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EVALUATION OF THE ENVIRONMENTAL TAXATION EFFECTIVENESS IN THE FIELD OF OIL AND GAS PRODUCTION[*]

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Abstract

The essence and main directions of ecological modernization are considered. It is noted that the application of effective environmental policy instruments based on the concept of ecological. It is highlighted that one of the main economic levers to reduce the negative impact on the environment by economic entities is environmental taxes. The use of environmental taxes in comparison with quotas, standards have a number of advantages. The effectiveness of the environmental tax has been assessed in the context of the implementation of the basic principles of environmental taxation on the example of a separate sector of the economy, which is characterized by significant environmental risks. For this, the oil and gas industry of Ivano-Frankivsk region has been chosen, which is among the largest regions in terms of hydrocarbon minerals production in Ukraine. For the analysis, modern methods of econometric analysis have been used, in particular, the construction of the ARDL model, to determine the relationship between the indicators of pollutant emissions into the atmosphere and the main factors. A procedure of bounds test has been performed to identify long-term trends between variables. It has been established that it is advisable to increase the efficiency of tax regulation to control the pollutants emissions in Ukraine. By raising the rates of environmental taxes in the long run, it is possible to achieve a reduction in pollutant emissions. The structure of pollutants emissions into the air and the rates of environmental taxation in Ukraine have been analyzed. It has been determined that sulfur dioxide and carbon monoxide anhydride have accounted for the largest share in the structure of emissions. There are several times lower rates of environmental taxation in Ukraine in comparison with European countries that do not stimulate business entities to introduce measures in the environmental field.

Keywords: environmental taxation; pollutant emissions; oil and gas enterprises; carbon dioxide; ecological modernization

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1. Introduction

In many countries of the world, one of the main instruments of an effective environmental policy is a system of environmental taxation, the essence of which is to increase the fiscal burden on consumption and production of goods that harm the environment, while reducing the fiscal burden on other components of the tax system as part of the concept of long-term balance of budget revenues. Such a “greening” of the taxation system is aimed at promoting the reorientation of the economic system towards reducing the anthropogenic impact, stimulating the development of a “green” economy, and promoting the introduction of the main provisions of the theory of ecological modernization

The authors of Ecological Modernization Theory, in particular its founders (Huber, 1982) and (Mol, 1992) defined ecological modernization as reducing the negative impact on the environment by replacing existing industrial technologies with resource-saving and less harmful for the environment, human health and nature. In their opinion, such a process is the basis for the process of industrial society transformation into a post-industrial one. The main subject of this process has been identified by the authors as the private sector (business) (Weale, 1992) has identified a more practical basis in the development of ecological modernization He has developed the principles of strategic planning and instruments in industrial innovation policy, according to which business and the state should interact in the process of reducing the negative impact on the natural environment. In his opinion, focusing on innovation will help to solve environmental problems and ensure the generation of economic. One of the fundamental provisions of the theory of ecological modernization is the focus on stimulation of innovation in the field of environmental protection, and as a result, synchronization of the processes of achieving environmental and economic efficiency of production.

Considering this, the issue of assessing the effectiveness of environmental taxation, including individual sectors and fields of activity that are characterized by significant environmental risks, is of particular relevance. The purpose of the study is to assess the effectiveness of the use of environmental tax instruments within a separate sector of the economy, the activity of which creates a significant anthropogenic burden on the environment.

According to the goal it is necessary to solve the following tasks:

- to characterize the main provisions of the theory of ecological modernization, and the importance of environmental taxation in the implementation of environmental policy;
- to summarize the experience of using tools for environmental taxation in foreign countries, to consider the principles of environmental taxation that have been formed in foreign countries;
- to identify, on the basis of temporary indicators of activity and payment of taxes of oil and gas enterprises in Ivano-Frankivsk region (Ukraine), the main trends and to analyze the effectiveness of environmental taxation in the context of incentives for the production of environmental innovations.
- to consider the changes that have occurred with the environmental taxation in Ukraine in 2017-2018 and compare the rates of environmental tax in Ukraine and European countries.

2. Material and methods

The theoretical basis for conducting and implementation of environmental policy of the state has become the theory of ecological modernization, which stood out and was further developed as an interdisciplinary field in the 70-s of the XX century. There is an opinion that the theory of ecological modernization has become the next (in the theory of sustainable development) stage of development of the scientific theory of environmental protection.

One of the modern researchers of this theory, namely Kuliasov (2015) notes that today there is no definitively formed definition of “ecological modernization”, however, there are four main directions that define the framework for the category of “ecological modernization”, namely:

- “ecological modernization” as a theoretical basis for eco-sociology;
- “ecological modernization” as a new model for understanding and analyzing technological and intensive environmental policies;
- “ecological modernization” is a qualitative model for displaying the progress of developed countries in environmental and economic reforms;
- “ecological modernization” is a theory of a friendly, non-aggressive attitude towards nature.

The development of Modernization Theory and its actual implementation in the practical sphere required the search for effective tools for implementing environmental policy. One of the most effective economic mechanisms for achieving the objectives of environmental policy, which was tested and showed its effectiveness in the developed countries of the world, was the greening of the tax system. One of the main economic instruments is determined by environmental taxes, which have both a stimulating and a fiscal function in regulating the economy and solving environmental management problems.

The main benefits of environmental taxes, compared with other traditional environmental regulatory instruments such as standards, quotas, and prohibitions, are their effectiveness. The overall effectiveness is that the same environmental effect can be achieved at a lower level of costs for taxpayers, or a greater environmental impact can be achieved at the same level of costs. Environmental taxes are also characterized by such features as: resilience to corruption, flexibility, fiscal opportunities, transparency and predictability of prices. These features and effectiveness of environmental taxation have led to its widespread introduction in the EU countries, in particular, they almost give effect to the principle of a "double dividend" from the implementation of environmental taxation, within the framework of implementation of environmental tax reform. Finland, Norway, the UK, Germany and the Netherlands were the first among the European countries that have reduced taxes on personal income and wages, having increased taxes on environmentally destructive activities (OECD, 2017). The environmental taxes can be divided into four main categories: energy taxes (including CO_2-taxes): transport taxes, pollution taxes, resource taxes (excluding taxes on oil and gas). Taxes on oil and gas extraction are excluded from the definition of environmental taxes. In addition to the argument mentioned above about the taxes being designed to capture the resource rent (Eurostat, 2019)

In Ukraine, the system of environmental taxation is regulated by the Tax Code, according to which, environmental tax is a national mandatory payment that is paid for: actual volumes of emission into the atmospheric air, discharge of pollutants into water sources, waste disposal as secondary raw material, radioactive waste production and temporary storage by manufacturers (The Tax Code of Ukraine, 2010). In general, its adoption and the main objectives coincide with the key provisions of environmental taxation, but issues of its effectiveness remain not studied in the current taxation system. Depending on the objectives of the study, the effectiveness of environmental taxation can be assessed by different approaches. It is necessary to highlight two main directions in assessing the effectiveness of environmental taxation: this is fiscal efficiency, regulatory (stimulating) efficiency.

Fiscal efficiency lies in the adequate receipt of environmental payments to the budget and the sufficiency of their size to cover the financing of environmental programs that were budgeted for. This concept of the effectiveness of environmental taxation is largely used in the system of tax administration by regulatory authorities. According to Nikitishyn (2017), "*The incentive potential of taxes is used to change the business entities behavior that are harmful to the environment, that is, revenues of such taxes to the budget will decrease with emissions of pollutants*".

When analyzing the effectiveness of environmental taxation in Ukraine, the overwhelming majority of domestic researchers (Kobzar, 2014; Shevchenko, 2014; Varlamova, 2015) note that it is not effective either in a fiscal or regulatory (stimulating) respect. At the same time claiming that there is such a situation in Ukraine that it is better for the payer to pay environmental taxes and fines than to introduce new environmental technologies or even rationally use old ones. They justify such conclusions with low tax rates for pollutant emissions in relation to other tax payments, which generally leads to a lack of incentives for taxpayers to introduce the necessary technological changes.

Due to the fact that the purpose of our study is to assess the effectiveness of environmental taxation in the context of the implementation of the basic principles of environmental taxation on the example of a separate sector of the economy, which is characterized by significant environmental risks. For this, the oil and gas industry in the Ivano-Frankivsk region was chosen. Ivano-Frankivsk region is one of the leaders in Ukraine in oil and gas production and is among the largest regions in terms of hydrocarbon production in Ukraine.

The methodology of the study is based on well-known modern methods of econometric analysis, in particular the design of the ARDL model, to determine the relationship between the indicators of emissions of harmful substances into the atmosphere and the main factors such as hydrocarbon production and the environmental tax rate. There has been conducted bounds test based on the approach of Pesaran et al. (2001) for identifying long-term trends (cointegration) between variables.

The data used in the study are obtained in an aggregated form from the tax reporting indicators of all economic entities of the region that produced hydrocarbons in the territory of Ivano-Frankivsk region. The data is a dynamic quarterly series from 2013 to 2016. The following are the conventions:

- Nafta, Gas - total oil and gas production in tons and thousand m^3, respectively;
- VYKYDY_summ, CO_2 - total pollutants emissions into the atmosphere and carbon dioxide emissions (CO_2) in tons;
- Renta_nafta, Renta_gas - rental payments for the extraction of oil and gas to the budget in thousand UAH.
- Ekol_Tax_summ - the total value of the environmental tax in thousand UAH.

The data dynamics is shown in Fig 1. In order to establish the relationship between the emission indicators and the hydrocarbon production rates, and the environmental tax rates, a certain modification of the data was carried out for our study, namely hydrocarbon production was aggregated to the total value (TOE) in tons of oil equivalent[1]. The average rate of environmental tax (T_e) was defined as the ratio of the value of Ekol_Tax_summ to VYKYDY_summ. To reduce the dimensionality of the data and bring them to comparable values, there were taken the logarithms of all the data. Their dynamics is shown in the Fig. 2.

Models of autoregressive distributed lags (ARDL model here) are widely used in the analysis of long-term relationships, when the data generation process, which underlies the dynamic series, is integrated into the first order (i.e., I (1)). If the dynamic series of regressors are in the order of > I (0), then using the usual methods of searching for regression dependencies leads to the problem of "false (fictitious)" regression. Therefore, when evaluating causal attitudes in time series, which are non-stationary, the cointegration estimate is used. If the series are cointegrating, then the estimates of the least squares method are consistent and qualitatively describe the dependencies.

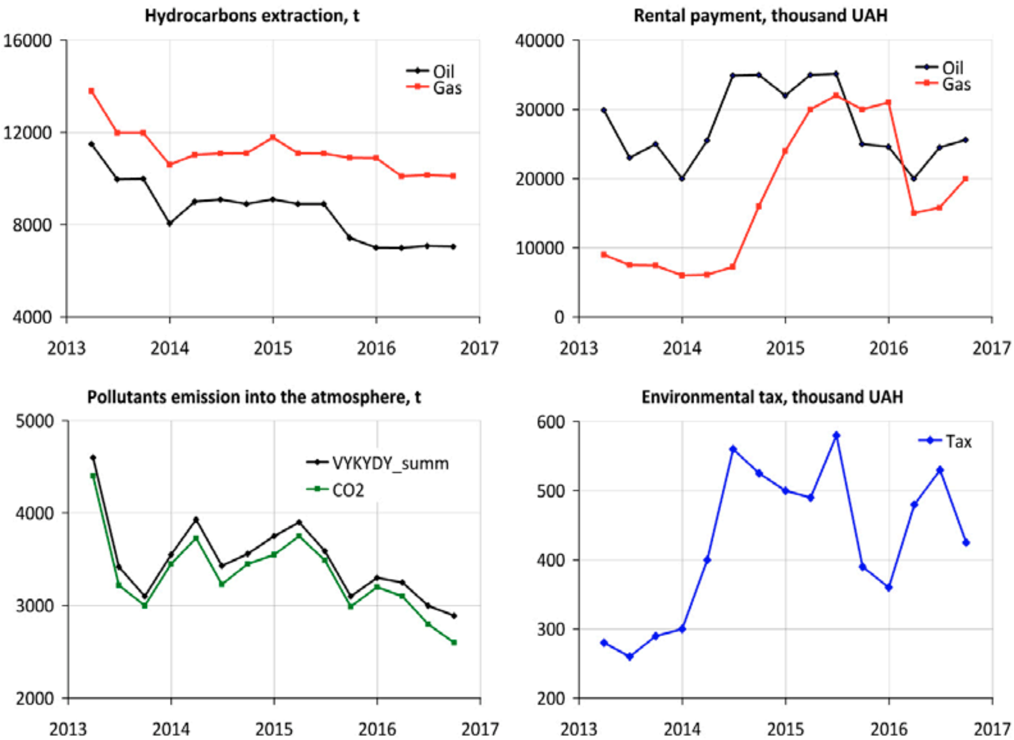

Fig. 1. Dynamics of indicators of environmental taxation and production of enterprises engaged in the extraction of hydrocarbons in the Ivano-Frankivsk region in 2013-2016

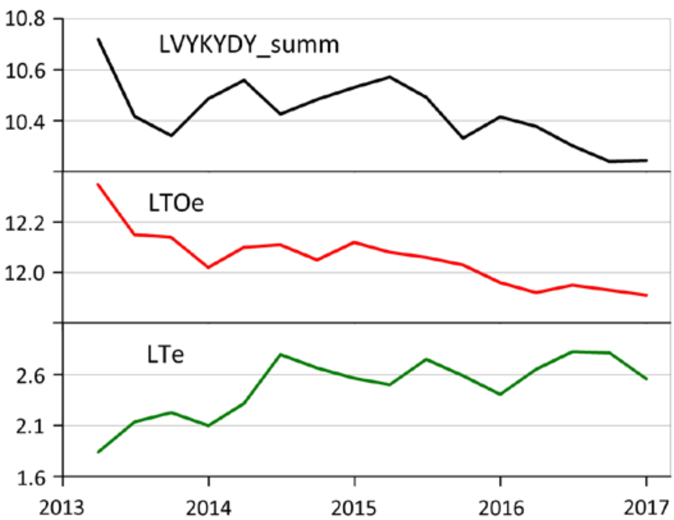

Fig 2. Dynamics of pollutants emissions, hydrocarbon production and the average rate of environmental tax (*in logarithms)* (thousand m^3 natural gas= 0.812 toe; L before the indicator means taking a natural logarithm, Δ - is the operator of the differences)

To assess the cointegration of dynamic series, there is a number of approaches, in particular these of Nkoro and Uko (2016) and Johansen and Nielsen (2016). Bounds test using the ARDL model according to the Pesaran M approach has the following advantages over other methods. First, Pesaran et al. (2001) prefers to use the ARDL model for evaluating interconnections in levels, since the model assumes that once the ARDL order is determined, the equation can be estimated using the least squares method (OLS). Secondly, the bounds test allows a mixture of I (1) and I (0) variables as regressors, that is, the order of integration of the corresponding variables may not necessarily be the same. Therefore, ARDL technology has the advantage of not requiring a specific identification of the order of the master data. Thirdly, this technique is suitable for small or finite sample sizes.

According to Pesaran et al. (2001), the main form of the regression model for ARDL (*p, q, r*) is given by Eq. (1).

$$y_t = \beta_0 + \sum_{i=1}^{p} \beta_i y_{t-i} + \sum_{j=0}^{q} \alpha_j x_{1t-j} + \sum_{k=0}^{r} \alpha_k x_{2t-k} + \varepsilon_t \qquad (1)$$

where y_t is the dependent variable, in our case, the pollutant emissions (VYKYDY_summ), x_t is a vector matrix, which is a set of explanatory variables, i.e. extraction of hydrocarbons (TOEs), average environmental tax rate (*Te*) and t is time or trend variable.

According to Pesaran et al. (2001), it should be I (1) variable, but the regressor can be I (0) or I (1). The usual error correction model (ECM), which is equivalent to ARDL from equation 1, can be represented as given by Eq. (2):

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{j=0}^{q} \gamma_j \Delta x_{1t-j} + \sum_{k=0}^{r} \delta_k \Delta x_{2t-k} + \ z_{t-1} + e_t \qquad (2)$$

where Δ is the first difference operator, z is the term for error correction, which represents a series of residues from the "long-term equilibrium" regression, namely: $Z_{t-1} = y_{t-1} - (\alpha_0 + \alpha_1 x_{1t-1} + \alpha_2 x_{2t-1})$ The coefficients are determined by OLS.

According to the Pesaran (2001) method, we proceed from the usual error correction model (ECM), according to Eq. (2), to unlimited (UECM) (Eq. 3):

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{j=0}^{q} \gamma_j \Delta x_{1t-j} + \sum_{k=0}^{r} \delta_k \Delta x_{2t-k} + \theta_0 y_{t-1} + \theta_1 x_{1t-1} + \theta_2 x_{2t-1} + v_t \qquad (3)$$

The coefficients θ_0, θ_0, θ_0 are determined by the formulas:

$$\theta_0 = \varphi, \theta_1 = \varphi * \alpha_1, \theta_2 = \varphi * \alpha_2$$

This makes it possible to obtain the values of coefficients α_1, α_2 from the coefficients of the regression equation 3 (UECM), from the long-term regression equation (long-term multipliers): $\alpha_1 = \theta_1 / \theta_0, \alpha_2 = \theta_2 / \theta_0$ Short-term effects are determined by the indices of the first differentiated variables in Eq. (3).

Our unlimited UECM model is as follows (Eq. 4):

$$\begin{aligned} \Delta(LVYKYDY_{summ})_t &= \beta_0 + \theta_0 (LVYKYDY_{summ})_{t-1} + \theta_1 (LTOE)_{t-1} + \\ &+ \theta_2 (LTe)_{t-1} \sum_{i=1}^{p} \beta_i \Delta(LVYKYDY_{summ})_{t-i} + \sum_{i=1}^{q} \gamma_i \Delta(LTOE)_{t-i} \sum_{i=1}^{r} \delta_i \Delta(LTe)_{t-i} + u_t \end{aligned} \qquad (4)$$

Equation (3) can also be considered as the ARDL order (*p, q, r*). Structural backlogs are set using the Minimum Akaike Information Criterion (AIC). After the regression of Eq. (3), a Wald test (F-statistics) was calculated to differentiate the long-term relationship between the corresponding changes. The Wald's test can be done by setting limits on expected long-term emission factors for polluting substances, hydrocarbon production, and environmental taxation rates.

The zero and alternative hypothesis is as follows:

$H_0 : \theta_0 = \theta_1 = \theta_2 = 0$ (No long term relationship (missing cointegration))

Against alternative hypothesis:

$H_1 : \theta_0 \neq \theta_1 \neq \theta_2 \neq 0$ (There is a long-term interaction (there is cointegration))

The calculated value of F-statistic is estimated using the critical values x_t given in Table CI (Pesaran et al., 2001). According to these authors, lower limit critical values x_t assume that explanatory variables x_t are integrated series of zero order or I (0), whereas the adopted upper limit critical values x_t are integrated series of the first order or I (1).

So, if the calculated F-statistic is less than the lower limit value, then the null hypothesis does not deviate, and we accept the conclusion that there is no long-term relationship between pollutant emissions and their determinants. Conversely, if the calculated F-statistics exceeds the upper limit value, then hydrocarbon production and the environmental tax rate affect emissions of pollutants in the long run, and there are long-term relationships between them. On the other hand, if the calculated F-statistic falls between the lower and upper limit values, then the results are not final.

3. Results and discussion

We will evaluate the order of integration of our variables. To do this, we use the standard ADF test (Augmented Dickey-Fuller). The results of testing our variables for a unit root are shown in Table 1.

Table 1. Assessment of a unit root using the ADF test*

	In levels		***In the first difference***	
	Constant	***Constant + trend***	***Constant***	***Constant + trend***
VYKYDY_summ	0.0034(2)	-2.5118(1)	-3.7347**(1)	-4.1374**(2)
TOE	-1.0767(1)	-3.3384*(2)	-3.529**(1)	-3.7661**(1)
Te	-1.3954(2)	-2.849(1)	-4.049***(1)	-3.9576**(1)

*The null hypothesis is that the series is not stationary or contains a unit root. The deviation of the null hypothesis is based on McKinnon critical values (1996). The length of the distance is chosen based on the AIC criteria, which ranges from zero to lag to two. *, ** and *** indicate deviations of the null hypothesis of non-stationarity by 10%, 5% and 1% of a significant level, respectively.

The calculations were carried out in R (package Urca). As Table 1 shows, the emission variables (VYKYDY_summ) and the average tax rate (Te) have the integration order I (1). A variable of hydrocarbon production (TOE) is a stationary series - I (0) taking into account the downstream trend.

The next step is to evaluate the ARDL model for our data. The evaluation results are shown in Table 2. The reliability of the validity of the specification, that is, the R-square and the corrected R-square, is 0.8165 and 0.6854, respectively.

Table 2. Evaluation of the basic ARDL model by the AIC information criterion
Dependent variable: LVYKYDY_summ. Selected model: ARDL(2,0,1)

Coefficients	***Estimate***	***Std. Error***	***t value***	***Pr(>|t|)***
(Intercept)	1.8737	2.8913	0.648	0.5376
L(LVYKYDY_summ, 1)	0.7330	0.2982	2.458	0.0436 *
L(LVYKYDY_summ, 2)	-0.5987	0.1912	-3.131	0.0166 *
LTOE	0.6254	0.3505	1.784	0.1176
LTe	-0.3481	0.1152	-3.022	0.0193 *
L(LTe, 1)	0.2130	0.1025	2.077	0.0764 .
Signif. codes:	0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1			
Residual standard error:	0.05835 on 7 degrees of freedom			
Multiple R-squared:	0.8165			
Adjusted R-squared:	0.6854			
F-statistic:	6.228 on 5 and 7 DF			
p-value	0.01632			
Diagnostic **Checking:**	LM-1=0.434[0.509]	LM-2=0.717[0.698]	LM-3=2.39[0.495]	
Ramsey	RESET = 0.18921[0.8324]	JB = 0.38424[0.8252]	BP = 6.4658[0.167]	

*Author's calculations using R. (packages: *fcbarbi/ardl*)

The model power was determined by several diagnostic tests, such as the Breusch–Godfrey serial correlation LM test, the Jarque-Bera test for normality (JB), the Breusch-Pagan test for heteroskedasticity (BP), and the Ramsey Regression Equation Specification Error Test (RESET). All tests reveal that the model has satisfactory econometric properties, the correct functional form, and the remnants of the model are serially uncorrelated, normally distributed and homoscedastic. Thus, the above results are valid for reliable interpretation.

We will conduct a bounds test in accordance with the methodology (Pesaran *et al.*, 2001). The results are shown in Table 2. The results of the limit cointegration test show that the null hypothesis is deviated at a significance level of 5%. The calculated F-statistic of 4.9197 exceeds the low critical value of 3.79, which indicates the existence of a stable, long-term relationship between pollutant emissions, hydrocarbon production and the environmental tax rate. The estimation of the model of conventional ECM, according to Eq. 2, and the definition of long-term and short-term multipliers are given in Table 4.

The equation of long-term regression between indicators of pollutant emissions, hydrocarbon production and the level of environmental taxation takes the form of Eq. (5):

$$(LVYKYDY_{summ})_t = 1.88 + 0.722(LTOE)_t + -0.156(LTE)_t \quad (5)$$

According to equation 5, a 1% increase in hydrocarbon production contributes to an increase in emissions of 0.722%, and a 1% increase in tax rates leads to a decrease in emissions by 0.156%. The coefficients are fully consistent with our initial theoretical assumptions in the long-run equilibrium equation. The extraction of hydrocarbons has a greater impact on emissions than environmental taxation. Environmental taxes do not have an effective influence on controlling emissions of pollutants in Ukraine. The quality of fitting the ARDL model (2.0.1) for pollutants emissions depending on hydrocarbon production and the environmental tax rate is shown in Fig. 3.

Table 3. Evaluation of the bounds test

Bounds Test:				
LVYKYDY_summ ~ +1 + L(LVYKYDY_summ, 1) + L(LVYKYDY_summ, 2) + LTOE + LTe + L (LTe, 1)				
PSS case 3	(unrestricted intercert, no trend)			
Regressors (K) 2	d(y_t) = alpha + pi (y_t-1,x_t)' + phi (d(y_t),d(x_t))' + epsilon_t			
Null hypothesis (H0)				
No long-run relation exist, ie H0				
pi=0	10%	5%	2.5%	1%
I(0)	3.17	3.79	4.41	5.15
I(1)	4.14	4.85	5.52	6.36
Wald test to compare the models:				
d(LVYKYDY_summ) ~ +1+L(d(LVYKYDY_summ)) +d(LTOE)+d(LTe)				
d(LVYKYDY_summ) ~ +1+L(d(LVYKYDY_summ)) +L(LVYKYDY_summ,1)+LTOE+LTe+d(LTOE)+d(LTe)				
F statistic	4.919727			

* Author's calculations using R. (packages: *fcbarbi/ardl*). Critical values (Pesaran *et al.*, 2001), Table CI, Case 3.

Table 4. Estimation of ECM model parameters

Auto Regressive Distributed Lag model				
Short-Run Coefficients. Dependent variable is d(LVYKYDY_summ)	Estimate	Std.Err	Z value	Pr(>z)
(Intercept)	1.88097	0.46580	4.038	5.39e-05 ***
L(d(LVYKYDY_summ))	0.60281	0.17463	3.452	0.000557 ***
d(LTOE)	0.59562	0.36238	1.644	0.100253
d(LTe)	-0.34432	0.09829	-3.503	0.000460 ***
L(coint)	-0.86944	0.21691	-4.008	6.12e-05 ***
Signif. codes	0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1			
Long-Run Coefficients. Dependent variable is LVYKYDY_summ	Estimate Std.Err Z value Pr(>z)			
LTOE	0.72237	0.12741	5.670	1.43e-08 ***
LTe	-0.15603	0.04585	-3.403	0.000666 ***
Signif. codes	0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1			

* Author's calculations using R. (packages: *fcbarbi/ardl*).

The analysis shows that in order to regulate pollutant emissions in Ukraine it is expedient to improve the efficiency of tax regulation. Raising tax rates in the long run, we can achieve emission reductions, including greenhouse gases. Studies show that during 2016-2018 there has been a gradual increase in environmental tax rates in Ukraine (Table 5).

In the structure of pollutant emissions, the largest amount falls on sulfur dioxide anhydride, the share of which decreases from 34.97% in 2016 to 26.54% in 2018 and carbon monoxide share from 26.1% in 2016 to 28 3% in 2018. About the rates of environmental tax, it should be noted that some of them are low, that is, they have little fiscal pressure on business entities for air pollution. In 2018, there was an increase in environmental tax rates by 11.2% compared with 2017, and there was an increase in tax rates by the same amount in 2017 compared to 2016. Thus, the tax rate for carbon monoxide emissions is 92.37 UAH/ton, while last year's value was 83.07 UAH/ton. The environmental tax rate for carbon dioxide emissions from stationary sources of pollution in 2016 is 0.33 UAH/t, in 2017 amounted to 0.37 UAH/t, in 2018 0.41 UAH/t, but in 2019 it increased to 10.0 UAH/t. However, despite the gradual increase in environmental tax rates, they remain not high compared with EU countries.

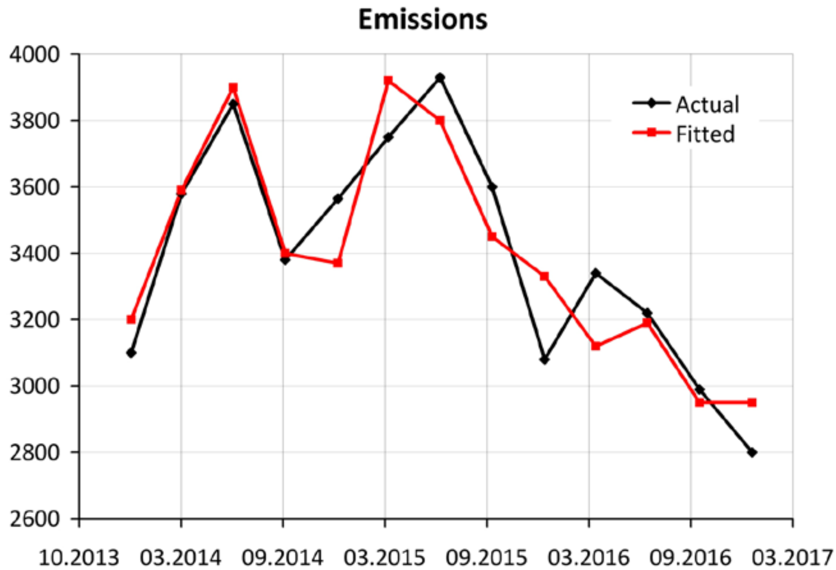

Fig 3. Pollutants emissions and fitted ARDL model (2.0.1)
(calculations by the author)

Table 5. The structure of pollutant emissions in atmosphere and the environmental tax rates set in 2016-2018

Pollutants	Emissions %[3]			Environmental tax rates UAH/t[4]		
	2016	2017	2018	2016	2017	2018
Carbon oxide	26.1	26.97	28.3	74.17	83.07	92.37
Sulfuric anhydride	34.97	26.89	26.54	1968.65	2204.89	2451.84
Hydrocarbons	15.15	20.44	18.81	111.26	124.61	138.57
Nitrogen dioxide	7.83	7.98	8.19	1968.65	2204.89	2451.84
Carbon dioxide	4.89	4.6	4.81	0.33	0.37	0.41
Other	11.06	13.12	13.35			

Sources: [3] calculated according to data Ukrstat; [4] is based on The Tax Code of Ukraine.

Thus, in 2016, the average tax rate for CO_2 emissions was: in Germany - 55.90 euros/ton, in Poland - 24.22 euro/ton, in France - 63.75 euro/ton, in the UK - 71.46 euro/ton, in Switzerland - 102.42 euro/ton (Euinfocenter, 2016). This indicates a significant difference between the setting of the environmental tax rates in Ukraine and European countries, including for carbon dioxide emissions. That is, in Ukraine, business entities do not have incentives to introduce environmental protection measures.

Consequently, environmental taxation has shown its effectiveness in implementing environmental policy in European countries. The principle of environmental taxation should help to create incentives for business entities to innovate in environmental protection and reduce environmental risks.

4. Concluding remarks

This paper evaluates the impact of changes in environmental tax rates on pollutants emissions in the oil and gas sector using time series data regarding the activities of oil and gas enterprises in the Ivano-Frankivsk region of Ukraine, using the Bound Testing approach. The analysis shows that tax increase reduces pollutants emissions in oil production enterprises by 0.156%, and hydrocarbon production growth, on the contrary, increases emissions by 0.722%.

As the analysis showed, it is necessary to increase the sensitivity of pollutants emissions to rates of environmental taxation. This can be achieved only through a significant increase in the rates of environmental taxation, taking into account the basic principles of ecological modernization, and through the active introduction of innovative technologies aimed at reducing emissions and their active stimulation.

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