The Influence of Ecological Competition Limitation in Russian economy

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The global processes have a strong influence on Russian economy. The rapid Russian economic growth in 1999-2008 mainly depended on favorable external factors: the substantial increase of average annual export oil prices and favorable real exchange rate.

The last events of modern world economic crisis made more evident understanding of scantiness and frailty of the existing economic model. The ignoring of social and ecological aspects of development, stereotypes of maximum of consumption standards, the building up of traditional economic indices and other factors have led to crisis phenomena, which have a global character and negative consequences. The modern type of economic development we can call as technological. It has such distinctive features: exhaustion and extra-exploitation of natural resources, enormous pollution and waste products, economic damage because of environmental degradation. Thus, the analysis and forecast of economic development have to be conducted taking into account ecological aspects.

The ecological problems have large actuality for Russia. Russia is one of the most pollutive countries in the world. Its contribution to the total world emission of major hazardous substances (solid substances, sulphurous oxide, nitrous oxide and carbonic gas) accounts for 13%.

There is a strong relation of environmental pollution and GDP (Fig.1). That shows: there is no improvement of production and environmental protection technologies from point of view their influence on quality of ecology.

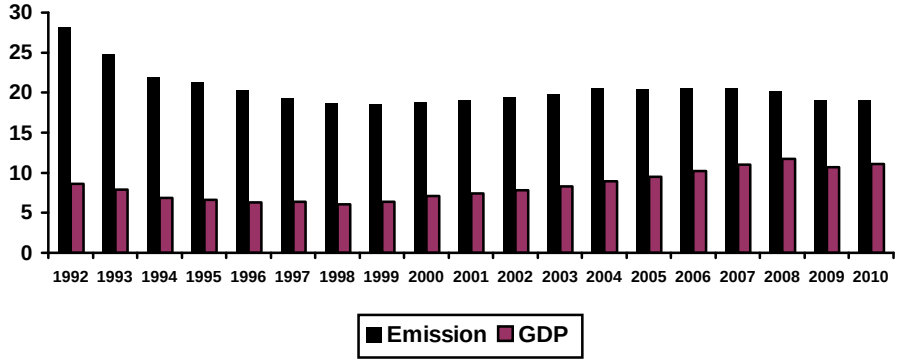

Fig. 1. Stationary emission (mln. tons) and GDP (bln. Rbl, before 1998 - trln. Rbl, prices of 2000).

In spite of some decrease in yearly pollution in crisis periods nature does not have time to neutralize pollution accumulated before and as a result there is increase of their general level.

Maximum concentration level of harmful substances is 5-10 times higher and more in the atmosphere of 210 Russian cities. According to the Russian State Committee on Statistics, only 15% of urban population lives on the territories where air pollution does not exceed hygienic regulations. 1/5 of urban population lives in ecologically harmful conditions; the cities where health control of environment is organized are spoken about here. A very hard situation with water supply of population emerges as a result of river and underground water pollution: clean water requirement in Russia covers only 50%. Considerable sources of contamination of the air is motor transport (Fig.2).

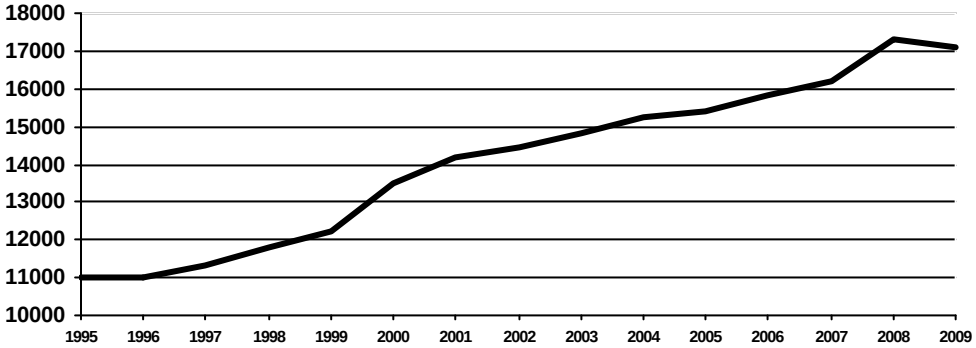

Fig.2. Motor transport emission of polluting substances into atmosphere (thousand tons)

In our opinion ecological factor is the main one among other risk factors (economic, cultural and so on) that have had a negative influence on health of the Russians during recent years. Children health rates have the most sensitive response to changes of environmental quality. Numerous data prove that a high children's sickness rate is registered in ecologically unfavorable areas, infant and children's mortality rate are higher (25% higher in comparison with safe areas). The level of unusual diseases, atypical clinical course of well-known diseases among children and "rejuvenation" of some diseases (ulcer diseases, pancreatic diabetes, essential hypertension, coronary heart disease, myocardial infarction and even cerebral stroke among children) also define ecological pathology.

The period of transition from command economy to market economy is characterized by serious enough health aggravation of the Russian citizens. The number of yearly registered people who fell ill with cancer for the first time increased by 90% during 1990 - 2009, the number of those who fell ill with diseases of the digestive apparatus increased by 22% and the number of those who fell ill with diseases of the circulatory system increased nearly as much as twice. The Figure 3 illustrates the common morbidity.

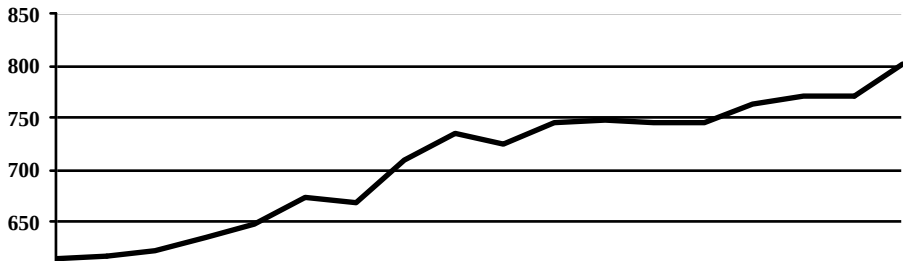

Fig.3. Morbidity in Russia (registered patients with the first diagnosed disease for every thousand people)

So, we can see, that Russian economy has very serious ecological problems. The increasing environmental loading allows to consider it as a competition limitation for branch development, which has to influence an economic structure for the benefit of more ecological industries. An ecological competitive limitation is formed by several factors (for example, enterprises of pollutive industries have to use ineffective equipment and sick workers in unfavorable ecological situation and pay pollution taxes). So, industries with large environmental pressure have to have more difficult conditions for development. If ecological competitive limitations are "strict" we may expect some changes in the sectoral structure towards more ecofriendly production. If such restrictions are insignificant no change is to be expected. The seriousness of Russian environmental problems makes it possible to set a task of estimating a degree of severity of ecological competitive limitations. Such approach allows us to make indirect conclusions concerning efficiency or non-efficiency of ecological governmental policy in Russia.

For analysis of Russian environment impact on economic structure we have estimated the pollution (direct and full) coefficients of main branches of Russian Economy.

Direct pollution coefficient of branch i (dp_i) shows an amount of pollution produced per unit of branch i total output. Let's take n as amount of branches, V^p_i as total annual pollution of branch i, and x_i as total annual output of branch i, then a direct pollution coefficient of branch i is calculated as follows:

$$dp_i = V^p_i / x_i \ , \ i = 1,\ldots, n.$$

The estimation of full pollutant coefficients based on full-costs I-O approach. Full pollutant coefficient of branch j (fp_j) shows an amount of pollution produced per unit of branch j final output. Calculation of full pollution coefficient of branch i is defined by the following equation:

$$fp_j = \sum_{(i=1,..n)} dp_i \cdot b_{ij},$$

where b_{ij} – specific coefficient of full costs I-O matrix (inverse matrix to the difference between unit matrix and input-output matrix).

In order to estimate pressure on Russian environment we use the following indicators: amount of waste water discharge (cubic meters) and amount of emission polluting the atmosphere (kg). Results of the calculation are presented in the Table 1.

Table 1

Pollution coefficients of main branches of Russian Economy in year 2003, price of 2003.

№	The industries	Waste water discharge coefficients, cubic m per 1 thou Rbl of output		Atmospheric pollutant emissions coefficient, kilo per 1 thou Rbl of output		Average annual growth rates of output in 2003-2007, %
		direct	full	direct	Full	
1	Power engineering	0,837	1,332	3,597	4,942	1,5
2	Fuel industry	0,127	0,579	1,302	2,413	3,3
3	Ferrous metallurgy	0,689	1,434	2,414	4,668	4,7
4	Non- ferrous metallurgy	0,453	1,140	3,562	6,514	4,4
5	Chemical and petrochemical industry	1,636	2,855	0,525	2,343	7,4
6	Machine-building and metal-working industry	0,244	1,118	0,214	2,107	8,7
7	Logging, wood-working, pulp and paper industry	2,518	3,868	0,556	1,853	5,1
8	Building materials industry	0,312	0,958	0,990	2,633	9,0
9	Light industry	0,277	1,114	0,195	1,258	1,6
10	Food industry	0,037	0,852	0,107	0,855	5,4
11	Other industries	0,603	1,650	0,356	2,377	6,8
12	Construction	0,008	0,553	0,185	1,314	14,2
13	Agriculture	0,988	1,553	0,095	0,644	3,0
14	Transport and communication services	0,104	0,538	1,452	2,279	2,9
15	Trade	0,001	0,260	0,019	0,475	13,9
16	Other branches of material production	0,014	0,535	0,082	0,704	7,2
17	Non-material service	2,754	3,361	0,262	0,935	7,3
	Average in Russia Economy	0,813	1,32	0,850	1,379	

Date of State Statistic Committee of the Russian Federation: Input-Output Tables of 2003/ Moscow, 2006.
Statistical Handbook "Russia. 2009 / State Statistic Committee of RF, Moscow, 2009.

Analysis of the direct and full pollution coefficients shows that full pollution level is very various in the branches. The largest full waste water discharge coefficient is in Logging, wood-working, pulp and paper industry (3,9 cubic meters per 1000 rubles of final output), the lowest – in Trade (0,26 cubic meters per 1000 rubles of final output).

The largest full atmospheric pollutant emissions coefficient is in Non-ferrous metallurgy (6,5 kg per 1000 rubles of final output), the lowest – in Trade (0,475 kg per 1000 rubles of final output).

Account of indirect costs for a number of branches of Russian Economy significantly increases the assessment of their negative impact on the environment. For example, Trade direct coefficient of discharges of polluted wastewater is only 0,001 cubic meters per 1000 rubles of total output, while the full coefficient is more 246 times (0.26 cubic meters per 1000 rubles of final output).

To verify the hardness of environmental restrictions in the Russian economy we estimate linear coefficients of pair correlation between the average annual growth rates of total output in 2003-2007 and the pollutant coefficients in 2003 (Table 2). All correlation coefficients are

negative, but the statistical significance of Student's criterion at a significance level of 5% is not taken.

Table 2

Linear coefficients of pair correlation between the average annual growth rates of gross output in 2003-2007 and the pollutant coefficients in 2003

	Correlation	Significant level
Direct waste water discharge coefficient, cubic m per 1 thou Rbl of total output	-0,147	0,573
Full waste water discharge coefficient, cubic m per 1 thou Rbl of final output	-0,159	0,542
Direct atmospheric pollutant emissions coefficient, kg per 1 thou Rbl of total output	-0,457	0,065
Full atmospheric pollutant emissions coefficient, kg per 1 thou Rbl of final output	-0,363	0,152

Negative correlation coefficients signify that industries which significantly influence the environment have on average lower growth rates. So, our results allow us to speak about possible influence of ecological competitive limitations on development of sectors of Russian economy. However, this possible influence is not significant. This may be caused first of all by very soft Russian environmental legislation, in particular in the part of water resources protection.

To investigate correlation between industrial environmental pressure and industrial development we forecasted industrial pollution structure transformation in 2010-2012. If Russian economy meets toughening of ecological limitations it will be reasonably to expect a decrease of shares of most polluting industries in the industrial structure.

All mentioned above processes show us that it is very important to take into account ecological aspects under analyzing and forecasting of Russian economic development. The purposes of our investigations is to explore the moving forces and trends of social development, development dynamics of the branches of national economy, economic structural exchanges and conditions of competitiveness in the industries taking into consideration not only production characteristics, but estimates of industry pollution loading. For these purposes we use CAIIN[1] – a System of Dynamic I-O Models of Russia, which has been created in the Intersectoral Research Department of the Institute of Economy and Industrial Organization (IEIE SB RAS) in Novosibirsk. Figure 4 presents a brief scheme of one of the variants of the CAIIN system functioning with the environmental protection block (EP block).

In addition to the *n* traditional sectors of the economy, *l* elements, which represent natural resources, are allocated, and one-to-one correspondence is expected between each of these elements and the areas of environmental protection (air protection, water conservation, etc.). At this stage, two natural resource are studied — atmospheric air and water. For water and air protection environmental activities, the reproduction processes of the main environmental funds and the formation of environmental costs are modeled into the DIOM (Dynamic Input-Output

[1] CAIIN - System of Comprehensive Analysis of Intersectoral Information

Model). The EP block describes the tangible indicators of ecological processes. Depending on the volume of manufactured goods in the traditional sectors of the economy (*Xj*), the volume of pollutants directly generated during the production process is determined. Thus, this model apparatus allows to forecast the level of pollution formation in the sphere of production depending on the economical development of Russia using coefficients of atmosphere polluting substances formation per unit of gross production output. With using estimates of the expenditures on the reduction of water and air pollution the model complex allows to determine volumes of pollution trapping. The difference between formation and pollution trapping gives us the volumes of emissions.

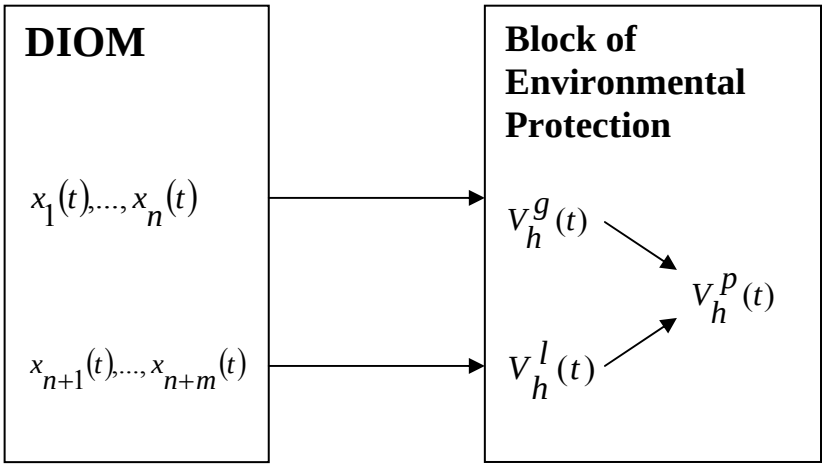

Fig.4. A brief outline of the CAIIN system with an EP block.

This is a description of the EP block:

$x(t) = (x_1(t),...,x_n(t),x_{n+1}(t),...,x_{n+m}(t))$ – a vector of gross outputs, where

$x_i(t), i = 1,...,n$ - gross output of industry i in year t, $x_{n+h}(t)$, h=1,…,m - current environmental protection cost for natural resource h;

$V_h^g(t) = \sum_{i=1}^{n} w_{ih}(t)x_i(t) + D_h(t)$ - volume of pollutants directly generated during the production process,

where w_{ih} – coefficient of pollutant h generation (volume of polluted natural resource h, referred to manufacturing of a unit of production of industry i); $D_h(t)$ - output of pollutant h (volume of pollution or destruction of a natural resource) in household;

$$x_{n+h}(t) = \sum_{i=1}^{n} v_{ih}(t) V_{ih}^{l}(t) \qquad V_h^l(t) = \sum_{i=1}^{n} V_{ih}^{l}(t),$$

where $v_{ih}(t)$ – current cost to recover unit of natural resource h (to destroy or to trap unit of pollutant h) in industry i; $V_h^l(t)$ - volume of a recovered natural resource (liquidated or trapped pollutant) of type h;

$V_h^p(t) = V_h^g(t) - V_h^l(t)$ - volume of pollutant h (a polluted natural resource) that gets into the natural environment without purification (or by volume of destroyed but not reproduced natural resource).

A more detailed description of the economic and ecological units of the model complex and the method of forming initial information is given in [1]. Tables 3 and 4 represent indexes of two scenarios of Russian development in 2009-2012, which were worked out for forecast calculations: basic and optimistic.

Table 3

Dynamics of branch outputs of Russian economy in 2009-2012 according to the basic scenario (%, 2008 year = 100%)

	2009	**2010**	**2011**	**2012**
GDP	93,3	95,2	100,3	108,7
Extractive industry	91,2	92,9	95,7	98,8
Manufacturing industry including Machine-building industry	80,6 85,2	82,2 88,1	85,3 101,4	91,0 120,1
Power engineering	94,2	90,1	91,5	94,9
Agriculture	101,5	104,2	103,8	105,9
Construction	83,1	82,1	88,2	99,9
Transport	84,7	87,3	88,1	91,5
Trade	99,9	102,9	111,9	126,9
Other branches of material production	98,6	85,5	87,9	93,6
Non-material service	91,2	89,2	94,6	103,6

The both scenarios of the forecast proceed from the assumption that there will be no explosive industrial recovery after world economic crisis. But optimistic scenario assumes more rapid and early recovery[2].

Table 4

[2] These forecast scenarios have created in the Intersectoral Research Department of IEIE SB RAS with participation of professors A. Baranov and V. Pavlov.

Dynamics of branch outputs of Russian economy in 2009-2012 according to the second scenario (%, 2008 year = 100%)

	2009	**2010**	**2011**	**2012**
GDP	95,3	99,4	107,5	116,6
Extractive industry	95,6	97,0	99,2	102,0
Manufacturing industry including Machine-building industry	92,4 85,7	93,8 93,6	99,6 112,7	105,5 134,0
Power engineering	96,0	97,2	99,2	99,7
Agriculture	101,5	102,6	106,8	110,8
Construction	82,7	85,6	96,2	108,7
Transport	87,5	88,1	91,5	95,1
Trade	94,6	102,4	116,7	135,4
Other branches of material production	88,4	89,9	95,2	101,0
Non-material service	101,5	109,0	120,5	132,8

The results of forecasting estimates of gross output volumes in the branches make it possible to assess the amount of emission of polluting substances into the atmosphere and the amounts of discharge of polluted waste waters into water reservoirs (see Figs. 5 and 6). The ecological block estimates were based on the hypothesis that unit rates of pollution as well as indices of sewage treatment and recovery of main pollutants of the atmosphere will stay at the level of 2008.

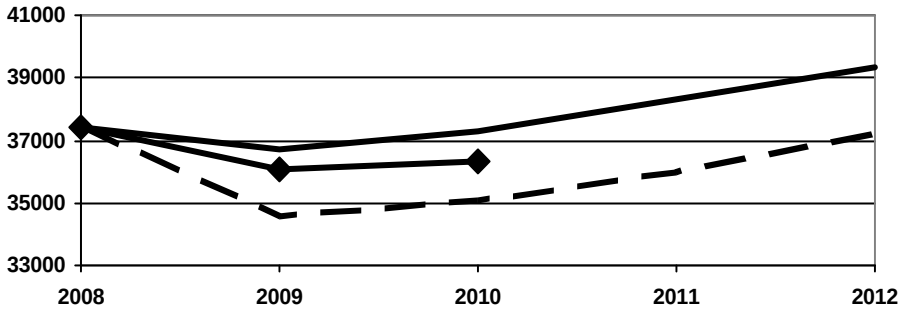

Fig. 5. Amount of emission polluting the atmosphere (thousand tons) according to results of forecasting estimates

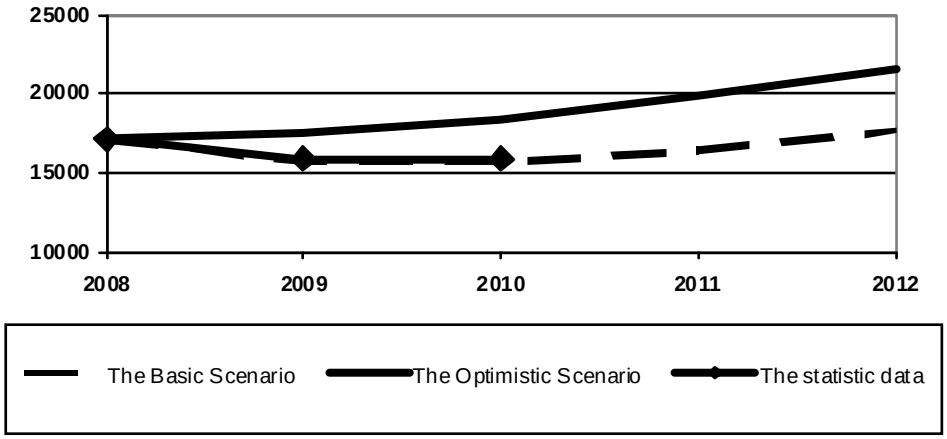

Fig. 6. Amount of waste water discharge (mln. cubic meters) according to results of forecasting estimates

We can see that the second scenario (it is more optimistic from economic development point) is more pessimistic from ecological point because of the most environmental pressure. According to the basic scenario amount of waste water discharge will increase by 3,4% and stationary sources emission doesn't increase in 2008-2012. According to the optimistic scenario amount of waste water discharge will increase by 26% and emission by 5,2% in the same period. The transformation of pollution industry structure because of economic structure changes according the optimistic scenario (there is the same dynamic according the basic scenario) is performed in Table 5.

Table 5.

The transformation of pollution industry structure
in 2008-2012 in Russia according the optimistic scenario, %

The industries	The atmospheric emission	The dumping of the polluted sewage
Power engineering	+0.2	-0.8
Fuel industry	+0.5	-0.4
Ferrous metallurgy	-0.8	-1.0
Non- ferrous metallurgy	-0.6	-0.7
Chemical and petrochemical industry	-0.2	-1.1
Machine-building and metal-working industry	+0.1	+0.1
Logging, wood-working, pulp and paper industry	0	-1.1
Building materials industry	-0.1	-0.3
Light industry	0	-0.1
Food industry	+0.1	0
Other industries	0	-0.3
Construction	+0.1	0
Agriculture	+0.1	-0.5
Transport and communication services	-0.4	-0.1
Other branches of material production	+0.1	0
Non-material service	+0.9	+6.3
Russian Economy	0	0

The analysis of results demonstrates that a share of industries having high direct and full pollution coefficient would be statistically slightly dropping in the total amount of emissions (ratios of linear pair correlation of direct and full emissions of industries with changing shares in the total pollution amount are -0,45 and -0,57 respectively). In the case of discharge of polluted water such correlation is not observed. One of the possible explanations is that Russia has an inefficient system of monitoring volumes of discharged polluted water.

Thus, the results of forecast calculations don't permit to make conclusions about substantial influence of ecological competitive limitations on the sectoral structure of national economy. So ecological limitation is very soft in Russia because of imperfection of Russian ecological legislation and low level of pollution taxes. The sizes of our pollution taxes don't provide the necessary volumes of investment and current expenditures for the purpose of pollution abatement. In addition, pollution taxes are depreciated quickly because of inflation. For instance, the price index increased in 2007 to the level of 1991 year 19,7 thou times, but index of pollution taxes was only 150,9 times. Thus, the difference is about 131 times. In such conditions Russian enterprises prefer to do emissions than to make pollution abatement.

Therefore results of our investigations illustrate the necessary of toughening of Russian ecological legislation.

Conclusions

Favorable external factors led to rapid economic growth in Russia, but it has appeared to be very unsustainable. Russian economic structure has become more raw-oriented because of a high competitiveness of primary sector.

The health and demographic situation in Russia very strongly depends on environment. Significant deterioration of environment attends high morbidity and mortality in Russia. For example, maximum concentration level of harmful substances is 5-10 times higher and more in the atmosphere of 210 Russian cities. The number of yearly registered patients with the first diagnosed disease for every thousand people has increased by 30% in 1992–2009.

Proposed approach based on direct and full pollution coefficients allows to take into consideration environmental competitive restrictions between branches for analysis of a national economy structural transformation. The results show a possible impact of environment restrictions on development of Russian branches, but this possible impact is very negligible, especially to waste water discharging.

The results of forecasting with using Dynamic Input-Output Model show us the growth of environmental pressure in 2009-2012 in Russia. The most optimistic from economic development point scenario is the most pessimistic from ecological point because of the most environmental pressure. Thus, the results of this study suggest a need for tightening of the Russian environmental legislation.

Reference

1. Baranov A., Pavlov V., Tagaeva T. Analysis and Forecast of the State of Environmental Protection in Russia // Environmental and Resource Economics. N 9: p.21-42, 1997. Kluwer Academic Publishers. ISSN 0924-6460.