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Detection of the Interdependence of Economic Development and Environmental Performance at the Industry Level

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ABSTRACT

The aim of the research is to identify the connection between economic development and environmental performance at the industrial level. *The subject* of the research is a set of processes of correlation analysis of economic and environmental indicators of the oil and gas producing industry. The urgency of the task of mitigating anthropogenic climate change caused by rising concentrations of greenhouse gases in the atmosphere is proven. Statistical data on emissions for the past 15 years are analyzed, change trends are identified. The authors establish the cause of the growth in greenhouse gas emissions, the energy sector being the main contributor. A description of the mechanism of the effect of greenhouse gases on the climate system is provided. The requirements set by international agreements and Russian documents aimed at reducing greenhouse gas emissions are unified. The main gases that cause the greenhouse effect are identified, their classification and brief characteristics are provided in the article. The necessity to promote the monitoring of greenhouse gas emissions and reporting system at the global level is substantiated. The purpose of the advanced metering system is to obtain relevant and reliable data for timely response to and planned reduction of greenhouse gas emissions. In accordance with the recommendations of the international standard for non-financial reporting, GRI, the effectiveness of reducing greenhouse gas emissions should be disclosed in the aspect of "Emissions". The progress of economic science has made it important to take into account the natural component, and the value of bioresources will increase over time, therefore, the company's economic development can not be isolated. In accordance with *the hypothesis*, it is assumed that the economy and ecology are interrelated and affect each other. To determine economic development and its environmental footprint at the industry level in the aspect of global warming, new approaches and methods must be applied. Based on statistical *methods*, a correlation model between economic develop-

ment and environmental performance has been developed to identify their interrelations based on non-financial reporting data. The developed model can be used by the owners of oil and gas companies and its general principles by the companies of different industries. The results may be of interest to all categories of non-financial reporting users, including government agencies in managing sustainable development at the industry level. The correlation model was tested on the non-financial reports of the oil and gas industry represented by the largest companies - British Petroleum, Lukoil, Shell and Surgutneftegas. Approbation showed different types of interrelations between the two development systems of individual companies: economy and ecology. Thus, the correlation coefficients *prove the hypothesis* that there is a connection between economic development and environmental performance. The overall result for the industry presented a weak positive relationship. The results obtained show the difference in the approach of companies to the issue of environmental and the lack of attention to the environment at the industry level. Further research in this area, using detailed data from a larger number of industry participants, will improve our understanding of the relationship between the two most important systems of sustainable development and will help to draw practical conclusions.

INTRODUCTION

Progressive population growth entails an increase in requests for resources. To create favorable conditions for social and economic life, society is increasing its industrial output, which is accompanied by the depletion of the global resource base and pollution of the environment (Bogdanov et al., 2016, p. 93; Anic, Budak & Rajh, 2016; Infante & Smirnova, 2016; Hanczar & Kaleta, 2016; Rajnoha & Lesníková, 2016, Mikita et al., 2017, p. 156). For the implementation of production activities, companies use energy resources (Ayres and Kneese, 1969, p. 282; Peters, 2008, p. 13; Semenenko, 2016, pp. 537-555). When burning various types of fuels, greenhouse gases are emitted into the atmosphere, which are the cause of climate change.

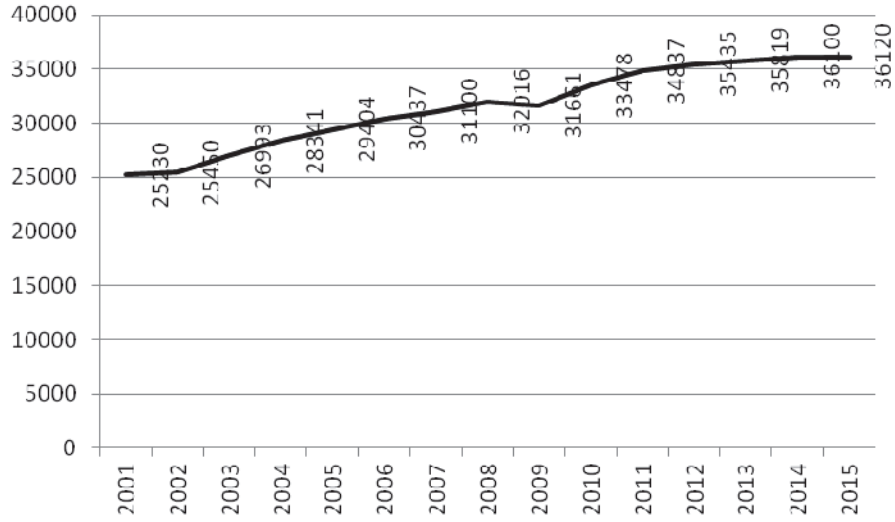
On November 14, 2016, the Global Carbon Project published the annual global carbon budget and national carbon emissions (Das et al., 2016, p. 1365). Using a conversion factor (1 billion. C = 3,664 tons Bln. Tonnes CO2) carbon can be transformed into carbon dioxide emissions.

Analyzing the global trends, it should be noted slowdown carbon dioxide emissions in recent years (Figure 1).

The greatest contribution to global carbon dioxide emissions is made by China, the United States, India and Russia (Table 1). In many ways, the changes in the volume of global emissions should be attributed to changes in the economic situation of those countries. Emission of carbon dioxide in China is 28.3% of the global volume, as a consequence, trends in the Chinese economy directly influence the global emissions. The reason for stabilization at 36.1 billion tons in recent years, Chinese researchers believe the activities related to the slowdown in coal consumption (Das et al., 2016, p. 1365).

Emissions from energy are dominant in the emissions structure, according to the Intergovernmental Panel on Climate Change (IPCC) study, the energy sector accounts for more than 90 percent of carbon dioxide emissions and 75 percent of total greenhouse gas (IPCC, 2006).

Figure. 1 The global trend of carbon dioxide emissions, millions of tons



Source: Compiled according to Global Carbon Budget, 2016
http://www. globalcarbonproject.org/carbonbudget

Table 1. Emissions of carbon dioxide in 2015

Country	*Emissions, million tonnes*	*Share in global emissions, %*	*Volume of emissions per capita, тons / person*
China	10216	28,3	7,4
USA	5093	14,1	15,7
India	2274	6,3	1,8
Russia	1727	4,8	11,8
Whole world	36120	100,0	4,9

Source: Compiled according to Global Carbon Budget, 2016.
URL: http://www.globalcarbonproject.org/carbonbudget/ (reference date: 14.11.2016)

Russia is the fourth largest country in terms of absolute emissions after China, the United States and India, and second after the United States in terms of emissions per capita (Table 1). Russia's contribution to the world cadastre is about 4.8%. According to some estimates (GCB, 2016) for the period 2001-2015 in Russia, 25127 million tons of carbon dioxide were thrown out, of which 20855 million tons (83%) were thrown out by the "Energy" sector. Thus, the energy sector is the most significant from the point of view of influence on the climate system, both in global trends and in Russia (Gritsevich, 2002, p. 9).

The mechanism of influence of the increase in the concentration of greenhouse gases in the atmosphere on the climate is as follows: solar energy penetrates through the atmosphere, is absorbed by the Earth's surface, transformed into thermal energy and released as infrared radiation. Greenhouse gases absorb this radiation, acquire a higher temperature and in turn heat the atmosphere in general. Consequently, the more greenhouse gases in it, the more infrared rays will be retained in the atmosphere, the warmer the climate becomes, resulting in the so-called «*greenhouse effect*» (Landsberg, 1985, p. 106; Vasile et al., 2012, p. 218). The greenhouse effect can

lead to such consequences as deformation of ecosystems, extreme weather events (drought, flooding) and risks to society. The problem of climate change is becoming more and more important and urgent task facing the world community. Mitigation of anthropogenic climate change can be achieved by taking into account and limit greenhouse gas emissions at the global level, which in turn requires international cooperation (Wiedmann, 2009, p. 175).

1. THEORY

International cooperation is carried out through international agreements. In autumn 2015, the UN Summit on Sustainable Development was held during which the final document "Transformation of Our World: An Agenda for Sustainable Development for the Period to 2030" was approved (UN, 2015). This document replaced the Millennium Development Goals. The validity period, like that of its predecessor, is 15 years. The document will contain 17 global goals and 169 tasks for future international cooperation. It has a recommendatory character, it is a kind of guide for countries that independently develop development strategies (Dirzyte & Rakauskiene, 2016).

One of the goals is devoted to the problem of climate change. Goal number 13 is: "*Take urgent measures to combat climate change and its consequences*".

To achieve the goal, countries need to prepare activities aimed at adapting to possible natural phenomena associated with climate change. From an economic point of view, climate change can carry not only negative consequences, but potential benefits associated with saving energy resources. Therefore, national strategies should be developed at the sectoral and regional levels, taking into account the specifics of economic development and the geographic location of the regions (Szyja, 2016, pp. 207-222). Human and institutional capacities are of great importance. Increasing the level of education in the field of climate change will contribute to the desire of society to minimize negative consequences. For developing countries, the UN document provides for material assistance from developed countries in the context of meaningful actions to prevent climate change. The final document of the UN is of a general character and reflects the main tasks for combating climate change, more disaggregated, with a detailed description of the principles of action, is the document of the United Nations Framework Convention on Climate Change (UN FCCC), adopted in December 2015 at the Paris Climate Change Conference (Paris Agreement).

The countries that signed the Paris Agreement have committed themselves to reducing greenhouse gas emissions. The new global agreement is liberal, does not provide for sanctions for not achieving the goals and should enter into force in 2020. The goals and objectives of this document are rather appeals of the world community, rather than requirements. However, in order to achieve the goals, it is necessary to show firmness, rigidity and political will (Davydova, 2016, p. 24).

According to the agreement, the participating countries are invited to disclose information on their contribution to solution the climate problems. Reports on greenhouse gas emissions should be prepared in accordance with the methodologies and common principles assessed by the IPCC and approved by the Conference (UN, 2015).

As well as in the UN document, the agreement provides assistance to adaptation effects of climate change and the provision of financial assistance to developing countries. In addition to human and institutional capital, particular importance is attached to forest resources, due to their ability to bind carbon. According to the results of calculations by a group of international experts published in 2011 in the authoritative journal «Science», the carbon absorption by forests of the boreal zone amounted to 500 ± 80 million tonnes of carbon (1850 ± 296 million tones of CO_2-eq.) On average per year for the period 1990-2007 (Pan et al., 2011, p. 988). To increase the assimilating potential, it is necessary to create a system of sustainable forest management, especially in developing countries (Urbaniec, 2015; Bilan, 2013; Streimikiene et al., 2016).

In the event of loss and damage from natural disasters related to climate change, support is provided that will be implemented through the Warsaw International Mechanism through the transfer of risks. Thus, the participating countries receive some legal support in case of adverse situations related to the consequences of climate change.

The world community calls for encouraging countries to develop and disseminate technologies aimed at mitigating climate change. Mechanism to promote and encourage the development and introduction of innovations can be built through the tax system, a system of grants for industrial and scientific complexes. Such actions and measures will not only contribute to combating climate change, but will also create favorable conditions for economic growth and sustainable development.

Paris Committee is envisaged to understand how effectively the global mechanism for combating climate change works, as well as which areas need improvement, the Paris Committee is envisaged. The Committee consists of 12 competent members and it assesses the increase in the synergy of cooperation, identifies gaps and capacity needs. Conference of Parties is envisaged to coordinate and regulate the implementation of this agreement, the supreme body of the Convention. The Conference of the Parties periodically conducts a global summary of the results for assessing collective progress in fulfilling the objective of this Agreement and in achieving its long-term goals (UN, 2015).

From international agreements on combating climate change, it is obvious that the world community calls for the encouragement and support of any actions by states aimed at reducing the effects on the climate. This applies to the development of renewable energy sources, regional and international cooperation for climate - monitoring and ensuring transparency of actions, supporting adaptation to the consequences of climate change, material assistance to developing countries, development and dissemination of technologies.

In Russia, the situation is somewhat different. Development of greenhouse gas monitoring and reporting system in Russia began by adopting the Climate Doctrine in 2009. The Climate Doctrine of the Russian Federation is a system of views on the purpose, principles, content and ways of implementing Russia's unified state policy in relation to climate change (Kremlin, 2009).

According to the strategy Climate Doctrine Russia's interests related to climate, are global in nature, but in public policy priority given to national interests. To reduce the risks associated with climate change, must be timely response to the consequences of these changes, in this regard, of particular relevance acquire statistics relating to climate change on the basis of which it is possible to drawing the most accurate predictions. The predicted data are a source of information that will be useful in the effort to adapt to the new environment, and reduce greenhouse gas emissions. The consequences of climate change can be both negative and positive.

The implementation of the climate policy implies the development of federal, regional and sectoral programs and action plans on its basis. In April 2014, an action plan was approved to reduce greenhouse gas emissions by 2020 to no more than 75% of the emissions in 1990 (Kokorin and Karppo, 2014, p.9). If in 1990 total emissions of greenhouse gases from stationary sources in Russia were estimated at 3314.29 million tons of CO_2-equivalent, by 2020 they should be reduced to 2,486 million tons of CO_2 equivalent (Tagaeva et al., 2016, p.78). According to the plan, it is planned to create a system for accounting for the volume of greenhouse gas emissions, to carry out an estimation and forecast of the volume of greenhouse gas emissions by 2030, and to take measures of state regulation of the volume of greenhouse gas emissions.

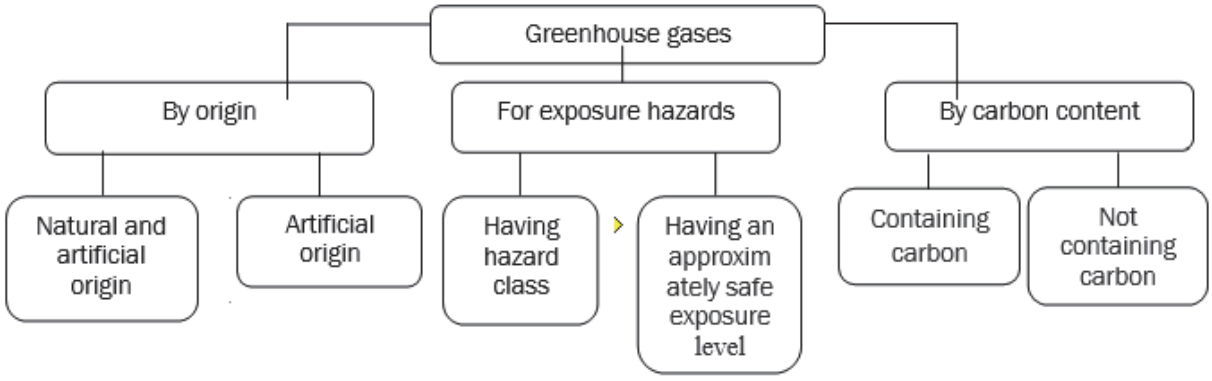
In April 2015, the Concept of a system for monitoring and reporting the volume of greenhouse gas emissions in Russia was approved. One of the main goals of this system is to raise awareness of the state, the public, and the business community about the extent of anthropogenic impact on the climate in the process of economic activity. Also, the monitoring system will serve as an infor-

mation base for developing targets for reducing greenhouse gas emissions, and in the future - monitoring compliance with these indicators (The Government of the Russian Federation, 2015).

Changes in climate legislation affect not only the regulation of greenhouse gas emissions, but also their classification. According to the Russian classification, seven gases are classified as greenhouse gases (Dvinin and Karimullina, 2011, p.76): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), trifluoromethane (CHF_3), perfluoromethane (CF_4), perfluoroethane (C_2F_6), hexafluoride sulfur (SF_6) (Fig. 2), of which only three are harmful and four do not apply (for example, carbon dioxide also does not apply to harmful emissions). As a result of these changes, it is planned to get more stringent control.

Figure 2 presents the author's classification of greenhouse gases.

Figure 2. Classification of greenhouse gases



2. DATA AND METHODS

Despite the recent news of the US - one of the largest producers of oil - getting out of the Paris Climate agreement, which happens to be the major international commitment for preserving the environment, the attention to global climate change and ecology in general has been getting thorough for the past decade.

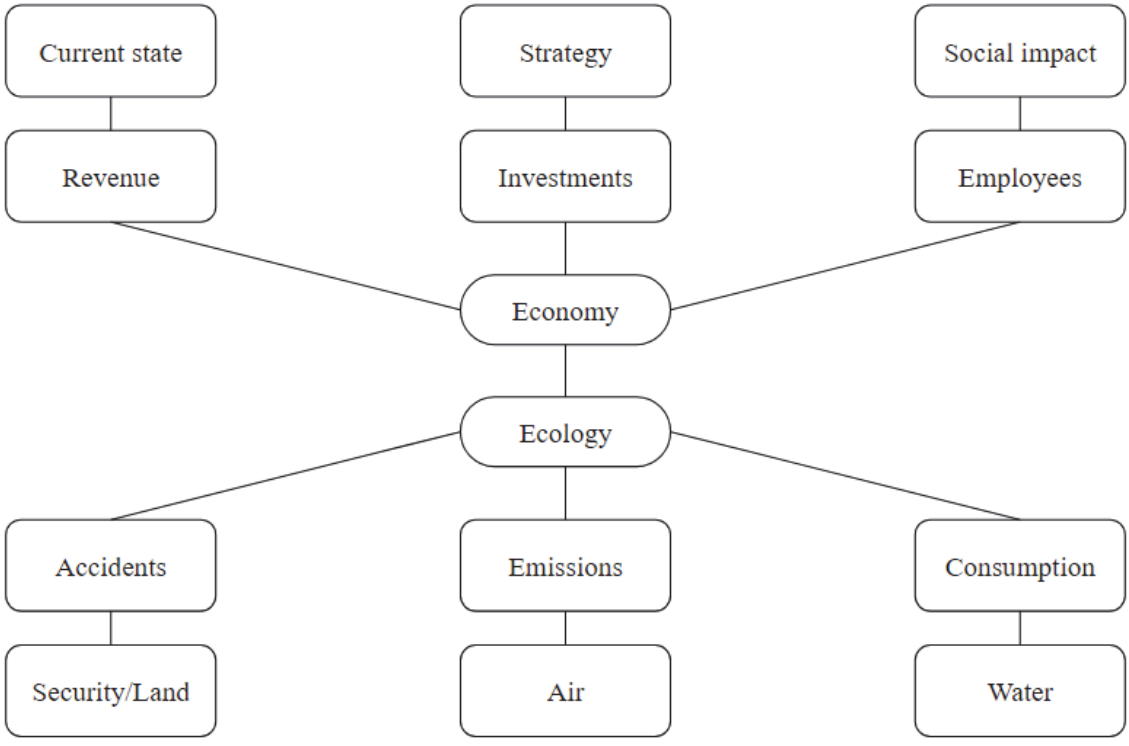
Amidst the vast economic and business welfare of oil and gas industry across the globe, the nature of the goods itself dictates companies to pay more attention to ecological development. Major players of the industry announce Sustainability reports at the end of each year, which are as detailed as the usual three musketeers of financial data: balance sheets, income statements and cash flow.

So what is the relationship between economy and ecology. There seems to be two different approaches to this question:

- One think, development that is focused more on environment causes a slowdown in business and economy. As mentioned before, the current US government is a good example of this approach, who saw in the Paris agreement a waste of money, money that could have been spent on creating jobs inside the country.
- Second view sees in focusing on the environment an indirect force for technological development. Companies and corporation will invest into much safer technologies that reduce the negative impact, thus boosting the technological architecture, which in turn enhances the economy and business as well.

In this paper we attempt to show the relationship between economy and ecology numerically. To do that we will use data for the years 2010-2015, from major oil and gas producers around the world, precisely British Petroleum, Lukoil, Shell and Surgutneftegas. We explore their annual financial and sustainability reports, use the information to build a simple correlation statistics between economic components and environmental parameters.

Figure 3. Overall view of the model



In the picture above we can see the parameters of the model:

- Economy is considered from three points:
  - ✓ current state that is represented by the revenues
  - ✓ strategy, or where the company is aimed in the future, that is proxied by investments
  - ✓ finally, social side of the business that is seen in the employee numbers

- Ecology is seen from another three points:
  - ✓ technological advancement of businesses, their safety. We used number of accidents to proxy this parameter, meaning the less accidents you have the better security you are ensuring.
  - ✓ impact on air, which is the major environment changing factor. We took the greenhouse emissions as our proxy data
  - ✓ finally, smart water usage is key to reducing the negative impact of the corporations on the ecological systems around.

We assume that each factor in respective categories defines the overall picture differently. While water consumption and security levels are important, ecological development is largely examined by the levels of air pollution. Similarly current state of the companies have bigger effect on the financial development, meaning depending on the revenues and current performance businesses decide where and how they invest, or how to move in social terms. As a result in the model, we gave different parameters various weights, while making sure their combined weight is equal to one.

The nature of the data in financial and sustainability reports are distinct from one another. Some are in million dollars and some are in numbers, hence it was important to make them to have one common base unit. We used natural logs to achieve this goal.

To represent the economy and ecology as one general units, we composed two variables, which we call development indices: *Ecol_dev_index* and *Econ_dev_index* which are calculated as follows (Moed, 2005, p.1088):

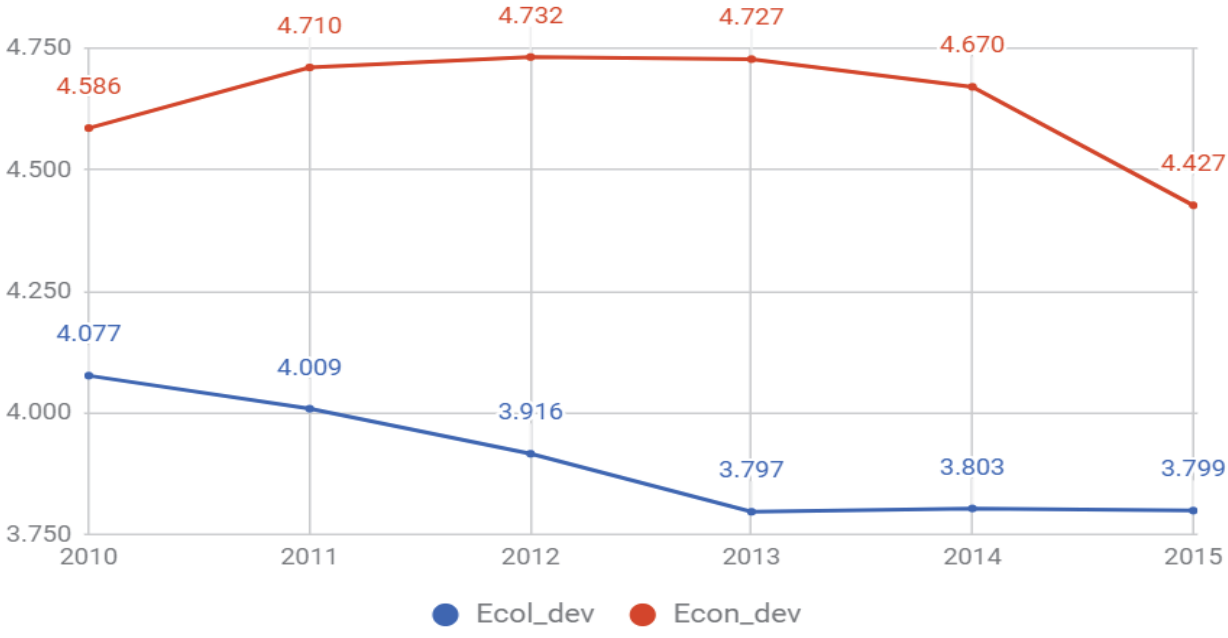
$$\text{Ecoldev} = 1/2 * \text{LN(Gasemiss)} + 1/4 * \text{LN(Watercons)} + 1/4 * \text{LN(Accidentnum)}$$

$$\text{Econdev} = 1/2 * \text{LN(Revenue)} + 1/4 * \text{LN(Investment)} + 1/4 * \text{LN(Employee)}$$

3. RESULTS

Each individual variable of the formulas are calculated as an average of respective metric from the four companies in our dataset during a particular year (Miri, 2013, p.1255). So the Gasemiss is an average value of greenhouse emissions across the BP, Shell, Lukoil and SurgutNeftGas for each year between 2010 and 2015. Other metrics are calculated in a similar fashion.

Figure 4. Indices trends between 2010 – 2015



As we can see the indices had different movements before and after 2013. Economy were stable until, while ecology index had decreased. After there was a role reversal. To see the relationship between the two indices, we ran simple correlation test (Gupta, 1987, p.82):

Table 2. Correlation between indices

	Ecol_dev	*Econ_dev*
Ecol_dev	1	
Econ_dev	0,126	1

Results show very weak positive relationship between environmental and economic development in oil and gas industry (represented by 4 companies) over the span of 6 years.

Nevertheless, we tried to explore the similar movements and relationships on a singular companies' levels. So we run similar correlations test for each company on our list, after calculating the indices separately for them:

Table 3. Individual correlation coefficients

Companies	*Correlation coefficients between indices*
British Petroleum	0.440
Shell	-0.428
Lukoil	-0.332
Surgutneftegas	0.228

While British Petroleum had moderate positive relationship between its ecological and economic development, Shell had demonstrated negative link between the indices.

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CONCLUSIONS

According to the results of the analysis of the statistical data on the volume of global carbon dioxide emissions over the past fifteen years, it should be noted the slowdown in the growth rates

of emissions in recent years. Due to the fact that China is the leader in terms of emissions, it can be assumed that the slowdown is directly related to the trends in the Chinese economy.

In terms of absolute emissions, Russia is in the top five and is fourth after China, the United States and India, with per capita emissions in the top three and is second only to the United States. Over the past ten years, the average concentration of carbon dioxide in the air in the regions of Russia has increased by 12%, including over the past 5 years - by 10% (Tagaeva et al., 2016, p. 79). Thus, the ecological situation in the Russia continues to remain quite tense.

The world community calls for encouraging any actions related to reducing greenhouse gas emissions. Monitoring, reporting and verification of greenhouse gas emissions are an integral part of international agreements in which Russia is a participating country. Also, through reporting, it becomes possible to control the amount of greenhouse gas emissions. The results of the assessment are reflected in the inventory, which is submitted annually to the secretariat of the Framework Convention. The assessment is carried out using approved methods. Analyzing the Russian methodological documents, it should be noted that the guidelines for quantifying the greenhouse gas emissions of the Russian adopted in 2015 require further development in terms of applicability and ease of use.

In conclusion, in this paper we demonstrated an approach to compare the environmental and business state of individual companies, as well as whole industry using basic techniques available. Results supported the both thinkings that exist at the moment towards the impact of environment to economy. We believe further research in this area with more detailed data from more participants of the market will enhance our understandings between two crucial aspects of the world and help us to draw practical conclusions.

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