

Sectoral Analysis of Environmental Economics: The View from Ukraine

Ruslan Biloskursky*, Andrii Verstiak**, Igor Vinnychuk***

Abstract

The study is devoted to environmentally extended input-output tables in the form of economic analysis based on the interdependencies between economic sectors. The Leontief-Ford model is considered as a basic method for research. This model generalizes the Leontief model in two groups of industries (production): primary (sectors of material production) and secondary production (industry, dealing with the destruction of pollutants). The analysis of the sectoral structure gave a general view of the current situation in Ukraine. The regional breakdown requires the development and implementation of regional concepts, strategies, programs of ecological and economic development. They should be based on the Strategy of macroeconomic development with the priority of the ecological economy formation, and its goals are formulated and based on the analysis of the sectoral structure of the economy. The short-term strategy should be based on structural changes in the economy with a gradual minimization of resource intensity and waste generation.

Keywords: environmentally extended input-output tables; industry; Ukrainian reform; sustainable development.

JEL classification: B22; C67; C68; P52.

1. INTRODUCTION

There is a well-known fact that the main source of the pollution is economic activity, especially production. The modern stage of development of Ukrainian economics goes through a very special period of prolonged economic and political crisis. In this particular case the problems of sustainable development and environmental protection are put on the back burner. From other side European vector of Ukrainian development claims to consider the fact that the world community, with the initiation of the most developed countries, focuses on environmental issues. From this perspective, Ukrainian society has the

* Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine; e-mail: r.biloskursky@chnu.edu.ua (corresponding author).

** Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine; e-mail: a.verstyak@chnu.edu.ua.

*** Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine; e-mail: i.vinnychuk@chnu.edu.ua.

opportunity to change the benchmarks of the latest trends of further development basin on the concept of sustainable development. This result has been reflected through the models of production and economic systems, particularly in input-output models. In economics, an input-output model is a quantitative economic technique that represents the interdependencies between different branches of a national economy or different regional economies (Thijs Ten, 2009).

We address our attention to the compile environmental data beyond criteria pollutants for input-output applications.

There is a huge amount of literature related with merger of economic development and environmental sustainability (and even political engagement as suggested by Apostoae, 2016). The scientists and experts investigate issues of its implementation into eco-economic and environmental state policies. Nevertheless, the variability and diversity of eco-economic systems indicate providing deep analysis with the aim of developing new methods for uncovering problems of sustainable development. Therefore the aim of the paper is analysis of the indicators of ecological and resource productivity in the framework of national environmental state policies.

2. CRITICAL LITERATURE REVIEW

Environmentally extended input-output models have been actively discussed from the early 1970s following the well-known Leontief (1966) framework, being a part of standard national accounts, describing inter-sectorial relationships within an economics and depicting the output of one sector of economics as an input for another. Environmentally extended input-output tables may include various issues and major results are presented in many research papers. Curiously Leontief (1970) himself started extending his framework stating that pollutants can be analyzed as what they actually are – integral parts of the economic process. Thus, investigated the relationship between air pollutants and 11 final demand categories stating that generation and elimination of various pollutants, in principle at least, lends itself as easily to systematic description and analysis within the framework of a conventional input-output system as production and consumption of all ordinary industrial products and services. Later, (Leontief, 1974) provided analysis of 45 sectors, 40 minerals and fuels, 30 pollutants; the subject of this research is the elucidation of a particular input-output view of the world economy.

In Forsund and Strom (1976) we found investigation of 35 different kinds of residuals and 28 demand categories in the 86 sectors of Norwegian economy in 1970. These pollutants are various high-density metals, acids and sours, carbons etc.

Bicknell *et al.* (1998) described a new methodology for investigating ecological footprints. The ‘ecological footprint’ provides an estimate of the land area necessary to sustain current levels of resource consumption for a given population; on an aggregate basis, the ecological footprint may be compared with the amount of ecologically productive land available to give an indication of whether consumption patterns are likely to be sustainable.

Lange (1998) provides an example of how natural resource accounts can be used for policy analysis based on work conducted in Indonesia. An environmental-economic model is constructed by integrating the NRA with a 30-sector, dynamic input-output model. To assess the environmental implications of Indonesia's second long-term development plan, six alternative scenarios of ways to achieve the objectives of the plan were constructed for the period 1984–2020.

Complementarily, input-output analysis has been successfully applied to address various environmental and energy issues (Ayres and Kneese, 1969; Berry and Fels, 1973; Bullard and Herendeen, 1975; Bullard *et al.*, 1978; Chapman, 1974; Cleveland *et al.*, 1984; Duchin, 1992; Duchin and Lange, 1994; Wright, 1974).

Shmelev (2011) points out other major contributions in environmentally extended input-output analysis, presented in Table no. 1.

Table no. 1 – Major contributions in environmentally extended input-output analysis

Author (year)	Extensions
Proops (1977)	Energy intensities
Barker (1981)	Econometrics, annual time series 1954–1979, and cross-section data in the form of input-output tables 1954, 1963, 1968, 1974
Luptacik and Bohm (1994)	MCDA , trade-off between economic goals and the quality of the environment
Kananen <i>et al.</i> (1990)	MCDA , emergency management
Gay and Proops (1993)	CO2
Sonis and Hewings (1998)	Structural path analysis, SAM
Nakamura (1999)	Waste , recycling and CO2 emissions
Ferrer and Ayres (2000)	Waste , remanufacturing
Moffatt and Hanley (2001)	12 pollution types
Hoekstra and van den Bergh (2002)	MFA and structural decomposition analysis
Aroche-Reyes (2003)	Qualitative analysis of economic structures
Lenzen (2003)	Environmentally adjusted linkage coefficients
Giljum and Hubacek (2004)	Primary material inputs
Lantner and Carluier (2004)	Spatial dominance: 6 regions, 6 sectors each
Suh (2005)	MFA and energy
Suh (2009)	Life cycle input-output
Peters and Hertwich (2006)	International trade, embodied CO2
Alejandro Cardenete and Sancho (2006)	SAM
Tarancón Morán and del Río González (2007)	CO2 emissions

Source: Shmelev (2011)

The direction of scientific development of the topic is multifaceted, which determines the need for study and synthesis of works of Ukrainian scientists - representatives of the study of environmental and economic processes. The substantiation of the advantages of the formation of the ecological economy, the peculiarities of ecological and economic development was the subject of attention of such Ukrainian scholars as Tunytsya and Tunytsya (2017), Khvesyuk *et al.* (2017), Holubka *et al.* (2017), Khvesyuk *et al.* (2017), Grygorkiv (2007; 2014), Biloskursky (2007; 2017; 2015), Grygorkiv *et al.* (2014) and others.

The tradition of scientific research in Ukraine on various issues of ecological and economic development is considered. As a generalization, the academic institutional framework of scientific research on ecological and economic development in Ukraine is reflected. The main scientific schools of Ukraine are characterized, the focus of which is the study of issues of ecological and economic development - Kyiv, Dnipro, L'viv, Kharkiv, Luts'k, Odesa.

3. METHODOLOGY AND MODEL CONSTRUCTING

The logic of the research reflects the transition from theoretical and methodological foundations in the field of eco-economic development to the mechanisms of sustainable development of Ukraine in inter-sectoral terms.

Let's consider inter-sectoral analysis of environmental economics on the basis of Leontief-Ford model (Leontief and Daniel, 1972) that generalize Leontief's classical input-output model (Leontief, 1966):

$$\begin{cases} x^{(1)} = Ax^{(1)} + Bx^{(2)} + y^{(1)} \\ x^{(2)} = Cx^{(1)} + Dx^{(2)} - y^{(2)}, \end{cases} \quad (1)$$

where $x^{(1)} = (x_1^{(1)}, \dots, x_n^{(1)})^T$ - vector of total output of main production; $x^{(2)} = (x_1^{(2)}, \dots, x_m^{(2)})^T$ - vector of total destroyed industrial pollutants (total output vector of secondary production sector); $y^{(1)} = (y_1^{(1)}, \dots, y_n^{(1)})^T$ - vector of final output; $y^{(2)} = (y_1^{(2)}, \dots, y_m^{(2)})^T$ - vector of undestroyed industrial pollutants; $A = (a_{ij})_{i,j=1}^n$ - the square matrix of spending of the good i for producing the good j in number; $B = (b_{il})_{i,l=1}^{n,m}$ - the rectangular matrix of spending of the good i for destroying the pollutant l ; $C = (c_{lj})_{l,j=1}^{m,n}$ - the rectangular matrix of production of the pollutant l during the production process of the good j ; $D = (d_{ls})_{l,s=1}^m$ - the square matrix of production of the contaminant s during the destroying process of the contaminant l (T - transpose operation). All components of the vectors and matrices are non-negative. The components of above vectors and matrixes are positive because it reflects the real economic sense. The meaning of model (1) is obvious: the first equality – it is good's distribution of material production on the spending in the main and secondary activities and final output; the second equality – it is balanced interrelation that concerns pollutants and means that the amount of destroyed contaminants equals the difference between the amount of the all produced pollutants and undestroyed ones.

In other words: the first equation of the system reflects the balance of distribution of manufactured products $x^{(1)} = (x_1^{(1)}, \dots, x_n^{(1)})^T$ for consumption at main production $Ax^{(1)}$, at secondary production $Bx^{(2)}$ and final product $y^{(1)} = (y_1^{(1)}, \dots, y_n^{(1)})^T$. The second vector equality of the system (1) is the balance of pollutants, which reflects the volume of pollutants of all types of production activity $Cx^{(1)} + Dx^{(2)}$ and the permissible dimensions of non-destructive pollutants $y^{(2)} = (y_1^{(2)}, \dots, y_m^{(2)})^T$. The vector column $y^{(1)}$ is determined by the market demand of the product, and the vector column $y^{(2)}$ is determined by the appropriate sanitary-hygienic standards.

Note that, provided that the matrices B , C , D and the vectors $x^{(2)}$, $y^{(2)}$ are zero, the system (1) degenerates into the classical Leontief input-output model.

Since in the real model (1) all vectors and matrices are considered to be positive (indeed, the number of technological methods is equal to the number of types of products and in each technological method there is produced only one type of product), one of the

main issues is the existence of positive values of $x^{(1)}$, $x^{(2)}$ when given $y^{(1)}$, $y^{(2)}$ that is, questions of model productivity. Investigation of the model on productivity is reduced to the analysis of the matrix productivity of direct material costs (technological matrix). As for the model (1), given that the vector $(y^{(1)}, -y^{(2)})^T$ is not negative, obviously, the matrix productivity

$$Q = \begin{pmatrix} A & B \\ C & D \end{pmatrix}$$

is not enough to exist in this model non negative solution.

If from the first equation of system (1) we define $x^{(1)}$ and substitute the obtained relation in the second equation, then we have a system of equations:

$$x^{(1)} = (I_n - A)^{-1}(Bx^{(2)} + y^{(1)}), \quad (2)$$

$$x^{(2)} = [C(I_n - A)^{-1}B + D]x^{(2)} + C(I_n - A)^{-1}y^{(1)} - y^{(2)}, \quad (3)$$

from those the following sufficient conditions are followed:

1) matrices A and $C(I_n - A)^{-1}B + D = \tilde{D}$ - productive (that is, non negative matrices $(I_n - A)^{-1} \geq 0$, $(I_m - \tilde{D})^{-1} \geq 0$ exist, where zeros indicate zero matrices of corresponding dimensions) and $C(I_n - A)^{-1}y^{(1)} \geq y^{(2)}$; I_n , I_m - unit matrix with dimensions $n \times n$ and $m \times m$ respectively.

If from the second equation of system (1) determine $x^{(2)}$ and substitute the obtained relation in the first equation, then we obtain a system of equations:

$$x^{(1)} = [A + B(I_m - D)^{-1}C]x^{(1)} - B(I_m - D)^{-1}y^{(2)} + y^{(1)}, \quad (4)$$

$$x^{(2)} = (I_m - D)^{-1}(Cx^{(1)} - y^{(2)}) \quad (5)$$

where sufficient conditions are followed;

2) matrices D та $A + B(I_m - D)^{-1}C = \tilde{A}$ - productive (there exist $(I_m - D)^{-1} \geq 0$, $(I_n - \tilde{A})^{-1} \geq 0$), and $y^{(1)} \geq B(I_m - D)^{-1}y^{(2)}$, $C(I_n - \tilde{A})^{-1}y^{(1)} \geq [C(I_n - \tilde{A})^{-1}B(I_m - D)^{-1} - I_m]y^{(2)}$.

Consequently, the system (2) - (3) defines sufficient conditions 1), and the system (4) - (5) is sufficient conditions 2). Hereafter we will assume that sufficient conditions 1) or 2) are fulfilled. The economic content of these sufficient conditions is that the primary and secondary production exist if the volume of non-destructive pollutants $y^{(2)}$ does not exceed the total emission of pollutants in the formation of the final product $y^{(1)}$.

The inter-sectoral eco-economic Leontief-Ford model (1) may also be considered as a generalization of the classical scheme of inter-sectoral balance in the case of an open economic system, when net imports of certain types of products exceed non-productive consumption (that is, these products are also imported for industrial consumption. with a

positive final product in one block, and other branches (with incomplete final consumption) in another, we obtain the matrix of direct material costs $A > 0, B > 0, C > 0, D > 0$ and the model of inter-sectoral balance in the form (1.6), where $y^{(1)} > 0, y^{(2)} > 0$. Therefore the results of investigation of Leontief-Ford model in the form (1) can also be used for the study of inter-sectoral open economies.

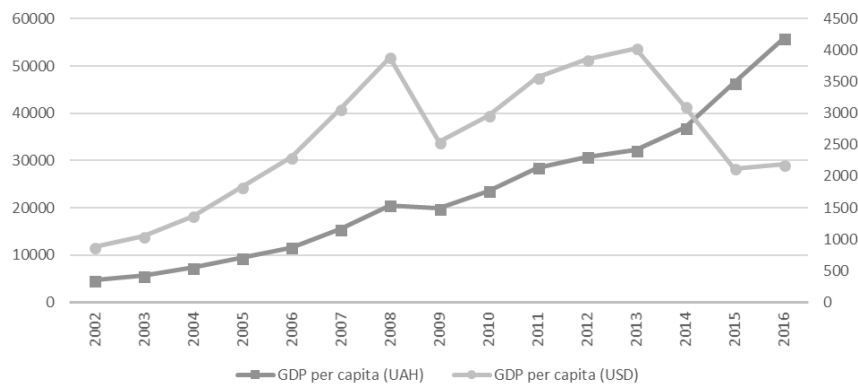
Described above technique provides some important practical application:

- assuming that the final product is a constant value, it is possible to quantify the increase in production costs of both the main and secondary production with a decrease in the release of pollutants to a certain ecological norm;
- the model can be used in determining environmental sanctions for a particular industry or enterprise: taxes, fines, limits, etc.;
- using the model, product pricing might be taken in the consideration as the costs of secondary production, that is, the price of destruction of pollutants;
- the model allows to investigate the optimal production structure at the regional level in relation with the possibility of interregional exchange of products and in order to ensure the implementation of environment protection.

4. EMPIRICAL RESULTS

The analysis of the sectoral structure of the economy and its structural changes is very important from the point of view of ensuring ecological and economic development. National or regional focuses can determine sectoral features of the use of natural resource comparing with important macro- and meso-economic indicators (gross domestic and regional product). An analysis of the sectoral structure could also cover foreign trade activities. The conclusions from such kind of analysis are very important in the context of expediency of the international investment activity in the country or region. [Zianko \(2014\)](#) points out on that the main reason for the unsatisfactory state of the global environment, which continues to deteriorate, is the irrational consumption and production that are now displaced from the industrialized countries to the poor worlds with cheaper material resources and labour force. Nowadays Ukraine is still a state with relatively low wages. Therefore, the risk of investing in resource-intensive types of economic activity is high, especially considering the low level of environmental business culture and lobbyist influences of the authorities.

If we focus on a more classical approach to the sectoral structure analysis of Ukraine's economy, then we need to take into consideration the gross domestic product (GDP). It should be noted that this indicator in the past years is quite variable. The events in Ukraine since the end of 2013 have had a significant impact on the macroeconomic situation. As a result, in 2016 the GDP in the dollar equivalent was at 2005-2006 levels (US \$93270 million), but with expected growth that has been already observed since 2016 ([Ukrstat, 2018](#)). At the same time, a significant devaluation of the national currency has made a significant adjustment to the economic opportunities of Ukraine ([Figure no. 1](#)).



Source: *World Bank (2018)*

Figure no. 1 – GRP per capita in Ukraine

This situation has also a positive aspect: an opportunity to stimulate structural changes in the GDP formation with a new qualitative approach and the priority of the ecological economy formation. To achieve this goal the share of the environmental business in GDP should be increased.

Based on model (1) described in the section above let us consider the sectoral structure of the Ukrainian economy in terms of products and services output in market prices. Taking into account the index of products and services output, it should be noted that in the period of 2010-2016, the share of agriculture, forestry and fisheries in the GDP structure has been increased from 7.6% to 12.1%, which raises the urgency of the ecological agricultural production development taking into account the importance of this activity categories for the Ukraine's economic development (Ukrstat, 2018). Similarly, the share of wholesale and retail; repair of motor vehicles and motorcycles increased from 11.3% in 2010 to 11.9% in 2016. For other types of economic activity, we can observe a reduction of their share in the GDP in terms of products and services output in market prices.

Despite the reduction, the dominant role in the formation of GDP is played by industrial types of economic activity – 41.02% in 2010 and 36.63% in 2016 (Ukrstat, 2018). It is clear that the reduction of the industrial activities share is partly caused by the crisis of territorial integrity of Ukraine. However, the reduction of the industrial activities share in GDP was observed as far back as 2012-2013. If we analyse in detail the industrial activities share in GDP in terms of product and services output, then the indicator for the processing industry has decreased the most - from 31.6% in 2010 to 26.91% in 2016 (Table no. 2).

The special attention to industrial activities is required because of their strong influence on the ecological and economic development processes. For the majority of other fields of management, it is possible to find promising ways of environmentalizing with the expected commercial results, but in industry such opportunities are very limited. There are certain opportunities in the area of electricity, gas, steam and conditioned air supply, as well as water supply, water carriage, waste management, with respect to the development of alternative power supplies and the market formation for recycling and consumption of secondary raw materials. In that case, a resource-saving approach is very important for industry and in this connection innovative technologies are key factors of development.

Table no. 2 – The share of industrial types of economic activity in the structure of Ukraine's GDP in terms of product and services output in market prices, 2010-2016, %

		2010	2011	2012	2013	2014	2015	2016
1. The share in the total products and services output								
1.1	Mining industry and quarrying	4.73	5.12	4.68	4.72	4.39	4.15	4.68
1.2	Processing industry	31.60	31.16	29.46	27.09	27.42	26.87	26.91
1.3	Electric, gas, steam and conditioned air supply	3.73	4.05	4.27	4.13	4.17	3.94	4.47
1.4	Water supply, water carriage, waste treatment	0.96	0.82	0.71	0.65	0.66	0.60	0.57
2. The share in products and services output by industry								
2.1	Mining industry and quarrying	11.54	12.45	11.97	12.90	11.98	11.67	12.78
2.2	Processing industry	77.02	75.72	75.31	74.04	74.84	75.57	73.47
2.3	Electric, gas, steam and conditioned air supply	9.10	9.85	10.91	11.27	11.38	11.08	12.2
2.4	Water supply, water carriage, waste treatment	2.34	1.98	1.81	1.79	1.80	1.69	1.55

Source: authors' calculations based on [State statistic services of Ukraine \(2018\)](#)

The undeveloped technological structure of Ukraine's economy is accompanied by a low level of technological capacity of industrial products. Even in pre-crisis 2013, the high-tech products accounted for only 3.25% of the total amount of sold products at the reference value of 19.0%; the medium-high technology products accounted for 19.9%; the medium-low technology products – 47.63%, the low technology products – 30.3% ([Smahliuk, 2015](#)). The current situation complicates the opportunities of the Ukraine's business environment in raising the level of product's productivity. The State Statistics Service reports that by 2015 only 17.3% of the surveyed industrial enterprises were engaged in innovative activity. Furthermore, in the context of innovative activity enterprises with different kind of products could be highlighted: basic pharmaceutical products (47.5%), motor vehicles, trailers and semitrailers (38.2%); computers, electronic and optical products (37.5%); other vehicles (36.1%); coke and refined products (28.6%), electrical equipment (28.2%). Only 21.4% of enterprises implementing innovations chose low-cost, resource-saving technologies ([Ukrstat, 2015](#)).

It is clear that at such a low level of innovative activity it is extremely difficult to talk about resource-saving. The situation is characterized by the extremely high level of accumulated depreciation, which reached its maximum value of 83.5% in 2014.

The sectoral structure of the Ukrainian economy in the context of its impact on the processes of ecological and economic development needs to be considered on the criteria of foreign trade activity.

The problem of a high Ukrainian resource-intensive foreign trade commodity structure is worsened during the last two decades. In recent years, it has been complemented by quantitative aspects. Thus, exports in 2015 compared to the previous year declined in all sectors, but if the export of fuel and energy complex products decreased by 4 times, exports of food and agricultural products declined by only 13%. Another negative conclusion is that the most "high-tech" products in the top 10 Ukrainian exports in 2015 were "wires and cables".

It is obvious that Ukraine is in a significant geographical and structural transformation of foreign trade activity. However, in the situation of low export performance, while preserving the external dependence on energy resources, the need for the temporary establishment of such a structure is intensified. The national economy, being in difficult macroeconomic and political conditions, needs internal structural changes in order to gradually overcome the raw material specialization of export activity.

The above features of the sectoral structure of the Ukrainian economy outline the general problems on the path to ecological and economic development and formation of the ecological economy. Another part of the problem is the environmental orientation of the economic activity under the existing structural conditions. Therefore, the analysis of the sectoral structure of Ukraine's economy should be connected with other structural approaches to the analysis of ecological and economic development. In particular, an indicative is a study of the waste generation by types of economic activity in Ukraine. As it is already noted, Ukraine has an extremely inefficient practice of recycling with a high proportion of disposal in specially designated places or objects. Moreover, this problem needs to be solved taking into account the participation of various types of economic activity in the waste generation. For these areas, the economic instruments of a stimulation and restriction with respect to waste management should be applied first of all.

The statistics show that the largest "source" of waste in Ukraine is mining industry and quarrying (Table no. 3). This type of activity generates mineral waste. In 2013, before the temporary occupation of the eastern territories for which mining industry is one of the main economic sector, the share of waste generated by mining industry accounted for 76.2% of the total volume. At that, only 32.3% of them remained under Ukraine control (Ukrstat, 2017).

Table no. 3 – The structure of waste generation by types of economic activity in Ukraine, 2005-2016, %

Years	Agriculture, forestry and fisheries	Mining industry and quarrying	Processing industry	Electric, gas, steam and conditioned air supply	Water supply, waste carriage, waste treatment	Construction	Other economic activities	Households
2005	8.0	1.3	84.5	0.4	1.9	2.5	1.5	-
2006	10.8	1.1	84.8	0.9	1.4	0.2	0.8	-
2007	8.7	0.8	87.8	0.4	0.1	0.1	2.2	-
2008	9.4	0.7	86.4	0.4	0.1	0.1	2.8	-
2009	18.8	1.4	74.5	0.8	0.3	0.2	4.1	-
2010	2.0	75.6	17.8	2.0	0.4	0.0	0.5	1.6
2011	2.8	73.8	17.8	2.2	1.6	0.1	0.6	1.2
2012	2.3	75.0	17.5	2.2	0.2	0.1	1.0	1.8
2013	2.3	76.2	16.6	2.1	0.2	0.1	0.5	2.0
2014	2.4	75.4	18.2	1.7	0.2	0.0	0.4	1.8
2015	2.8	74.5	18.1	2.1	0.2	0.0	0.3	1.9
2016	2.9	73.6	18.2	2.5	0.2	0.0	0.3	2.1

Source: authors' calculations based on *State statistic services of Ukraine (2017)*

From the analysis, it turns out that the regulation improving of waste management activities in the first stages should be regionally specific. This means that at the state level it is necessary to develop and implement a concept that would outline the regulatory, economic, information, institutional framework for waste management regulation. It should be based on the motivation of environmental entrepreneurship in this area. At the regional level, where industry structure tends to mining industry and quarrying, special waste management programs must be developed. The ideal solution to the problems could be a cluster model of cooperation.

The analysis of the sectoral structure gives a general view of the current situation in Ukraine. The regional breakdown further specifies the problems and requires the development and implementation of regional concepts, strategies, programs of ecological and economic development. They should be based on the Strategy of macroeconomic development with the priority of the ecological economy formation, and its goals are formulated based on the analysis of the sectoral structure of the economy. The short-term strategy should be based on structural changes in the economy with a gradual minimization of resource intensity and waste generation. On the assumption of structural changes (Table no. 4), we can talk about the further transition to the model of ecological and economic development with the formation of a competitive ecological economy of Ukraine.

Table no. 4 – Priorities of structural changes in the Ukrainian economy in the context of ecological and economic development and the formation of ecological economy

	Structural criterion	Main problems	Priorities of structural changes and accompanying measures for the short-term period
1	The GDP structure, volumes of sold products	Dependence of economic growth on resource-intensive industrial production	Targeted support for the development of ecological agricultural production Development of a transparent and effective system of environmental control, environmental marking in trade operations
2	Technological structure	Very low technological level of industrial products High resource-intensiveness of production processes in the conditions of significant accumulated depreciation, low innovation activity of economic entities	Urgent solution to the problem of significant accumulated depreciation Motivation for innovative activity of industrial enterprises Mandatory resource saving in industrial types of economic activity Motivation for the implementation of environmental innovations
3	Employment pattern	Unregulated changes in the employment pattern in favor of non-material areas, while for selected areas we still can observe a high level of dependence on employment in industry	Reorientation of the population to self-employment and entrepreneurship in the environmental spheres of agriculture and employment in the intangible sector of the economy Motivation of innovative employment in the material sector of the economy
4	Foreign trade structure	Very low technological level of exported products and retaining external dependence on imports of energy sources	Overcoming of raw material specialization of export as a result of primary internal structural changes (long-term priority)

This analysis shows that the current sectoral structure of the Ukrainian economy is a significant deviation of ecological and economic development. This is confirmed by analysis of various structural indicators: GDP formation, sales of products, technological level of products, foreign trade and employment structure. The solution to this problem requires qualitative structural changes, which requires at least a decade for the ecological economy formation.

5. CONCLUSIONS

The findings and results of this study indicate that the issues of eco-economic development are complex and multifaceted. Therefore, it deserves the constant attention of experts and scholars in order to formulate the recommendations on the priorities of balancing ecological and economic interests, as well as the establishment of an ecological economics.

Provided analysis might be a basis for a governmental policy and investment programme to develop economy and reduce environmental consequences of such development. This programme seems to be particularly desirable in the conditions of the current Ukrainian economic crisis, which in our opinion presents a challenge and at the same time offers an opportunity for the reorientation of governmental investment priorities towards more sustainable industries.

It should be noted that Leontief-Ford model is an appropriate technique for the regional analysis, groups of related enterprises and even for a separate enterprise, characterized by multi-choice production. For such enterprises, the following classification is proposed: $A=0$ - enterprises that do not have the material costs of the main production, $B=0$ - enterprises that do not have the material costs of secondary production, $C=0$ - enterprises with environmentally clean production, $D=0$ - enterprises with environmentally friendly secondary production.

An important point is the possibility of operative regulation of the production of in certain industries in one region or another in order to ensure integrated management of the region's economy in accordance with the principles of sustainable development.

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ORCID

Ruslan Biloskursky  <https://orcid.org/0000-0001-6934-4192>

Andrii Verstiak  <https://orcid.org/0000-0002-8090-1233>

Igor Vinnychuk  <https://orcid.org/0000-0001-5961-550X>

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