model of ecological and economic development



Source: authors' approaches

Accordingly, achieving the maximum of the EKC No 2, which describes emissions of the pollutants, also does not determine the point of maximum pollution level, if we take into account the accumulation effect of the pollution, which will begin to develop from the moment of exceeding the assimilative capacities of the environment. Thus, a minimum condition that should guarantee the nonavailability of deterioration in the sustainable development is to overcome the maximum of the EKC No 3, which describes emissions of the pollutants, taking into account the effect of the accumulation of the pollution.

The proposed approach was applied to analyze the sustainable development relative to the environmental component in the case of carbon dioxide (CO2) emissions from the fossil fuel use and the cement production in Ukraine over a period of 1990-2016. The analysis of 1990 is based on the fact that, in relation to the data of 1990, many countries estimate the fulfillment of their obligations under climate agreements. In addition, Ukraine became an independent state in 1991 and its data since 1990 allow for a better analysis in terms of a separate state. Initial data and the main indicators obtained within the model framework proposed in this article are presented in Table 1. The accumulation of CO2 gases in the atmosphere emitted by Ukraine was calculated according to the Eq. (3).

Table 1. Initial and estimated data for Ukraine over a period of 1990-2016 for the model of ecological and economic development

Year	Q (GDP), billion current US$	E (CO2 emissions), Kton CO2	Accumulation of CO2 in the atmosphere, Kton CO2	E/Q, Kton CO2 per billion current US$	ΔQ/Q, %	Δ(E/Q)/(E/Q), %
1990	81,46	782438	782438	9605,18		
1991	77,47	732515	1479639	9455,47	-4,9	-1,6
1992	73,94	642308	2057785	8686,88	-4,6	-8,1
1993	65,65	560915	2533149	8544,02	-11,2	-1,6
1994	52,55	464031	2896373	8830,28	-20,0	3,4
1995	48,21	458186	3244565	9503,96	-8,3	7,6
1996	44,56	391184	3517787	8778,82	-7,6	-7,6
1997	50,15	376079	3771758	7499,08	12,5	-14,6
1998	41,88	358824	4005347	8567,91	-16,5	14,3
1999	31,58	357686	4235661	11326,35	-24,6	32,2
2000	31,26	354869	4461165	11352,18	-1,0	0,2
2001	38,01	353285	4683298	9294,53	21,6	-18,1
2002	42,39	353554	4904039	8340,51	11,5	-10,3
2003	50,13	376037	5145629	7501,24	18,3	-10,1
2004	64,88	356638	5365212	5496,89	29,4	-26,7
2005	86,14	347920	5574501	4039,01	32,8	-26,5
2006	107,75	350552	5785274	3253,38	25,1	-19,5
2007	142,72	358475	6002688	2511,74	32,5	-22,8
2008	179,99	342294	6202284	1901,74	26,1	-24,3
2009	117,23	283200	6341928	2415,76	-34,9	27,0
2010	136,01	305045	6505182	2242,81	16,0	-7,2
2011	163,16	320961	6684777	1967,16	20,0	-12,3
2012	175,78	311430	6854359	1771,70	7,7	-9,9
2013	183,31	297977	7010361	1625,54	4,3	-8,3
2014	133,50	249065	7117817	1865,66	-27,2	14,8
2015	91,03	215892	7194501	2371,66	-31,8	27,1
2016	93,27	233220	7292003	2500,48	2,5	5,4

Source: World Bank (2018), Olivier et al. (2015), Janssens-Maenhout et al. (2017) and authors' calculations

To analyze the sustainable development in Ukraine relative to the environmental component of CO2 emissions, the following indicators were calculated: GDP adjusted by emission from CO2 emissions, production-based CO2 emissions, which are presented in Table 2.

Table 2. Indicators of Ukraine's sustainable development relative to CO2 emissions over a period of 1990-2016

Year	GDP adjusted by damages from CO2 emissions, billion current US$	Production-based CO2 productivity, US$ per ton	Adjusted economic output per unit of CO2 emissions (AEO), US$ per ton
1990	65,81	104,11	84,11
1991	62,82	105,76	85,76
1992	61,09	115,12	95,12
1993	54,43	117,04	97,04
1994	43,27	113,25	93,25
1995	39,05	105,22	85,22
1996	36,74	113,91	93,91
1997	42,63	133,35	113,35
1998	34,70	116,71	96,71
1999	24,43	88,29	68,29
2000	24,16	88,09	68,09
2001	30,94	107,59	87,59

2002	35,32	119,90	99,90
2003	42,61	133,31	113,31
2004	57,75	181,92	161,92
2005	79,18	247,59	227,59
2006	100,74	307,37	287,37
2007	135,55	398,13	378,13
2008	173,14	525,83	505,83
2009	111,57	413,95	393,95
2010	129,91	445,87	42587
2011	156,74	508,35	488,35
2012	169,55	564,43	544,43
2013	177,35	615,18	595,18
2014	128,52	536,01	516,01
2015	86,71	421,65	401,65
2016	88,61	399,92	379,92

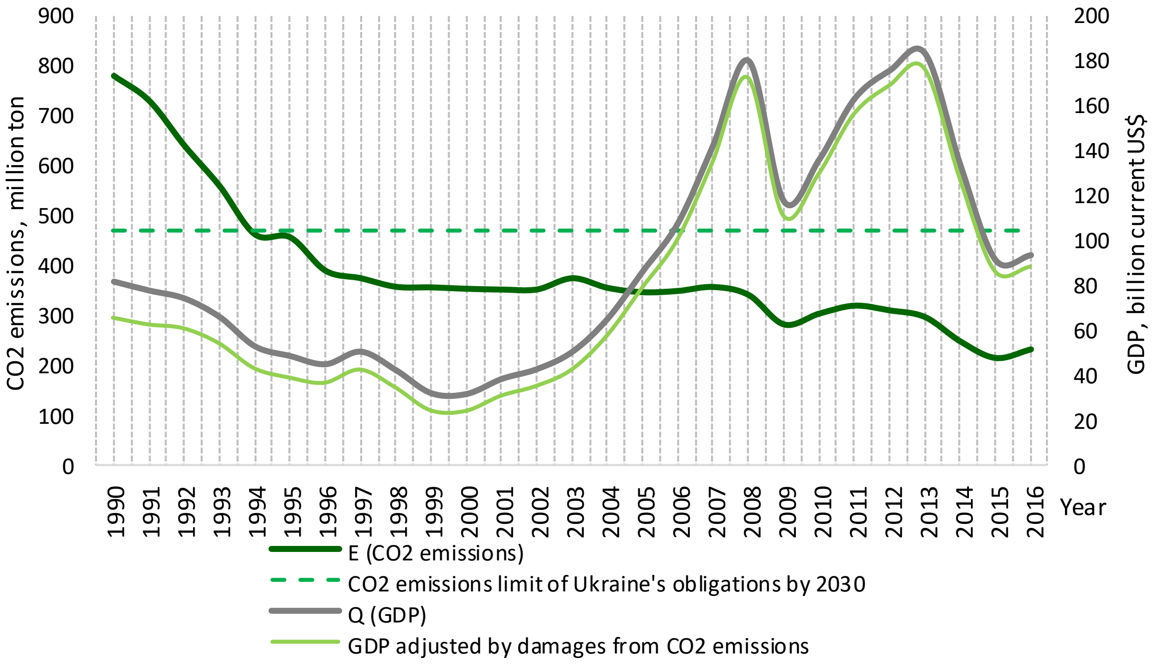
Source: authors' calculations

According to the data from Tables 1 and 2, the graphs of indicators in dynamics for Ukraine are drawn, which are presented in Figures 2, 3, 4 and 5.

In 2015, the Government of Ukraine adopted a decree to approve an expected definite contribution of the country into the new Global Climate Agreement. According to this decree, a target task is defined. It states that in 2030 Ukraine should not exceed 60% of the level of greenhouse gas emissions in the reference year of 1990 (UNDP Ukraine, 2017).

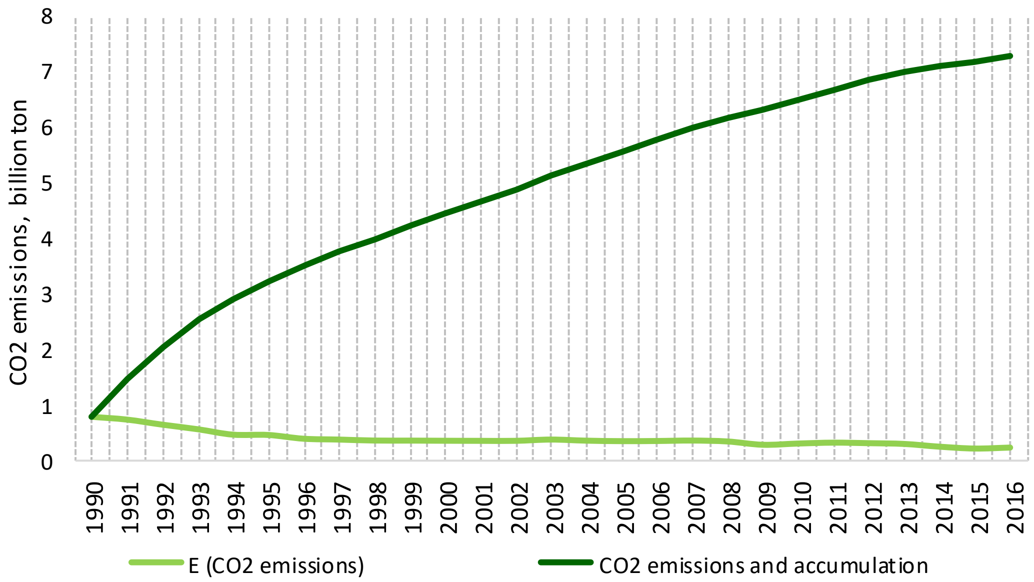
Since the analysis in this article is carried out only for CO2 emissions, we assume that Ukraine's CO2 emissions in 2030 should not exceed 60% of the 1990 level. According to the data (Table 1) in 1990, Ukraine's CO2 emissions were at 782438 Kt, then 60% will be 469462,8 Kt (Figure 2).

Figure 2. Dynamics of indicators of CO2 emissions and GDP of Ukraine in 1990-2016 according to the model of the ecological and economic development



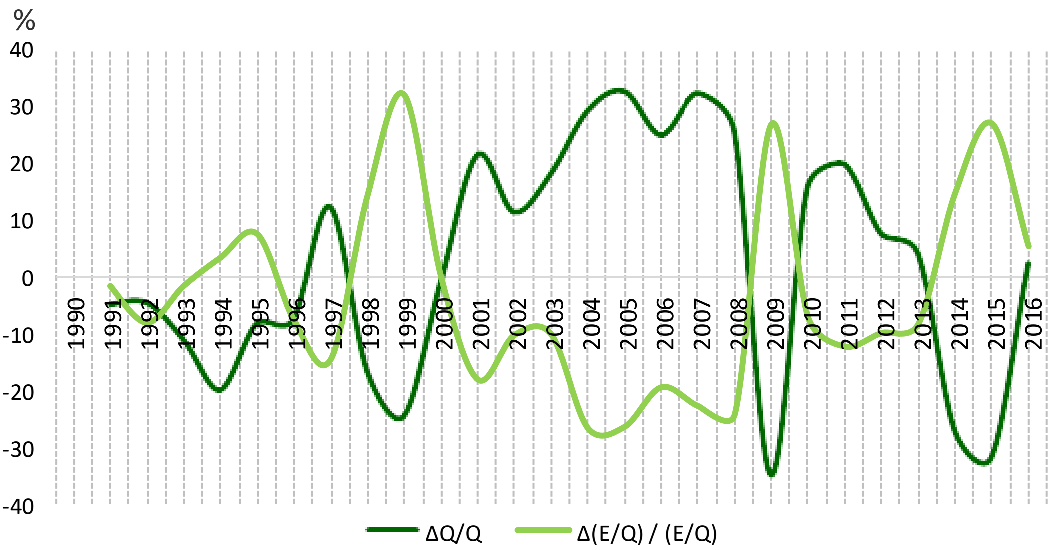
Source: World Bank (2018), Olivier et al. (2015), Janssens-Maenhout et al. (2017) and authors' calculations

Figure 3. Comparison of the dynamics of Ukraine's emissions of CO_2 gases and their accumulation in the atmosphere over a period of 1990-2016



Source: Olivier et al. (2015), Janssens-Maenhout et al. (2017) and authors' calculations

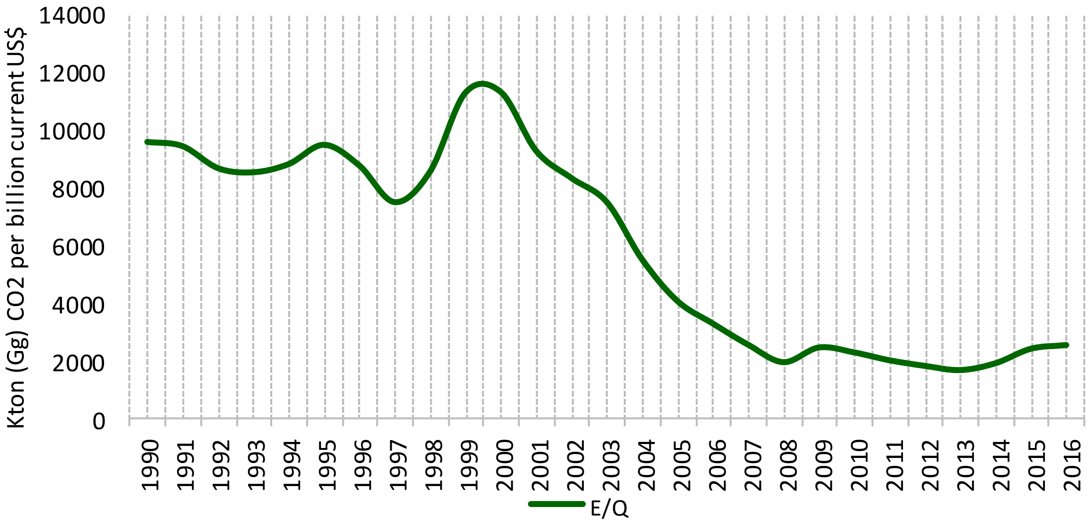
Figure 4. Dynamics of indicators *ΔQ/Q* and *Δ(E/Q)/(E/Q)* of Ukraine according to the model of the ecological and economic development



Source: authors' calculations

The results of the calculations show a positive trend for the EKC No 1 (indicator E/Q, Figure 5) until 2013, i.e. a steady decline in the specific emission of CO_2 gases per unit of GDP. However, since 2014 there has been a negative dynamics associated with a sharp drop in Ukraine's GDP (Figure 2), which may be caused by the political crisis in this region. The growth of the E/Q indicator in 2009 is also associated with a significant drop in Ukraine's GDP, possibly caused by the global financial and economic crisis of 2008-2009. CO_2 emissions also decreased in 2009 (Figure 2), though not significantly. This may indicate a large share in the structure of the economy in those areas where the ratio of pollution to the national income is the least optimal in terms of the sustainable development.

Figure 5. Dynamics of the E/Q indicator of Ukraine according to the model of the ecological and economic development



Source: authors' calculations

The growth rate of the specific emission Δ(E/Q)/(E/Q) is characterized mainly by a negative value with the prevailing positive dynamics of the GDP growth, which, in general, can be considered a positive trend (Figure 4). However, in a number of cases, there was a development of the ricochet effect caused by the excess of economic growth rates over the rate of decrease in specific emissions.

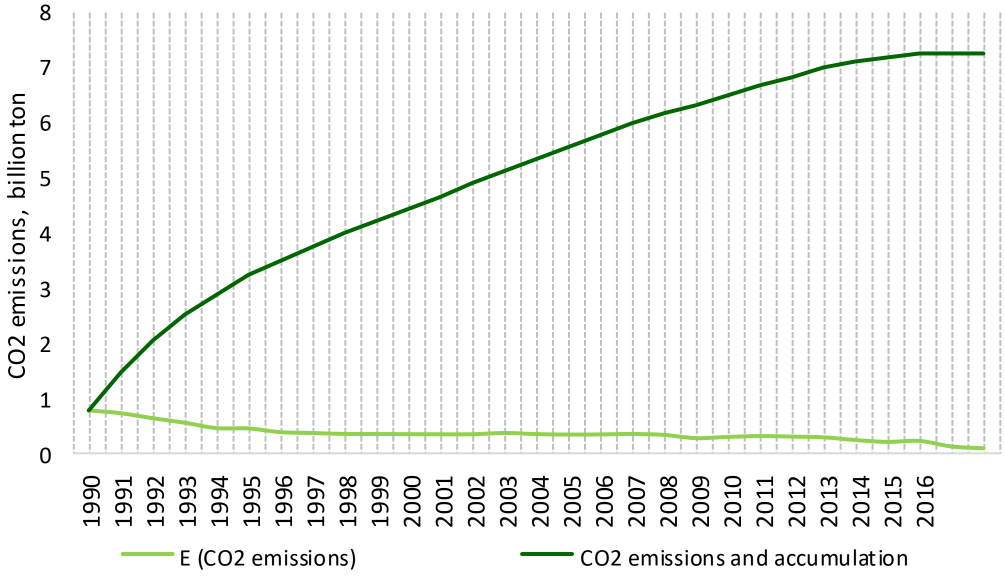
As for the EKC No 2 (indicator E), the relative stability of the gross CO2 emission is observed here, as indicated by its insignificant fluctuations (Figure 2). Nevertheless, the general trend indicates a gradual decrease in the pollution levels. A factor that significantly slows the growth of emissions is a permanent decrease in the specific emission indicator. Therefore, taking into account the crisis phenomena, from 1990 to 2016, the volume of the GDP increased 1,14 times, and the emission level decreased 3,35 times. Taking into account the difficult economic situation, such statistics can generally be considered a positive trend, regarding the fact that at separate stages of development, economic interests can exceed the environmental interests of society.

Indicators of the sustainable development relative to CO2 emissions (Table 2) should also be emphasized. Correction of the GDP by the damage from CO2 emissions shows that during the periods of economic growth, the impact of damage is not as strong as during the periods of decline (Figure 2). This can be confirmed by the results of calculating the values of the proposed AEO indicator. The values of AEO are the largest during the periods of economic growth, which characterizes a more environmentally sustainable development. However, the AEO values are lower than the values of the production-based CO2 productivity, which shows the amount of damage from CO2 emissions.

Concerning the EKC No 3, which describes the total emission of CO2 gases and their accumulation, its extremely negative trend towards the constant and rapid growth should be noted (Figure 3). This, in the first place, is related to the slow dynamics of CO2 absorption. Considering the planet's ability to absorb the greenhouse gases, the research showed that in order to stabilize the concentration of CO2 emitted by Ukraine, its emissions should be reduced by 43% in comparison with 2016 or by 83% in comparison with 1990. This should reverse the trend towards the growth of the EKC No 3. Then, the level of emissions should be gradually reduced. Figure 6 shows the trajectory of the EKC No 2 and No 3 after 2016, which correspond to this scenario.

It should be noted that Ukraine is currently fulfilling the target task of reducing the greenhouse gas emissions by 2030 to 60% of the 1990 level. This result was achieved for CO2 gases back in 1994 and it has improved since. This trend should be maintained until 2030. However, this process should not happen at the expense of economic contraction, as it often happened in Ukraine. Moreover, if we take into account the accumulation of CO2 in the atmosphere, the 60% limit by 2030 will not be enough to stabilize or reduce the concentration of CO2 emitted by Ukraine. The implementation of such a scenario is rather difficult, which necessitates the determination of the achievable indicators of the environmental and economic development, considering the emissions of other greenhouse gases. Earlier, the International Panel of Experts on Climate Change determined the targets, which were included in the appropriate scenarios. Scenarios 450 and 550, determining the target concentration of the greenhouse gases in mg/m3, are most often considered. According to a new global climate agreement for Ukraine, an achievable scenario would be to fulfill the target task for 2030 not exceeding 60% of the 1990 level of greenhouse gas emissions.

Figure 6. The scenario of stabilization after 2016 of the concentration of CO2 emitted by Ukraine



Source: Olivier et al. (2015), Janssens-Maenhout et al. (2017) and authors' calculations

Achievement of the target values requires the reduction in the value of a specific emission index for suppressing the emission itself when increasing rates of the economic development. The research aimed at identifying the economic effects of the measures to achieve the forecast values show that the short-term and medium-term measures might be unprofitable. However, in the long-term measure, the profitability of these measures may increase, which directly depends on the time and target concentration of the greenhouse gases at an approximately constant rate growth of the profitability.

Conclusion

Results of the research make it possible to state a generally positive trend towards the sustainable development of Ukraine relative to the ecological component in the case of CO2 emissions. This trend is partially supported by a predominant decrease in the specific indicators of CO2 emissions per unit of output in the economy. This trend has been disrupted in the past few years; the reason may be a political crisis in the region. A possible increase in gross emissions is significantly slowed by the influence of this factor, but the growth in emissions is not completely prevented, as the year 2016 showed. As for the increase of the concentration of CO2 in the atmosphere, its significant increase should be noted, despite the fact that since Ukrainian statehood in 1991, the total level of emissions has decreased three-fold. To offset the tendency of increasing the concentration of CO2 together with all other greenhouse gases, a significant increase in environmental effects of the economic activity is required. However, this should happen in accordance with the purpose of the economic activity. In addition, the coordination of actions on the international level is necessary, since some states' failure to fulfill the commitments to reduce the greenhouse gas emissions may jeopardize the overall goal of achieving the sustainable development.

The prospects for further research are to study a changing nature of the relationship between the economic growth and the greenhouse gas emissions. Since the alternative energy develops, this relationship should weaken; this fact must be of interest to the research community. Proceeding from this, the future research will deal with studying new factors of the progress towards the sustainable development.

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