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ECOLOGICAL ECONOMICS VS ECONOMIC(AL) ECOLOGY

Currently world faces the dilemma – ecological economy or economic(al) ecology. The researchers produce hundreds of surveys on the topic. However the analyses of recent most cited simulations had shown the diversity of results. Thus, for some states the Kuznets environmental curve has place, for others – no. Same could be said about different years for the same state. It provokes the necessity of drawing new group analyses to reveal the tendencies and relationships between economic and environmental factors. Most flexible and mirror factor of environmental sustainability is the volume of CO_2 emissions. The econometric analysis was used for detecting the economic impact on this indicator at the global level and in the spectra of group of states depending on their income. The hypothesis of the existence of environmental Kuznets curve for the analysed data is rejected. Real GDP per capita impact on carbon dioxide emissions is considered only at the global level. The impact of openness of the economy is weak. Rejection happened also to the hypothesis that for the developed countries there is a reverse dependence between the environmental pollution and economic openness. Indicator "energy consumption per capita" impacts on greenhouse gas emissions only in countries with high income. Whereby it should be noted that the more developed a country is, the more elastic is this influence. These results have a potential usage for environmental policy regulation and climate strategy.

Key words. Ecological economy, econometric modeling, environment, income, CO_2 emission.

Introduction. The ecologization of the economy and social consciousness is not entirely new problem. Practical realization of the ecological economics is closely associated primarily with state regulation of natural resources. New to this issue is the equivalent exchange between the state, the nature and humanity based on legal, organizational and technical solutions. This problem has been generated over two centuries and has assumed its critical importance, as there is an objective need for government intervention in the natural and environmental protection in order to achieve a balanced state.

Appearance in the scientific world the concept of "greening the economy" / "ecologization of the economy" has led to a substantial restructuring of existing notions about the nature conservation. Peak of these transition changes came in the second half of the XX century, when radically new ideas about emerging environmental hazards have developed. According to the ideas, the essence of the economic aspect of the Nature conservation has undergone changes. The concept of the greening of all aspects of human life has appeared.

Greening the economy caused by technological progress and its results, accompanied by the movement of the center of economic analysis of costs and outcomes in intermediate outcomes of economic activity and further projected trends. The main object of the strategy implementation for the greening economy and the main structural units of the economy should be the eco-economic system.

The main components of the ecologization of the economy (Fig. 1) can be seen in:

• the inclusion of environmental conditions, factors and objects, including resources usage among economic categories as equal with other categories of wealth assessment;

• formation of international and domestic environmental values and environmental factors;

• transition to a new pricing system that takes into account environmental factors, losses and risks;

• substantial expansion and refinement of payment for the nature usage;

• submission to the economy of natural resources and economic production of environmental constraints and the principle of sustainable environmental management;

• shifting the production to quality growth strategy based on technological upgrading at the ecological and economic control;

• rejection of costly approach to the environment that includes environmental features directly into the economy of production;

• rejection of the dictates of supply and artificial stimulation of optional secondary needs;

• reducing of the excessive range of products with increasing environmental quality control;

• the change and the ecological – economic orientation of the needs structure and welfare standards.

Analyzing the nature and the meaning of the term "greening/ecologization of the economy" [1], one can come to the following conclusions:

1) the term "greening/ecologization" is a result of the conversion of the term "ecology". It is a single-rooted, but is used in different senses. As it is well known, the term "ecology" in science was coined by the German naturalist Ernest Haeckel in 1866. Since then, for a long time arguing about the environment – until the second half of XX century – there were talking about greening.

2) the modern term "greening/ecologization" demonstrates a significant turnaround in the outlook of human and mankind in general. If earlier, before the term, the world is knowable in the materialization, geographization, biological function, then the offensive ecological crisis appeared because of intense human impact on the nature and the impending inability to regenerate the biosphere. Thus, there grown up a need to develop a new approach, called "ecological approach".

3) the actual category of "greening/ecologization" arose due to the fact that the notion of the nature and its protection could no longer contribute to the protection needs of the entire biosphere (Fig. 2).

4) from the perspective of representatives of environmental science, greening of the economy, in principle, can be subjected to all human society: science, consciousness, and thinking. But in any way to the use of the category of "greening/ecologization", its essence is in the implementation of ecological approach to people's lives to conducive the formation of a new worldview, according to which a human (and humanity in general) must weight its activities to how its actions are harmonized with the laws of nature.

Consequently, the essence of ecologization of the economy is that humanity must understand that the age of mechanization of the nature should be replaced by the century of the greening of human activity [11]. Otherwise, the human beings, as a species will not survive. Greening acquires the status of economic decision-making factor (example – environmental certification of products).
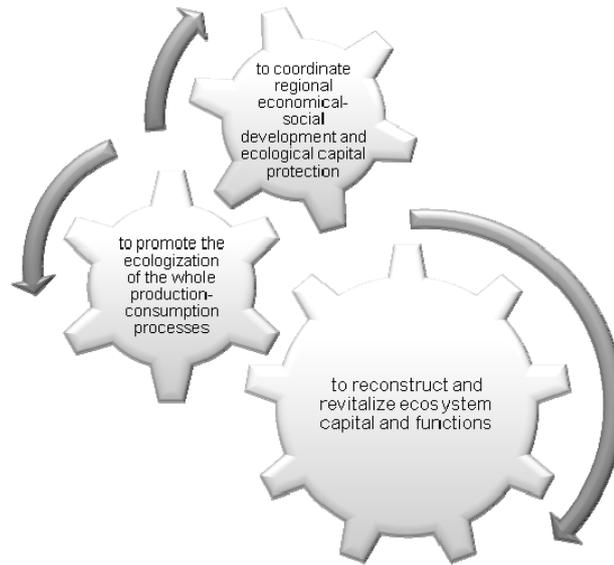

Fig. 1. Mechanisms of the ecological economization
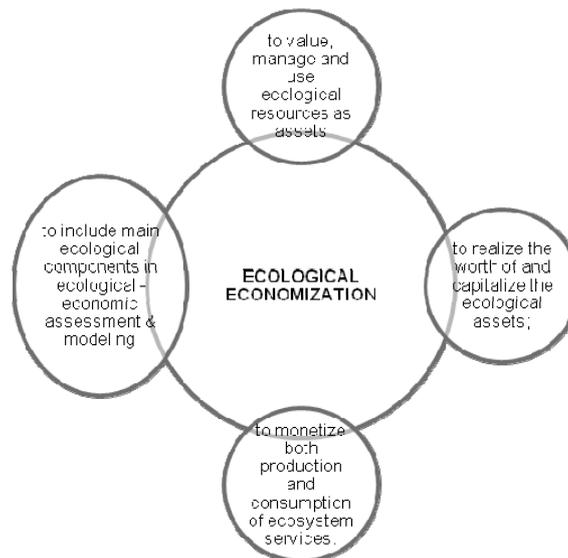
Source: authors' compilation

Fig. 2. The key components of ecological economization

Source: authors' compilation

Methodology.
ECOLOGICAL ECONOMICS.
Current production and consumption systems are usually accompanying ecosystem losses. Facing increasingly acute contradictions between economic development and the degrading environment and exhausted resources, most countries and regions are trying to explore new development ways.

Sustainable development provides mandatory coordination of economic, environmental and human development so that from generation to generation quality of life and the environment will not be deteriorating.
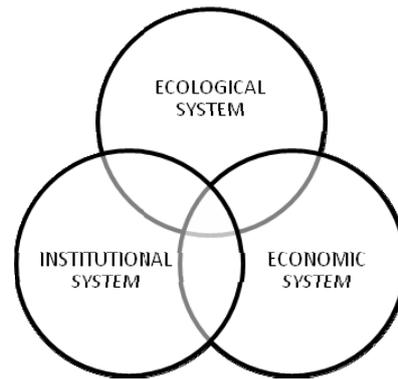
Fig. 3. The logic scheme of ecological economics

Source: authors' compilation

The complication of economic relations manifested in bringing environmental factors in economic management necessitates the identification of regulators and regulatory mechanisms to ensure the effective dynamics of a transforming economy in the face of environmental degradation and the increasing of the wear out production impact on the nation's health and ability to work. Objectivity and continuity of interaction of the economic system and the environment, lack of substitute benefits for the natural environment requires the ordering of the parameters of the interaction between participants. That is understood as the institutionalization.
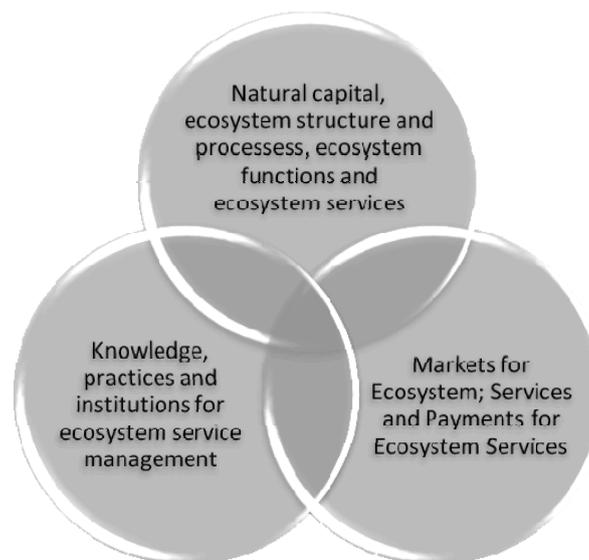

Fig. 4. The logic scheme of institutionalization of ecological economics

Source: authors' compilation

The development of a society is accompanied by increased anthropogenic pressure on the environment and the increasing of the priority of environmental factors. In this way, the environment implements backbone function in economic relations, because, on the one hand, contains non-interchangeable primary production resources, on the other – restricts its development. Sustainable economic development of the area (local, regional, global levels) is the strategy of managed, maintained, controlled development without destroying the natural environment, providing continuous social progress.

It always has been that the economy faced the economic interests of various social groups. Today face to face are environmental interests, mostly that of different countries. Reflecting an economic concept appeared in the 90s of the XX century in the framework of reforming economy [2].

Modern critical ecological and economic realities indicate the need to change the existing type of technological development on a sustainable environmentally balanced type. Creation of a brand new eco-economic projects and programs in various sectors of the economy needs to develop the concept of greening economic development. This requires a significant change in priorities and objectives for the whole economy and its sectors and systems, a revision of the areas of structural and investment policy, scientific and technological progress, market regulators for such changes.

To face and support the ecologization the economic theory has radically to change the number of positions:

1
- To deploy the domestic economic theory to the problems of production, or rather - reproduction, but to its original sense, as a process of interaction with the environment - to "Nature usage". Economic theory can be turned to its most important subject - the production of surplus product, but taking into account the ecological limits of productive labor.

2
- Currently in determining the prices , socio-environmental impacts of biogeocenosis degradation are not taken into account (ecocide of small nations, ecological migration, the growth of antisocial behavior among immigrants, their psychological unease, nepolnotsennorozhdennyh growth, etc.)
- The ecologization powers of ownership of natural resources should be considered as the most important economic institution regulation of this interface .

3
- Greening of the economic theory would require to accept the priority of "the common good" over the individual profit in all spheres .

4
- Greening of the economic theory suggests harmonization of relations not only among members of society (classes, business entities), but also between sectors, sub-sectors and regions. In economic theory, this will require a greater emphasis on macroeconomic issues.
- This allows to establish a hierarchy in the sectoral structure of production, ensuring consistency of more deep processing of raw materials.

5
- Task of the economic theory - back to the state environmental regulatory functions, ecologing its functions.

6
- Greening of the economic theory suggests harmonization nature of relations, not only domestically, but also between individual states .

To ensure a real assessment of environmental and economic phenomena and processes it is necessary to include an environmental factor in the system of basic socio-economic development indicators at the all state levels. The environmental factor must not only be taken into account, but also to comply with the equality of all factors: environmental, economic and social. It is necessary to establish the accounting and evaluation of the use of natural resources as an ecological factor, from the very beginning of the planning process of economic and business decisions, and not just as a complement to the analysis of the development of macroeconomic policies. Introduction of new advanced technologies and conservation measures into practice management areas depends precisely on the greening of economic management tools.

Unfortunately, nowhere in the world there is no adequate valuation of natural resources and the ecological and economic damage. Of course, one can estimate the value used for the year based on natural resources, such as market prices. However, the general case is under pricing of used natural resources, reduction of their prices. Thus, at the macro level the environmental capacity indicator turns deliberately understated.

ECONOMIC ECOLOGY vs ECONOMICAL ECOLOGY.

Economics cannot remain indifferent to the aggravation of environmental problems. Resulting there are new categories of theoretical and methodological nature, which include "economic ecology". Earlier scholars have noted "phylosophization" of sciences; today it is possible to ascertain its ecologization.

To solve environmental problems in the economy it is necessary to use a macroeconomic approach focusing on outcomes. The traditional "narrow" environmental economics usually only considers natural resources and produce more waste and pollution, not paying enough attention to the economy itself ("black box"). To implement macroeconomic approach it is advisable for each construction of a natural resource or group of resources of its natural-product vertical (chain) connecting the primary natural factors of production to final product. In connection with this approach substitutability and complementarities of production factors should be carefully analyzed (or different types of capital) in the economy from the standpoint of the final results, the possibility of saving natural resources while maintaining and increasing the final output. There is a wide range of possibilities of replacing natural capital with an artificial, but there is a critical natural capital stock to be stored for any economic development options.

An important indicator of the effectiveness of environmental management as a whole is the indicator of environmental capacity, defined as the ratio of volumes of natural resources used and the amount of pollution and final products.

There are two types (levels) indicators of the environmental capacity:
- the macro level, the level of the whole economy;
- grocery sector level.

The inverse of the coefficient is a measure of the natural environmental capacity impact of resources. Metrics of the environmental capacity in the dynamics may be one of the main criteria for the transition to sustainable development type. Reduction of these indicators at the macro level will be an important indication of the transition from man-made type to sustainable economic development type.

The economic environment/ecology is a relatively new discipline, approach. The subject of which is the study of the relationships and interdependencies between production and nonproduction spheres of activity and the

state of the natural environment, the quality and quantity of natural resources. The main task of economic ecology – justification on the basis of known economic and biological laws of the optimal interaction between society and nature, the development of forms and methods of management, conservation and restoration of natural resources and natural conditions of living environment.

There are two levels of economic ecology:
- general theoretical
- applied (environmental economics).

Economic ecology develops economic mechanisms of environmental management: the valuation of resources (water, wood, oil) and fines for their pollution.

Economic environment – part of a social ecology that develops methods of regulating the relationship between human and nature-based economic mechanisms that reduce pollution, resource conservation, energy conservation, protection of biodiversity and overcome consumer approach. As a result of the economic principles of ecology, non-ecological usage of the nature becomes uneconomical.

ECOLOGICAL – ECONOMIC MODELING

Both ecologists and economists use models to develop strategies for biodiversity management. However, the practical use of single discipline models can be limited because ecological models tend to ignore the socioeconomic dimension of biodiversity management, and economic models – the ecological dimension. Problems of preservation of the environment are mainly the topic for investigation for physists, chemists, and biologists. But as one of the main parts of state safety and as a component of a nation's level of development, a country's environmental strategy should be developed also from the position of economic theory [7,8].

Given these shortcomings, there is a necessity to integrate ecological and economic knowledge in ecological-economic models. Modelling of economic effects on the ecology is divided on 2 stages:
- creating of dynamic and optimization models;
- creating of multifactor cross-section regression models.

As to dynamic and optimization models, there are 2 main directions in building of ecological – economic models:
- with account of ecological factor in economic-mathematical models;
- with account of anthropogenic impact in models of ecosystems.

Models of the first type have a traditional structure of economic-mathematical models; include additional variables and connections that characterize ecological subsystem.

At the basis of second type models is a model of mathematical ecology, and anthropogenic activity is considered as exogenous impact on ecosystem.

The classic representatives of both types of ecological – economic models are Leontiev-Ford Model and Mono-Irusalimskiy Model, correspondently.

The character of ecological-economical models is controllability – the presence of vacant exogenic variables, that one can define some self. As usual, combinations of values of defined variables are combined in scenarios of regulations of ecological – economic systems.

The issue of ecological and economic interactions and study it by the economic-mathematical methods became especially important after the signing of the Kyoto Protocol (1997). The most well-known is the model that was developed in 2003 by scientists Ch. Bartz and D. Kelly [1].

This model includes the factor of labour and technological change factor, which reduces pollution.

The next stage of mathematical ecological-economic models that are directed to ensure environmental safety is the analysis of micro-level of countries, i.e. industries and their separate effects on the environment. In 2004, A. Levinson [10] and M. Taylor proposed a new model of ecological and economic interactions based on the fact that each sector includes some industries, consumers spend a constant part of the income on goods of every sector of the economy, and these costs are distributed evenly to all industry sector of the economy. The production of each economic sector uses two factors: labour and specific to the industry factor. Production leads to the pollution, but firms have access to technologies that can be used to reduce harmful emissions. Manufacturers may use a portion of its resources to reduce pollution. The main practical value of this model is that it allows ranking industries within each sector according to the degree of contamination.

The process of overcoming scientific and technical backwardness and unsustainable usage of natural resources requires the development of new methods and models of ecological-economic interaction, like Hryhorkiv V. [5] approach. He proposed the optimization model of diversified production structure in an environmentally sustainable economy, which is based on a dynamic model of inter-sectoral ecological-economic balance (a dynamic model of Leontiev-Ford [9]). The eco-economic system operates both as a producer and as a cleaner of the environment, and the dynamics of the system is actually limited only by economic resources. Thus, in mathematical form it was described the optimization model of the industrial structure of an ecological-economic system based on both economic and environmental constraints.

Further the optimization model was developed and supplemented by Skraschukom L. The scientist suggested that the objective function is independent of the discounting factor.

Such formulation of the problem is quite complex and cannot always be solved by exact methods, but provides single approach to building trajectories of ecological and economic dynamics. It should be noted that the complexity of this task is significantly affected by the dimension of the vector of primary production and the final products, destroyed and uncompensated pollutants, as well as technological matrix outputs, costs and capital intensity ratios of main and auxiliary industries. The dimension of the real problems depends on the level of aggregation and the adequacy of the problems reflected in reality. So it can vary from a few to hundreds of specific core and ancillary industries. This dimension should be consistent with the capabilities of modern mathematics, computer and information tools.

Thus, the mathematical modelling of ecological and economic production function as a model of dependence of the result of the manufacturing process on economic and environmental factors that contribute to it, based on the optimization approach theory, provides an ability to receive a maximum output production functions [6]. These economic and mathematical models demonstrate the importance of ensuring environmental safety for the sustainability of economic growth.

ECONOMETRIC MODELS: THE IMPACT OF SOCIO-ECONOMIC FACTORS ON THE ENVIRONMENT

Econometric techniques are widely used to study the relationship between the economic development and the environment. The latter can give quantitative answers to basic questions of researchers, such as the existence of the relationship, nature of such interdependence and what scale of impact each factor has on another. Conclusions of the econometric analysis could help

public and private bodies to adopt the correct policies to protect the environment.

R. Omay [12] in his research studied the relationship between the economic growth and environmental pollution. Emissions CO_2 per capita were used as an indicator of air pollution. GDP per capita was used as an indicator of economic growth. The aim of the study was to test the hypothesis of the existence of environmental Kuznets curve: that evidences the increase in the level of pollution firstly with the increase of income, but reaching a certain level begins to decrease. The case of Turkey in the period from 1980 to 2007 was under the analysis. To investigate the effect of income on air pollution the author used cubic polynomial regression (1) resulted as Fig. 5 demonstrates:

$$CO_{2t} = a_0 + a_1 GDP_t + a_2 GDP_t^2 + a_3 GDP_t^3 + \varepsilon_t, \quad (1)$$

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-728.8645	349.0423	-2.088	0.0476	*
gdp	259.9108	127.6549	2.036	0.0529	.
gdp^2	-30.8813	15.5562	-1.958	0.0587	.
gdp^3	1.2221	0.6313	1.935	0.0649	.
Adjusted R-squared: 0.6906					
F-statistic: 21.09 on 3 and 24 DF, p-value: 6.513e-07					
D-W Statistic: 1.952181 p-value: 0.428					

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Fig. 5. Modelling results

Source: [12]

The results (Fig. 5) indicated that the relationship between income and air quality can be described by the N-form (according to the signs of the coefficients), which rejects the existence of Kuznets curve in Turkey for the analysed period.

Next broadly cited work is the research of S. Hossain [4] who examines the causal link between CO_2 emissions, energy consumption, economic growth, foreign trade and urbanization in Japan for the period 1960-2009. He proved that energy and openness of the economy can affect carbon dioxide emissions. The survey results also proved the existence of a long-term relationship between the variables in the form of the following equation:

$$\ln CO_{2t} = a_0 + a_1 \ln EN_t + a_2 PGDP_t + a_3 \ln OPEN_t + a_4 \ln UR_t + \varepsilon_t, (2)$$

where CO_2 – carbon dioxide emissions per capita, EN – energy consumption per capita, PGDP – real GDP per capita, OPEN – the level of openness of the economy (sum of exports and imports divided by GDP),%, UR – urbanization level,%.

The study revealed that the energy consumption growth per capita by 10% would increase carbon dioxide emissions by 9.7% in the long term. Accepting the fact that Japan is a developed country, the openness of the economy is inversely proportional to the environmental pollution: thus, increasing of economic openness by 100% causes the reduction of the greenhouse gas emissions by 13.6%. GDP per capita and the level of urbanization on the simulation results appeared to be insignificant. The simulation revealed that over the time the consumption of energy could lead to an increase in carbon dioxide emissions resulting more polluted environment in Japan.

The author of other world-wide highly cited research – F. Halicioglu [3] studied the dynamic causal relationship between carbon dioxide emissions, energy consumption, income and foreign trade on the case of Turkey during 1960 to 2005. The results shown that there was a long-term relationship between the variables: carbon dioxide emissions are determined by energy consumption, income and foreign trade:

$$c_t = a_0 + a_1 e_t + a_2 y_t + a_3 y_t^2 + a_4 f_t + \varepsilon_t, \quad (3)$$

where c_t – carbon dioxide emissions per capita, e_t – energy usage per capita, y_t – real per capita income, f_t – a proxy variable for economic openness (the sum of exports and imports divided by GDP). All variables in the model were considered in natural logarithms.

Expected simulation results were as follows:

1) coefficient $a_1>0$, because the growth of energy consumption leads to stimulating the economic activity and CO_2 emissions;

2) according to the environmental Kuznets curve: $a_2 >0$, $a_3<0$;

3) the sign a_4 depends on economic development. In the case of developed countries, the sign is expected to be negative because the country produces more environmentally friendly products. In the case of developing countries, it is expected that the coefficient is greater than zero, because production is more environmentally polluting with a large share of hazardous emissions (Fig. 6).

Regressors	Model Selection Criterion			
	$\overline{R}^2$	AIC	SBC	HQC
	ARDL	ARDL	ARDL	ARDL
	(1,1,0,0,0)	(1,1,0,0,0)	(0,0,0,0,0)	(1,1,0,0,0)
e	0.78	0.78	0.76	0.78
	(3.07)*	(3.07)*	(3.97)*	(3.07)*
y	12.31	12.31	12.73	12.31
	(5.83)*	(5.83)*	(8.04)*	(5.83)*
y^2	-0.83	-0.83	-0.83	-0.83
	(6.04)*	(6.04)*	(8.30)	(6.04)*
f	0.07	0.07	0.07	0.07
	(1.97)*	(1.97)*	(2.56)	(1.97)*
Constant	-49.98	-49.98	-51.47	-49.98
	(7.31)*	(7.31)*	(10.06)*	(7.31)*

Fig. 6. Modelling results

Source: [3]

Empirical research (Fig. 6) confirmed the assumption about signs of coefficients. The increase in energy consumption per capita by 10% would increase carbon dioxide emissions by 7.8%. Statistical significance of a_3 factor and its negative sign confirmed the hypothesis of the existence of Kuznets curve for the case. The openness of the Turkish economy had little effect on the environment pollution: increased openness of the economy by 10% would increase the carbon dioxide emissions by only 0.7%. Thus, the results shown that the income is the most important variable in explaining the emissions in Turkey, followed by – energy consumption and foreign trade

Meanwhile other researchers [13] tried to explain pollution not only by economic development but also through financing, including a group of independent variables to economic, financial and energy indicators. The model was as follows:

$$CO_{2t} = a_0 + a_1 GDP_t + a_2 IS_t + a_3 R\&D + a_4 SMVA_t +$$
$$+ a_5 FDI_t + a_6 DBA_t + a_7 CAC_t + a_8 FL_t + a_9 FO_t + a_{10} EI_t + \quad (4)$$
$$+ a_{11} OC_t + a_{12} EC_t + \varepsilon_t,$$

where CO_2 – carbon dioxide emissions per capita, GDP – growth rate of real GDP per capita, IS – the share of industry in GDP, R&D – costs for research and development, % of GDP, SMVA – the total number of shares traded on the stock exchange, FDI – foreign direct investments in a country, DBA – the share of deposits of GDP, FL – a proxy variable of financial liberalization, FO – state financial openness, EI – imports of energy, OC – oil consumption, EC – energy consumption. Similarly, the researchers tested the existence of U-relationship between economic development and environmental pollution. The model is the following (Fig. 7):

$$CO_{2t} = a_0 + a_1 GDP_t + a_2 IS_t + a_3 R\&D + a_4 SMVA_t +$$
$$+ a_5 FDI_t + a_6 DBA_t + a_7 CAC_t + a_8 FL_t + a_9 FO_t + a_{10} EI_t + \quad (5)$$
$$+ a_{11} OC_t + a_{12} EC_t + a_{13} GDP_t^2 + \varepsilon_t,$$

Variables	BRIC panel	
	Model–1	Model–2
Constant	1.106 (1.42)	0.343 (1.05)
Economic development variables		
Economic growth rate	0.010* (0.00)	0.009* (0.00)
Economic growth rate squared	–	−0.001 (0.00)
Industry share in GDP	0.007* (0.00)	0.008* (0.00)
R&D expenditure	−0.037*** (0.08)	−0.009 (0.04)
Financial development variables		
Stock market value added	−0.001 (0.06)	−0.053* (0.02)
Log (FDI Stock)	−0.045* (0.01)	0.003** (0.00)
Deposit money bank assets/GDP	0.002** (0.00)	−0.030** (0.07)
Capital account convertibility	−0.030* (0.01)	−0.031* (0.01)
Financial liberalization	−0.025*** (0.06)	−0.025** (0.03)
Financial openness	0.001*** (0.00)	0.001 (0.00)
Control variables		
Net energy imports	6.21E-07* (1.55E−07)	5.50E-07* (1.10E−07)
Log (Oil consumption)	0.216* (0.07)	0.256* (0.08)
Log (Energy consumption)	0.180** (0.10)	0.148** (0.07)
Adjust. R^2	0.9786	0.9780
F-statistic	2755.54	2516.03
Prob (*F-statistic*)	0.0000	0.0000
Total no. observations	52	52

Dependent variable: log (per capita CO_2 emissions).
White heteroskedasticity-consistent standard errors are reported in parenthesis.
   * Significant at 1% confidence level.
   ** Significant at 5% confidence level.
   *** Significant at 10% confidence level.

Fig. 7. Modelling results

Source: [13]

The assessment results (Fig. 7) supported environment Kuznets curve for the case, and conclude that the economic development as well as an industrial production leads to increased carbon dioxide emissions. Spending on R&D has potential to reduce environment pollution because it increases the proportion of "green" production. Almost all financial variables are in inverse dependence to greenhouse gas emissions. Thus, the development of the financial markets is a key factor in reducing environmental degradation, especially for developing countries. In fact, improving the financial performance of the country reduces CO_2 emissions, i.e. *financial market liberalization can improve the environment.* Energy factors, as hypothesized initially, are in direct proportion to the emissions of carbon dioxide.

Among the analyzed econometric models we can be divide two main types:
• models aimed at testing the hypothesis of environmental Kuznets curve existence;
• models assessing the impact of economic indicators on emissions of carbon dioxide.

However, the eco-economic development concepts analyzed only certain environmental conditions, leaving aside integral indicator of ecological safety. To address this issue we will consider the main approaches to calculating the integral index of environmental safety in the next section.

Results of econometric analysis of the impact of social and economic factors on the environment (global case).

Based on the latter, the dependent variable for the analysis is determined as the CO_2 emissions per capita. The following variables are chosen as factors: EN – energy consumption per capita, PGDP – real GDP per capita, OPEN – economic openness, UR – the level of urbanization, %, ALT – consumption of nuclear and alternative energy, % of total energy consumption. The following model is assessed:

$$\ln CO2_t = \beta_0 + \beta_1 \ln \Delta EN_t + \beta_2 \ln \Delta OPEN_t + \beta_3 \ln \Delta PGPP_t +$$
$$+ \beta_4 \ln \Delta ALT_t + \beta_5 \ln \Delta UR_t + \varepsilon_t \qquad (6)$$

Hypothesis & assumptions:

1) well known fact is that the increase in energy consumption leads to an increase of production, which in turn increases carbon dioxide emissions. So it is expected that $\beta_1 > 0$;

2) the sign β_2 depends on economic development. In the case of developed countries, it is expected to be less than zero, because the country is using more environmentally efficient methods of production and imports more environmentally friendly products. In the case of developing countries, it is expected that the ratio is greater than zero, because production is more environmentally polluting with a large share of greenhouse gas emissions.

3) improving in the economic situation leads to an increase in production and, in turn, CO_2 emissions: $\beta_3 > 0$.

4) consumption of nuclear and renewable energy should be in opposite relationship to emissions, as in the production of energy there is no greenhouse gas emissions: $\beta_4 < 0$.

First of all we analyze the influence of socio-economic indicators at the global level, using aggregated indicators (annual World Bank official data from 1971 to 2010 [14]).

The test for Stationarity (Dickey-Fuller test), as the first step of econometric modelling technique, resulted that all variables, excepting UR, are integer in first order, so we should use them in the first differences. Since the variable UR is not integer in the first order and shows steady growth since 1973, we exclude it in the model. The estimated model (in logarithms) is as follows:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	0.116005	0.134176	0.864571	0.3933
DLNOPEN	0.084011	0.050995	1.647441	0.1087
DLNPGDP	0.178987	0.061842	2.894279	0.0066
DLNALT	-0.126759	0.062746	-2.020198	0.0513
C	0.007511	0.003905	1.923133	0.0629

R-squared	0.494300	Mean dependent var		0.004664
Adjusted R-squared	0.434805	S.D. dependent var		0.021966
S.E. of regression	0.016514	Akaike info criterion		5.250015
Sum squared resid	0.009272	Schwarz criterion		5.036737
Log likelihood	107.3753	Hannan-Quinn criter.		5.173493
F-statistic	8.308369	Durbin-Watson stat		2.029757
Prob(F-statistic)	0.000087			

This model is adequate, no residual autocorrelation, but there is heteroscedasticity. On the level of reliability of 95% variables DLNEN, DLNOPEN, DLNALT and constant are not significant. As the attempt to improve the model we exclude variable DLNEN and verify the results:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNALT	-0.148337	0.057361	-2.586029	0.0140
DLNOPEN	0.089550	0.050408	1.776510	0.0843
DLNPGDP	0.203403	0.054818	3.710508	0.0007
C	0.009291	0.003306	2.809903	0.0081

R-squared	0.483182	Mean dependent var		0.004664
Adjusted R-squared	0.438883	S.D. dependent var		0.021966
S.E. of regression	0.016454	Akaike info criterion		5.279550
Sum squared resid	0.009476	Schwarz criterion		5.108928
Log likelihood	106.9512	Hannan-Quinn criter.		5.218332
F-statistic	10.90736	Durbin-Watson stat		1.943368
Prob(F-statistic)	0.000033			

The model is adequate; it has neither heteroscedasticity nor autocorrelation . It should be noted that not including DLNEN variable just slightly decreased adj-R^2, that suggests the factor DLNEN as not significant indeed. With 10% probability of error all variables are significant, but the 5% probability of error reveals DLNOPEN independent variable as not statistically significant. Elimination of DLNOPEN variable resulted in following:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNALT	-0.148648	0.059053	-2.517181	0.0164
DLNPGDP	0.223321	0.055243	4.042561	0.0003
C	0.011038	0.003250	3.396259	0.0017
R-squared	0.436580	Mean dependent var		0.004664
Adjusted R-squared	0.405279	S.D. dependent var		0.021966
S.E. of regression	0.016940	Akaike info criterion		5.244497
Sum squared resid	0.010330	Schwarz criterion		5.116531
Log likelihood	105.2677	Hannan-Quinn criter.		5.198584
F-statistic	13.94773	Durbin-Watson stat		2.073257
Prob(F-statistic)	0.000033			

The model

$$\ln CO2_t = 0.01 + 0.22 \cdot \ln \Delta PGPP_t - 0.15 \cdot \ln \Delta ALT_t \quad (7)$$

is appropriate with all significant factors, has neither heteroscedasticity nor autocorrelation. According to the model (7) the greatest impact on carbon dioxide emissions has GDP per capita. So, global GDP increase by 10% would increase greenhouse gas emissions by 2.2%. As expected, the relationship between the consumption of nuclear and alternative energy has the reverse relationship with CO_2 emissions. Growing usage of alternative fuels by 1% will reduce carbon dioxide emissions by 0.15%.

Another important issue that needs to be addressed is to compare the impact of socio-economic indicators on greenhouse gas emissions for countries with different income levels. This will test the hypothesis of the existence of environmental Kuznets curve at the global level. The main question is *what level of income has the most negative impact on environment?* For the simulation we distinguish four groups of countries depending on the level of income:

1) Low income countries (LIC): GDP per capita less than 1045 USD;

2) Lower middle income (LMC): GDP per capita from 1046 to 4125 USD;

3) Upper middle income (UMC): GDP per capita from 4126 to 12745 USD;

4) High income (HIC): GDP per capita of 12746 USD.

For *the richest countries in the world (HIC in our classification)*, 1960 – 2010 annual data [14] the assessed model is following:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	0.958531	0.084336	11.36568	0.0000
DLNOPEN	0.042254	0.029915	1.412454	0.1669
DLNPGDP	0.027878	0.029811	0.935160	0.3563
DLNALT	-0.020885	0.030477	-0.685276	0.4978
C	-0.005387	0.002012	-2.677449	0.0113
R-squared	0.881292	Mean dependent var		0.000251
Adjusted R-squared	0.867326	S.D. dependent var		0.025545
S.E. of regression	0.009305	Akaike info criterion		6.397422
Sum squared resid	0.002944	Schwarz criterion		6.184144
Log likelihood	129.7497	Hannan-Quinn criter.		6.320900
F-statistic	63.10406	Durbin-Watson stat		2.438544
Prob(F-statistic)	0.000000			

This model is adequate; however there is autocorrelation. The results show that GDP growth and per capita consumption of energy from alternative sources has no effect on CO_2 emissions for rich countries. Try to eliminate insignificant variables, considering only economic openness factor:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	0.834923	0.071369	11.69860	0.0000
DLNOPEN	0.057528	0.042172	1.364146	0.1790
C	-0.002526	0.002179	-1.159075	0.2523
R-squared	0.767652	Mean dependent var		0.008162
Adjusted R-squared	0.757764	S.D. dependent var		0.028308
S.E. of regression	0.013933	Akaike info criterion		5.651056
Sum squared resid	0.009123	Schwarz criterion		5.536334
Log likelihood	144.2764	Hannan-Quinn criter.		5.607369
F-statistic	77.64118	Durbin-Watson stat		1.588599
Prob(F-statistic)	0.000000			

The model is adequate, however the Durbin-Watson criterion shows the uncertainty zone, which is closer to positive autocorrelation. The constant factor and economic openness are insignificant factors. A graph of residuels must reveal the reasons of insignificance and autocorrelation (Fig. 8).
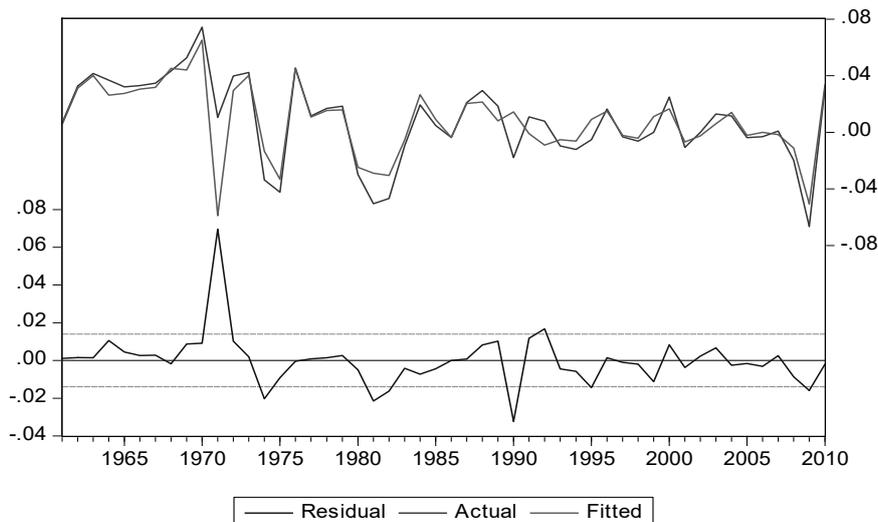

Fig. 8. Model results in graph

Source: own calculations

Fig. 8 shows a significant deviation of forecasted and actual values in 1971. This is due to the rapid drop in energy consumption that year. To accept this fact, we add a dummy variable equal to 1 in the 1971st and 0 in all other years to the model. We estimate the model with dummy variable:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	1.006775	0.046848	21.49043	0.0000
DLNOPEN	0.044027	0.025408	1.732789	0.0898
DUMMY_1971	0.084709	0.009247	9.160457	0.0000
C	-0.006026	0.001365	-4.413511	0.0001
R-squared	0.917730	Mean dependent var		0.008162
Adjusted R-squared	0.912365	S.D. dependent var		0.028308
S.E. of regression	0.008380	Akaike info criterion		6.649287
Sum squared resid	0.003230	Schwarz criterion		6.496325
Log likelihood	170.2322	Hannan-Quinn criter.		6.591038
F-statistic	171.0447	Durbin-Watson stat		2.277231
Prob(F-statistic)	0.000000			

The model is adequate, autocorrelation and heteroscedasticity are absent. Adding the dummy variable allowed to increase adj-R^2 up to 0.91. With 1% probability of error all our variables, except DLNOPEN, are significant. Factor of openness of the economy affects the CO_2 emissions only at the 90% level of reliability, but the effect of this indicator is rather small: with the 10% increasing of economic openness factor the emissions will increase by 0.4%. This rejects our hypothesis that the openness of the economy and greenhouse gas emissions are in inverse dependence for developed countries.

As next specifying step we exclude DLNOPEN variable from the model, to consider all variables with 99% reliability level of significance.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	1.026454	0.046408	22.11794	0.0000
DUMMY_1971	0.085638	0.009426	9.085065	0.0000
C	-0.005591	0.001370	-4.080017	0.0002
R-squared	0.912360	Mean dependent var		0.008162
Adjusted R-squared	0.908631	S.D. dependent var		0.028308
S.E. of regression	0.008557	Akaike info criterion		6.626056
Sum squared resid	0.003441	Schwarz criterion		6.511334
Log likelihood	168.6514	Hannan-Quinn criter.		6.582369
F-statistic	244.6422	Durbin-Watson stat		2.280761
Prob(F-statistic)	0.000000			

Model

$$\ln CO2_t = -0.006 + 1.03 \cdot \ln \Delta EN_t + 0.09 \cdot DUMMY\_1971 \quad (8)$$

is adequate, heteroscedasticity and autocorrelation are missing. All regression coefficients are significant. With the

1% increasing of energy consumption the carbon dioxide emissions will increase by 1.03%.

Draw a similar simulation *for the poorest countries (LIC in our classification)* (annual data from 1979 to 2010 [14]):

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNALT	-0.062751	0.291287	-0.215425	0.8311
DLNEN	1.125693	1.981410	0.568127	0.5746
DLNOPEN	0.160103	0.477878	0.335030	0.7402
DLNPGDP	-0.205590	0.422797	-0.486263	0.6307
C	-0.025870	0.035711	-0.724422	0.4750
R-squared	0.017820	Mean dependent var		0.016023
Adjusted R-squared	0.127688	S.D. dependent var		0.140962
S.E. of regression	0.149691	Akaike info criterion		0.817886
Sum squared resid	0.605000	Schwarz criterion		0.588865
Log likelihood	18.08618	Hannan-Quinn criter.		0.741972
F-statistic	0.122466	Durbin-Watson stat		1.821640
Prob(F-statistic)	0.973198			

The evaluation model is fully not adequate. Consider graph of residuals to gain the reason – why tested model is not proper for LIC group (Fig. 9).
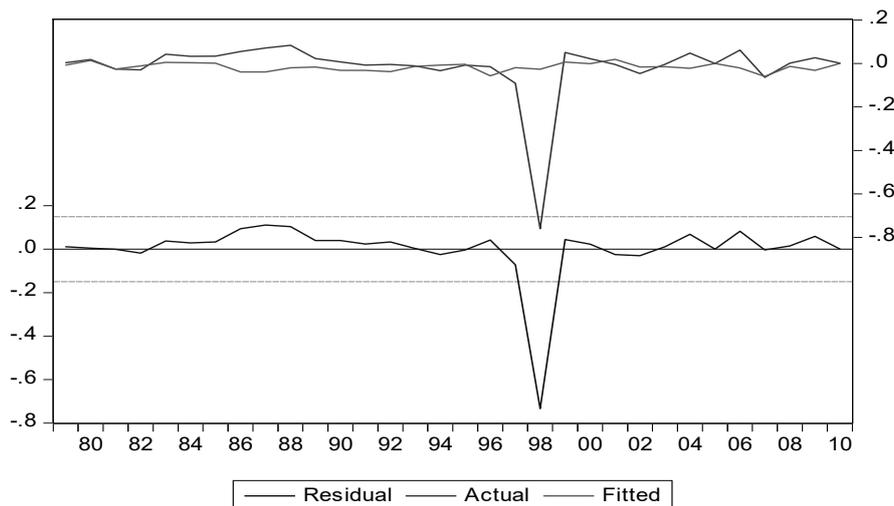

Fig. 9. Model results in graph

Source: own calculations

The problem is that in 1998 there was a significant reducing in emissions of carbon dioxide. We add to the model a dummy variable equal to 1 in 1998 and 0 in all other years. The following results are obtained:
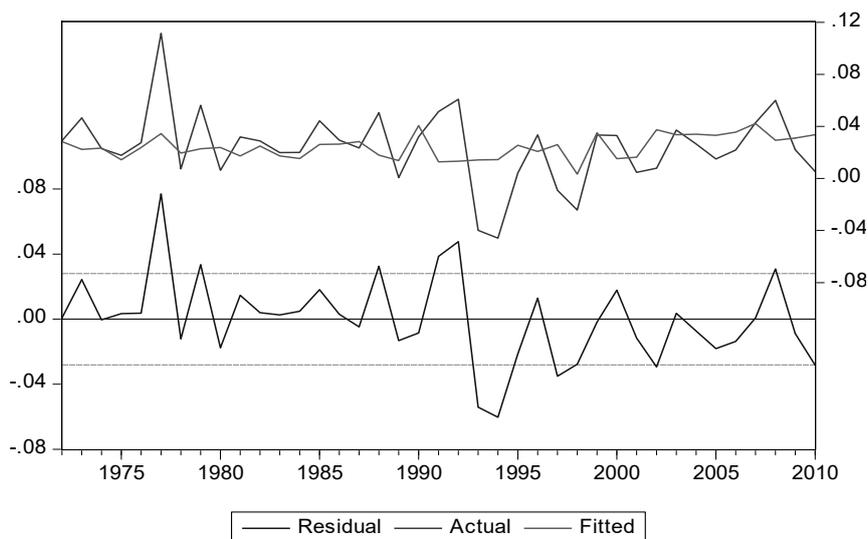
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNALT	0.074910	0.077542	0.966055	0.3429
DLNEN	0.718881	0.525577	1.367794	0.1831
DLNPGDP	-0.059671	0.112320	-0.531263	0.5997
DLNOPEN	-0.014901	0.126990	-0.117344	0.9075
DUMMY_1998	-0.769390	0.040642	-18.93106	0.0000
C	0.004771	0.009602	0.496900	0.6234
R-squared	0.933565	Mean dependent var		0.016023
Adjusted R-squared	0.920789	S.D. dependent var		0.140962
S.E. of regression	0.039673	Akaike info criterion		3.448935
Sum squared resid	0.040922	Schwarz criterion		3.174109
Log likelihood	61.18295	Hannan-Quinn criter.		3.357838
F-statistic	73.07181	Durbin-Watson stat		1.533887
Prob(F-statistic)	0.000000			

The model is adequate, but most variables are not significant. Step-wise exclusion of independent variables suggested that countries with the lowest income have no effect of the selected factors on CO_2 emissions.

Continue studies for *the countries with below average income levels (LMC in our classification)* (annual data from 1972 to 2010 [14]):

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNALT	-0.078239	0.090919	-0.860538	0.3955
DLNEN	0.103043	0.093392	1.103345	0.2776
DLNOPEN	-0.043770	0.067764	-0.645914	0.5227
DLNPGDP	0.086982	0.058445	1.488278	0.1459
C	0.028207	0.005620	5.019349	0.0000
R-squared	0.102944	Mean dependent var		0.024294
Adjusted R-squared	0.002592	S.D. dependent var		0.027995
S.E. of regression	0.028031	Akaike info criterion		4.191795
Sum squared resid	0.026715	Schwarz criterion		3.978518
Log likelihood	86.74000	Hannan-Quinn criter.		4.115273
F-statistic	0.975436	Durbin-Watson stat		1.822213
Prob(F-statistic)	0.433785			

Model is not adequate at all, and the graph of residuals (Fig. 10) shows a significant deviation of actual and forecast data in 1977. This is due to the rapid increase in CO_2 emissions that year.

Fig. 10. Model results in graph

Source: own calculations

We add to the model a dummy variable equal to 1 in the 1977th and 0 in all other years with along exclusion of DLNALT and DLNOPEN:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	0.054376	0.064298	0.845683	0.4035
DLNPGDP	0.059023	0.049290	1.197474	0.2392
DUMMY_1977	0.086221	0.024735	3.485843	0.0013
C	0.022492	0.004383	5.131518	0.0000
R-squared	0.307957	Mean dependent var		0.024294
Adjusted R-squared	0.248640	S.D. dependent var		0.027995
S.E. of regression	0.024266	Akaike info criterion		4.502548
Sum squared resid	0.020610	Schwarz criterion		4.331926
Log likelihood	91.79969	Hannan-Quinn criter.		4.441330
F-statistic	5.191641	Durbin-Watson stat		1.692999
Prob(F-statistic)	0.004509			

The model is adequate, no heteroscedasticity is detected, but there is autocorrelation. Consumption of energy and GDP per capita are not significant. Thus, we exclude DLNEN:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNPGDP	0.074755	0.049920	1.497509	0.1419
DUMMY_1977	0.084111	0.025899	3.247630	0.0023
C	0.025270	0.004023	6.281670	0.0000

R-squared	0.252331	Mean dependent var		0.025712
Adjusted R-squared	0.215860	S.D. dependent var		0.028783
S.E. of regression	0.025488	Akaike info criterion		4.435497
Sum squared resid	0.026634	Schwarz criterion		4.313848
Log likelihood	100.5809	Hannan-Quinn criter.		4.390384
F-statistic	6.918564	Durbin-Watson stat		1.867216
Prob(F-statistic)	0.002577			

This model is appropriate, as there is no heteroscedasticity, no autocorrelation, but GDP per capita is not significant (only with the 80% level of reliability). Consequently, we result that for the group of LMC as well as for the poorest countries in the lowest income level group, none of the selected factors has any effect on CO_2 emissions.

Complete our survey with the simulation for *the countries with above-average income (UMC)* (annual data from 1972 to 2010 [14]):

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	0.749893	0.278345	2.694113	0.0130
DLNOPEN	-0.067179	0.089851	-0.747665	0.4622
DLNPGDP	0.059750	0.092972	0.642671	0.5268
DLNALT	0.377649	0.185449	2.036403	0.0534
C	0.004261	0.011381	0.374404	0.7115

R-squared	0.429128	Mean dependent var		0.030724
Adjusted R-squared	0.329845	S.D. dependent var		0.031732
S.E. of regression	0.025977	Akaike info criterion		4.302800
Sum squared resid	0.015520	Schwarz criterion		4.064906
Log likelihood	65.23920	Hannan-Quinn criter.		4.230074
F-statistic	4.322303	Durbin-Watson stat		2.023278
Prob(F-statistic)	0.009411			

This model is adequate, no residual autocorrelation, but there is heteroscedasticity.
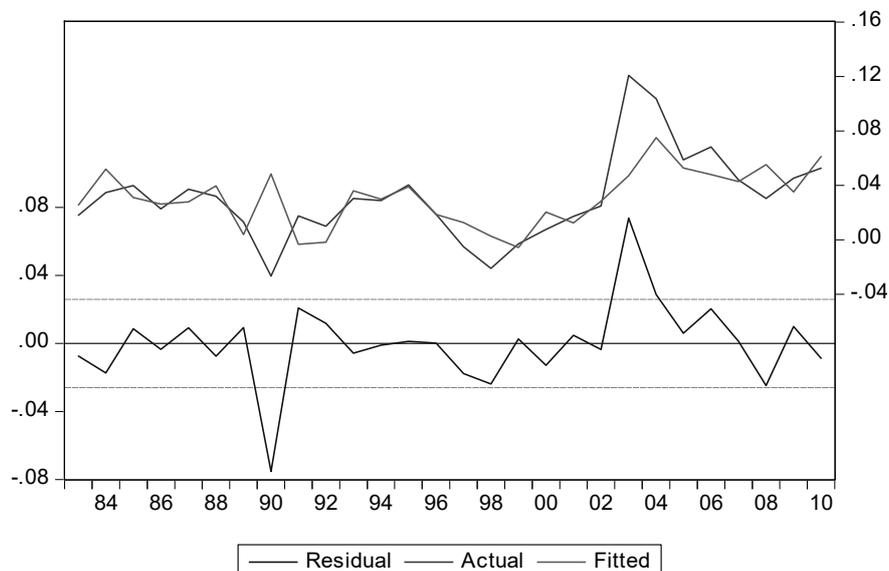

Fig. 11. Model results in graph

Source: own calculations

Graph (Fig 11) shows a significant deviation of forecasted and actual values in 1990 and 2003, which caused a rapid increase in carbon dioxide emissions and new policy launching. Add two dummy variables to the model with consequent exclusion of DLNOPEN and DLNPGDP:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNALT	-0.017463	0.071340	-0.244785	0.8081
DLNEN	0.952562	0.103004	9.247799	0.0000
DUMMY_1990	-0.125286	0.016460	-7.611384	0.0000
DUMMY_2003	0.043753	0.015090	2.899420	0.0065
C	0.006570	0.004689	1.401374	0.1002
R-squared	0.820573	Mean dependent var		0.030381
Adjusted R-squared	0.799464	S.D. dependent var		0.030725
S.E. of regression	0.013759	Akaike info criterion		5.615036
Sum squared resid	0.006437	Schwarz criterion		5.401759
Log likelihood	114.4932	Hannan-Quinn criter.		5.538514
F-statistic	38.87294	Durbin-Watson stat		1.755821
Prob(F-statistic)	0.000000			

Variable DLNALT is not significant; this fact lets us to exclude it:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNEN	0.959872	0.097247	9.870420	0.0000
DUMMY_1990	-0.123987	0.015372	-8.065940	0.0000
DUMMY_2003	0.044534	0.014550	3.060789	0.0042
C	0.005761	0.003279	1.756776	0.0377
R-squared	0.820256	Mean dependent var		0.030381
Adjusted R-squared	0.804850	S.D. dependent var		0.030725
S.E. of regression	0.013573	Akaike info criterion		5.664557
Sum squared resid	0.006448	Schwarz criterion		5.493936
Log likelihood	114.4589	Hannan-Quinn criter.		5.603340
F-statistic	53.24063	Durbin-Watson stat		1.776163
Prob(F-statistic)	0.000000			

Model
$$\ln CO_{2t} = 0.006 + 0.96 \cdot \ln \Delta EN_t - 0.12 \cdot DUMMY\_1990 + 0.04 \cdot DUMMY\_2003 \quad (9)$$

is adequate, it has neither heteroscedasticity nor autocorrelation. All regression coefficients are significant. With the 1% increasing energy consumption the carbon dioxide emissions will increase by 0.96%. According to the empirical results evoked that all other factors do not affect the environment for the countries of UMC group.

Conclusion & Discussion. Compare the results for countries with different income levels (Table 1). Indicator "energy consumption per capita" impacts on greenhouse gas emissions only in countries with high income. Whereby it should be noted that the more developed a country is, the more elastic is this influence. This can be explained by the fact that countries continue to use combustible fuels for energy production. Thus, for the countries with a level of GDP per capita 12746 USD and higher the 10% increase of energy production would stimulate 10.1% CO_2 emissions increase. The usage of alternative energy in the considered period has no effect on emissions for selected groups of countries, but this effect is observed globally. Growing usage of alternative and nuclear energy up to 10% has the potential to reduce air emissions by 1.5%

T a b l e 1. The comparison of empirical modeling results

Group	EN	PGDP	OPEN	ALT
LIC	N/D	N/D	N/D	N/D
LMC	N/D	0.07****	N/D	N/D
UMC	0.96*	N/D	N/D	N/D
HIC	1.01*	N/D	0.05***	N/D
WORLD	N/D	0.20*	0.09***	-0.15**
The level of significance: *0.99; **0.95; ***0.9; ****0.8.				

Source: own calculations

The hypothesis of the existence of environmental Kuznets curve for these data is rejected. Real GDP per capita impact on carbon dioxide emissions is considered only at the global level (Fig. 12). The impact of openness of the economy is weak. Rejection happened also to the hypothesis that for the developed countries there is a reverse dependence between the environmental pollution and economic openness.
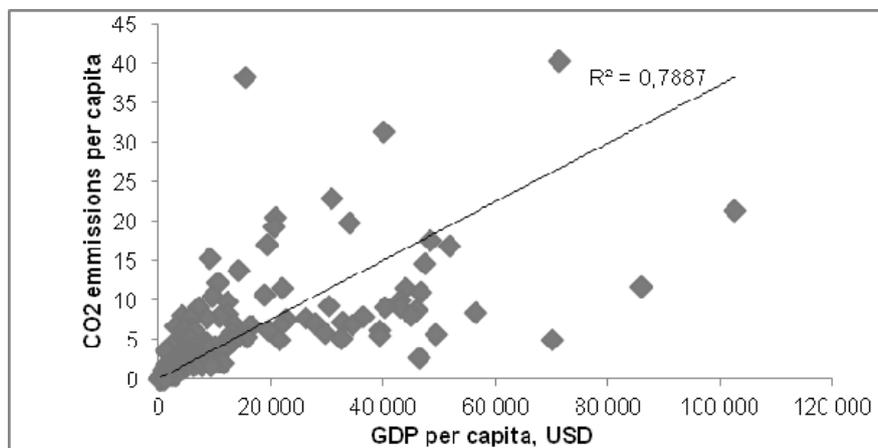

Fig. 12. Dependence of CO$_2$ emissions and GDP per capita

Source: own calculations on the data [14]

The trace of ecological economization and economical ecologization suggests: the government should actively promote the shift of the development to a mode of economical ecologization over developed areas with inadequate natural resources and ecosystem services, and to a mode of ecological economization over the undeveloped areas with abundant natural resources and ecosystem services. The global policy in the sphere of environmental sustainability can be unified for all states, but regional approaches and mechanisms should be developed according to specific income level and technological absorption ability of a state.

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ЕКОЛОГІЧНА ЕКОНОМІКА ПРОТИ ЕКОНОМІЧНОЇ (ЕКОНОМНОЇ) ЕКОЛОГІЇ

В даний час світ стикається з дилемою - екологічна економіка чи економна(ічна) екологія. Дослідники навиробляти сотні обстежень по цій темі. Однак аналіз останніх найбільш цитованих публікацій ще більш підсилює різноманітність результатів. Так, для деяких держав екологічна крива Кузнеця має місце, для інших - ні. Те ж саме можна сказати і про різні роки для однієї і тієї ж країни. Це провокує необхідність вироблення нового групового аналізу виявлення тенденцій і взаємозв'язку між економічними та екологічними факторами. Найгнучкіший і найбільш відзеркалюючий фактор екологічної стійкості є обсяг викидів СО2. В цій статті ми втикористали економетричний аналіз для визначення економічного впливу на цей показник на глобальному рівні і в спектрах груп держав залежно від їхнього доходу. Гіпотеза про існування екологічного кривої Кузнеця для аналізованих даних була відхилена. Реальний ВВП на душу населення як впливова змінна на вплив викидів вуглекислого газу може розглядатися тільки на глобальному рівні. Вплив відкритості економіки є слабким. Було відхилено також припущення, що для розвинених країн є зворотна залежність між забрудненням навколишнього середовища та економічною відкритістю. Індикатор "споживання енергії на душу населення" впливає на викиди парнико-

вих газів лише в країнах з високим рівнем доходу. Причому слід зазначити, що чим більше розвинена країна, тим більш еластичним є цей вплив. Ці результати мають потенціал використання для регулювання екологічної політики і стратегії клімату.

Ключові слова. Екологічна економіка, економетричне моделювання, навколишнє середовище, дохід, викиди CO2.

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ЭКОЛОГИЧЕСКАЯ ЭКОНОМИКА ПРОТИВ ЭКОНОМИЧЕСКОЙ (ЭКОНОМИЧЕСКОЙ) ЭКОЛОГИИ

В настоящее время мир сталкивается с дилеммой - экологическая экономика или экономная (ичная) экология. Исследователи наработали сотни обследований по этой теме. Однако анализ последних наиболее цитируемых публикаций еще более усиливает разнообразие результатов. Так, для некоторых государств экологическая кривая Кузнеца имеет место, для других - нет. То же самое можно сказать и о различных годах для одной и той же страны. Это провоцирует необходимость выработки нового группового анализа выявления тенденций и взаимосвязи между экономическими и экологическими факторами. Гибкий и наиболее репрезентативный фактор экологической устойчивости является объем выбросов CO2. В этой статье мы использовали эконометрический анализ для определения экономического влияния на этот показатель на глобальном уровне и в спектрах групп государств в зависимости от их дохода. Гипотеза о существовании экологического кривой Кузнеца для анализируемых данных была отклонена. Реальный ВВП на душу населения как влиятельная переменная на влияние выбросов углекислого газа может рассматриваться только на глобальном уровне. Влияние открытости экономики является слабым. Было отклонено также предположение, что для развитых стран является обратная зависимость между загрязнением окружающей среды и экономической открытостью. Индикатор "потребление энергии на душу населения" влияет на выбросы парниковых газов только в странах с высоким уровнем дохода. Причем следует отметить, что чем более развита страна, тем более эластичным является это влияние. Эти результаты имеют потенциал использования для регулирования экологической политики и стратегии климата.

Ключевые слова. Экологическая экономика, эконометрического моделирования, окружающая среда, доход, выбросы CO2.

Appendix 1

ANNOTATION AND REFERENCES (IN LATIN): TRANSLATION / TRANSLITERATION / TRANSCRIPTION

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INTELLECTUAL RENT AS AN ESSENTIAL FACTOR OF INNOVATIVE DEVELOPMENT OF ECONOMY

The article is devoted to the analysis of the problems of formation, distribution and effective regulation of intellectual rent as an essential factor of innovative development of the Ukrainian economy. In the first sections of the article the authors reveal the nature, structure and conditions of formation of intellectual rent. In the further sections the article covers specific properties, structuring criteria and types of intellectual rent as well as its role in the modern market economy. A considerable attention is paid to the analysis of the problems of evaluation of intellectual rent, its distribution between the main economic actors and improvement of state regulation of this sphere of social relations. The authors analyze experience of developed countries in this area and highlight the possible ways of improvement of legislation on the protection and enforcement of intellectual property rights.

Relying on the materials of the Eurostat and the State Statistics Service of Ukraine the article reveals basic limitations of the expanded reproduction of intellectual rent in the national economy, which are caused by: high transaction costs of property rights, intellectual resources and products of intellectual activity; presence of information asymmetries between the parties of the respective contractual relations; imperfect competition; weak legal protection of innovators' intellectual property; lack of real instruments of accounting and stimulation of productive use of intellectual rent in the national economy. In the concluding sections of the article practical recommendations to improve state regulation of intellectual rent in Ukraine are provided.

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