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Decoupling effect in the industrial region (the case of the Kemerovo Oblast)

The article considers the possibility of eco-economic decoupling in the industrial region (in the case of the Kemerovo Oblast). The analysis of the trends of economic development and production output volumes (in particular, in the coal industry) has proved that there are no decoupling effects in the region. The increase in production volumes has a direct negative impact on the environment. In order to change the situation, a substantial increase of investment in environmental protection is required, otherwise the ecological situation in the Kemerovo Oblast will deteriorate even more significantly.

Decoupling, industry, Kemerovo Oblast, modernization, environment, air pollution, water pollution, surface disturbance.

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Economic development of the majority of Russia's regions during their post-crisis recovery and modernization will be connected in many respects with the key branches of heavy industry. The transition to the innovation model of economic growth does not reduce the importance of modern industry in the economy. Substantial evidence can be found in the U.S. experience; being a global innovation and technology leader, the country extracted 997 million tons of coal, 275 million tons of oil, produced 80 million tons of steel, 4361 billion kW*h of electric power, 64.4 million tons of cement in 2010 [14]. Economy modernization and technological breakthrough enhance, rather than reduce, the significance of present-day industry that provides enterprises and citizens with fuel, energy, modern construction materials.

It should be also noted that the actual branch-wise structure of Russia's economy, as V.A. Ilyin points out, is changing by no means toward high-tech manufacturing industries. On the contrary, in practice, there has been a shift in favour of raw material sectors, extractive industries, in particular, the fuel and energy complex [6]. This problem is especially acute in a number of Russia's old industrial regions

dominated by fuel, metallurgical and chemical industries, and metal-intensive engineering. Such regions comprise the Vologda, Kemerovo and Chelyabinsk oblasts, Krasnoyarsk Krai, the Republic of Khakassia, etc. Their economic growth pattern in the 1999 – 2008 period was based on the recovery of industries connected with the exploitation of natural resources, energy and fuel. Thus, in the Kemerovo Oblast, the rise of the economy was to a great extent reduced to the recovery of mining industry [10].

The problems, difficulties and disadvantages of this economic growth alternative are well-known, and they have been analysed by Russian scientists [1, 2, 3, 5, 6]. A most acute problem lies in the environmental impact of heavy industry that damages biodiversity, environment, human health, agricultural land, and deteriorates the quality of life. However, economic growth in most of Russia's regions is still based on raw materials and exploitation of natural resources. Moreover, such state of affairs is reflected in official strategies and programmes of many constituent entities of Russia. For instance, the "Socio-economic development strategy of the Kemerovo Oblast up to 2025" envisages the increase in coal mining up to 270 million tons [16].

At the same time, industrial growth, the increase in the volumes of natural resources extraction and processing do not always have to result in grave or disastrous environmental damage, since there exist certain technological solutions, organizational and economic methods of management, which help to reduce the damage inflicted or compensate for it [4, 8, 17, 18, 19]. In this regard, the concept of decoupling has become very popular for the last 10–15 years. The concept implies that economic growth (in raw material industries as well) is possible without the increase of natural resource intensity and environmental damage [11]. There have been speculations concerning the presence of decoupling in the Kemerovo Oblast economy, in its coal industry in particular [10]. However, the feasibility of decoupling is doubted by many specialists [20]. D. Meadows, the author of a widely known work *The Limits to Growth*, speaking at the lecture in SKOLKOVO, declared: "Decoupling does not work. There are some examples of minor changes of the dependence coefficient, for example in Denmark, but there are no long-term examples" [12].

Taking into account the high attractiveness of development in the framework of decoupling for industrial regions, the article is aimed at identifying the presence or absence of decoupling in the primary industrial sectors of the old industrial region (in the case of the Kemerovo Oblast).

However, to identify the presence or absence of decoupling, it is necessary to define this very concept. The English word *decoupling* means "splitting; separation; breakdown of connection" (in Russian: "развязывание, развязка, расщепление, разъединение, отделение, нарушение связи"). It follows that the concept of decoupling is applicable to the situations when two processes or a set of indicators that should have a correlation or other dependence actually move in different directions. The term *decoupling* indicates, in particular, the violation of synchronism in the economic growth and recession of developed and developing countries – instead of the expected synchronisation of economic cycles, there is a mismatch in economic dynamics of these countries [13, 15].

In eco-economic sphere, the term *decoupling* initially characterized the splitting of the trends of GDP growth and primary energy consumption in the OECD countries: while GDP was growing, the primary energy consumption remained stable or even slightly reduced [9]. At present, decoupling is regarded as the mismatch between the pace of population's welfare improvement on the one hand, and the consumption of resources and environmental impact – on the other.

Decoupling implies that the achievement of economic progress is based on lower rates of resources consumption and the reduction of environmental damage [11].

In view of the above, the author proposes to define the term *decoupling* (as applied to environmental economics) as the discrepancy and divergence between economic growth rates at the level of countries, regions and economic branches and the rate of changes in environmental damage indicators. In other words, an economy is said to be decoupled, when the indicators of negative impact on the environment remain stable or even show a decreasing trend along with a positive dynamics of economic growth rates.

Having defined the notion of decoupling, we can proceed to the methodology of its identification in the industrial region. The presence of decoupling is characterized by the divergence between the dynamics of economic indicators and indicators of environmental damage; thus, it is necessary, in the first place, to determine the structure (list) of indicators, which characterize the pace of economic development of a branch or region, as well as environmental damage indicators. Consequently, the links between them are examined at the second stage of the study, which helps to determine the presence or absence of decoupling effect.

It has been proposed to reveal the presence or absence of decoupling effects in the old industrial region in the case of the Kemerovo Oblast and the region's coal industry. Firstly, the Kemerovo Oblast is a typical representative of a group of historically old industrial regions, where economic growth was and, apparently, will be conditioned in the long term by the development of mining industry. Secondly, coal industry, as a branch of the region's specialisation, clearly reflects its economic performance, as well as an approach to the solution of environmental problems.

The volume of coal mining in natural units (in tons) was accepted as an indicator reflecting growth rates in the coal industry. Cost indicators of the volumes of coal production and sales weren't used, since they largely depend on fluctuations of coal prices and the situation in the sphere of rail transport. In order to determine the composition of indicators, reflecting negative industrial impact on the environment, the author proceeds from the fact, that coal industry affects the environment in the following ways:

1) withdrawal of land, its pollution by wastes from coal mining and enrichment are characterized by the indicator of the area of damaged land (in hectares);

2) change of hydrological behaviour of underground and surface waters, and depletion of water resources are characterized by the indicator of water intake from water bodies (cubic metres) and the use of fresh water (cubic metres);

3) pollution of groundwater and surface water bodies by industrial and household wastewater is characterized by the indicator of the discharge of sewage, transit, mine water into water bodies (cubic metres), as well as the discharge of polluted water (cubic metres);

4) pollution of air by solid and gaseous harmful substances is characterized by the indicator of the total emission of polluting substances into the air (tons).

The analysis covers the 2005 – 2011 period, which, in the author's viewpoint, is the most significant one for studying the decoupling effect in the Kemerovo Oblast. Generally, the years 2004–2005 witness the expansion of production capacities of coal-mining enterprises, while earlier, the growth in extraction volumes had been achieved mainly by using idle facilities and without conducting large-scale technological renovation. The data on environmental pollution in the Kemerovo Oblast in 2012, have not yet been published.

Table 1. Indicators used to identify the decoupling effect in the coal industry of the Kemerovo Oblast

Indicator	2005	2006	2007	2008	2009	2010	2011
Coal mining, million tons	164.3	174.8	181.4	182.8	179.2	181.8	188.3
Area of disturbed land, hectares	62783	62386	62361	62511	62700	63700	63531
Intake of water from water bodies, million cubic metres	274.2	298.4	316.2	323.9	327.5	328.9	329.1
Use of fresh water, total, million cubic metres	57.8	69.2	69.0	64.0	59.9	60.3	60.1
Discharge of sewage, transit, mine water into water bodies, million cubic metres	240.9	260.2	283.5	291.2	293.6	295.3	297.1
Including polluted water, million cubic metres	202.0	217.0	233.6	251.8	245.7	249.7	248.6
Overall air pollution, thousand tons	590.9	625.2	798.2	852.1	851.4	826.9	804.3
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The empirical data used in the research are presented in *table 1.*

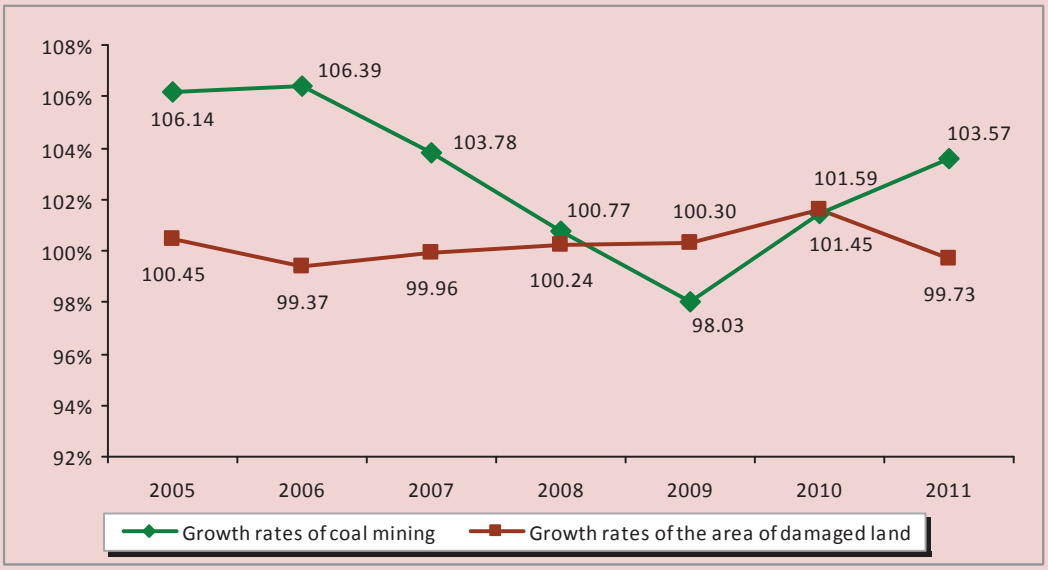
Coal production indicators have been obtained from official statistical reference book *Kuzbass in Figures*, published by the territorial body of the Federal State Statistics Service in the Kemerovo Oblast. Other indicators have been taken from the annual state reports on the condition and protection of environment in the Kemerovo Oblast, published by the Natural Resources and Ecology Department of the Kemerovo Oblast Administration on its official website (available at: http://kuzbasseco.ru/doklady/).

Let us first consider the dependence between the growth rates of coal industry and the increase in the area of disturbed land. For this purpose, let us calculate the chain rates of growth of coal mining and the change in the area of disturbed land. The results in *fig. 1* prove that there is no definite connection between the changes in the area of disturbed land and the volume of coal output.

While the pace of coal mining volumes increase was slowing down, the rate of damaged land areas increase remained stable; in 2006 – 2007 it was reducing alongside increasing extraction. Rapid increase of extraction in 2010 – 2011 didn't result in acceleration of land damage. The Pearson correlation coefficient between the variables *coal mining* and *area of damaged land* is 0.37, which indicates the absence of a statistically significant relationship.

Therefore, the increase of coal mining in Kuzbass doesn't necessarily imply the increase in the area of damaged land, which creates certain prerequisites for the implementation of decoupling effect. Since the damaged land area is reduced due to land rehabilitation and due to the change of a category of previously disturbed and exhausted land, we can conclude that the land, which is no longer in use, undergoes a relatively timely and full rehabilitation. The Kemerovo Oblast proves an argument of V.I. Danilov-Danilyan, who stated that "coal industry (unlike oil industry) pays off its land rehabilitation debts" [7]. However, it should be taken into account, that in the case of surface disturbance, it is easier to get the decoupling effect, because disturbed land is still possible to restore with the due quality and timing of rehabilitation.

Figure 1. Correlation between the growth rates of the area of damaged land and the growth rates of coal mining in the Kemerovo Oblast in 2005–2011, %



Let us consider the correlation between coal mining and water pollution. *Table 2* shows the Pearson correlation coefficients between the rates of coal mining volumes increase and the indicators of water consumption and pollution.

The data show that three out of the four indicators of water consumption and pollution have a strong positive correlation with coal mining increase rates. The increase in coal mining correlates closely with the volume of fresh water intake, total water discharge in water bodies and the discharge of polluted water – correlation coefficients exceed 0.9000 while the critical value is more than 0.7545.

The increase in coal production volumes leads directly to the increased intake of fresh water, which is explained by objective technological peculiarities of coal mining, an underground mining in the first place. The peculiarity of water consumption in coal industry consists in the prevalence of water intake from underground sources while draining mine workings. Only a small amount of water is taken from surface water bodies. It is not possible to reduce the volume of mine workings draining when using the present extraction technologies. At the same time, the main volume of consumed water still returns to natural environment, because the water, used in coal industry, doesn't become part of the finished product. This is expressed in the absence of statistical correlation between the increase of coal mining and the use of fresh water (the correlation coefficient is 0.1584, which is significantly lower than the critical value).

Discharge of waste water in general and the discharge of polluted sewage water, as can be seen in *table 2*, are directly connected with the change in the volumes of coal mining. The discharge of waste water is explained by the return of the previously taken water when draining mine workings, and it will objectively have the same dynamics as the volume of coal mining, tunnelling and second working.

A more serious problem lies in the closest connection between the overall production volume and the discharge of polluted waste water, which can be described by the regression equation explaining 87% of the variance:

Table 2. Correlation coefficients between the growth rates of coal production and indicators of water consumption and pollution*

Water consumption and pollution indicator	Value of correlation coefficient between this indicator and the growth rates of coal production	Number of degrees of freedom	Critical value of correlation coefficient at the level of significance = 0.05
Intake of fresh water, cubic metres	0.9298	5	0.7545
Use of fresh water, total, million cubic metres	0.1584	5	0.7545
Discharge of residuary, transit, mine water into water bodies, million cubic metres	0.9302	5	0.7545
Discharge of polluted sewage, transit, mine water, million cubic metres	0.9016	5	0.7545
* author's calculations.			

$$C = 2.6231D - 189.14,$$

where C is the discharge volume of waste, transit and mine waters into water bodies, million cubic metres;

D is the volume of coal mining, million tons.

It turns out that every million tons of coal in the current situation will increase the discharge of polluted water by approximately 2.6 million cubic metres. The increase in extraction causes the pollution of aquatic environment, and any decoupling effect in this case is definitely out of the question.

The main reason consists in the fact that the share of partially clean water in the drains of coal industry is small due to certain technological peculiarities, and the number of treatment facilities is not enough. Less than half of wastewater discharges at coal enterprises have treatment facilities. Moreover, most of these structures use technologies that have been obsolete for decades.

Consequently, at present, coal enterprises are not able to treat waste water to a standard quality. Therefore, the increase in coal extraction will inevitably cause the increase in the amount of waste water. The problem lies not only in the lack of treatment facilities, but also in the obsolete technologies of mechanical water treatment at the enterprises that have treatment facilities. Their performance does not reach even 60%; therefore, without the large-scale construction of new sewage treatment facilities, it will be impossible to achieve decoupling effect.

Thus, land rehabilitation in general makes up for land damage in the Kemerovo Oblast; however, at present it is impossible to overcome the tendency of simultaneous increase in the amount of waste water.

Further on, let us consider the relationship between the volumes of coal production and the level of air pollution. The calculated correlation coefficient is 0.8249, which exceeds the critical level at the value of $\alpha = 0.05$. Therefore, in the period under review, air pollution intensity was in close correlation with the total volume of coal mining, so there was no decoupling effect in this aspect, either.

A connection between the increase in the amount of pollutants in the air and the change in the coal mining volume is illustrated by the following regression equation, which explains 68% of the variance:

$$E = 11.809M - 1349,$$

where E is the amount of emissions into the air, thousand tons;

M is the volume of coal mining, million tons.

The increase in coal production by one million tons can lead to additional emissions of pollutants in the air amounting to 11809 tons. However, the data for 2010–2011 give rise to certain optimism due to the fact that while the volume of coal mining output increased, air pollution in absolute terms reduced by

47.1 thousand tons or 5.53%, even though the volume of coal extraction over that period increased by 9.1 million tons or 5.08%. There is also a tendency toward the reduction of specific emissions of pollutants in the air per tonne of coal produced *(fig. 2)*. But, of course, the positive dynamics observed in such a short time-span doesn't confirm the existence of decoupling effect.

Studying the environmental impact of coal industry, one should point out that the absolute amount of its water and air pollution is greater than that of metallurgical and chemical industries. However, it should be emphasized that emissions from coal industry are less harmful regarding the content of 'heavy' pollutants. Coal industry pollutes the environment with a greater volume of less hazardous waste substances, while metallurgy and chemicals produce a smaller amount of waste, but it is more harmful.

The influence of coal industry on the environment has another peculiarity that is manifested in such phenomena that can not always be measured by quantitative indicators. These phenomena include changes of the landscape, hydrological behaviour of surface and ground water, and tectonic processes; indirect impact on wildlife; destruction of natural ecosystems. They are the consequences of large-scale displacement of soil, rock and minerals, industrial explosions, dramatically changing the environment. Such impact is not typical of other industries, their activities are 'restricted' mainly to the discharge of polluting substances and to the heat pollution. This should be also taken into account when evaluating the possibility to implement decoupling effect in this industry.

The analysis carried out in the article shows that it is at least premature to speak about the presence of decoupling in the coal industry, which is the key industry in the Kemerovo Oblast. 2005–2011 witnessed a positive correlation rather than divergence between the indicators of coal mining volumes increase and the negative impact on the environment. The increase in coal extraction leads directly to the increase of water and air pollution in the region.

Certain prerequisites for the emergence of decoupling effect exist only with regard to the divergence between the dynamics of coal extraction volumes and the rates of increase of disturbed land area. We can assume as a hypothesis that a certain tendency toward the

Figure 2. Specific emissions of pollutants in the air per ton of coal produced in the Kemerovo Oblast, kg

divergence between the growth rates of coal production and the intensity of air pollution could be observed in 2010 – 2011, but this period is too short for making grounded conclusions. In general, there was no decoupling effect in the Kemerovo Oblast coal industry in 2005– 2011. Therefore, under the circumstances, the increase of air and water pollution intensity in the region that is already suffering from environmental problems is the price, which has to be paid for the increase in the coal mining volumes.

The experience of other Russia's regions, for instance, the Republic of Karelia, proves that negative environmental impact caused by industrial growth can be actually reduced through ecological modernization and investments in environmental conservation [4]. That's why the implementation of decoupling effect in practice will be connected with the promotion of environmental investments based on a set of administrative and economic methods of the government.

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